U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

VEHICLE TECHNOLOGIES PROGRAM

2009 Annual Merit Review

Results Report

October 2009

Prepared by New West Technologies, LLC
for the U.S. Department of Energy Vehicle Technologies Program

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Introduction

The 2009 DOE Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting was held May 18-22, 2009 in Arlington, Virginia. The review encompassed all of the work done by the Hydrogen Program and the Vehicle Technologies Program: a total of 304 individual activities were reviewed for Vehicle Technologies, by a total of 142 reviewers. A total of 1,286 individual review responses were received for the technical reviews.

The objective of the meeting was to review the FY 2008 accomplishments and FY 2009 plans for the Vehicle Technologies Program, and provide an opportunity for industry, government, and academic to give inputs to DOE on the Program with a structured and formal methodology. The meeting also provided attendees with a forum for interaction and technology information transfer.

The reviewers for the technical sessions were drawn from a wide variety of backgrounds, including current and former vehicle industry members, academia, government, and other expertise areas. In the technical sessions, these reviewers were asked to respond to a series of specific questions regarding the breadth, depth, and appropriateness of the DOE Vehicle Technologies Program. The technical questions are listed below, along with the scoring metrics (if appropriate): these questions were used for all Vehicle Technologies Program reviews with the exception of the Education and Technology Integration work that had been transferred from the Hydrogen Program during FY 2009.

Question 1: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Question 2: Approach to performing the work: the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts. Scoring: 4=outstanding (sharply focused on technical barriers; difficult to improve approach significantly); 3=good (generally effective but could be improved; contributes to overcoming some barriers); 2=fair (has significant weaknesses; may have some impact on overcoming barriers); 1=poor (not responsive to project objectives; unlikely to contribute to overcoming the barriers). (Scoring weight for overall average: 20%)

Question 3: Technical accomplishments and progress toward overall project and DOE goals: the degree to which progress has been made, measured against performance indicators and demonstrated progress toward DOE goals. Scoring: 4=outstanding (excellent progress toward objectives, suggests that barriers will be overcome); 3=good (significant progress toward objectives and overcoming one or more barriers); 2=fair (modest progress in overcoming barriers, rate of progress has been slow); 1=poor (little or no demonstrated progress toward objectives or any barriers). (Scoring weight for overall average: 40%)

Question 4: Collaboration and coordination with other institutions. Scoring: 4=outstanding (close, appropriate collaboration with other institutions, partners are full participants and well coordinated); 3=good (some collaboration exists, partners are fairly well coordinated); 2=fair (a little collaboration exists, coordination between partners could be improved); 1=poor (most work is done at the sponsoring organization with little outside collaboration, little or no apparent coordination between partners). (Scoring weight for overall average: 10%)

Question 5: Proposed future research: the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways. Scoring: 4=outstanding (plans clearly build on past progress and are sharply focused on barriers); 3=good (plans build on past progress and generally address overcoming barriers); 2=fair (plans may lead to improvements, but need better focus on overcoming barriers); 1=poor (plans have little relevance toward eliminating barriers or advancing the program).

Question 6: Resources: how sufficient are the resources for the project to achieve the stated milestones in a timely fashion? Responses: excessive, sufficient, insufficient.

The Education and Technology Integration work used the following questions, which were generally similar to the ones used for the other projects in this Merit Review.

Question 1: Relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the relevant section of the Multi-Year RD&D plan. Scoring: 4 - Outstanding. Project is critical to the DOE Program RD&D objectives and fully addresses the key technical targets; 3 - Good. Project strongly supports the DOE Program RD&D objectives and addresses key technical targets; 2 - Fair. Project only partially supports the DOE Program RD&D objectives or the key technical targets; and 1 - Poor. Project provides little support to the Program RD&D objectives or the key technical targets. (Scoring weight for overall average: 20%)

Question 2: Approach to performing the work – the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts. Scoring: 4 - Outstanding. Sharply focused on technical barriers; difficult to improve approach significantly; 3 - Good. Generally effective but could be improved; contributes to overcoming some barriers; 2 - Fair. Has significant weaknesses; may have some impact on overcoming barriers; and 1 - Poor. Not responsive to project objectives; unlikely to contribute to overcoming the barriers. (Scoring weight for overall average: 20%)

Question 3: Technical Accomplishments and Progress toward overall project and DOE Technology Validation goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals. Scoring: 4 - Outstanding. Excellent progress toward objectives; suggests that barrier(s) will be overcome; 3 - Good. Significant progress toward objectives and overcoming one or more barriers; 2 - Fair. Modest progress in overcoming barriers; rate of progress has been slow; and 1 - Poor. Little or no demonstrated progress towards objectives or any barriers. (Scoring weight for overall average: 40%)

Question 4: Collaborations with other institutions - the degree to which the project interacts with industry partners, universities and laboratories. Scoring: 4 - Outstanding. Close, appropriate collaboration with other institutions; partners are full participants; 3 - Good. Some collaboration exists; full/needed coordination could be accomplished easily; 2 - Fair. A little collaboration exists; full/needed coordination would take additional significant; and 1 - Poor. Most work is done at the sponsoring organization with little outside interaction. (Scoring weight for overall average: 10%)

Question 5: Proposed Future Activities – the degree to which the project has effectively planned its future work in a logical manner. Scoring: 4 - Outstanding. Plans clearly build on past progress and are sharply focused on barriers; 3 - Good. Plans build on past progress and generally address overcoming barriers; 2 - Fair. Plans may lead to improvements, but need better focus on overcoming barriers; and 1 - Poor. Plans have little relevance toward eliminating barriers or advancing the program. (Scoring weight for overall average: 10%)

Question 6: Project Strengths

Question 7: Project Weaknesses

Question 8: Recommendations for Additions/Deletions to Project Scope

Responses to the questions were submitted electronically through a web-based software application, PeerNet, operated by the Oak Ridge Institute for Science and Education (ORISE). Database outputs from this software application were then analyzed and summarized to collate the multiple-choice, text comment, and numeric scoring responses to produce the summary report.

The report is organized into individual sections for each technical area. Responses to the questions are summarized in the pages that follow, with summaries of numeric scores for each technical session, as well as text and graphical summaries of the responses for each individual technical activity. A list of the activities (and page numbers) for each section appears at the start of each section.

1. Hybrid and Vehicle Systems Technologies

Introduction

Hybrid and vehicle systems research provides an overarching vehicle systems perspective to the technology research and development (R&D) activities of the U.S. Department of Energy's (DOE's) vehicle research programs, and identifies major opportunities for improving vehicle efficiencies. The effort evaluates and validates the integration of technologies, provides component and vehicle benchmarking, develops and validates heavy hybrid propulsion technologies, and develops technologies to reduce the parasitic losses from heavy vehicle systems. Analytic and empirical tools are used to model and simulate potential vehicle systems, validate component performance in a systems context, benchmark emerging technology, and validate computer models. Extensive collaboration with the technology development activities is required for success. The results of hybrid and vehicle systems activities are used to estimate the national benefits and impacts of DOE-sponsored technology development, and successfully transfer developed technology to industry.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Advanced Vehicle Testing Activity (AVTA) - Vehicle Testing and Demonstration Activities	James Francfort (Idaho National Laboratory)	1-6	3.22	3.22	3.67	3.22	3.28
Plug-in Hybrid (PHEV) Vehicle Technology Advancement and Demonstration Activity	Rosalind Sell (General Motors) and Greg Frenette (Ford)	1-8	2.43	2.86	3.00	2.57	2.73
Advanced Vehicle Benchmarking of HEVs and PHEVs	Barney Carlson (Argonne National Laboratory)	1-11	3.30	3.60	3.00	3.00	3.38
Off-Cycle Benchmarking of PHEVs; Wide Range of Temperatures and Aggressive Driving Cycles	Barney Carlson (Argonne National Laboratory)	1-13	3.20	3.00	3.10	3.00	3.06
Argonne Facilitation of PHEV Standard Testing Procedure (SAE J1711)	Michael Duoba (Argonne National Laboratory)	1-15	3.90	3.00	3.70	3.30	3.35
PHEV Engine and Aftertreatment Model Development	Stuart Daw (Oak Ridge National Laboratory)	1-17	3.00	3.00	3.14	2.71	2.98
Heavy Duty & Medium Duty Drive Cycle Data Collection for Modeling Expansion	Gary Capps (Oak Ridge National Laboratory)	1-19	3.13	3.25	3.38	3.00	3.20
Light Duty Plug-in Hybrid Vehicle Systems Analysis	Tony Markel (National Renewable Energy Laboratory)	1-21	3.43	3.57	3.00	3.29	3.43
Government Performance Result Act (GPRA) / Portfolio Decision Support (PDS)	Sylvain Pagerit (Argonne National Laboratory)	1-23	2.63	2.75	2.75	2.63	2.70

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
PHEVs Component Requirements and Efficiencies	Aymeric Rousseau (Argonne National Laboratory)	1-25	3.50	3.25	2.63	2.75	3.17
Autonomie Plug&Play Software Architecture	Aymeric Rousseau (Argonne National Laboratory)	1-27	2.89	3.22	2.67	2.75	3.01
Overview of Friction and Wear Reduction for Heavy Vehicles	George Fenske (Argonne National Laboratory)	1-29	3.67	3.67	3.67	3.67	3.67
Overview of Thermal Management	Jules Routbort (Argonne National Laboratory)	1-31	3.14	2.43	3.17	2.40	2.70
DOE's Effort to Reduce Truck Aerodynamic Drag through Joint Experiments and Computations	Kambiz Salari (Lawrence Livermore National Laboratory)	1-33	3.40	3.00	3.00	2.40	3.03
Active Combination of Ultracapacitors and Batteries for PHEV ESS	Ted Bohn (Argonne National Laboratory)	1-35	3.00	2.63	3.13	3.00	2.83
Battery Systems Performance Studies - HIL Components Testing	Neeraj Shidore (Argonne National Laboratory)	1-37	3.00	2.88	2.63	2.75	2.86
Parasitic Energy Losses	George Fenske (Argonne National Laboratory)	1-39	3.00	2.86	3.14	2.86	2.93
Integrated Vehicle Thermal Management Systems (VTMS) Analysis/Modeling	*Matthew Thornton (National Renewable Energy Laboratory)*	*1-41*	*2.00*	*2.00*	*2.00*	*2.00*	*2.00*
Renewable Fuel Vehicle Modeling and Analysis	*Aaron Brooker (National Renewable Energy Laboratory)*	*1-43*	*3.00*	*2.00*	*1.00*	*2.00*	*2.13*
Low-Friction Hard Coatings	*Ali Erdemir (Argonne National Laboratory)*	*1-44*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Route-Based Controls Potential for Efficiency Gains	*Jeffrey Gonder (National Renewable Energy Laboratory)*	*1-46*	*3.00*	*3.00*	*3.00*	*2.00*	*2.88*
PHEV Development Test Platform Utilization	*Henning Lohse-Busch (Argonne National Laboratory)*	*1-47*	*4.00*	*4.00*	*4.00*	*3.00*	*3.88*
GPS Travel Survey Data Collection and Analysis	*Tony Markel (National Renewable Energy Laboratory)*	*1-48*	*3.00*	*4.00*	*3.00*	*3.00*	*3.50*
CoolCab Truck Thermal Load Reduction	*Ken Proc (National Renewable Energy Laboratory)*	*1-49*	*2.50*	*2.50*	*3.00*	*2.00*	*2.50*
Erosion of Radiator Materials by Nanofluids	*Dileep Singh (Argonne National Laboratory)*	*1-50*	*4.00*		*2.00*		*1.25*
Enabling High Efficiency Ethanol Engines	*Robert Wagner (Oak Ridge National Laboratory)*	*1-51*	*3.33*	*3.00*	*3.00*	*2.67*	*3.04*
Heavy-Duty Vehicle Field Evaluations	*Kevin Walcowicz (National Renewable Energy Laboratory)*	*1-53*	*3.00*	*3.00*	*4.00*	*3.00*	*3.13*
Efficient Cooling in Engines with Nucleated Boiling	*Wenhua Yu (Argonne National Laboratory)*	*1-54*	*2.50*	*2.00*	*2.50*	*2.00*	*2.19*
Heavy Duty Vehicle Modeling & Simulation	*Aymeric Rousseau (Argonne National Laboratory)*	*1-56*	*3.00*	*4.00*	*4.00*	*3.00*	*3.63*
Fuel Efficiency Potential of Hydrogen Vehicles	*Thomas Wallner (Argonne National Laboratory)*	*1-57*	*3.00*	*3.00*	*2.00*	*3.00*	*2.88*
PHEV Control Strategy	*Aymeric Rousseau (Argonne National Laboratory)*	*1-58*	*3.00*	*3.00*	*2.50*	*3.00*	*2.94*
D3 Website Database	*Glenn Keller (Argonne National Laboratory)*	*1-59*	*3.00*	*3.00*	*2.00*	*3.00*	*2.88*

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Heavy Truck Friction & Wear Reduction Technologies	*Michael Killian (Eaton Corporation)*	*1-60*	*--*	*--*	*--*	*--*	*--*
Nanofluid Development for Engine Cooling Systems	*Elena Timofeeva (Argonne National Laboratory)*	*1-61*	*3.50*	*3.50*	*2.50*	*3.50*	*3.38*
Nanofluids for Thermal Conditions Underhood Heat Transfer	*Wenhua Yu (Argonne National Laboratory)*	*1-62*	*3.00*	*2.00*	*2.00*	*2.50*	*2.31*
OVERALL AVERAGE FOR VEHICLE SYSTEMS			**3.13**	**3.03**	**3.02**	**2.85**	**3.03**

NOTE: Italics denote poster presentations.

Overview of Hybrid and Vehicle Systems Technologies: Lee Slezak (U.S. Department of Energy)

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated the sub-program was adequately covered. There continue to be challenges identified with inadequate budgets on certain projects. Another reviewer commented the subprogram area of VSS was very well described, but the challenges, issues, and progress since last year were not well described. One reviewer mentioned the presentation was maybe a bit on the short side but generally okay. Comparison with prior years was fairly limited while the issues and approach were well covered. Comments from another reviewer noted it was good but a brief overview. The link between modeling and simulation, and testing was given. No information was given relative to the previous year other than budget. Two reviewers answered yes with one adding; overall this is excellent and very informative.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated they personally would like to see a more comprehensive strategy that shows the linking of all the programs in the Vehicle Technologies Program, including how they tie into other parts of DOE projects. This would be along the line of a Technology Roadmap, which would show progress on projects as well as future expectations of project milestones for the upcoming years. This should also make it easier to budget for upcoming years. Another reviewer noted the planning seems well thought out, especially for PHEV-related studies. The focus is necessarily short term because of economic conditions, but will hopefully return to longer range after the current crisis is over. More studies are needed in the field of fuel conversion devices such as diesel engine generators, micro turbines, free-piston engines, and so forth to support the development of series PHEVs. Fuel cells have already received more than their fair share of coverage. One reviewer mentioned the plan seems OK, except it was unclear to them why two sharply different vehicle types are addressed - small passenger cars and heavy trucks. There may be a good reason but it would be interesting to know why these were chosen - what about the midrange, such as light trucks and delivery vehicles? Another reviewer stated that the targets and challenges were not sufficiently covered. One reviewer said the plan was not really addressed in the presentation with another reviewer noting there are significant cost gaps with all these technologies for hybridization.

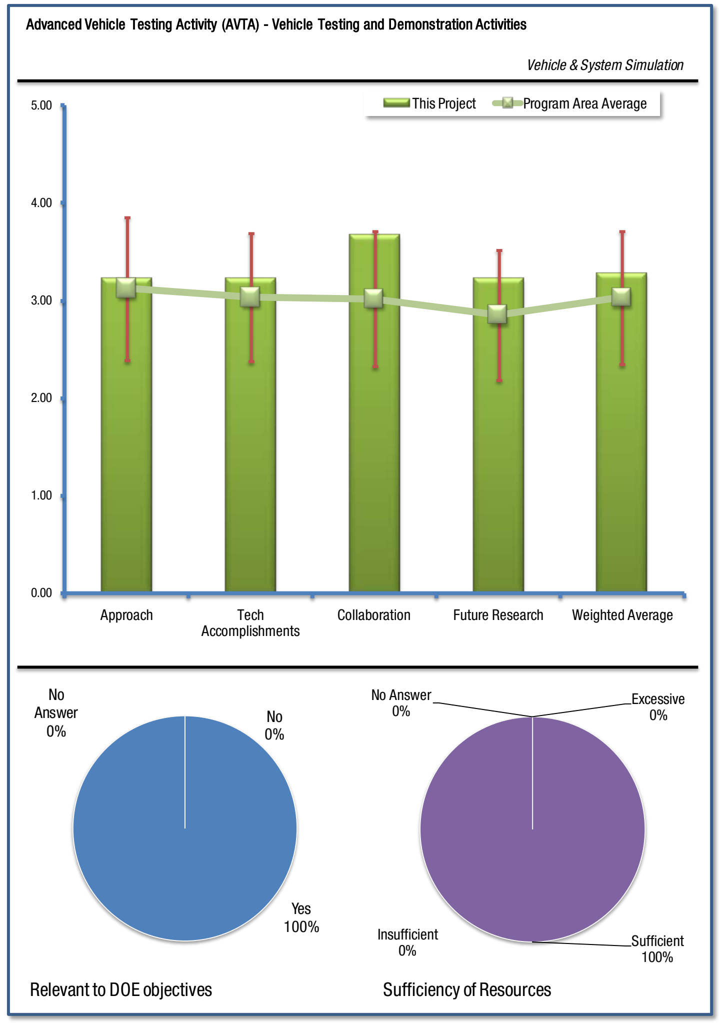
3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

A reviewer stated they believe that the DOE Vehicle Technologies is moving in the correct direction with improved methods in modeling! They truly appreciated the work that ORNL is doing with regards to putting together a rather large industrial fleet. ANL is also touching on interesting financial/business modeling which has merit -- and is showing stretch in thinking. If we continue to look at projects as systems, we are moving in the right direction. Another reviewer notes in general, the program is very well focused and managed considering the very broad range of projects and topics being covered in VSS. Four other reviewers answered yes with one adding it's not quite clear how the many studies are integrated and where they will lead? And will they ever end? What is the final state?

4. Other comments:

A reviewer stated VSS is one of the most important programs at DOE. It is developing tools and techniques for studying system level interactions and synergies. This is where some of the biggest gains and insights are to be found. It is unlikely that component suppliers or OEMs would develop these tools or make them generally available. Another reviewer mentioned from a management standpoint, they would put further measurables on the projects (i.e.: milestone dates, milestones being met, estimated hours of tasks being met, etc) such as what is done in the Engineering Services industry. We also need to be cognizant that fuel economy and emissions are inherently linked. One reviewer commented many of the smaller VSS projects seem to be a bit unconnected from the main goals and focus; try to show how they support the entire program. Comments from another reviewer noted they would prefer data sheets and project lists where the budget dollars listed match the ones in the researchers' presentations. One reviewer stated the research area is of very high relevance with another reviewer commenting well done.

Advanced Vehicle Testing Activity (AVTA) - Vehicle Testing and Demonstration Activities: James Francfort (Idaho National Laboratory)



Reviewer Sample Size

This project had a total of 9 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers felt this work involved comprehensive and advanced testing and demonstration of a suite of DOE test vehicles, including PHEV, HEV, HICEV and EV and NEV models (all of which have high potential to reduce petroleum consumption, and near term potential for introduction). Overall the reviewers felt the project directly supports the DOE objective of petroleum displacement by conducting test track, dynamometer, battery testing, field testing, evaluations of accuracy and efficiency, validations of various performance variables in each demonstrate of vehicles. A reviewer said by supporting the advancement of technologies for various types of electric vehicles, the DOE is supporting new alternatives in fuel technologies and fuel displacement. The work provides benchmarking vehicle and fueling infrastructure data to target setters, technology modelers, R&D programs and DOE management, therefore supporting the overall DOE goal of petroleum displacement.

The vast amount of information collected (including providing insight on how real world customers will use plug in vehicles.) will help purchasers and policy makers understand which vehicles offer the most fuel savings. One reviewer felt that the project was a very visible program that helps with commercialization of these technologies to have a real and early impact.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer feels the approach to the work appears comprehensive and well-designed. They feel the new technologies are well integrated to the work, as they become available. Also, the work is a productive partnership between INL and ETEC (Phoenix), where ETEC is managed by NETL. Furthermore the reviewer feels the mission and geographical data is diverse and strong, similarly other reviewer felt there were clear milestones.

One reviewer points out that the project depends quite a lot on the availability of partner fleets. The variability of driver behavior, climate, charging patterns etc. make it very hard to draw clear conclusions, but they certainly are trying. Another felt it was a very good testing program and data source, but barriers will be addressed by others. At the vehicle testing and data collection/processing level, many issues have been solved.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers feel the AVTA program appears to have made significant progress towards its 2008 milestones, and has leveraged testing relationships to maximize testing value to DOE and taxpayers. Reviewers noted that the many milestones had been achieved producing and distributing high volumes of high quality data, while current problems in technologies were partly identified. Also noted by the reviewer was that the work and data has been provided as a resource to other government groups such as Clean Cities Program and National Science Foundation. Also mentioned is that the detailed milestones within each category of vehicles is extensive. One reviewer raised the question whether the data can be useful in future designs and if there is a point when victory can be claimed and the program closed?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer noted that the collaboration and coordination of this program appears strong with a wealth of coordinated efforts across disciplines, agencies and areas of interest. They also note that the work is a well-coordinated effort between INL and ETEC where ETEC is managed by NETL. Reviewers note that there is good executive collaboration with strong, demonstrated leadership from INL and is well coordinated with state government and industry stakeholders, so much so that one reviewer wondered if too much time is spent just keeping all the stakeholders informed. Another reviewer points out that they should coordinate test work, dynamometer, and end-of-life tear-down data better with other labs.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

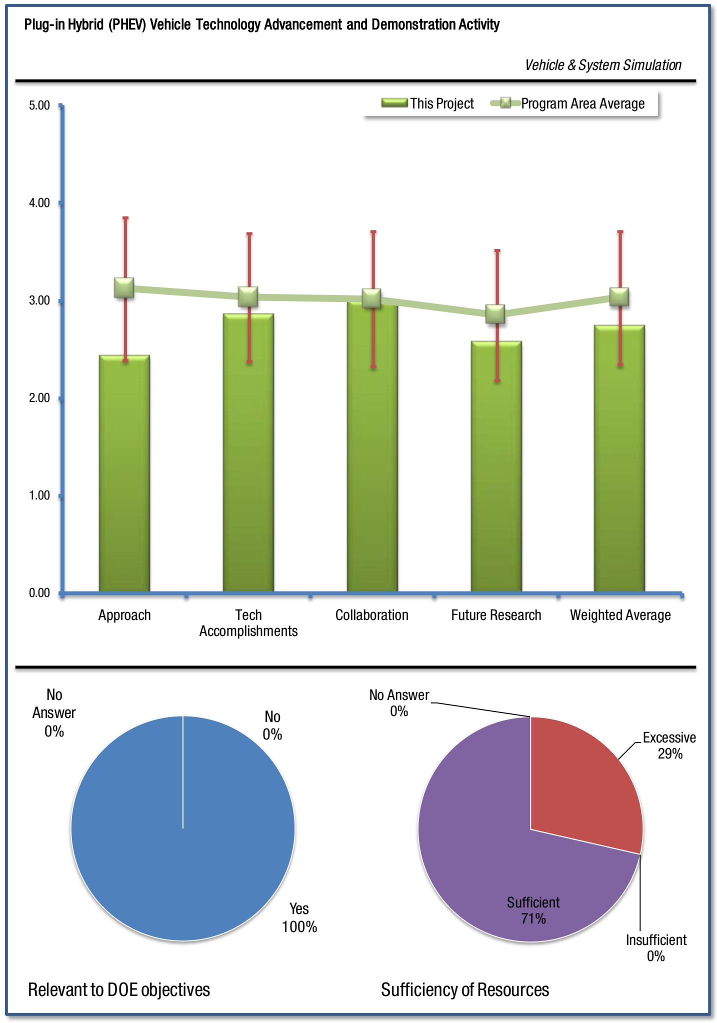
Reviewers conclude that projects plans for future work and testing appear adequate given the budget allocated. The future work planned appears logical and flexible enough to allow for contingency and technical barriers. They note that the mule testing for battery systems seems especially sensible, and allows for some unique testing and even high-risk, high-payoff advancement. A reviewer notes that the work and new milestones seem to have realistic near-term potential for commercialization and will continue to support CARB's requirement that all NEVs be tested by the AVTA.

A few reviewers like that the program is using its lessons learned from prior years to tune its approach and has a good focus at overcoming barriers. One reviewer would have liked to see a way to extract useful design data from the data collection. A reviewer says the project needs to address the issue of fleet versus typical consumer/owner driver behavior and that the current testing and data probably cannot address this issue.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewers all generally feel that the resources are sufficient appear adequate and effective. One reviewer says the team has accomplished a significant amount of work and provided necessary data with a relatively small budget (to the work performed), and has done an excellent job of leveraging coordinated facilities and partners.

Plug-in Hybrid (PHEV) Vehicle Technology Advancement and Demonstration Activity: Rosalind Sell (General Motors) and Greg Frenette (Ford)



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer feels that the work is well aligned with the DOE's overall mission of decreasing the nation's dependence on petroleum by optimizing system component integration, and including advanced ESS. The reviewer notes that while this project is still in its beginning production phase, it has accomplished DOE requested milestones in a relatively short amount of time (only about a half of a year). The reviewer says that when complete, the project will have developed one of the first commercially available plug-in hybrid electric vehicles (PHEV) produced by an automotive manufacturer that will incorporate advanced lithium-ion battery technology and feature high tech E85-capable Flex Fuel engine technology. Overall by evaluating and testing the balance of fuel economy, emissions, vehicle performance and battery life tradeoffs, the project directly supports DOE overarching VSS objectives of displacing petroleum. Some reviewers note that it is critical for the big three to develop practical, affordable PHEVs and it is significant that GM/Ford treating this as a production development program rather than just a research project.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer says that the approach to the project objective appears strong overall. Because some of the technical approach falls into proprietary information, it will be difficult for this reviewer to grant an 'outstanding' performance on approach without access to more technical information on the materials science and engineering novel approach to the work. However, enough information is presented to indicate a strong, comprehensive systems approach to the work. One reviewer makes the point that basing the program on an overweight mule vehicle is a serious weakness in the approach. Many others have taken this path and fallen short of their goals. Why would this project be different?

Many reviewers point out that the report does not indicate what data will be shared with the DOE, such as trip data, CS, CD FE and plug in habits. They also point out that not enough data or sufficient detail (mainly in the GM's information) was presented to evaluate. Another reviewer feels that statistical relevance of so few vehicles from Ford could hamper data analysis. Other potential faults/questions mentioned by reviewers can be found below:

- Will comparisons to the other Vue powertrians such as conventional, mild hybrid, and the base 2-mode HEV be included?

- Will development issues with the main plug-in components be shared? If so, relevance may be rated at medium to high.
- No discussion of cost analysis for vehicle production. In the past, lack of progress by OEMs on hybrid vehicles was excessive cost.
- Cost barriers and mitigation techniques have not been discussed which may very well prove to be the key barrier.
- One reviewer asked whether this project could move "faster," and was given the answer that we are working as fast as we can. The reviewer believes that there are ways to make the project go faster, while still maintaining engineering integrity.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers conclude that according to the public information presented, the work has rapidly made significant progress against the project's performance baselines. The project is only 8% complete but is on schedule. DOE - HQ review in April 2009 indicated excellent progress toward mule prototyping and production is still on track. Again, it would be better for this reviewer to have access to more technical information in ESS to comment on overcoming technical barriers and significant accomplishments, but DOE-HQ indicates that ESS and integration is on track. Another reviewer points out that it is difficult to truly assess progress so far as no specific milestone dates are provided in which to gauge progress against plans.

A reviewer would like DOE to consider how OnStar technology could be used for other DOE projects for communication, mapping driver behavior, etc.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer feels that the collaboration and coordination of the work with other institutions appears good. Another reviewer mentions that collaboration with EPRI seems particularly wise considering the potential impact on utility infrastructure and capacity. Another reviewer feels partners have been defined but collaboration is not highly evident at this point.

One reviewer saw that the one critical technical area that does seem to include a partner is power electronics and machines. Additionally, as PHEVs clearly have a better value proposition in certain applications and geographical locations, the reviewer feels it would be beneficial to consider adding a State entity to prepare the ground for initial niche market entry. Another reviewer would like to have seen more details on how the collaborations are actually going. Are some collaborators behind schedule, other ahead of schedule?

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

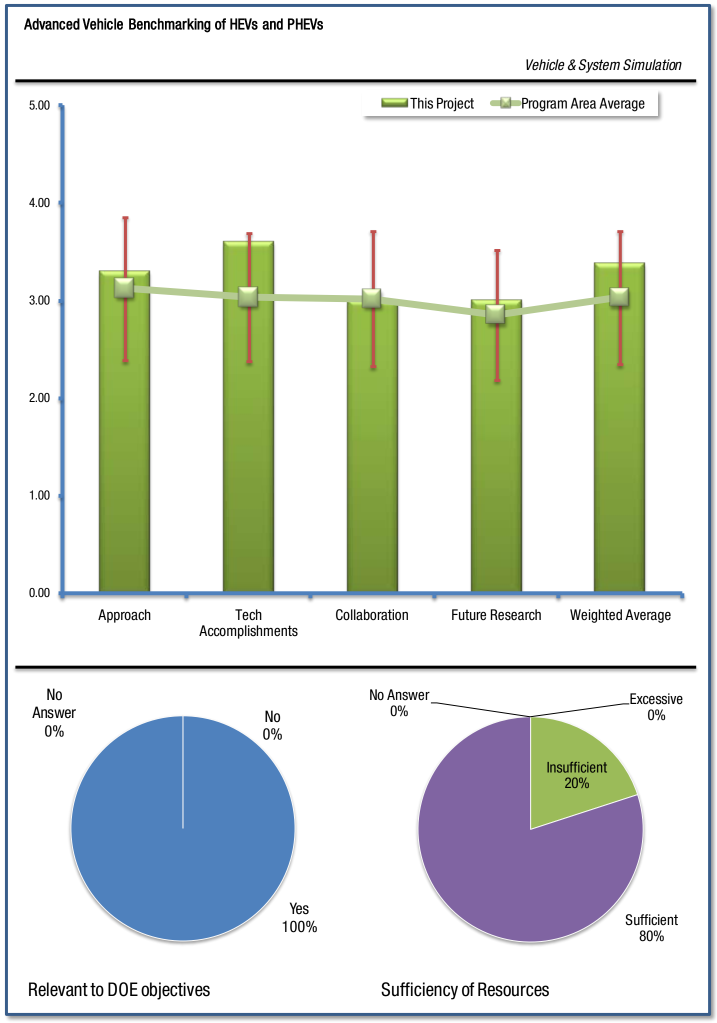
Some reviewers feel the proposed future research plans appear sound. But many reviewers feel the data provided is very generic with insufficient detail to judge the proposed work accurately, but the limited information provided appears sound and logical.

One reviewer points out that there is no mention of production cost analysis or indication of production volume determination. Another reviewer recommends to document process specific to PHEV/EV vehicles and how to utilize on-star as a data collection mechanism on broader terms. Is there possible integration with the smart grid? Furthermore, a reviewer reminds us that there are still many technical challenges ahead.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer specifically mentions that to review the budget fairly more information is needed but at first glance and without much detailed data for analysis, the budget appears accessible and excessive, but one reviewer says it is actually too difficult to ascertain from the presentation given. Another reviewer states that major OEMs should be accomplishing this type of study on their own, not relying on the government funds at this point in time. One reviewer makes a point that the GM program extends too long (2014) to be impactful.

Advanced Vehicle Benchmarking of HEVs and PHEVs: Barney Carlson (Argonne National Laboratory)



Reviewer Sample Size

This project had a total of 10 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers feel that the project provides accurate, valuable, relevant and comparative data on emerging petroleum-replacing light duty vehicles, data useful to OEMs and policymakers. Furthermore reviewers approve of the benchmark testing of low fuel consumption vehicles, which helps to provide good validation information for analytical models.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewers believe that the technical approach is rigorous and seems ok, but that there are too few PHEV's to be benchmarked and much depends on vehicle availability and manufacturers' design choices.

Two reviewers bring up the following points: Is it really necessary to benchmark all of the vehicles proposed in order to validate analytical models? This could go on for a long period of time with new models constantly emerging. When is the amount of data adequate? Furthermore, testing of mostly production or near-production vehicles only demonstrates how the barriers have been addressed so far.

One reviewer mentions that the presenter said that a benchmark test manual is not used and does not exist. They feel that while the data collection, analyses and reporting appear to be first rate, benchmark testing could possibly be optimized and done more efficiently if a benchmark test manual were developed and utilized. This comment is relevant to conduct of operations, data fidelity, test repeatability, quality control and quality assurance.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer brings up that obtaining advanced technology vehicles is difficult due to the prototype nature of PHEVs. Another reviewer says that eight vehicles were benchmarked during the reporting period and a great deal of useful information was obtained and made available to stakeholders. The reviewer views this as the "gold standard" of advanced vehicle testing and data reporting for the technical community. Another reviewer feels the project is making significant progress and gaining excellent insight into vehicle performance.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer felt the collaborations were not clearly stated, while another clearly listed the collaborators to include the INL, AVTA and OEMs and noted that detailed results from the vehicle benchmark testing are available on the

ANL web site. Another reviewer felt that it appeared as if the project is providing free information to OEMs. If the OEMs are so interested in the data, they should be cost-sharing in the activity.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

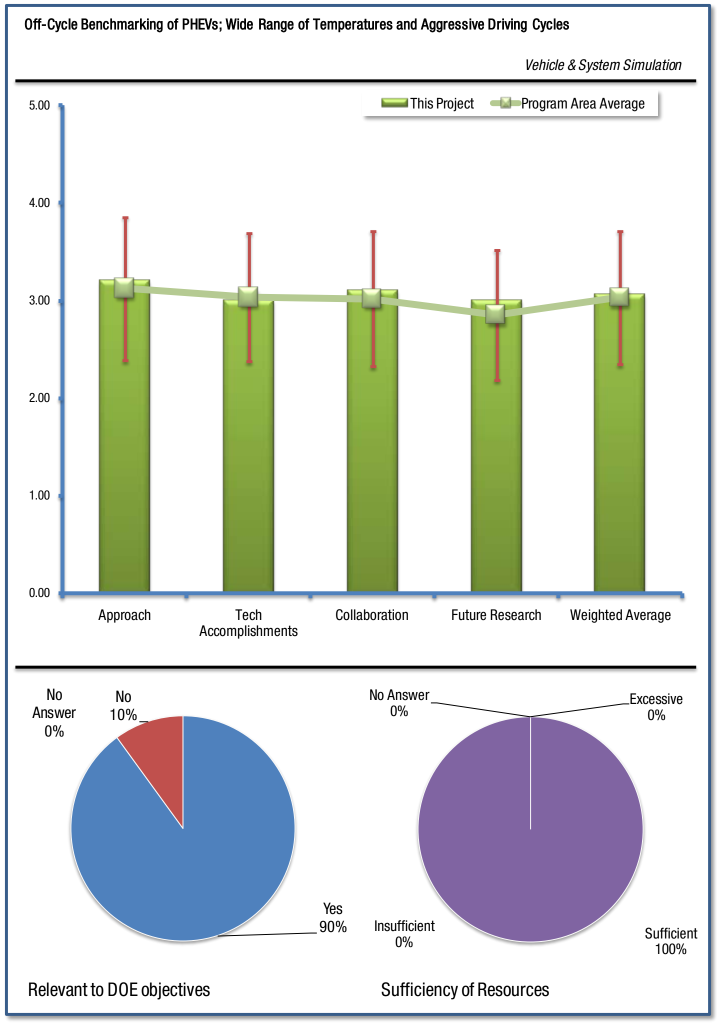
Overall the reviewers felt that a good selection of models appears in the list for future testing and fall exactly in line with expectations. One reviewer noted that the planed testing of the proposed Upgrade APRF capability for Sub-Freezing FTP and Hot SC03 with solar heat load capabilities for 5-cycle testing capability sounds like an interesting subfield. The only criticism came in the suggestion to do a more balanced load of PHEV testing vs. HEV testing (there is only one PHEV planned). It was also suggested that there needs to be some definition of scope and end-point so that this does not become a never ending project (there will always be more vehicles to test).

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented on the difficulty in getting early vehicle models and it will be an ongoing challenge. They felt the research team appears to be coping with this problem. Other reviewers felt that the resources were not clearly formulated and questioned how expensive some of the equipment might be.

One reviewer pointed out that if future work is to expand the APRF to full 5 cycle capability will require more resources.

Off-Cycle Benchmarking of PHEVs; Wide Range of Temperatures and Aggressive Driving Cycles: Barney Carlson (Argonne National Laboratory)



Reviewer Sample Size

This project had a total of 10 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The reviewers felt that he work supports the overall DOE objective of petroleum displacement by providing important data for PHEVs. They felt it accomplished this by providing data on the effect of temperatures and driver aggressiveness on real world fuel efficiency/consumption variance. In general the reviewers thought the work helps the DOE understand and is necessary to help comprehensively assess the petroleum displacement potential of PHEVs in real world scenarios, but only in the definition of petroleum displacement being a function of battery power and capacity of the PHEV.

Some reviewers felt that this information is critical to educate the customer on how to maximize fuel economy and another thought that the issues of off-cycle performance could be better understood using analysis tools.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer stated that the work takes a very logical approach to the two problems of effect of temperature and aggressive driving. Another reviewer elaborated on their rating saying that the approach receives a 'fair' from them and not a 'good' only because the work seems very mundane, straightforward and the drive-cycle tests fairly limited. They suggested that the work might be enhanced by extended applications. (Granted the budget is very small for more extensive work). One reviewer felt that given the straight-forward range of tests, the data provided is comprehensive and effective.

Another reviewer commented that the cold ambient problem and aggressive driver problem are very dependent on controller strategy. In this study, most of the testing was performed on one vehicle model (i.e. the same controller strategy). On a similar note, other reviewers wondered how the cold environment tests will enter into future design considerations - do we need larger or different batteries at low temperatures or some warming system? How will the results be transferred to the design community? What could be done to make future designs insensitive to temperature effects?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer felt that the work proposed and budget provided, the accomplishments are sound and that the project does provide some interesting data on performance at sub-freezing temperatures. Another reviewer felt that the project seems to be doing as well as can be expected, but they also point out that the fleet data do not seem to be particularly useful, except to illustrate the wide spread in performance.

Two reviewers had similar opinions on the accomplishments by saying that this task has demonstrated strong technical accomplishments including the impacts of cold temperatures and aggressive driving on engine operating time, usable battery capacity and charge depletion range, and emissions. They both noted that an interesting finding is that charge depletion range can decrease, increase, or remain constant depending upon battery power and capacity. Furthermore they were interested to see the effect of driving intensity on energy consumption differs for vehicle EV capability. Overall they feel this task is demonstrating significant productivity and usable results.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers commented that the project collaborates with Environment Canada (collaboration with Canada viewed as very good) who provides the Cold Dynamometer testing facility, Idaho National Lab, on-road fleets and not many others. They recommend that coordination might be improved or extended to other vehicle partners or national labs such as ORNL.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Some of the reviewers think the proposed work appears sound and logical but possibly a bit mundane and they make the comment that it seems to be more of the same, more-or-less, testing vehicle types as they become available. One reviewer goes as far to say "My opinion is that I did not see a need for future work as outlined."

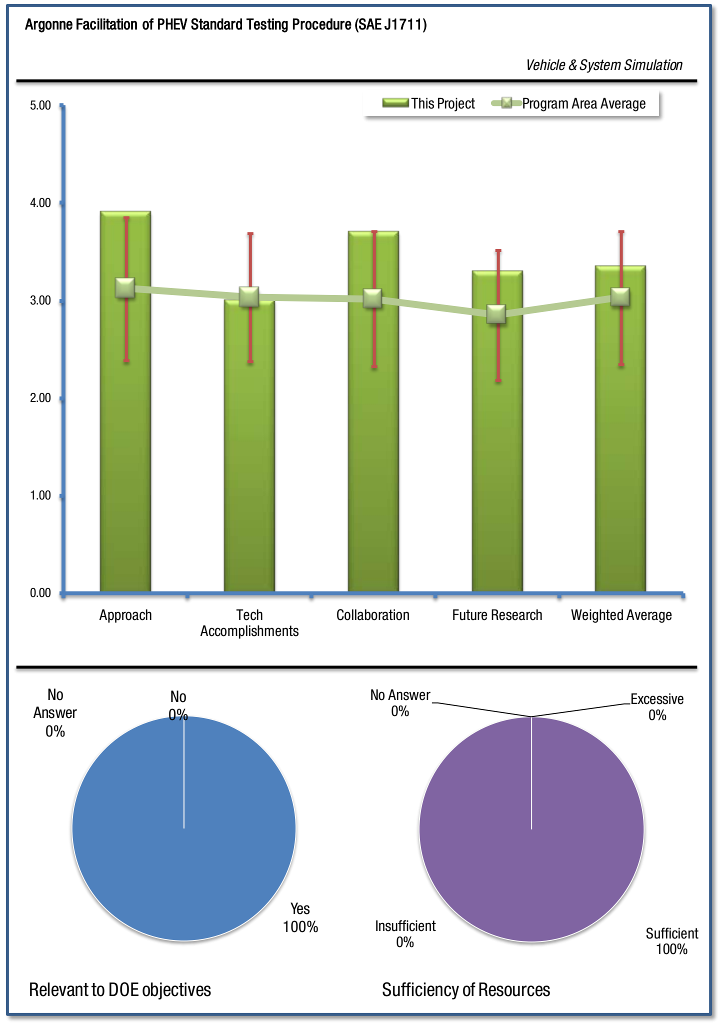
One reviewer commented that they would like to see additional study as to the variation of CD range obtained vs. use function/vocation, temperature and humidity, and driver behavior vs. ideal. They feel that mathematically predicting range based on these factors would serve very useful to future efforts to cost effectively improve it.

While some reviewers thought that the facility upgrade plans are good, another reviewer gave some detailed insight on the issue: they felt the proposal for future work to upgrade the Advanced Powertrain Research Facility (APRF) with to sub-freezing and hot A/C capabilities should be closely examined. They feel this is an expensive proposition ($1.5-1.8 Million) and it may be more advantageous to continue to use Environment Canada's facilities. The same reviewer also thinks that this task may also benefit from establishment of a longer term vehicle testing plan (2-3 years out) that bounds the types of PHEVs to be tested and to what level.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All ten reviewers thought that the resources were sufficient. Some comments were that the budget is small but the milestones and expected accomplishment comparable. One reviewer said that the task is sufficiently funded and should continue at current levels.

Argonne Facilitation of PHEV Standard Testing Procedure (SAE J1711): Michael Duoba (Argonne National Laboratory)



Reviewer Sample Size

This project had a total of 10 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Most of the reviewers agree that by providing SAE procedure standards, the work supports the overall DOE objective of petroleum displacement. They applaud the project for providing testing and evaluation standards for a suite of J1711 PHEVs and eventually the J1634 platform. A reviewer also points out that is good that the project does not directly support the regulations efforts at EPA but provides the complementary testing capabilities and set of baseline standards to establish regulations in the future. The reviewers also like that project is including development of common terminology and definitions. A few reviewers note that a standardized PHEV testing procedure is needed, to fight conversion companies' claims of "100 mpg". This project is a necessary step towards consistently quantifying petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer comments that the approach to the work and establishment of J1711 HEV and PHEV standards appears comprehensive and sound. They continue by saying that the dynamometer testing methods are very carefully approached and designed with adequate attention the PHEV unique operation. They also applaud that the testing, experimentation and evaluation is compatible with legacy testing requirements and overcome historical barriers for longer PHEV tests. One reviewer feels there is a need to find a way to relate DC energy measured on vehicle to AC kWh from charger. Another reviewer states that SAE is the right forum and participation from all OEM's is appropriate.

One reviewer complemented the project team by saying "Very challenging problem that probably only the team and facilities at ANL can address."

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers say overall the project appears that it is meeting its established project milestones with respect to its baseline performance goals. The reviewers feel that the project team has made significant progress toward its technical objectives of establishing J1711 standard procedures and point out that success would not have been possible without DOE maintaining leadership in vehicle systems. The reviewers also feel the project team has also been very proactive in communicating with it various stakeholders, including JARI-ISO, CARB, EPA. The amount of partnership and collaboration should be commended and has contributed to the overall technical accomplishment and progress of the project.

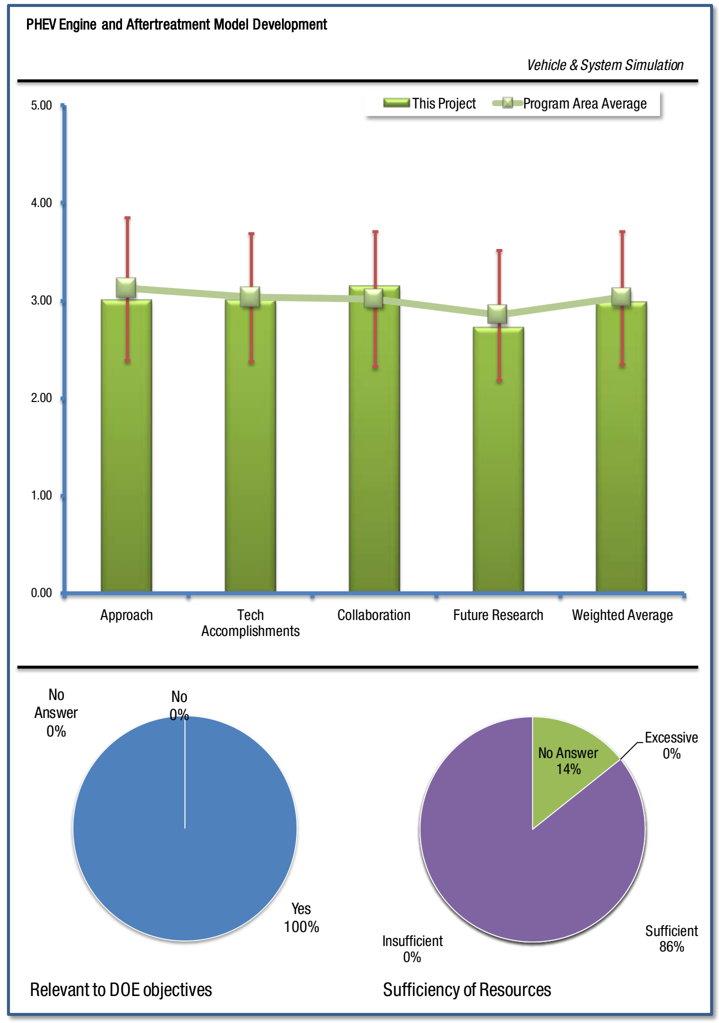
There is concern among a few reviewers about the timeline, one of them is that this standard has been under construction for some time. They feel the end of the year is a target that must be met and this project should be concluded before that. The reviewers point to the rewrite, which has been in progress for a couple of years now. Based on the time it took for the rewrite the reviewers feel that coordinating and getting consensus from all parties may be difficult. Overall the reviewers feel there needs to be a greater drive for results in a more timely fashion.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers say that the collaboration and coordination for this project is extremely challenging, and is necessary to gather all of the input and understanding of how PHEVs operate and perform. The project does an outstanding job of raising consensus with its wide range of stakeholders and takes a leadership role in the J1711 Task Force and the joint work between ANL and INL (Testing -ANL & On-Road EVAL INL) is commendable. The reviewers mention that the nature and level of collaboration and coordination was discussed and shown to be excellent in addressing the varying interests of a wide variety of stake holders.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Reviewers agree that the project is nearing a successful completion and that wrap-up by Q4 2009 is an appropriate timeline.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
All ten of the reviewers agree that the level of resources is sufficient and that the budget of $300 million was used efficiently and in a timely fashion producing a very significant effect. One reviewer felt that there was not enough information available to determine if resources were sufficient.

PHEV Engine and Aftertreatment Model Development: Stuart Daw (Oak Ridge National Laboratory)



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The reviewers agree that the aftertreatment of IC engines used in hybrid powertrains will become more and more challenging as the engine is used less and electric motors are used more. This is an area that needs to be studied in detail. The reviewers believe that the model developments will facilitate future development and implementation of non-petroleum or limited-petroleum using vehicles. They point out that helping define where resources should be applied for maximum petroleum displacement does support objectives. However, one reviewer says that engines and aftertreatment in the LD sector will be obsolete if AEDV's are available so better focus would be on HD engine/aftertreatment simulation studies.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer says that a model based approach here seems to be overestimating the ability of current simulation tools and that the project team needs to make sure that the results are correlated to full vehicle testing.

Some other reviewers feel that the project is well planned and executed and appears to address the most important barriers. They would have liked to see more specifics on what type of models and maps were being discussed, analytical, thermodynamic, computational, etc.

One reviewer says that the barriers represented in the project could be overcome and there should be additional planning and costs associated with getting engine models. They feel that PHEV engine optimization can also be modeled.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
The reviewers say that 2008 milestones were achieved and the 2009 milestones are in progress. They mention that the project team performed a detailed analysis making good use of available data and issues were efficiency addressed. One reviewer makes the point of that it seems the validations are very good, almost too close to experimental results for comfort; perhaps all has been done? Another reviewer makes the statement that various advanced engine technologies should also be considered/modeled going forward.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers provided very little feedback on this question only saying that it seems to be very good and that one of the reviewers liked the continued outreach to industry, including the CLEERS consortium.

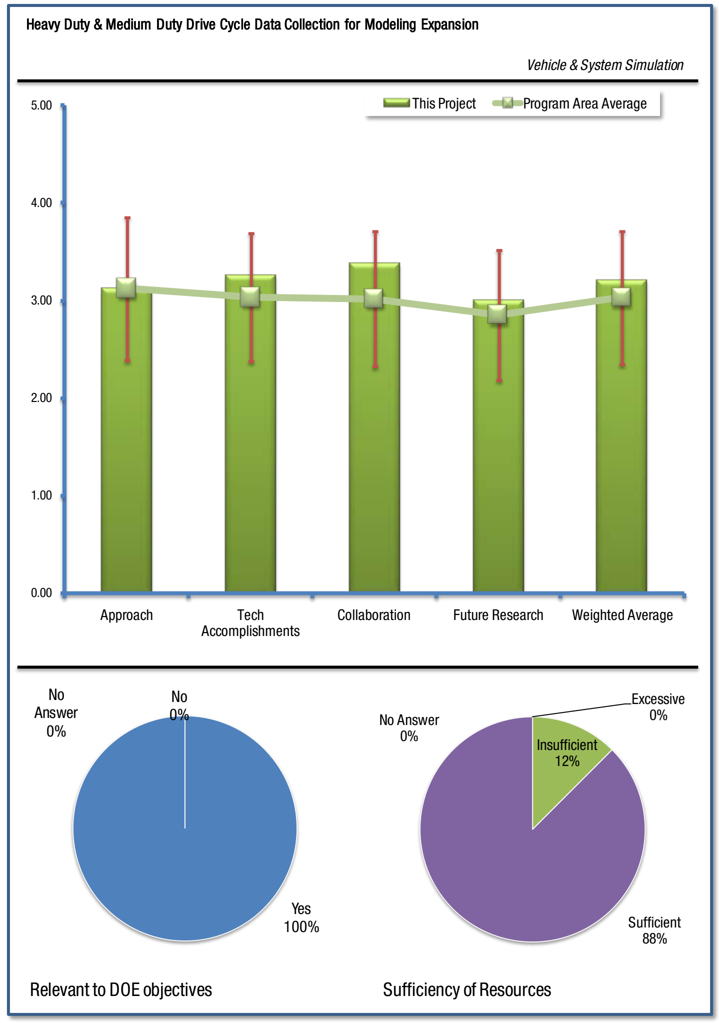
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers feel that the project has well planned research, they feel the project captured many of the technologies that need to be incorporated but failed to discuss how to define actual interactions and compare to other (non-diesel) technologies. One reviewer points out that there are many opportunities here for future research as the audience noted such as: hydrogen fumigation of gasoline engines (SWRI indicated a 5-20% fuel economy improvement through their HEDGE consortium). Biofuel effect on emissions and emission equipment needs to be reviewed (some work being done by NREL in this area).

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All six of the reviewers feel the resources are sufficient, but some feel that there was not enough information. Other reviewers feel that it was not quite clear from the presentation but seem to be OK.

Heavy Duty & Medium Duty Drive Cycle Data Collection for Modeling Expansion: Gary Capps (Oak Ridge National Laboratory)



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer says that the project develops and tests effective and practical methods to collect and analyze operating data to measure heavy truck fuel consumption. They feel the knowledge obtained will be critical in prioritizing customer and research program choices in selecting technologies to improve heavy/medium duty truck fuel economy. Another reviewer point out that characterization of heavy-duty drive cycles is key to developing technologies that can improve their fuel efficiency. Another reviewer says that instrumentation of vehicles is a key to determining "true" driving cycles. The cooperation of fleets is highly important in this area, and ORNL should be commended for being able to obtain as much data as they have.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer feels the barriers defined by the presenter seem narrowly focused on this specific project, and of little broad or long term value. While another reviewer feels the key barriers and targets are identified barriers and the project has demonstrated good progress on overcoming the barriers and meeting the targets.

Many reviewers gave praise to the excellent acquisition and analysis of data and said that it is good to get the data. Some reviewers' feel the best approach would to enable dispersal of the data to industry and that it would have been helpful for ORNL to show the depth of the data parameters that were collected on this project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewers point out that sixteen objectives and 12 milestones have been accomplished so far in 2008 and 2009; they also note that the report has been completed and is available to public. One reviewer recommends that a complete vetting of the wireless download data acquisition would be helpful to the audience, as well as understanding how this would work on other programs -- including off-highway vehicles.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer feels that the cooperation of DOE/DOT/EPA is absolutely critical to making this project a success and that the shared funding is a good indicator of cooperation. Another reviewer points to the fact that the project has obtained use of 12 vehicles plus partnerships with relevant organizations as an example of collaboration. Similarly, another reviewer says there is excellent coordination with end users and the project may want to coordinate with HTUF to gain understanding of how hybrids perform in different applications.

One reviewer would love to see more sharing of the data, including the sharing the analysis of the data that was collected.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer says that the future works described seems like a collection of activities without clear focus. Another reviewer had a contrasting view that the future work coincides with the targets and objectives of the project and has a detailed schedule of performance. One reviewer says that they are not sure that highway wrecker trucks represent a large fraction of typical vocations and recommends that the project investigate other vocations instead.

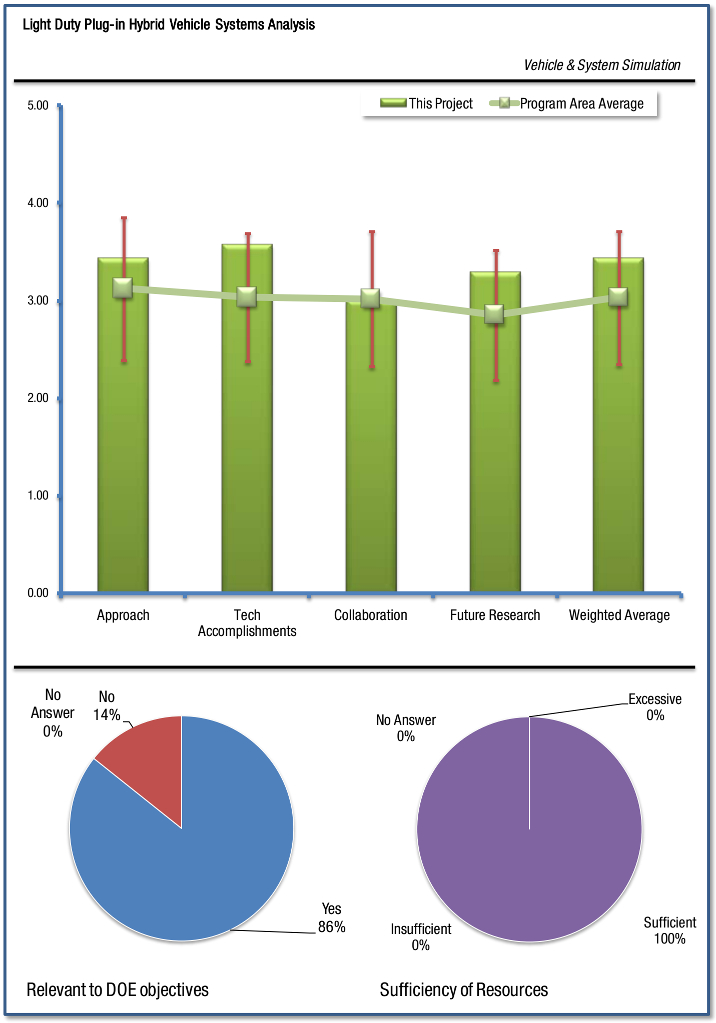
One reviewer is very excited to see what duty-cycles are derived from this data and was personally interested in seeing what the duty-cycle looks like across Trans Canada-US crossings.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Some reviewers agree that the combined agency funding and effective use of resources is evident and that the budget, expenditures and progress appear to be in balance.

One reviewer says additional resources will be necessary to fully define drive cycles of a wider variant of truck vocations. Another reviewer would love to see the man-hours associated with this project and the cost to instrument a truck, as it would be helpful for other projects across the DOT, EPA and ARB.

Light Duty Plug-in Hybrid Vehicle Systems Analysis: Tony Markel (National Renewable Energy Laboratory)



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer says that this project takes an overall systems approach to advancing light-duty PHEV systems which directly supports the DOE objective of petroleum displacement.

Another reviewer feels that the project will make it possible to develop an integrated picture of battery charge/discharge patterns based not just on driving behaviors but on grid electricity availability when wind power is used for charging.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer feels the approach includes comprehensive collaborations (SAE, GM, Metro, Labs) that appear to strengthen the approach, and give the data and analysis the breath required. Another reviewer wonders if all the data are necessary - effect of wind cycle, for example, while OK it is marginally relevant at this time. They feel it could obviously become useful later on in time when vehicle penetration is much greater than now but by then both technologies will be significantly different. Also, they think it would be interesting to compare driver data from the different cities to see how much commonality there is and whether there could be a semi-standard model for driver behavior that can be used for technology development.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer commented that to achieve the overarching finding, various technical accomplishments were achieved within for travel pattern data applications, battery cost/life modeling, PHEV integration with renewables, economic assessment tools, and PHEV test procedure improvement. The reviewer also mentions that the project worked with an SAE committee (Labs and Industry) to evolve the J1711 standard. Another reviewer mentions that “Slide 26 is unclear and needs some elaboration.”

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer notes that the collaborations are critical to the analysis and report findings and that the project had strong collaborations with stakeholders, including Congressional Visitors, General Motors, Chevy Volt, Xcel Energy and V2Green, Hymotion, EnergyCS, and Hybrids-Plus, Tesla Motors and AC Propulsion, Southern California Edison and Google. Another reviewer says “Seems Ok if not spectacular.” A reviewer would like to know what "active on SAE J1711" means and highlights the cooperation with vehicle and trip data efforts at INL AVTA, and perhaps UC-Davis work.

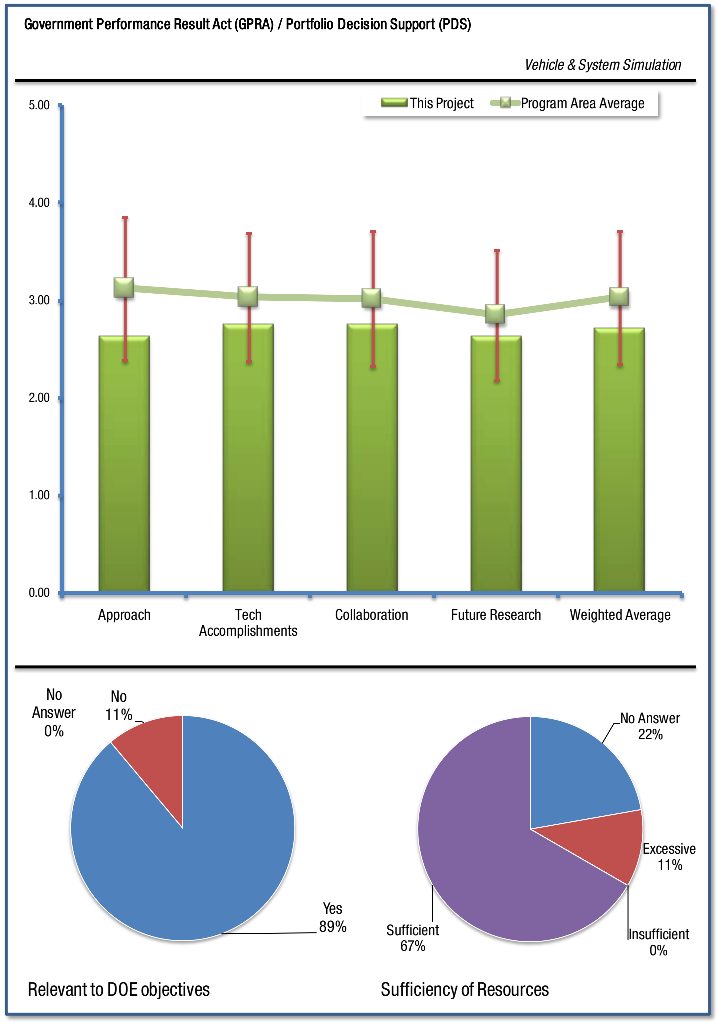
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer believes that the future work proposed is bound to be as successful as the initial work provided and this work will continue to be very valuable to the government, industry and the consumer. Another reviewer would like for the project to consider more interaction with others on proposed work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All six of the reviewers feel that the resources are sufficient. One reviewer believes that the budget is moderate for the amount of data provided. Another reviewer points out that, while not clearly addressed, there are no obvious budgetary barriers nor windfalls.

Government Performance Result Act (GPRA) / Portfolio Decision Support (PDS): Sylvain Pagerit (Argonne National Laboratory)



Reviewer Sample Size

This project had a total of 9 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The reviewers believe that the project directly supports the DOE objectives of reducing our national dependence on petroleum, by further developing the Government Performance Results Act (GPRA), and specifically assessing the efficacy of the FreedomCAR initiative. The reviewer also notes that this project is able to project what the total petroleum displacement would be, if we were to meet all FreedomCAR milestones.

Reviewers state that it is important to understand the potential impacts of vehicle technology utilization. The project also serves to help guide future research and development by evaluating benefits of latest technologies both from a component and control perspectives.

One reviewer says that the program looks at efficiency of overall government programs and from their point of view this is not applicable (i.e. the things this project reviews help to meet the DOE objectives not the actual project). Another reviewer would have liked to have known what the FreedomCAR goals are so they could have assessed better.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer recommends that the approach might be more sharply focused by including a more detailed level of component variables along the drivetrain or for example materials advancement in energy storage systems. Some reviewers believe the approach was not presented in detail and the project could use better substantiate cost assumptions. They also think the project should reference studies where possible. Another reviewer says it is hard to understand the approach and there doesn't seem to be a coherent strategy. They state it appears like a “shotgun" approach to the do analysis without a well-defined goal.

Another reviewer points out that the project leaves out hydraulic hybrids, flywheel solutions, system solutions with waste heat recovery, turbo compounding, optimized biofuel based engines for hybrids, and other technologies.

On the other side one reviewer says that the barriers have been identified and are being successfully addressed, the project appears to be well designed and has demonstrated its feasibility and has shown integration with other FreedomCAR team efforts. Similarly another reviewer feels the approach appears sound and logical and has implemented means to examine and assess the petroleum displacement potential of a large number (approximately 600) powertrain/fuel/vehicle size configurations. But this reviewer still questions cost.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer noted that the project has achieved 75% total project complete on an aggressive schedule. They also said in addition to GPRA/PDS, the team results were used to support other studies like component requirement uncertainties, fuel efficiency improvement of different fuels, configurations and cost benefit analysis of each technology. One reviewer said significant analysis has been accomplished but it's difficult to understand how it all hooks together. Reviewers commented that the project has exhibited high productivity and solid results. They were pleased with the interesting results that were presented on hybridization petroleum displacement benefits with vehicle class and fuel cell HEV fuel consumption uncertainties. Another reviewer felt that there was more reporting than analysis.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers thought that the work demonstrates strong, close and appropriate collaborations with various technical teams, National Laboratories, Additional experts, Academia, and PSAT/GREET users. Another reviewer thought that there are lots of opportunities to collaborate with similar work at other agencies, within industry, etc.

One reviewer thought that it was not clear where some of the data comes from, especially costs- it would beneficial to have a clearer picture of this aspect. For example, exactly which literature sources are tapped and approaches used to access cost information. What other approaches or sources (including direct purchase) could be used to broaden access? Another question they had was how well coordinated this activity is with the automotive system cost model effort historically conducted at ORNL and now at NREL.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

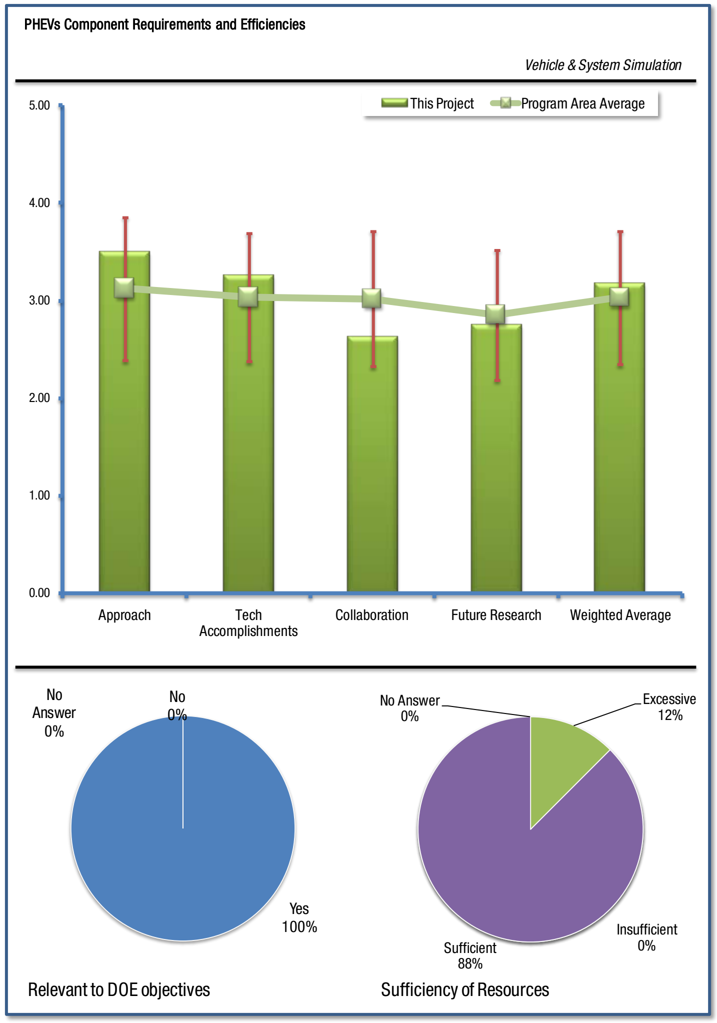
Reviewers thought that the future work proposed and focused on addressing the barriers is logical, and is planned systematically. They also said that it builds very nicely and appropriately on past years work.

Another reviewer thought that the use of an optimization tool for component sizing and control strategy tuning is a good approach as well increased implementation of Monte-Carlo risk analysis. But they said there is a lot of details are provided on other future activities and recommended that consideration be given to bounding the number of powertrain/vehicle size/fuel configurations to be examined to increase accuracy and acceptance of results. One reviewer elaborated that there are many techniques one can use for portfolio analysis and this project needs to be rethought.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that the budget could be increased and another said it was not discussed. To elaborate on the excessive budget the reviewer said that the amount of funding for this activity seems to be excessive in terms of benefits to DOE.

PHEVs Component Requirements and Efficiencies: Aymeric Rousseau (Argonne National Laboratory)



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer said that the relevance of this work was not clearly stated. It may have some limited value in guiding early component decisions. Other reviewers said that the project is relevant to the transition to electric vehicle fleets and is useful for PHEV energy consumption estimation, in particular as battery energy capacity changes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer said that the RWDC based results are useful, but should also include standard drive cycles for comparison? Is US06 close enough to RWDC? Another reviewer thought that significant analysis has been accomplished but it is difficult to tell how it applies to the problem at hand.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer thought that the accomplishments appeared clear and readily understood. Another reviewer said the presentation was very hard to follow, charts were not clear or understandable and the presenter should have used a pointer when referring to complex charts with lots of data. Some reviewers thought that most goals seem to have been reached by now and that there was good analysis accomplished, but did not understand what it all meant.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers generally agreed that collaboration was minor and may have been the nature of the project, it appeared to be a predominantly in-house study and support activity. The reviewers also wondered if fleet data from AVTA or other data on drive cycles from NREL could have been used.

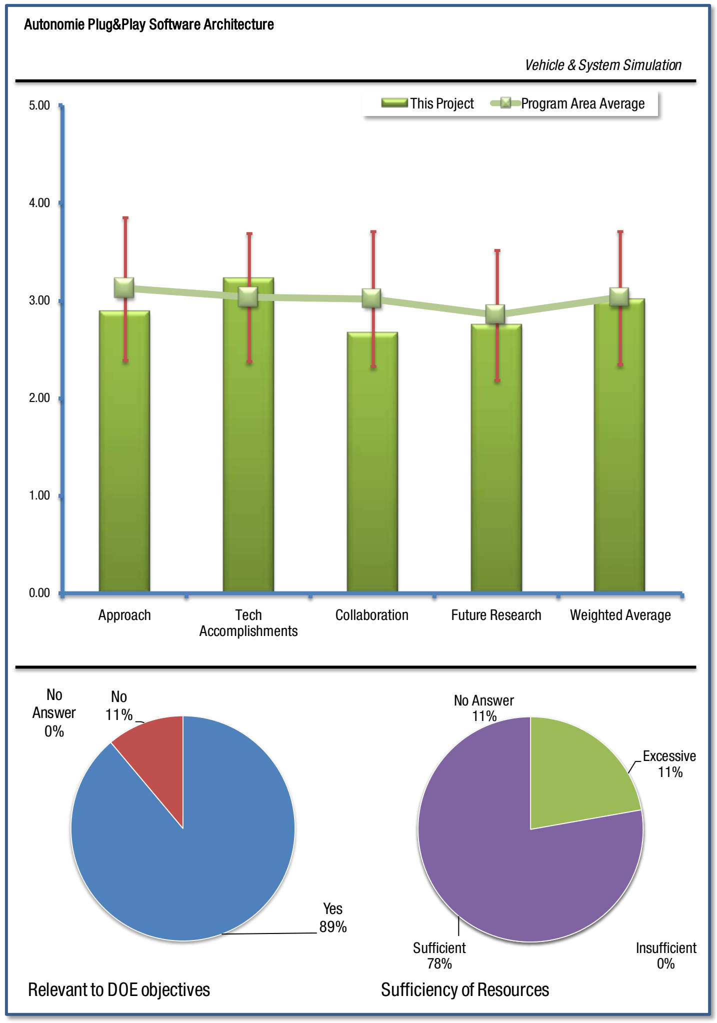
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

While one reviewer said that the future work seemed to be very reasonable, another said that it seemed to be rather random questions that are being addressed. The same reviewer also wondered how the future work feeds into a coherent answer to a question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer said that it was not specifically discussed but there seemed to be no specific budget-related problems. A reviewer added that the amount of funding for this effort appears excessive related to its value.

Autonomie Plug & Play Software Architecture: Aymeric Rousseau (Argonne National Laboratory)



Reviewer Sample Size
This project had a total of 9 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer feels that the project may or may not support the overall DOE objective of petroleum displacement, but they feel it may well improve the efficiency of the overall processes and thereby help reduce petroleum consumption in very general terms. But this is only their guess, as it was not addressed clearly or specifically in the presentation.

Other reviewers view this as a supportive analysis tool and say that bringing technologies to the market faster through lifecycle modeling and simulation is an absolute necessity for bringing about highly electrified vehicles that will maximize fuel displacement. They also point out that cost to assess vehicular technologies would be reduced, time to market would be accelerated, and the ability of smaller firms (with more limited resources) to contribute would be enhanced.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
In general the reviewers point out that this project will help sort technologies quickly to reduce hardware build iterations and the work seems to be very well done, even if it possibly is only marginally relevant to the DOE mission. It may also intrude on the areas of activity generally handled by the software industry or by universities. One reviewer points out that this is very good and useful work, but the vehicle technical barriers will be overcome with or without this program. They would have also liked to see an example of the methodology to outline the consistency of modeling analysis from one project to the next.

One reviewer made helpful suggestions that the scope of this effort appears to be well organized, but is extremely broad. They said the project appears to attempt to provide universally applicable software architecture for integrating all models - both future and existing. They feel there is a need for additional metrics such as computer hardware requirements, speed of analyses, cost of maintenance, cost of training, nor prioritization of the boundless options.

Another reviewer elaborates in detail that the barriers in the presentation are not specific technology/software development barriers-- they are actually goals that the tool hopes to achieve. As such the reviewer feels it is difficult to assess the effectiveness of the approach. Furthermore they feel that the approach seems reasonable but would benefit from a harder discussion of the overall potential show stoppers, approaches to address them, and contingencies. Some of the potential show stoppers the reviewer points out is not only software development barriers but also industry collaboration and ways of doing business and how these elements could affect implementation of an industry wide enterprise software system.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
The reviewers feel that the project is doing nice work and objectives are on target for this complex program. They stated that given the daunting scope of this effort, the projected completion of the first version of this code by September 2009 is to be lauded.

However due to the fact that clear performance indicators and milestones are not detailed it makes it difficult to truly assess progress, so the reviewer will have to wait until September to see if it lives up to its claims. A reviewer recommends since this is a fairly large task, it would benefit from a more structured project outline with very clearly delineated subtasks, milestones (including go/no-gos), and contingency approaches. The reviewers do note that if this task should prove successful, it would prove a revelation in the conduct of car design and development. A reviewer does caution that in some ways, the task appears to be trying to be everything to everyone which may not be feasible from a technical nor business standpoint.

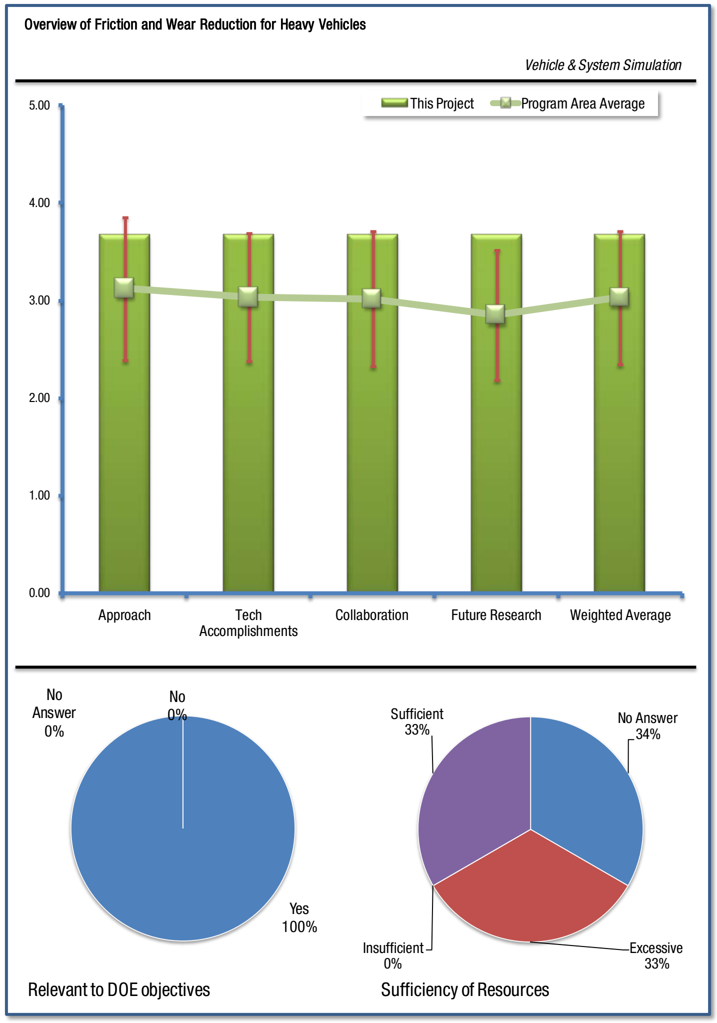
Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
In general the reviewers agree that collaboration with GM, Mathworks and Mechanical Simulation is excellent, but it is not clear if anybody else is involved. They recommend as the product matures, universities, National Labs, OEMs and other users should be called upon to provide a range of models and software options beyond those utilized by GM, which may already have some degree of in-house standardization. They would hope to soon have buy-in from the rest of the vehicle systems analysis community (including support of Ford and Chrysler and if possible some large suppliers) and that the project will be rolled out in a commercially available way. One reviewer makes the point that the simulation world is moving rather fast, and cautions if the project is really capturing all of the latest capabilities with the current partners involved?

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
The reviewers feel that there are extensive goals and the project seems to be on target. However they note that the end date for this project is specified as September 2010, but the list of future activities seems to be very general and open ended, with little in the way of specifics or prioritization. They recommend that if this is planned to be an ongoing level-of-effort project, it should be so stated. The reviewers also say that the efforts to initiate the definition of a standard for the automotive industry are very appealing and well received, but question how the distribution within the industry will work and state that it needs to be part of the plan.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
While one reviewer says the task is sufficiently resourced other reviewers raise concerns. Two reviewers fees that budget/resources were not addressed and no clear budget-related problems identified. Other reviewers note that this appears to be a project driven by budget rather than scope and ask if GM will continue with their side of the project.

Another reviewer recommends that the annual maintenance cost of this project needs to be assessed. They say it was verbally mentioned at $1.2 million annually. They also point out that modeling needs will continue to be enhanced, such as tying into infrastructure, modeling emissions, etc.

Overview of Friction and Wear Reduction for Heavy Vehicles: George Fenske (Argonne National Laboratory)



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer said that the project directly supports the overall DOE objective of petroleum displacement by investigation the effects of friction and wear for heavy vehicles and their effect on energy use. By gathering test and modeling data on Safety, Durability, Reliability, of heavy vehicles the project promotes energy efficiency and more responsible use of petroleum.

Another reviewer points out that a lot of work has been done in this field, so the gains are likely to be incremental.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers feel the project takes a comprehensive approach including experimental and theoretical (and modeling with simulation) to reduce friction and wear in heavy vehicle systems is effectively working to reduce our dependence on petroleum. They also feel that the experimental and modeling approach is effective.

Another reviewer thought that there was a very strong scientific approach that carries through a collection of projects with a related theme. The use of the APS to measure residual stresses versus depth was impressive. A reviewer also complements the project for an excellent approach to defining a bench-top test rig to validate the analytical approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer believes that there was some very encouraging progress made in hard coatings. Another reviewer said that there was good progress made in defining the characteristics of the problem and in defining an approach for how to tackle the investigation.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
The reviewers complemented the project for working with key players in the modeling and simulations arena, namely Ricardo and for using a university partner. They also note that the breadth and coordination with the partners appears well coordinated.

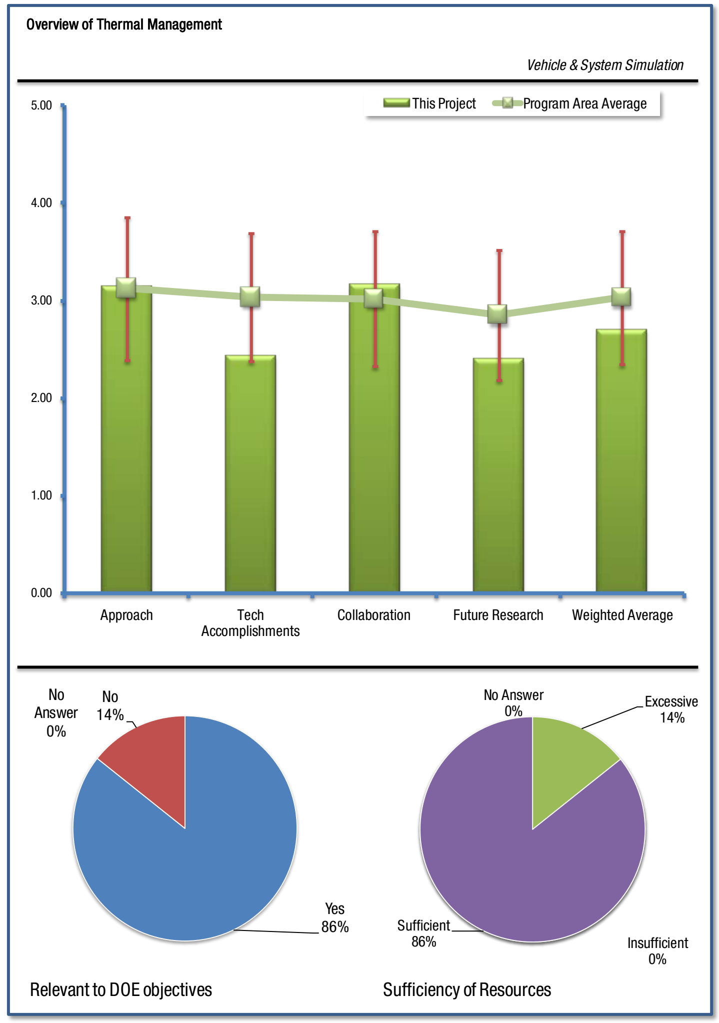
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The only comment provided for this question was a reviewer wanting to understand what other organizations are investigating friction reduction in the engine and how their activities could be coordinated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewers said that the budget resources appear adequate to perform the work and achieve the project milestones. One reviewer felt that the cost to benefit ratio seems to be a bit out of balance unless the benefits of the technology could be better calculated.

Overview of Thermal Management: Jules Routbort (Argonne National Laboratory)



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The reviewers felt that the program's three principal investigations all contribute to advancing the DOE objective of petroleum displacement. They noted that the results of this work, in the long term, may result in more effective heat transfer through automotive radiators, leading to smaller radiators (reduce fuel consumption in heavy duty trucks by 2.5% via downsizing and reshaping of the radiator and reduced pumping losses) and consequent drag reductions in vehicles, thus reduced fuel usage. One reviewer stated that nanofluids are potentially attractive in other areas such as industrial applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers like the experimental and analytical approaches to the nanofluids project and believe it is sound, logical, straightforward and uses up-to-date methods. A reviewer points out that the project objective mentions "nanotubes or other cooling schemes" but nothing further is said about "other cooling schemes" in the body of the presentation. They also mention that the suite of projects has been ongoing since at least FY06 and they are surprised to see that the critical barriers are only now being quantified in FY08. Further, the suite of five projects has the same identical list of barriers. There is also insufficient information regarding the details of the barriers and approaches in regards to the individual projects as presented.

One reviewer says that ANL's approach to nanofluids is very well structured and logical, with a balanced and coordinated theoretical and empirical effort well underway. They also point out that ANL is conducting work for others (TARDEC and Michelin) in this area and is also receiving cost share funding from commercial entities (Saint Gobain and Michelin) indicating strong industrial interest in this technology.

One thing that the reviewers pointed out was that one area that could be improved is a harder, more transparent presentation of specific project go-no-go milestones and potential show stoppers from research through end-use applications. This is discussed but not in significant detail.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer said that this project faces problems in fluid mechanics, small particle interactions, and surface chemistry that may pose fundamental barriers to meeting the objectives. Thus there is a large portion of basic research to address. Considering the fundamental issues and a 40% level of accomplishment, the project appears at risk of not

meeting its objectives. Another reviewer pointed out that the sub-projects seem to be well under way, except the erosion test which is coming on line, a different reviewer said that technical accomplishments have been solid over the last year or two with progress being achieved in a number of fronts. One reviewer could not tell specifically which accomplishments and progress pertained to which of the five projects, especially in the context of the history, scope, funding and duration.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers point out that the project has enlisted a very good list of collaborators and has shown strong collaboration. Another reviewer could not tell which set of collaborations went with which project, while a different reviewer said that ANL's work with others for TARDEC and co-funding from the DOE industrial technologies program indicate a strong effort to coordinate and leverage industry expertise. They feel that the funding should continue to be aggressively pursued.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer points out that improving the air-side heat transfer coefficient of a radiator is the hardest problem because features that increase the coefficient also tend to increase pressure drop and impede heat transfer. Another reviewer says that the systematic characterization is a part of important fundamental research.

A reviewer could not tell which future research went with which project. Further, they point out that a bulletized list of nouns and adjectives with no verbs and timing does little to inform anyone about what the plans really are.

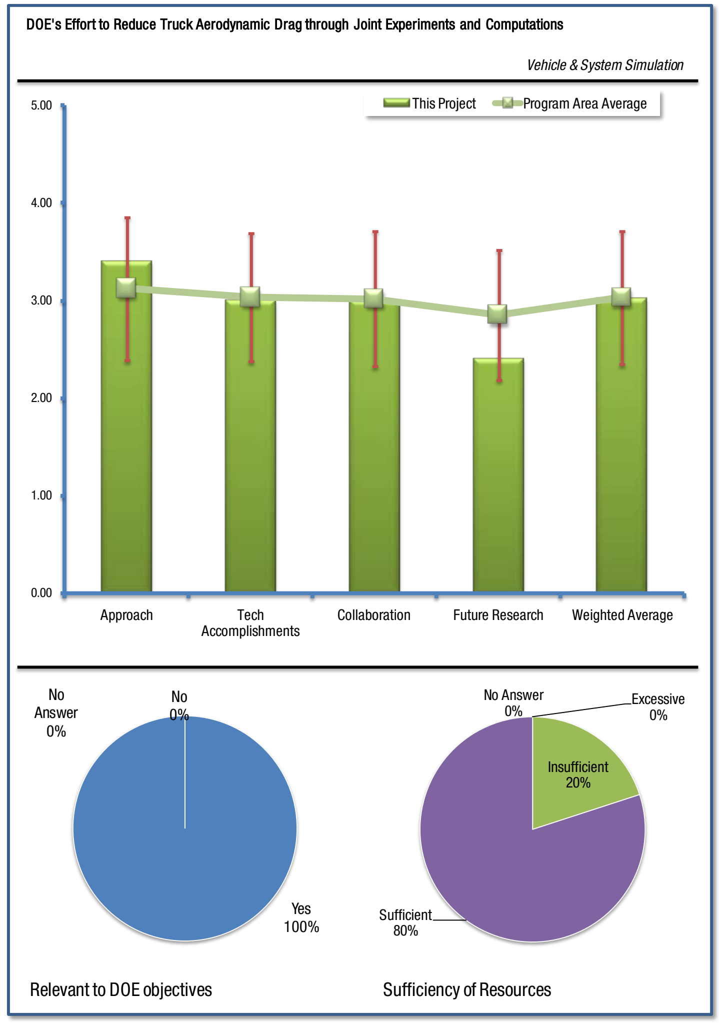
One reviewer said the proposed future research is logical and follows from technical achievements thus far and continues to say that it may already be well understood, but it would be beneficial to have a very clear understanding of potential commercial barriers to widespread application of nanofluids- most especially cost requirements. They think this may help narrow down future research areas.

One critical reviewer points out that if you look at the overall thermal system of the vehicle, it would be nice to have a smaller radiator through the use of a new fluid, but there are overall issues that are driving a vehicle to actually need to have larger cooling systems. They also point out that using the picture of a flat square hooded PACCAR truck compared to a streamlined NAVISTAR truck was biased.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewers said that there was not enough information available and that it was unclear as presented, no clear budget-related problems seem to have been identified. Another reviewer thought that the list of milestones were really a list of activities, rather than a list of specific accomplishments with a specific completion date.

DOE's Effort to Reduce Truck Aerodynamic Drag through Joint Experiments and Computations: Kambiz Salari (Lawrence Livermore National Laboratory)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The reviewers point out that reduction of aerodynamic drag in heavy vehicles is clearly an enabler for fuel economy improvement in trucks and is capable of relatively near term results.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The feasibility of the approach is limited by the availability of the Ames facility. In light of this, the project is well designed to test multiple vehicle configurations in a limited amount of test time. One reviewer wonders how the project is planning to encourage industry to apply validated improvement ideas.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer notes that there is still no market penetration. Another reviewer states that this investigation has been going on for a number of years and it is difficult to tell what the recent progress has been. One reviewer mentions the practical aspects of getting trailer manufacturers to incorporate changes into their trailers needs to be considered.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers point out that there is good collaboration with OEMs and end-users, but need to bring in trailer manufacturers as they will be the ones to incorporate many of the aero changes that need to take place. One reviewer says there should have a fleet in the project team. They also want to know how the results will be integrated into the EPA SmartWay program.

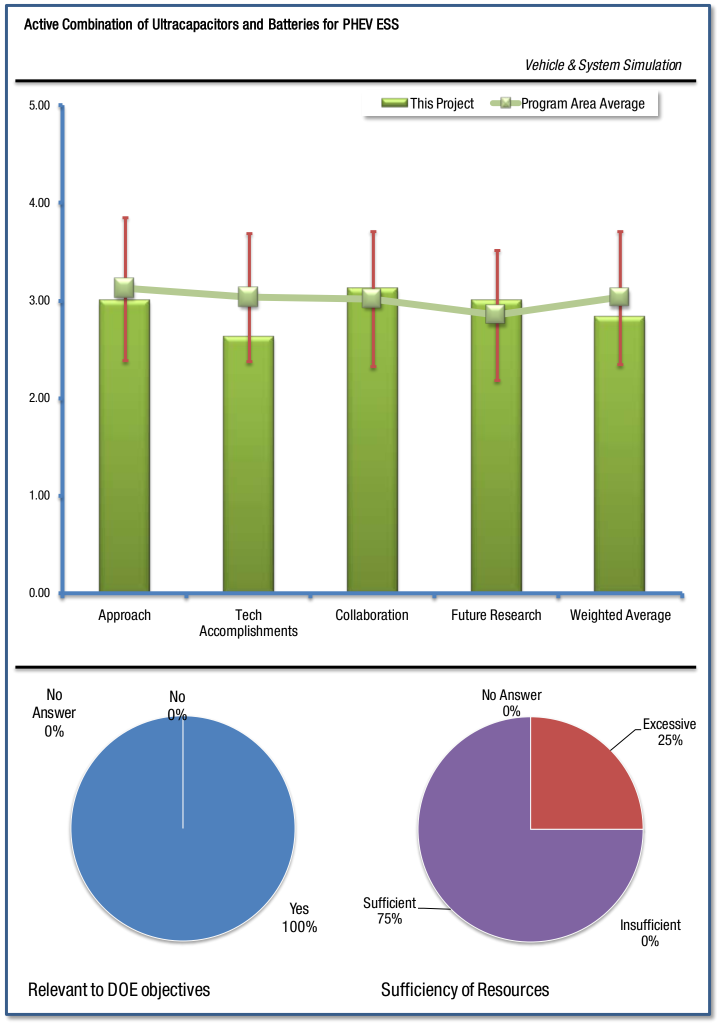
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewers say it is not clear what will happen after the Ames wind tunnel test is completed and that the project should also consider mass and cost added by devices. The reviewers also say there is a need to determine how aero devices will be better accepted by the trailer manufacturers and end users. A reviewer wants to know what publication plans for benefits have been addressed and if results will be drive cycle based.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer gave the comment that greater funding is needed to help educate the end-user and prepare them for new technologies entering the market.

Active Combination of Ultracapacitors and Batteries for PHEV ESS: Ted Bohn (Argonne National Laboratory)



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer felt that in general, the project does support the overall DOE objective of petroleum displacement. They also mention that to really address the overall DOE objective it would be helpful if the project include a more comprehensive cost analysis with the systems analysis program. Another reviewer comment was that the PI stated with a limited budget ($800K for FY 2009) cost was not assessed and they felt that that amount seems like a reasonable budget to include cost assessment analysis. With this assessment the project would be more effective toward meeting DOE goals in FreedomCAR and therefore better support the overall goal of petroleum displacement by assessing cost. Another reviewer points out that advanced energy storage is an enabling technology for advanced vehicles aimed at petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer said that, as stated above, the technical systems approach appears fine but should include not only the energy/power assessment but a cost assessment to be a more effective approach. Another reviewer said that the project has a well-planned approach covering most or all of the main bases.

One reviewer commented in detail that the key to this project is cost reduction compared to a battery-only energy storage system. They also point out that no cost study results have been presented yet, but rather are the penultimate task. They feel the cost study should have been done as the first task to determine whether any of this work has merit. Given the high cost of ultracapacitors and the expected higher cost due to the more complex control system demands, it is difficult to see how this approach can overcome the key barrier of cost, which is the only one not resolvable with a battery-only energy storage system. They also say that this task does not fit well under Vehicle Systems, but rather, if it is to be done at all should be performed under the auspices of the Energy Storage Technical Team that has the capabilities, resources and expertise to monitor and perform this work. The reviewer also points out that this concept has been previously investigated by the Energy Storage Technical Team and judged to be not viable.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer felt that the team has done a nice job of investigating (experimentally and theoretically) SOC- state of charge controls and regulations, and best practice in ultracap -battery systems. A different reviewer feels that there has been impressive progress to date, and some questions about long-term performance will presumably be answered in the next stage of the work.

Another reviewer points out that the presenter stated the project is 80% complete, yet the 24-month cycling of the three lithium-ion battery packs is only in its first quarter, and no cost trade study has yet been presented which is the key to whether this project should proceed. A second reviewer brings up a similar point that the project still needs to show cost can be the same as an oversized battery when DC/DC, caps, controller are added (system complexity).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers point out that quite a few industrial and lab collaborators and that ultracap studies support other DOE programs. One reviewer would like to see this work coordinated with and reviewed by Electrochemical Energy Storage Tech Team and USABC.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer feels that the proposed future work appears fine. This work will leverage interest from OEM's, DOE EE-Tech Team & ES-Tech Team. A different reviewer also mentions that it seems that most of the remaining problems will be addressed, except possibly the questions of overall cost.

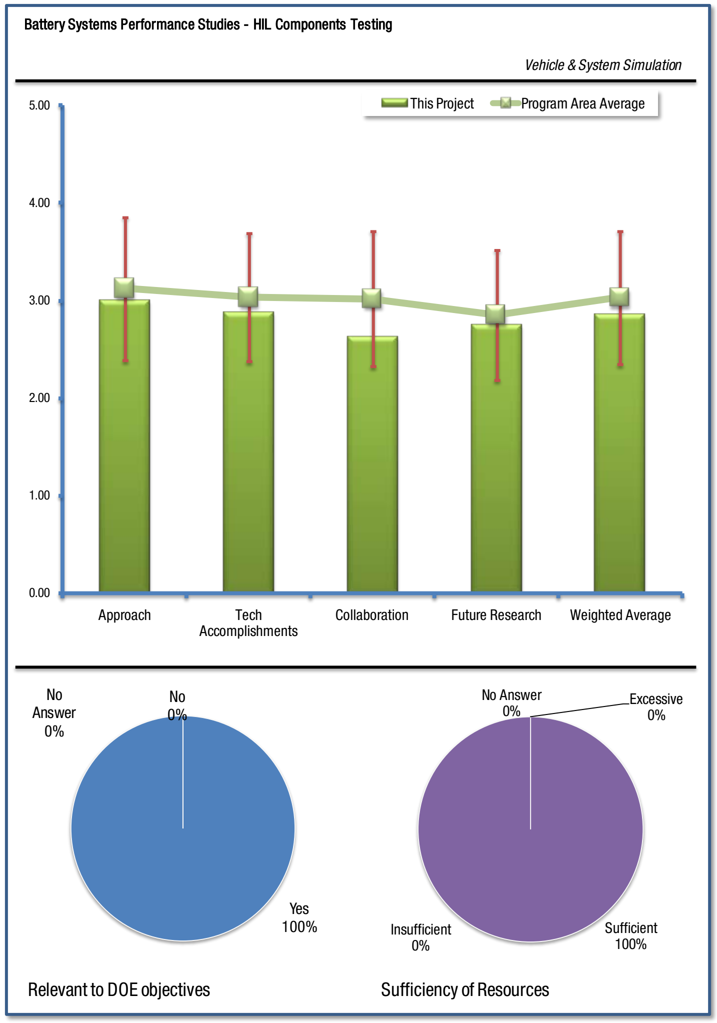
Furthermore a reviewer points out that the energy storage performance studies are a duplicate of efforts being performed by the Electrochemical Energy Storage Technical team members who have vastly more experience and resources. Some of the studies on battery and/or ultracapacitor performance and system trade-off have already been performed by the ECES team.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer wonders if the funds are used as effectively as possible, despite the project team feeling the resources are not sufficient for the work. It would be better judged with a breakdown of the budget. Immediate results -better results, less cost with cost analysis of the packages includes. etc.

Reviewers feel the system cost study is key to the efficacy to this project. One also mentions that it is a relatively inexpensive scoping study could and should be done and results presented before this project proceeds. A reviewer also says the FY-2009 budget of $800k appears excessive for the identified scope.

Battery Systems Performance Studies - HIL Components Testing: Neeraj Shidore (Argonne National Laboratory)



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The reviewers point out that this work addresses important issues for battery life and cost in PHEVs and helps to define how battery system performance affects fuel economy. One reviewer says that if optimized strategies identified are valid once other system level factors are introduced then this will improve cost effectiveness of PHEVs.

One reviewer would like to have this extended to more a national level, that says, if this is the typical drive cycle that we will see in the US on PHEVs, there is a portfolio of PHEVs that would need to be used to cover these driving cycles, and extend that to a National Portfolio of PHEVs with a petroleum displacement at a National level.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer points out that the approach is good, but it is limited to Saft lithium batteries only and feels the study should be generalized to include other types of batteries.

A reviewer also says that there is a very good combination of HIL battery testing with vehicle models to show cycle life and possible cost impacts. A different review felt that the single factor analysis implies no interaction with other system level factors and that results may not be valid. The reviewer looks forward to future work which will address this. They also made the point that a warm engine was assumed in the fuel consumption numbers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewers point out that since the study is narrowly focused on Saft batteries, it is of limited use in planning and developing PHEV vehicles. However other reviewers feel that there is very good progress on tasks with demonstrated results and publications.

A different reviewer thinks this could be extended to trade-off of costs, full life cycle costs, use of types of metals in batteries (where do they come from) vs. petroleum displacement and of course, emission trade-offs.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The limited comments from reviewers point out that this appears to be a predominantly in-house study and they would like to see another data set besides Johnson Controls- SAFT.

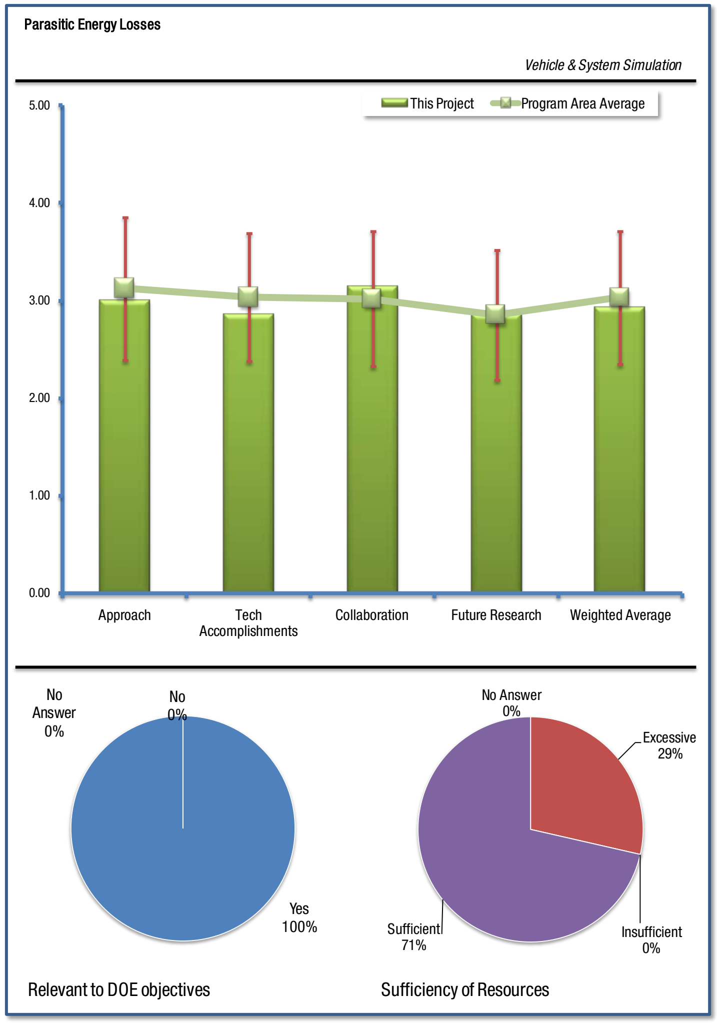
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer feels that there is good definition of next steps of the analysis. But another reviewer would like to see thoughts extended on this study. They ask what assumptions have really been made for battery replacement for the 15 year assumed life of the vehicle.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewers feel the funding is adequate for the expected benefits of this study.

Parasitic Energy Losses: George Fenske (Argonne National Laboratory)



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The reviewers agree that reduction in friction losses clearly could improve fuel economy and lead to petroleum displacement. One reviewer points out that limited but important potential for fuel consumption reduction. They point out that the project needs to demonstrate that the results of this project will be adopted in the market to actually achieve reductions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer points out that the approach is good, if somewhat pedestrian and incremental, there are no clear indications of promise of breakthrough in any of the areas. Nevertheless they feel the work is necessary. One reviewer points out that in Slide #3 of the presentation is an Energy Map, but some of the units are in horsepower. It is incorrect to mix energy and power on the same flow chart. Yet another reviewer says that this is a good approach to making some difficult measurements that relate to practical engine systems. Two reviewers have also pointed out that this project appears to be redundant with vss_12, Friction and Wear Reduction for Heavy Vehicles.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers feel that good progress was made in benchtop testing. One reviewer elaborates that things are moving along at a measured pace, as they have for years. And maybe that is the best one can expect in this complex field.

A different reviewer says a number of accomplishments were cited, but no cumulative measure of reduction in friction losses was presented. They would like to be provided the net cumulative impact of friction loss reduction that has been actually realized by this project, not only the hypothetical potentials. Also, they would like the project to quantify and provide the potential fuel savings for each of the research areas.

One reviewer commented that there have been very little, if any, recent publications on results in the literature and would like to know why.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers point out that there are a number of good partnerships that were identified and they seem to be reasonable. Further, some of these include cost share.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

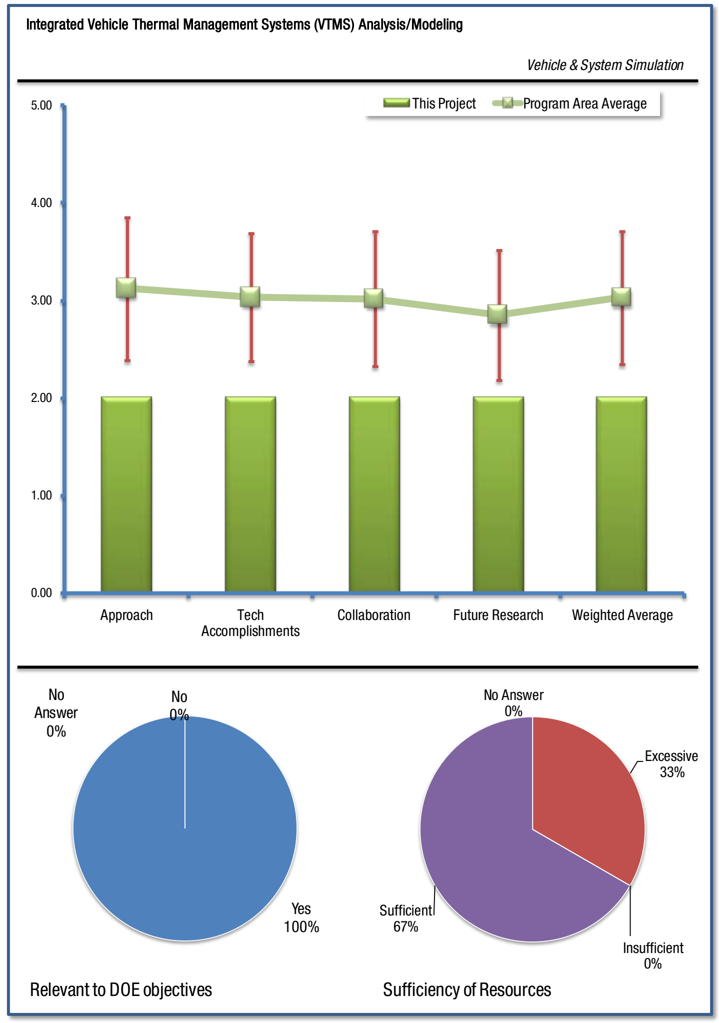
Reviewers point out that the path forward seems reasonable, while it is more of the same but that is probably OK.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers say it is unclear if budgetary issues limit any of the work. They see a steady need to continue to research and develop new coatings and additives that may lead to reduction in friction losses. Some reviewers feel the funding seems reasonable relative to all the other projects funded by the overall DOE program.

However a few reviewers feel this is very high funding for the relative output of data and publications, and wonder if partners that stand to benefit could share more of the cost. They also point out that this funding, along with the Friction and Wear Reduction for Heavy Vehicles, appears to be excessive for the relative benefits that could result.

Integrated Vehicle Thermal Management Systems (VTMS) Analysis/Modeling: Matthew Thornton (National Renewable Energy Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers feel that this is an important research area that investigates current technologies for improved vehicle thermal management, waste heat utilization, and integrated cooling. They say that any improvements in energy efficiency may lead to petroleum reduction, but may have rather limited potential.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer gave insight that the project started in FY07, yet one of the FY08 goals is to identify potential areas for research related to waste heat utilization and that this looks like funding looking for scope. They elaborate that the project looks like it is duplicating many existing capabilities elsewhere including the OEMs, universities and National Labs. They say the DOE resources should not be utilized to duplicate existing capabilities such as developing thermal modeling capabilities and performing run-of-the-mill thermal analysis scenarios. A reviewer also says the specified barrier is about a commercially viable integrated vehicle thermal management system, yet the approach and scope of this work does not address the commercial viability (i.e., cost) anywhere. The reviewer is not even sure if the stated barrier truly is a barrier.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer says that the presented technical accomplishments mostly look like restatements of well know or easily obtainable component and system performance and operating conditions. They continue to say that there is really nothing new here that couldn't be done by the OEMs if it interested them and they saw value in it.

A different reviewer says these are limited results of limited value. They also say that the heat exchanger for power electronics and ac condenser was integrated in the 2004 Prius. The 2010 Prius has engine exhaust heat recovery into the coolant. This work is being done at the vehicle systems level by OEMs. They also say that most previous reviewer comments have not been addressed.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer says that the partnerships are with other National Labs rather than industrial customers or OEMs which leads them to believe there is not much outside interest in this work.

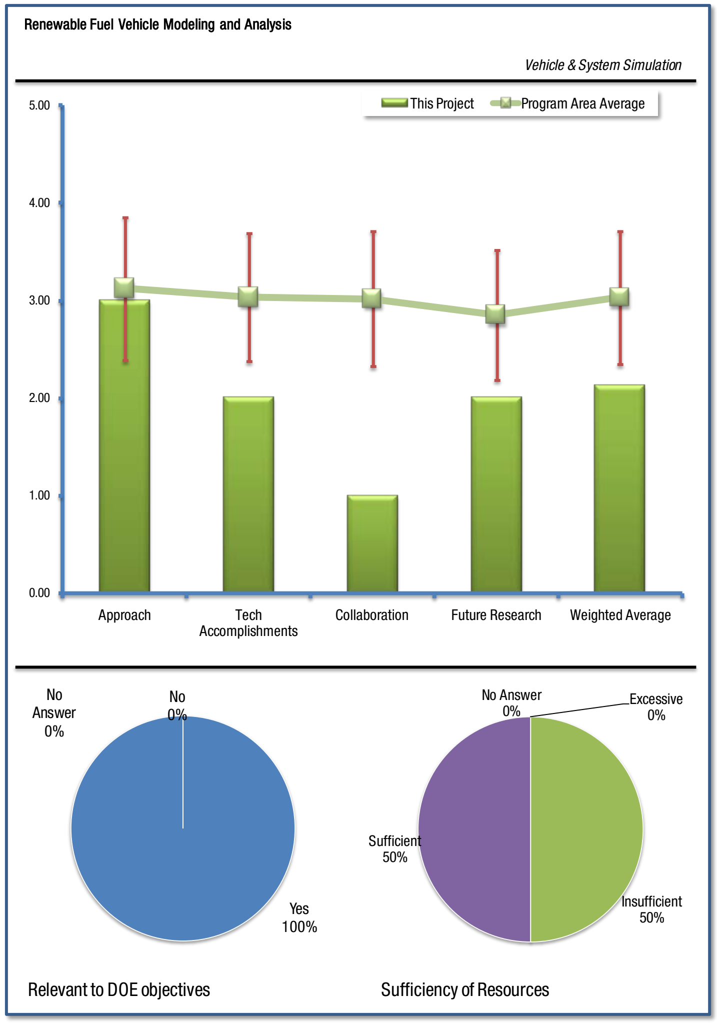
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer feels that this is an important area, transfer and costs should be considered. A different reviewer says that there is not much of anything new or anything that couldn't be done by the OEMs if they cared about it.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer is disturbed that this appears to be 100% DOE funded. A different reviewer didn't see a lot of value in this project and at a minimum, it should be combined with the NREL CoolCab Truck Thermal Load Reduction project.

Renewable Fuel Vehicle Modeling and Analysis: Aaron Brooker (National Renewable Energy Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The reviewer says this is very important research area for the future. No other comments were made.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer says that the projects long term perspective is analyzed and is a very good approach. Without looking at optimization of systems involving renewable fuels the analysis is missing major opportunities.

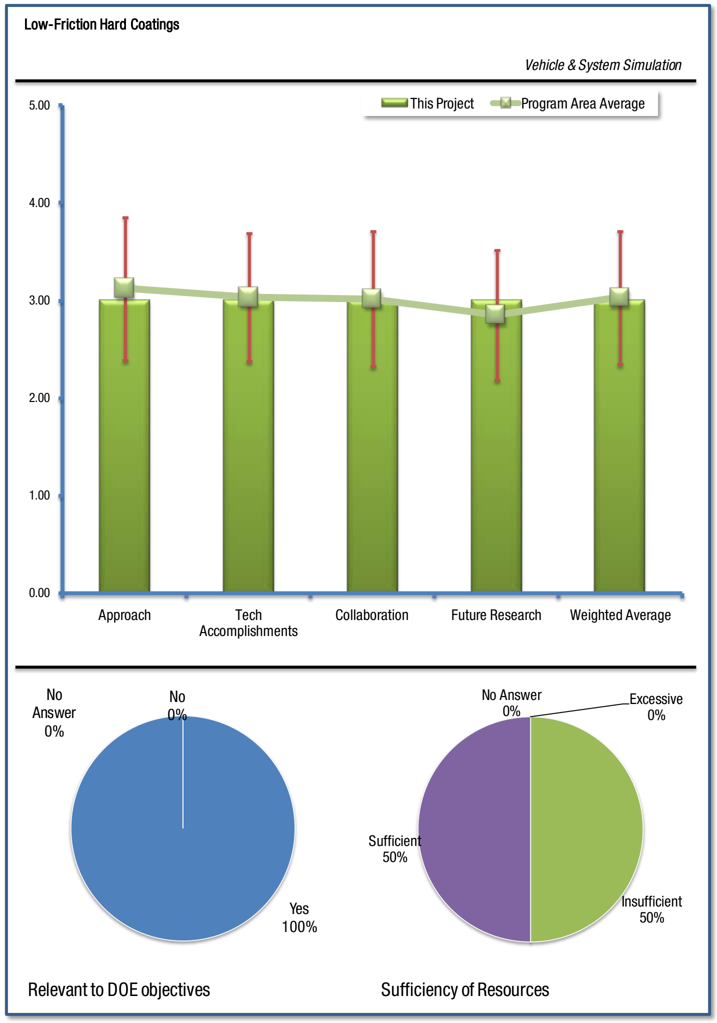
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer says that HEVs could provide a large reduction in oil use with little additional cost. They also say that the major challenge to address is the cost analysis and the need for lower cost ethanol or increasing efficiency. No other reviewers made comments.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer points out that the industry could also be involved and allow for market entry factors to be analyzed. A different reviewer asks if there is even any collaboration at all.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
None of the reviewers provided comments back to this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
None of the reviewers provided comments to this question.

Low-Friction Hard Coatings: Ali Erdemir (Argonne National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer points out that the component and system performance is too low. Another reviewer says the improved surfaced coatings may be used on components to extend life and reduce friction which leads to petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer notes that the approach to the work is very encompassing and includes look at component and system performance, safety, durability, and reliability, vehicular operational demands. They also say that the approach for the target problem is fine but might be improved by including future mechanical and wear testing....and more experiments at APS to look a residual behavior.

A different reviewer says that the approach looks sound and reasonable and is comprised of a series of logical steps with go/no-go decision points and has led to the bench top demonstration of a new capability. They feel this could be further strengthened if the specific criteria for continuing or stopping at each of the decision points were specifically stated.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer says the effort is commendable but will rely heavily on the partnerships beyond ANL to be truly successful. Another reviewer feels the project shows promise for success.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer says that to truly achieve demonstration, commercialization and scale up, it may behoove the team to include more collaborators in the commercial sector to truly go into production mode. A different reviewer says the collaborators are appropriate for this work and are involved in the key steps leading to commercialization of a product.

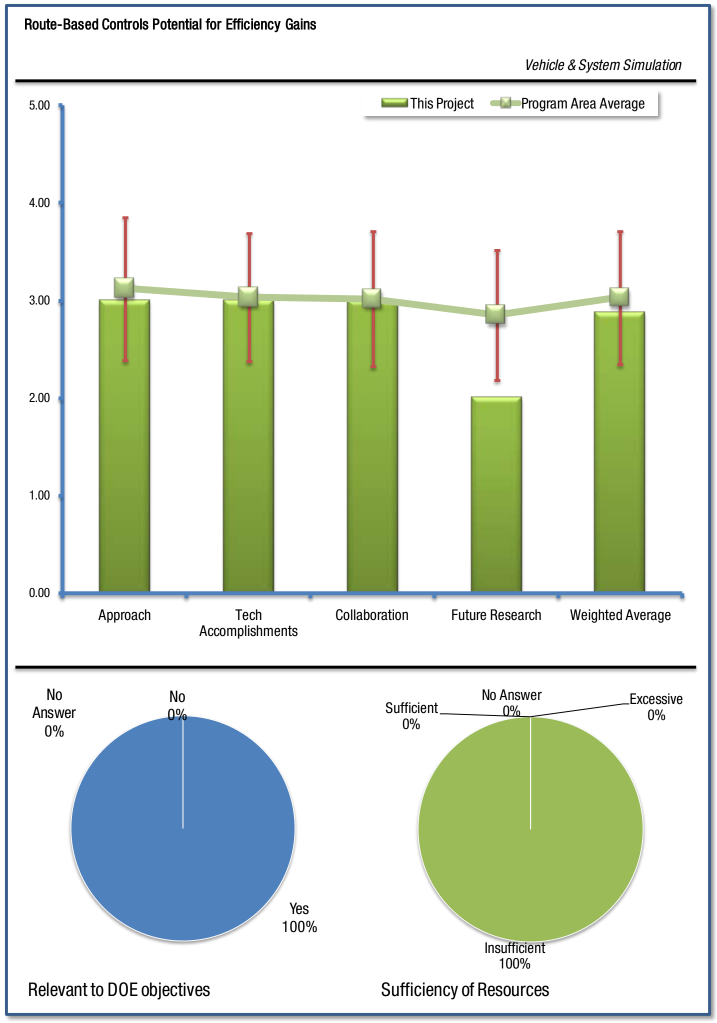
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer feels that to truly achieve the future work as outlined, the ANL team will need to increase collaboration with industrial partners, demonstrate more effective cost-competitiveness and benefits and include partners who can

take production full scale quickly and economically. Another reviewer says the proposed future work looks like a logical conclusion to this project.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer feels that the budget appears sufficient for the characterization but not demonstration, commercialization and scale up --if truly achieved. A second reviewer says that no funding issues were identified.

Route-Based Controls Potential for Efficiency Gains: Jeffrey Gonder (National Renewable Energy Laboratory) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The single reviewer felt that relatively free fuel consumption reduction is something that must be explored.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The single reviewer would like to know if z-dimension map data was included. They felt it wasn't clear from the presentation materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

There was only one reviewer for this presentation and they did not comment on this question.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

There was only one reviewer for this presentation and they did not comment on this question.

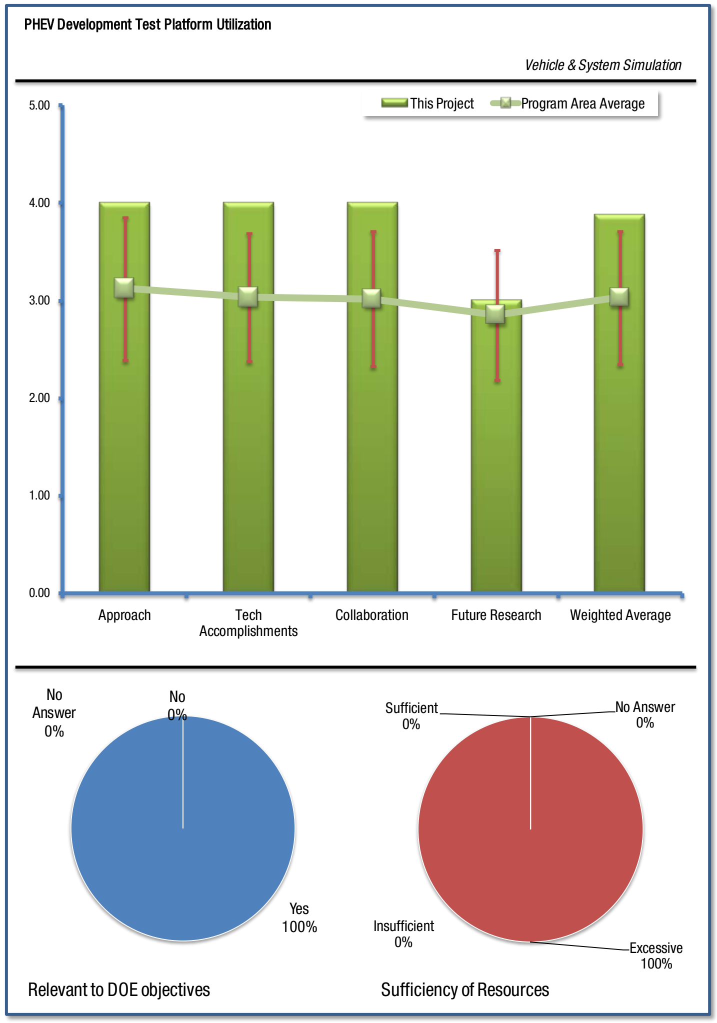
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer feels that true benefits are likely to be seen from combining green routing with other ITS, active safety, and smart pedals.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer feels the funding is insufficient and that much greater focus in this area is warranted.

PHEV Development Test Platform Utilization: Henning Lohse-Busch (Argonne National Laboratory) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The single reviewer thought that the evaluation of EV, HEV and PHEV systems in the context of the total vehicle is key to understanding the performance of each systems and its interactions with other systems. They feel that this will contribute to the development of EVs, HEVs and PHEVs which will lead to petroleum displacement

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The single reviewer felt that the approach looks reasonable and has led to the development of the new system evaluation capability provided by the Modular Automotive Technology Testbed and its use in evaluating system impacts and interactions as demonstrated in the collaborations with the SAE J1711 test standards committee.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The sole reviewer said that the accomplishments look noteworthy and have led to the development of the new system evaluation capability provided by MATT and its use in evaluating system impacts and various scenarios that could not easily be done in a production or prototype vehicle. They also think the timely collaborations with the SAE J1711 test standards committee are also noteworthy.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer also felt that it appears this new capability has aided the SAE J1711 committee in the formulation of new PHEV test standards.

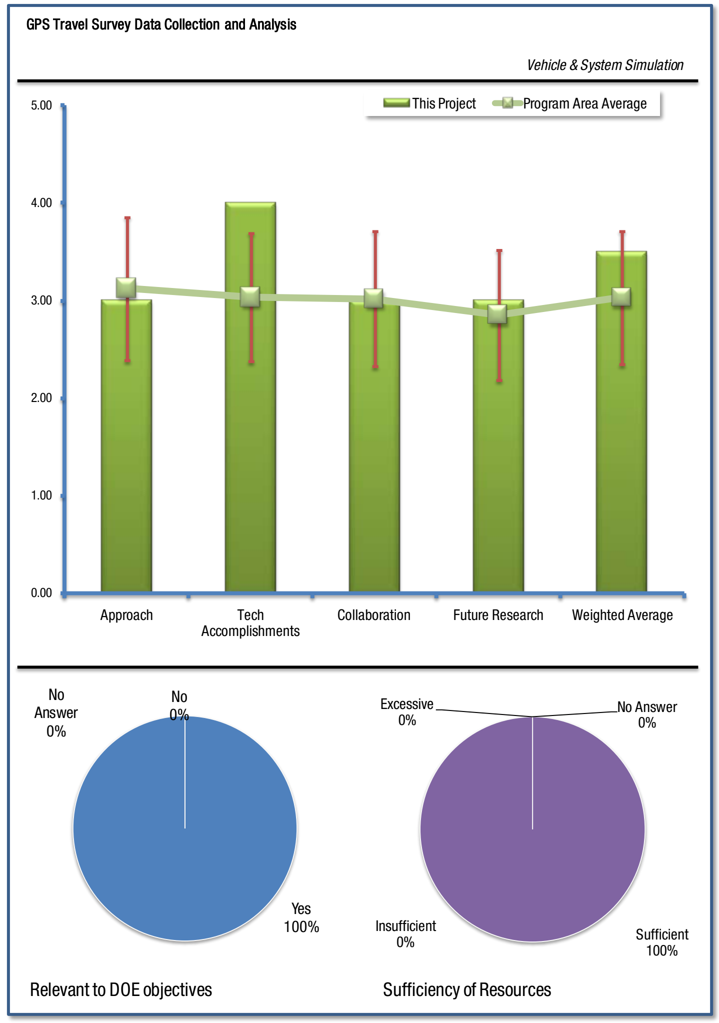
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer said the proposed future work seems like a reasonable utilization of this new capability.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The single reviewer feels the resources are excessive given that the new capability has now been established and that an $800K budget for the proposed scope of work seems excessive.

GPS Travel Survey Data Collection and Analysis: Tony Markel (National Renewable Energy Laboratory) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The reviewer thought that collection of car usage profile data is useful in overall infrastructure and vehicle design, especially PHEVs, and that it will eventually lead to some fuel savings and substitution of PHEVs for gasoline driven autos.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer says that there are no real barriers, project is quite straight forward. They recommend that it might be a good idea to integrate it with the two projects presented from ANL, 03 and 04.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer noted that the project was a one-year project and has been completed.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The single reviewer said that there was some collaboration reported with GM, MPOs, Battelle and FHWA. They also mentioned again that it might have been useful to include the two ANL projects in the list of collaborations.

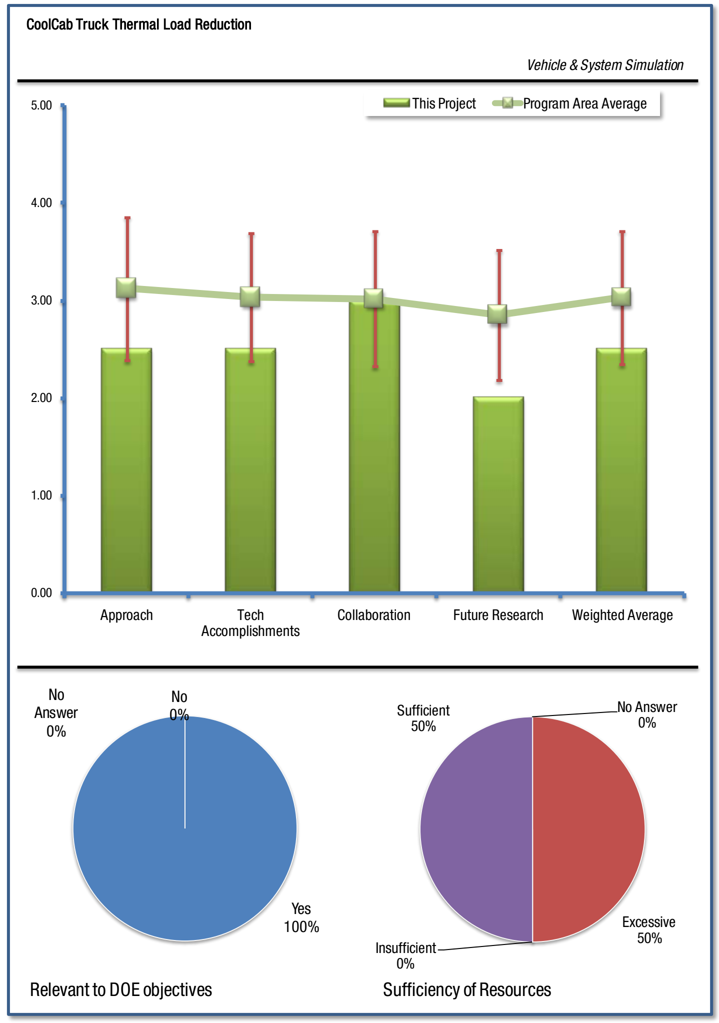
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewer says that since the project is finished the planned future work is only a suggestion. As such it seems very good. They wonder if any more data of this nature is needed, when should the project stop.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The single reviewer noted that the project generated a large amount of data on a small budget.

CoolCab Truck Thermal Load Reduction: Ken Proc (National Renewable Energy Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer felt that a reduction in truck cabin heat loads during idle will reduce the use of air conditioning and result in a reduction in petroleum consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer felt that the approach is quite good, but not clearly stated in the presentation. The other reviewer said that this work seems like it could have been done with existing thermal analysis tools by the OEM or a paid consultant. This reviewer does not see the need for a National Lab to develop new tools when adequate existing tools are available.

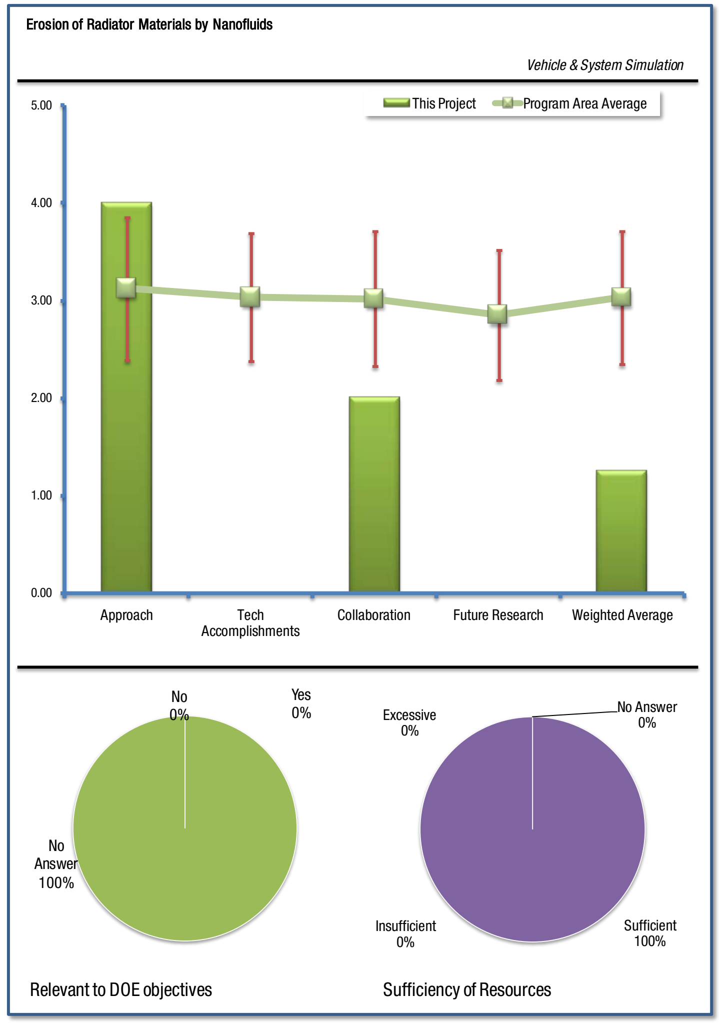
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer said that the development of simple to use analysis tools for HVAC load will help the OEMs to make improvements. A different reviewer said the results are interesting, but have no real surprises and could have been obtained elsewhere.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One of the reviewers said the collaborating organizations seem appropriate.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One reviewer said that the results should be generically applicable to future cab designs and they don't see a need to repeat or further refine this work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer pointed out that the scope is largely completed and they did not see a need for any further work by a National Lab. They felt that, at a minimum, this project should be combined with the NREL Integrated Vehicle Thermal Management System Analysis/Modeling project.

Erosion of Radiator Materials by Nanofluids: Dileep Singh (Argonne National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The single reviewer said that the project effectively supports the DOE objective of petroleum displacement by investigating the effects of nanofluids for thermal management in heavy vehicles that are not established. Furthermore they feel the work investigates comprehensive questions to understand improve energy efficiency using nanofluids vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
The reviewer feels that the approach is sound and takes an excellent detailed look at effect of nanofluids in various aspects of the systems. They note that the experimental approach uses SAXS and other very advanced characterization tools, complemented with strong modeling analysis.

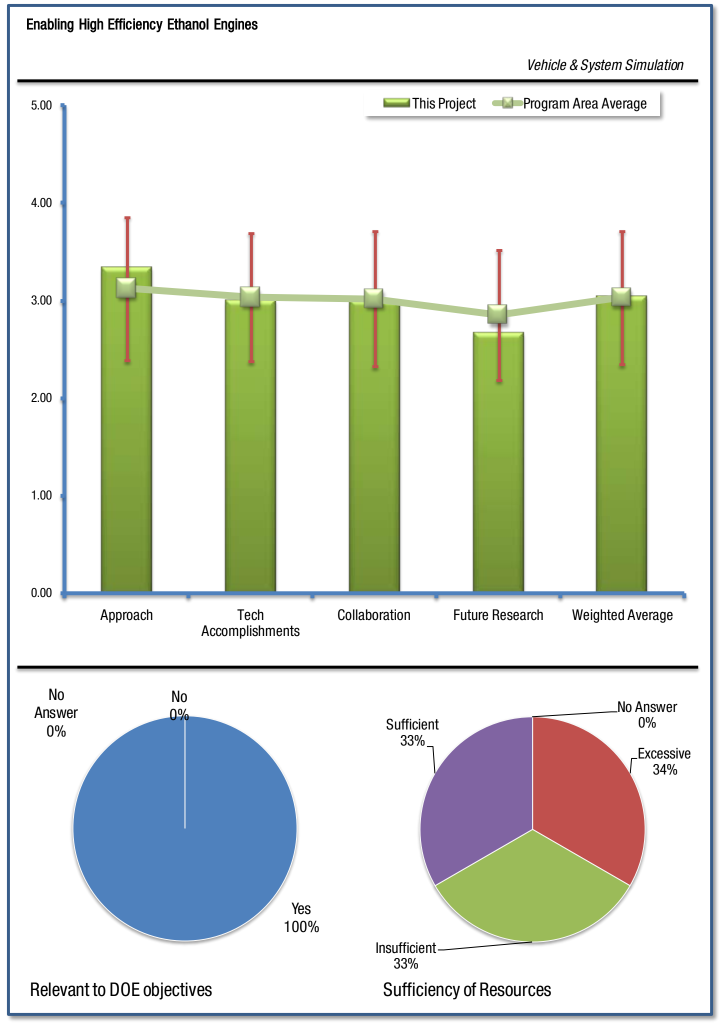
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
The reviewer said that the accomplishments are underway and consistent with the project approach and that SAX characterization measurements are impressive. They also feel that the team is measuring the erosion of radiator material using SiC EG/H_2O based nanofluids and looking at velocity and impact angle as well as particle loading. They continue to elaborate by saying that this surely will be important for understanding the effect of nanofluids and continue on the path to understand/find any showstoppers for use of them in heavy vehicle systems.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
The reviewer noted that the partners include TARDEC/WFO and Michelin WFO/cost-share, but say that the partnership and collaboration could be expanded.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
The reviewer gave a simple comment about the future work after describing what the work would be: “This is fantastic”.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The reviewer feels that the project has a very humble budget for the work achieved.

Enabling High Efficiency Ethanol Engines: Robert Wagner (Oak Ridge National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer points out that combustion engine efficiency/management are important issues in regard to petroleum displacement. Another reviewer says that the development of alternative-fueled engines may lead to petroleum displacement. A different reviewer says that in order to reduce the amount of petroleum consumed, alternative fuels, such as ethanol, need to be maximized in their efficiency of use.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer says that this activity makes use of state-of-the-art engine technology through industry partnership in support of VTP R&D priorities. They also say that the approach for the work as accomplished appears to be reasonable. A different reviewer says there is excellent coverage of the experiment field with single cylinder engine and Saab bi-fuel engine work to be able to assess ethanol combustion characteristics.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One of the reviewers noted that the work is still in progress and it is hard to comment on technical accomplishments, but that they look good so far. Another reviewer says the important technical accomplishments are the development of engine models and corresponding ethanol-based engine maps that can be used in vehicle system simulation codes as PSAT. They note that these have largely been accomplished. One of the other reviewers said that there has been good progress towards meeting the objectives of defining ethanol combustion characteristics and improving engine efficiency.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer feels that active collaboration with industry for testing is advantageous. A different reviewer says that interactions with Delphi were mentioned several times and seem reasonable. One of the other reviewers say that that it is good to have a CRADA with Delphi and co-funding with Fuels Program, but that the project could use the involvement of an engine manufacturer as well.

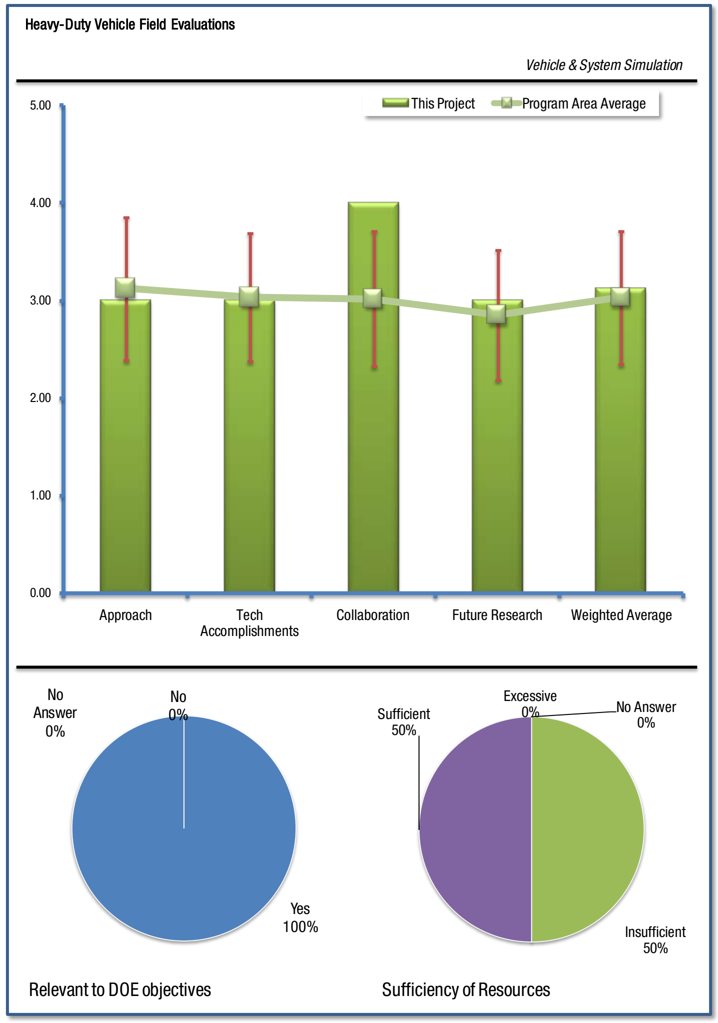
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One of the reviewers says that there are good potential and concrete goals. Another reviewer says that the important aspects of this project are the engine models and associated ethanol-based engine maps. They say that this has largely

been completed and the need for further development should be greatly diminished. Furthermore they note that other ethanol-based engine work is likely already being performed by the OEMs at a much larger and more sophisticated level. They feel that future work at ORNL should focus on simulations and analyses utilizing the newly developed capabilities. One of the other reviewers says that the project has a good plan for addressing barriers and demonstrating ethanol capabilities.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer says that the identified budget is $150k/yr from Vehicle Systems plus $350k/yr from Fuels Technologies for a total of $500k/yr and that given that the most important new capabilities have now been largely established the $500k/yr seems excessive for the proposed engine and system simulation studies. Another reviewer says that for the potential benefits to be demonstrated by this activity in the improved efficiency of ethanol engines, this project seems to be under-funded.

Heavy-Duty Vehicle Field Evaluations: Kevin Walcowicz (National Renewable Energy Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer says that fleet measurements of this type are useful, but only support the objectives of petroleum displacement indirectly. Another reviewer says that this activity helps to characterize the performance of hybrid trucks and buses, leading to an expanded penetration of these vehicles in the marketplace.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer felt that there was a good approach to data acquisition and analysis. They also said that development of an analysis tool to develop duty cycle characteristics is valuable.

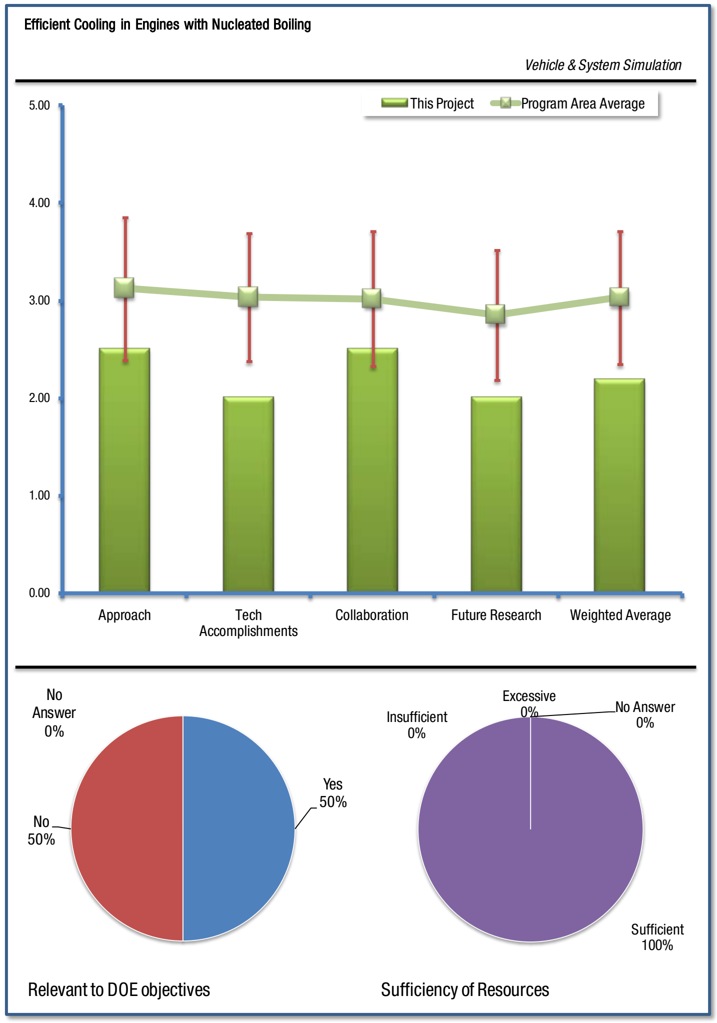
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One of the reviewers said that there was a good assessment of test vehicles and performance results. They also feel that there is a need to determine whether plug-in capability for school buses provides a significant benefit for the additional cost.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer pointed out that there was excellent collaboration with a number of end-users, vehicle OEMs and suppliers.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One of the reviewers felt that the engine off at idle performance measurement is critical to determining potential of hybrid configurations. They also noted that the further development of duty cycle analysis tool should be beneficial.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer felt that the funding was insufficient and additional resources are required to expand the work on the duty-cycle analysis tool and to monitor additional vehicle vocations.

Efficient Cooling in Engines with Nucleated Boiling: Wenhua Yu (Argonne National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One of the reviewers thought that any improvements in heat transfer could result in reduced system weight leading to reduced petroleum consumption. The other reviewer thought that this is a sub point and thermal systems really need to be looked at with regards to the overall vehicle system.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One of the reviewers said that the presentation alludes to potential engine and aerodynamic enhancements but they are not mentioned any further and in reality this is strictly a 2-phase heat transfer and fluid flow study using mixtures of water and ethylene glycol. They go on to say that the only reasonable place where 2-phase heat transfer and fluid flow might occur is at the heat source which is the engine, not in the radiator where heat is dissipated. Otherwise, the penalty due to the increase in pumping power required for 2-phase flow would likely overshadow any improvements in heat transfer. Because of many potential issues including greatly increased pumping power requirements and the potential for flow blockages, this reviewer believed a 2-phase flow system comprised of engine, pumps, hoses, flow passages and radiator is not feasible. Thus, they feel that the aerodynamic improvements from reduced radiator sizes really don't come into play since the project is most likely limited to single-phase flow and heat transfer at the radiator which is already well studied and understood.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer felt that the presentation mixes current reporting-period results with past accomplishments. They feel much of the discussion of technical accomplishments is related to heat transfer and fluid flow studies in horizontal geometries, which is not part of the present scope. The PI told the reviewer that the present work is for vertical geometries. Further, the reviewer notes that much of the work relates to 2-phase flow and heat transfer in both horizontal and vertical geometries which has already been accomplished by others as exemplified by the use of the figure on Page 12 which they believe was lifted from a rather old and uncited text book. The reviewer continues to say that the world-wide commercial nuclear power industry has and continues to perform extensive studies on 2-phase flow and heat transfer in all kinds of geometries for both pressurized light water reactors and boiling water reactors. They note that the only truly unique aspect of this work is the use of a 2-phase mixture of water and ethylene glycol.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer noted that potential collaborations with PACCAR and Caterpillar were mentioned but are still pending.

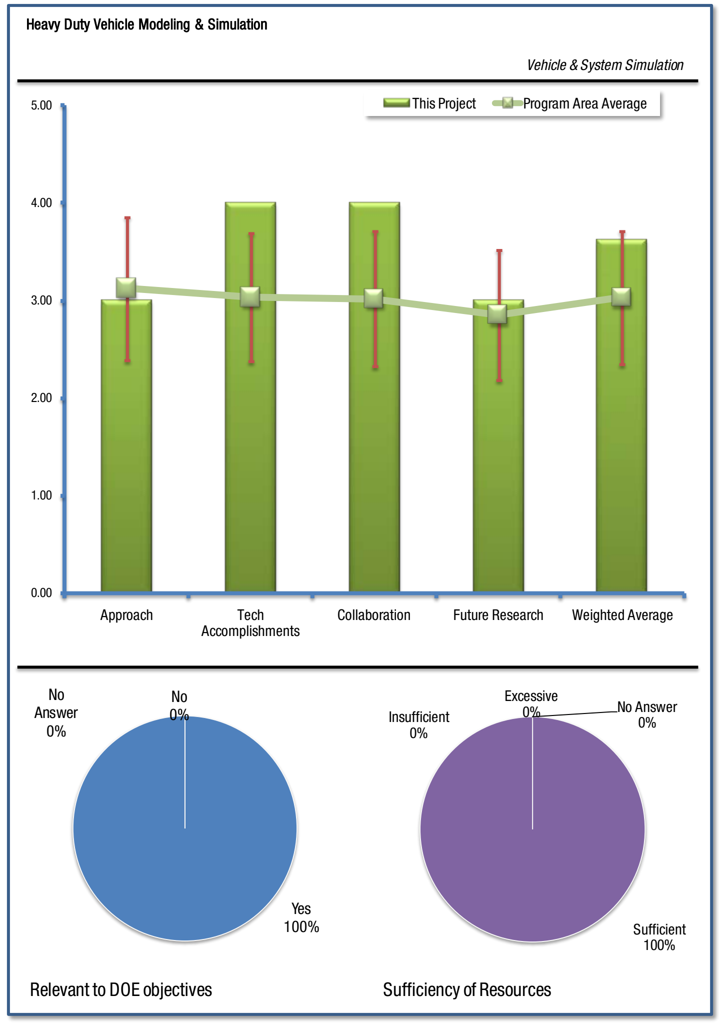
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One of the reviewers said that once the vertical geometry studies are complete, the project should be brought to a close. They see no need for additional work to combine the results of the horizontal studies with those of the vertical studies. The reviewer noted that the two cases bound other orientations and one can logically interpolate between these extremes if needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer pointed out that the resources seem reasonable and once the vertical geometry studies are complete, this project should be brought to a logical conclusion.

Heavy Duty Vehicle Modeling & Simulation: Aymeric Rousseau (Argonne National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The single reviewer thought that this helps develop and support a valuable simulation tool for heavy duty vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
The single reviewer did not have any comments for this question.

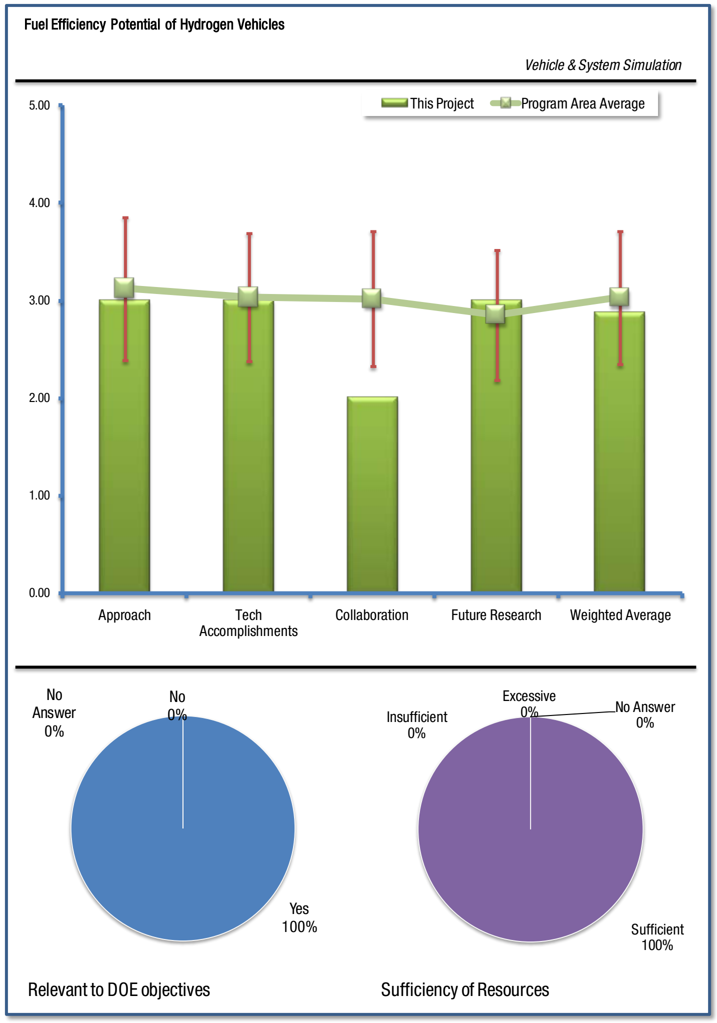
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
The reviewer thought that the correlation between PSAT and measured data was very impressive.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
The reviewer commented that there was a very wide variety of contributors and that it is essential to collect this quantity of data.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
The single reviewer did not have any comments for this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The single reviewer did not have any comments for this question, but thought the amount of resources was sufficient.

Fuel Efficiency Potential of Hydrogen Vehicles: Thomas Wallner (Argonne National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer thought that the data on hydrogen fuel use in combustion engines is needed for economic estimation and engineering designs. The other reviewer thought that alternative-fuel vehicles have the potential to reduce petroleum consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer commented that the approach seems to be well done. But, they do mention that some of the graphs are difficult to read and the choice of reference gasoline engine is not quite clear, as two graphs seem to show different numbers. The other reviewer said the study investigated the use of H_2 ICE in various vehicle configurations and found them to perform quite well.

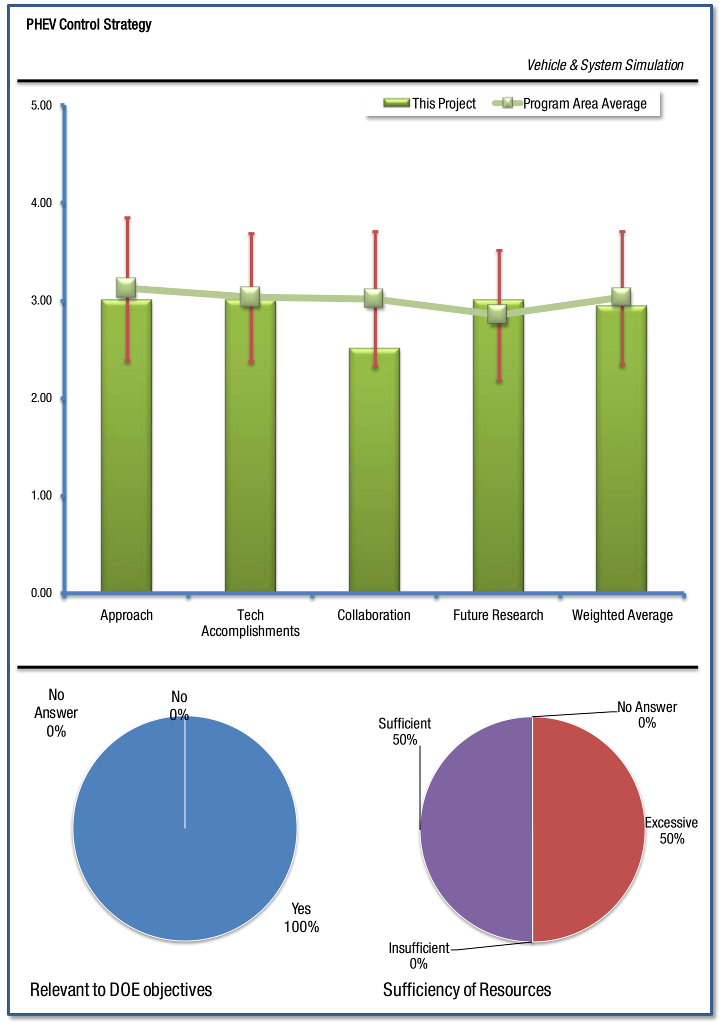
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer says that the accomplishments seem to be more or less on target. The other reviewer noted that the project is near completion and has generated useful information related to H_2 ICE data in hybrid powertrains.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer noted that no collaborations were mentioned and the other reviewer said that the collaborations were limited to in-house within ANL.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One reviewer said that it seems to be the right approach - moving from one cylinder to multi cylinder H_2 engines, for example. The other reviewer thought that the project has been successfully completed and could enable further H_2 ICE studies if so desired.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Both reviewers agreed that the resources seemed reasonable for a study of this depth and scope.

PHEV Control Strategy: Aymeric Rousseau (Argonne National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer noted that optimizing control strategies leads to optimization of vehicle performance and the commensurate reduction in petroleum consumption. The other reviewer agreed by saying that this work indirectly supports PHEV work to reduce fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One of the reviewers said that the objective was to investigate and determine the best control strategy for a PHEV within certain constraints and the objective was met. The other reviewer felt that the details and optimization of HEV control strategies will depend on specific vehicles and implementation by OEMs. They further noted that while the importance of control strategy is well known, most of the results can be anticipated, and the uncertainty of applying optimization at this stage of vehicle analysis is questionable.

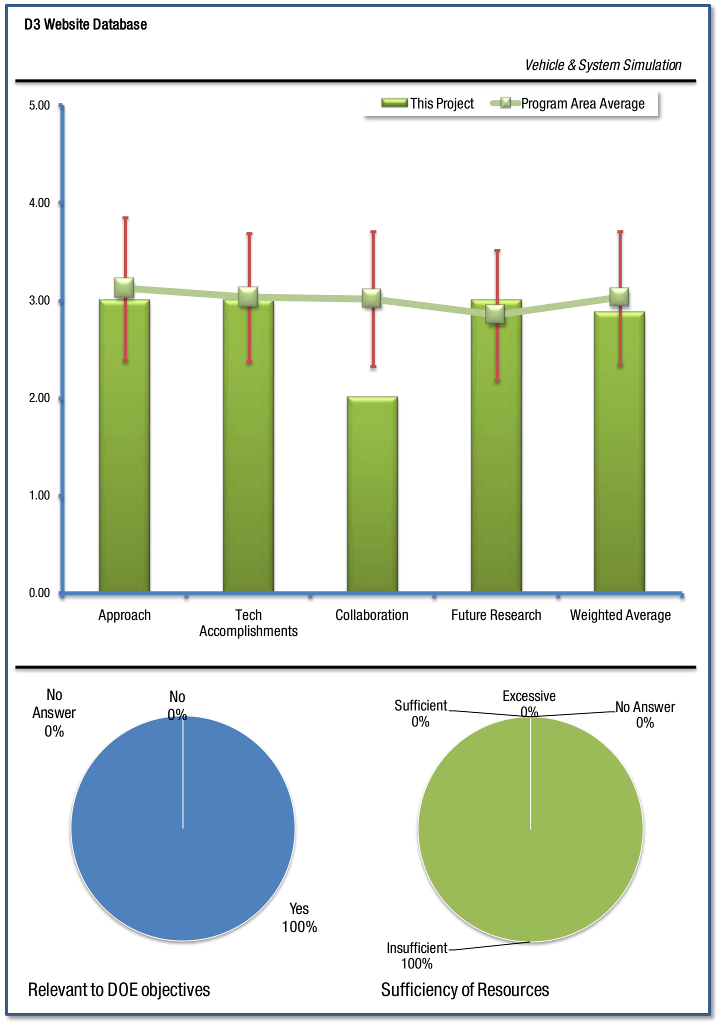
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One of the reviewers thought that the project completed the objective of investigating and determining the best control strategy for a PHEV within certain constraints. The other reviewer felt that the project demonstrated expected results.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
The reviewers agreed that collaboration existed between this project and some EPA partners, along with work accomplished with ATVA, NREL and others on drive cycles.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One of the reviewers noted that the PI proposes additional control strategy studies. The reviewer felt that this may be warranted and desirable but scope needs to be bounded and prioritized.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer said that for a study of this scope, size and nature, the size of the budgets, especially FY08, seem rather large.

D3 Website Database: Glenn Keller (Argonne National Laboratory) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The single reviewer felt that this project provides detailed data on vehicle dynamometer performance that should be beneficial to the industry and educational institutions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewer felt that it would be good to define and quantify the need for this type of tool in order to better justify the activity. They also noted that these types of databases are expensive to set up, customize and maintain, so justification of the project is a must.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewer also said that the project seems to be making good progress on a limited budget. They also commented that the one page reporting tool is useful for a snapshot of vehicle dynamometer performance.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewer said that more extensive coordination with other commercial entities would be helpful in defining and expanding the utility of this tool.

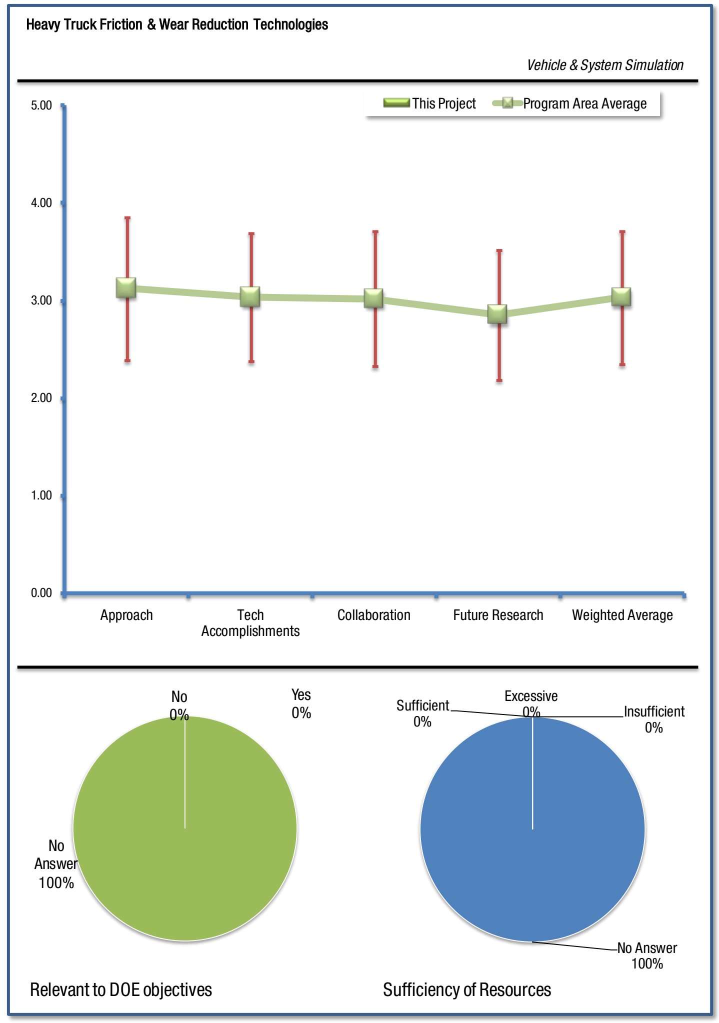
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The single reviewer said that the next steps in database and access refinement seem appropriate.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

The reviewer felt that the resources are insufficient and that if this is truly a necessary tool, the amount of funding it is receiving is insufficient to fully build its capabilities.

Heavy Truck Friction & Wear Reduction Technologies: Michael Killian (Eaton Corporation) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The primary reviewer did not see this presentation (it was a poster presentation). There were no other reviewers listed and no other comments made.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
The primary reviewer did not see this presentation (it was a poster presentation). There were no other reviewers listed and no other comments made.

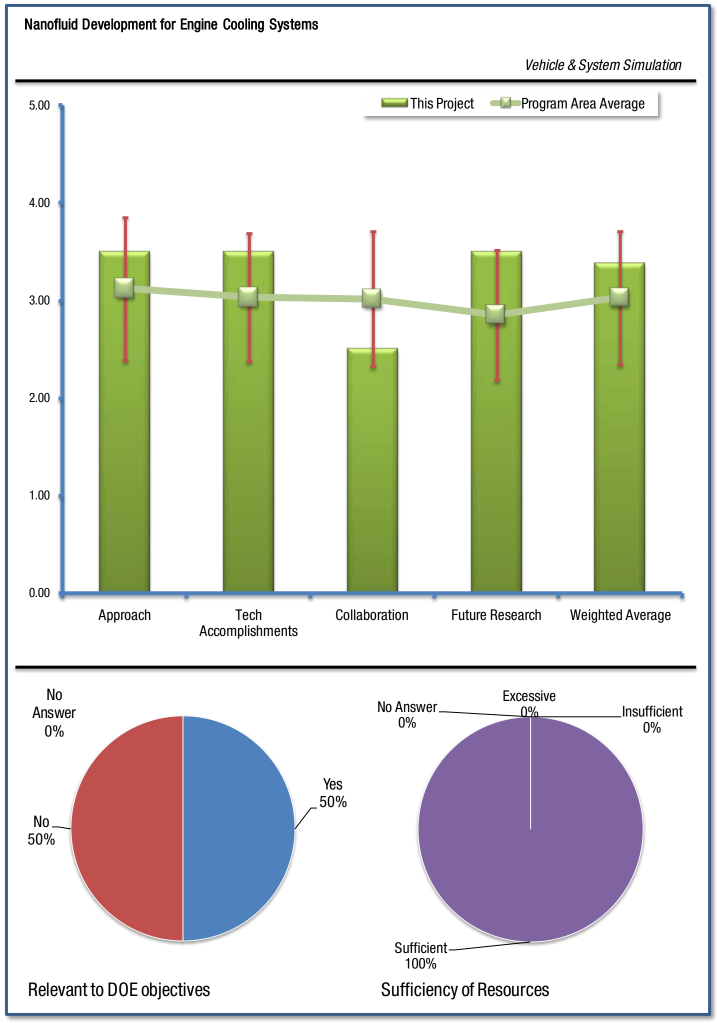
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
The primary reviewer did not see this presentation (it was a poster presentation). There were no other reviewers listed and no other comments made.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
The primary reviewer did not see this presentation (it was a poster presentation). There were no other reviewers listed and no other comments made.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
The primary reviewer did not see this presentation (it was a poster presentation). There were no other reviewers listed and no other comments made.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The primary reviewer did not see this presentation (it was a poster presentation). There were no other reviewers listed and no other comments made.

Nanofluid Development for Engine Cooling Systems: Elena Timofeeva (Argonne National Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One of the reviewers felt that the contribution is somewhat indirect, by noting that the project is directed towards improving the heat removal efficiency of the radiator fluid in trucks. The reviewer said this in turn, will allow a decrease in radiator size with resultant weight reduction and decreased air resistance and this, then, results in lower fuel consumption.

The other reviewer felt this is a sub point and felt that the thermal systems really need to be looked at with regards to the overall vehicle system.

Question 2: What is your assessment of the approach to performing the work?
To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One of the reviewers said that the project is very nicely done work, and the PI obviously knows the nanofluids field and the related chemistry. They do note that some theoretical development remains to be done in the field, such as heat transfer and viscosity vs. particle shape. They feel that this might worth some future effort.

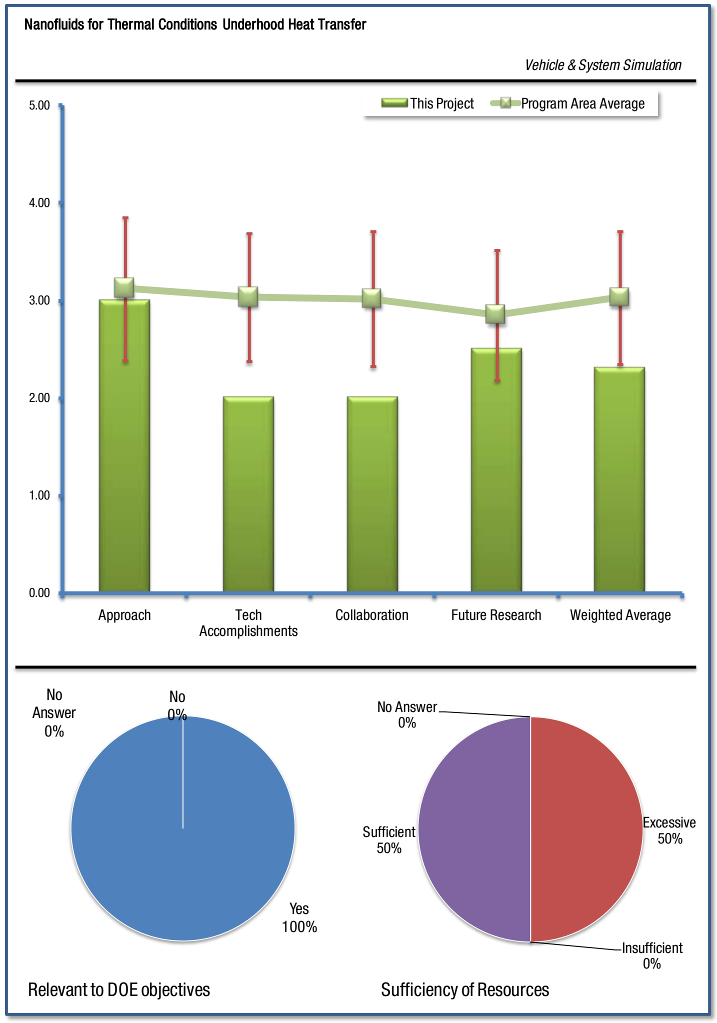
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer said the project is doing very well, although somewhat limited by the size and shape of nano- or submicron particles available.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One of the reviewers said that the level of collaboration is relatively minor, mostly contribution of particles from Saint Gobain, but certainly worthwhile.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One reviewer felt that the project is well on track and has interesting promise, not only for diesel coolant development but potentially for many other technological cooling applications.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The reviewers feel that the level of resources seems to be ok.

Nanofluids for Thermal Conditions Underhood Heat Transfer: Wenhua Yu (Argonne National Laboratory) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One of the reviewers felt that the project contributes to the DOE objective of petroleum displacement by looking at engine cooling via behavior and evaluation of nanofluids. They also said that by looking at the reduction of radiator weight, aerodynamic drag, and parasitic energy losses by engineering stable nanofluids, the project is increasing energy efficiency systems that could displace petroleum further. They also commented that nanofluids have high thermal conductivities, high heat transfers, low viscosity, and are environmentally friendly. The other reviewer said that the possibility of significantly enhanced heat transfer offered by nanofluids could lead to a small reduction in engine weight and a small reduction in petroleum consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer felt that the PI seems to have a good understanding of heat transfer and fluid flow and a systematic approach to the research.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One of the reviewers said that while the quality of the work appears to be very high, the amount of progress and nanoparticle-associated improvements seems somewhat more limited. They feel some small incremental improvements in heat transfer seem possible but nothing really revolutionary appears to be on the horizon. Since the project is specified to have been ongoing since FY06, it seems odd that the critical barriers were not identified until FY08.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers note that the partners include TARDEC/WFO, Saint Gobain-cost share, Michelin WFO/cost-share, PACCAR (CRADA in progress) and Industrial Technologies Program (DOE). One notes that the nature of the collaborations is not really discussed. A reviewer also feels that given the limited success, it is difficult to envision much third-party interest. Further they noted that no third party funding or cost share was identified.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One of the reviewers said it would be nice to see simulations already on past results. The other reviewer felt that given that various aspects of this work have been ongoing since at least FY06, the potential improvements so far seem be rather under whelming and nothing in the proposed future work shows any potential breakthroughs.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer feels the funds are adequate for the targeted program. However the other reviewer feels that given the limited improvements observed in heat transfer so far, the budget increase in FY09 to $400K from $250K in FY08 seems excessive and unwarranted.

2. Energy Storage Technologies

Introduction

Energy storage technologies, especially batteries, are critical enabling technologies for the development of advanced, fuel-efficient, light- and heavy-duty vehicles, which are critical components of the U.S. Department of Energy's (DOE's) Energy Strategic Goal: "to protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy." The program's vision supports the development of durable and affordable advanced batteries covering the full range of vehicle applications, from start/stop to full-power hybrid electric, electric, and fuel cell vehicles. Much of this work will transfer to energy storage for heavy hybrid vehicles as well. Energy storage research aims to overcome specific technical barriers that have been identified by the automotive industry together with the Vehicle Technologies Program. These include cost, performance, life, and abuse tolerance. These barriers are being addressed collaboratively by the DOE's technical research teams and battery manufacturers.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Battery Pack Requirements and Targets Validation FY 2009 DOE Vehicle Technologies Program	Dan Santini (Argonne National Laboratory (ANL))	2-8	3.00	3.40	3.00	3.00	3.20
PHEV Battery Cost Assessments	Brian Barnett (TIAX LLC)	2-10	2.50	2.50	2.25	2.50	2.47
United States Advanced Battery Consortium	Kent Snyder (Ford Motor Company)	2-13	3.25	2.75	3.00	2.50	2.88
Review of A123's HEV and PHEV USABC Programs	Ric Fulop (A123Systems)	2-15	2.33	2.33	2.00	2.67	2.33
Plug-in Hybrid Battery Development	Cyrus Ashtiani (Enerdel)	2-17	2.67	2.67	2.33	3.50	2.73
JCS PHEV System Development	Scott Engstrom (Johnson Controls-Saft)	2-19	2.00	1.75	2.67	1.75	1.93
USABC Program Highlights	Mohamed Alamgir (Compact Power)	2-21	3.00	3.00	2.67	2.67	2.92
Celgard and Entek - Battery Separator Development	Harshad Tataria (Celgard and Entek)	2-23	2.75	2.50	2.00	2.50	2.50
Energy Storage Testing and Analysis High Power and High Energy Development	Tim Murphy (INL, ANL, and SNL)	2-26	3.40	3.50	3.75	3.60	3.52
Testing USABC Deliverables/Benchmarking	Ira Bloom (Argonne National Laboratory (ANL))	2-28	2.33	2.33	2.67	2.33	2.38
Abuse Testing of High Power Batteries	Peter Roth (Sandia National Laboratory (SNL))	2-30	3.60	3.75	3.75	3.25	3.65
Thermal Management Studies and Modeling	Ahmad Pesaran (National Renewable Energy Laboratory (NREL))	2-32	3.25	3.25	3.25	3.50	3.28

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
International Collaboration With a Case Study in Assessment of World's Supply of Lithium	James Barnes (US DOE/ ANL)	2-35	3.00	3.60	3.60	2.60	3.33
Overview of Applied Battery Research	Gary Henriksen (Argonne National Laboratory (ANL))	2-37	3.60	3.60	3.60	3.40	3.58
Overview of the Batteries for Advanced Transportation Technologies (BATT) Program	Venkat Srinivasan (Lawrence Berkeley National Laboratory (LBNL))	2-40	3.50	3.25	3.50	2.75	3.28
Electrode Construction and Analysis	Vince Battaglia (Lawrence Berkeley National Laboratory (LBNL))	2-43	2.80	2.80	3.20	2.80	2.85
Microscale Electrode Design Using Coupled Kinetic, Thermal and Mechanical Modeling	Ann Marie Sastry (University of Michigan)	2-46	3.25	3.25	3.00	3.00	3.19
Analysis and Simulation of Electrochemical Energy Systems	John Newman (University of California - Berkeley)	2-48	3.40	3.20	3.20	3.40	3.28
Low Cost SiOx-Graphite and Olivine Materials	Karim Zaghib (Hydro-Quebec)	2-50	3.33	3.00	3.00	2.67	3.04
Layered Cathode Materials	Michael Thackeray (Argonne National Laboratory (ANL))	2-52	3.40	3.40	3.20	3.60	3.40
The Role of Surface Chemistry on the Cycling and Rate Capability of Lithium Positive Electrode Materials	Yang Shao-Horn (Massachusetts Institute of Technology)	2-54	3.25	3.00	2.75	3.00	3.03
The Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides	Stanley Whittingham (SUNY-Binghamton)	2-56	3.20	3.00	3.40	3.20	3.13
Stabilized Spinels and Nano Olivines	Arumugam Manthiram (University of Texas at Austin)	2-58	2.75	3.25	2.00	2.25	2.84
Olivines and Substituted Layered Materials	Marca Doeff (Lawrence Berkeley National Laboratory (LBNL))	2-60	3.40	3.25	3.80	3.00	3.33
Phase Behavior and Solid State Chemistry in Olivines	Thomas Richardson (Lawrence Berkeley National Laboratory (LBNL))	2-62	3.25	3.00	3.25	2.75	3.06
First Principles Calculations (and NMR Spectroscopy of Electrode Materials)	Gerbrand Ceder (MIT/SUNY-Stony Brook)	2-64	3.50	3.00	3.50	3.00	3.19
First Principles Calculations and NMR Spectroscopy of Electrode Materials	Clare Grey (SUNY-Stony Brook)	2-66	3.75	3.75	3.50	3.00	3.63
Characterization of New Cathode Materials using Synchrotron-based X-ray Techniques and the Studies of Li-Air Batteries	Xiao-Qing Yang (Brookhaven National Laboratory (BNL))	2-68	3.60	3.50	3.60	3.00	3.48
Search for New Anode Materials	John Goodenough (University of Texas at Austin)	2-71	3.50	3.50	3.00	3.00	3.38
Nano-scale Composite Hetero-structures: Novel High Capacity Reversible Anodes for Lithium-ion Batteries	Prashant Kumta (University of Pittsburgh)	2-73	3.00	3.00	3.00	3.00	3.00

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Intermetallic Anodes	Michael Thackeray (Argonne National Laboratory (ANL))	2-75	2.75	3.25	3.25	2.75	3.06
Nano-structured Materials as Anodes	Stanley Whittingham (SUNY-Binghamton)	2-77	2.50	2.25	2.25	2.25	2.31
Interfacial Processes Diagnostics	Robert Kostecki (Lawrence Berkeley National Laboratory (LBNL))	2-79	3.50	3.75	3.75	3.25	3.63
Model-Experimental Studies on Next-Generation Li-ion Materials	Venkat Srinivasan (Lawrence Berkeley National Laboratory (LBNL))	2-81	3.67	3.33	3.00	3.33	3.38
Nanostructured Metal Oxide Anodes	A.C. Dillon (National Renewable Energy Laboratory (NREL))	2-83	3.00	3.00	3.25	3.00	3.03
Investigations of Electrode Interface and Architecture	Nancy Dudney (Oak Ridge National Laboratory (ORNL))	2-85	3.33	3.00	3.00	2.33	3.00
Development of Novel Electrolytes for Use in High Energy Lithium-Ion Batteries with Wide Operating Temperature Range	Marshall Smart (California Institute of Technology)	2-87	3.00	2.00	2.67	2.67	2.42
Polymer Electrolytes for Advanced Lithium Batteries	Nitash Balsara (Lawrence Berkeley National Laboratory (LBNL))	2-89	2.75	2.25	2.50	2.50	2.44
Interfacial Behavior of Electrolytes	John Kerr (Lawrence Berkeley National Laboratory (LBNL))	2-91	2.00	1.33	2.67	2.33	1.79
Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte/Electrode Interfaces	Grant Smith (University of Utah)	2-93	3.00	3.00	3.00	3.00	3.00
Bifunctional Electrolytes for Lithium Ion batteries	Daniel Scherson (Case Western Reserve University)	2-96	2.60	2.67	2.40	2.80	2.63
BATT Program- Summary and Future Plans	Venkat Srinivasan (Lawrence Berkeley National Laboratory (LBNL))	2-98	2.67	2.67	2.00	2.67	2.58
Electrochemistry Cell Model	*Dennis Dees (Argonne National Laboratory (ANL))*	*2-100*	*3.50*	*3.50*	*3.00*	*3.50*	*3.44*
Diagnostic Studies on Li-Battery Cells and Cell Components	*Daniel Abraham (Argonne National Laboratory (ANL))*	*2-102*	*3.00*	*2.67*	*3.00*	*2.67*	*2.79*
Statistical Design of Experiment for Li-ion Cell Formation Parameters using Gen3 Electrode Materials: Final Summary	*Kevin Gering (Idaho National Laboratory (INL))*	*2-104*	*2.60*	*2.40*	*1.80*	*1.33*	*2.24*
Low Temperature Performance Characterization & Modeling	*Andrew Jansen (Argonne National Laboratory (ANL))*	*2-106*	*3.00*	*3.00*	*2.67*		*2.58*
Electrochemistry Diagnostics at LBNL	*Frank McLarnon (Lawrence Berkeley National Laboratory (LBNL))*	*2-107*	*3.00*	*3.00*	*2.50*	*3.00*	*2.94*
Diagnostic Studies to Improve Abuse Tolerance and the Synthesis of New Electrolyte Materials	*Xiao-Qing Yang (Brookhaven National Laboratory (BNL))*	*2-109*	*3.50*	*3.33*	*3.33*	*3.00*	*3.33*

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Abuse Tolerance Improvement	*Peter Roth (Sandia National Laboratory (SNL))*	*2-111*	*3.50*	*3.50*	*2.50*	*3.50*	*3.38*
Engineering of High Energy Cathode Material	*Khalil Amine (Argonne National Laboratory (ANL))*	*2-112*	*3.67*	*3.67*	*2.67*	*3.33*	*3.50*
Developing New High Energy Gradient Concentration Cathode Material	*Khalil Amine (Argonne National Laboratory (ANL))*	*2-113*	*3.67*	*4.00*	*3.67*	*3.67*	*3.83*
Developing a New High Capacity Anode with Long Life	*Khalil Amine (Argonne National Laboratory (ANL))*	*2-116*	*2.50*	*2.00*	*2.00*	*2.50*	*2.19*
Streamlining the Optimization of Li-Ion Battery Electrodes	*Wenquan Lu (Argonne National Laboratory (ANL))*	*2-118*	*3.67*	*3.67*	*3.00*	*3.00*	*3.50*
Design and Evaluation of Novel High Capacity Cathode Materials	*Michael Thackeray (Argonne National Laboratory (ANL))*	*2-120*	*3.33*	*3.67*	*3.00*	*3.33*	*3.46*
Development of High-Capacity Cathode Materials with Integrated Structures	*Sun-Ho Kang (Argonne National Laboratory (ANL))*	*2-122*	*3.50*	*3.00*	*3.00*	*3.00*	*3.13*
Novel Electrolytes and Electrolyte Additives for PHEV Applications	*Daniel Abraham (Argonne National Laboratory (ANL))*	*2-124*	*3.00*	*3.33*	*3.33*	*3.00*	*3.21*
Develop Improved Methods of Making Intermetallic Anodes	*Andrew Jansen (Argonne National Laboratory (ANL))*	*2-126*	*3.50*	*3.50*	*3.50*	*3.50*	*3.50*
Lithium Metal Anodes	*Jack Vaughey (Argonne National Laboratory (ANL))*	*2-128*	*2.50*	*2.50*	*2.50*	*3.00*	*2.56*
Structural Investigations of Layered Oxide Materials for PHEV Applications	*Daniel Abraham (Argonne National Laboratory (ANL))*	*2-129*	*3.00*	*3.33*	*2.33*	*2.67*	*3.04*
High Voltage Electrolytes for Li-ion Batteries	*Richard Jow (Army Research Laboratory)*	*2-131*	*3.00*			*3.00*	*1.13*
New High Power $Li_2MTi_6O_{14}$ Anode Material	*Khalil Amine (Argonne National Laboratory (ANL))*	*2-132*	*3.00*	*3.00*	*2.00*	*3.00*	*2.88*
High Energy Density Ultracapacitors	*Patricia Smith (Naval Surface Warfare Center)*	*2-133*	*2.50*	*2.75*	*3.75*	*2.75*	*2.81*
Develop & Evaluate Materials & Additives that Enhance Thermal & Overcharge Abuse	*Khalil Amine (Argonne National Laboratory (ANL))*	*2-135*	*3.50*	*3.00*	*4.00*	*3.00*	*3.25*
Screen Electrode Materials and Cell Chemistries	*Wenquan Lu (Argonne National Laboratory (ANL))*	*2-137*	*2.50*	*3.00*	*2.50*	*2.50*	*2.75*
Fabricate PHEV Cells for Testing & Diagnostics	*Andrew Jansen (Argonne National Laboratory (ANL))*	*2-138*	*3.33*	*3.00*	*3.33*	*3.00*	*3.13*
OVERALL AVERAGE FOR ENERGY STORAGE			3.13	3.03	3.02	2.85	3.03

NOTE: Italics denote poster presentations.

Overview of Energy Storage: Dave Howell, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated the projects were covered very well. The program has expanded over the years and now covers the area very well. The program has also expanded to include collaborations between investigators. These cooperations need to be encouraged. Both benefit and it leads to a greater understanding of the problems and potential solutions. Another reviewer commented yes, the presentation clearly describes the energy storage program and its three components that range from basic research to advanced technology development and finally to the mature technology implementation efforts from the battery industries under the USABC program. The significant technical challenges related to the batteries for hybrid vehicles, plug-in hybrids and electric vehicles have been clearly listed. Also, the recent progress made in several areas to fill in the technology gaps between the desired performance characteristics and the current technology metrics has been adequately described. Finally, the upcoming opportunities in the energy storage program have been mentioned. Another reviewer said the Sub-program is well organized and described with clear views about issues and challenges. The progress is synthetically presented with limited comparison at goals level. There were five reviewers, who answered yes, with one saying the program was comprehensively covered.

A reviewer stated the sub-program was well covered including summarizing the technical and business challenges. The reviewer could not make comments relative to previous year - however it was well organized and presented accurately following the outline. Clearly the sub-program is addressing the most relevant technology gaps in vehicle technology. The reviewer believes a gap exists in the transfer of technology created to U.S. implementation - whether materials, cell, battery or automotive applications. They also think the USABC effort is positive in addressing and the recent recovery act will make a big difference here. Another reviewer noted the energy storage R&D program covered today's most important issues and challenges. Its charter, targets, and goals are clear and well defined.

Main challenges identified during the presentation are around reducing cost, extending life, improving safety, and developing materials with higher energy densities, which are clearly the key challenges towards commercialization. There are some additional challenges that were not addressed in the program (see more details in the answer to question 2). The reviewer went on to say the three areas of focus in this program are battery development, applied, and fundamental research. Progress was reported along these three areas. Based on the report, HEV requirements are met with the help of DOE funding, although cost targets have not been met yet. Based on DOE goals, both labs and companies are shifting efforts into PHEV developments and are showing good progress, especially from applied and fundamental research perspectives. Although the overall progress has been clearly presented, some of the presenters in this program (mostly from the industry) were lacking technology data and specs to support their progress claims. Since their talks were often not detailed enough, reviewing some of these talks was challenging. Comments from another reviewer answered yes in terms of next steps. The need to emphasize higher energy systems for PHEV was well covered and is logical in view of the success in the recent cell technology to meet most of the goals for HEV. Progress on the HEV program was glossed over a bit, no doubt due to time constraints. Good review of big picture.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated no obvious gaps in the program; plans include the main issues to advance the technology. Another reviewer commented the research strategies to address the needs of the near-term HEVs, PHEVs and the long-term electric vehicles have been identified and the technical challenges have been highlighted. There are no visible gaps in the project portfolio, especially for the HEVs and PHEVs. The long-term solutions are understandably more speculative and hence are not as comprehensive. One reviewer said yes the plans are identified for addressing issues and challenges and no there aren't any gaps in the project portfolio.

A reviewer stated the plans are well focused on key issues and challenges putting the right emphasis on lithium costs and safety. The activities on alternative electrochemical couples are present but not wide enough in the Fundamental research: this seems to the main gap. Another reviewer commented the recovery act is an excellent example of addressing one of the primary gaps - establishment of US capabilities to meet automotive needs. Additionally USABC efforts reviewed in this forum are well aligned to focus resources on establishing relevant US capabilities and addressing technology gaps. While almost all of the research reviewed was relevant to vehicle technology objectives there is a gap that should be addressed. Specifically, establishment of U.S. based technology and capability should be encouraged. This reviewer went on to say a large concern here is that much of the technology development at Argonne National Lab, sponsored by the DOE, while relevant to vehicle objectives is not addressing the gap of supporting US capabilities and industry. It appears from posters and presentations that Argonne, in the name of "return on tax payer $" is licensing technology to, partnering with and promoting non-US companies technology. Additionally the aggressive non U.S. activity on licensing and promotion of materials is actually detrimental to U.S. companies. Addressing this gap by promoting work that encouraged U.S. based partnership and benefited U.S. would be beneficial. Fund the technology development but focus the licensing activity to the benefit of U.S. industry. Comments from another reviewer said they see two gaps; PHEV work should be transitioning into application engineering and the level of EV work should be increased and accelerated. This is already taking place within some of the automobile companies. One reviewer stated yes, plans are identified for addressing issues and challenges. The apparent lack of further significant focus on energy storage for HEV applications, as opposed to focus on PHEV only is a gap which should be addressed. Another reviewer stated it looks good. Low temperature performance issue is a little unclear. In the past this was cited as the limiting design factor in sizing the battery, which affects performance and cost. They have never understood why there was a requirement to design the battery around a -30C power limitation. In later discussions with ANL staff it now seems that the low temperature performance requirements are being deemphasized and will be addressed with engineering controls and/or maybe compromising on the goals. This seems a very reasonable approach to me. The cost implications of trying to run these batteries at -30C are prohibitive and not really necessary in their view.

A reviewer stated most areas of the program demonstrated innovative plans and solutions for achieving the DOE HEV and PHEV goals. Plans were identified from cell to packs, from battery development to applied research, both from empirical and theoretical aspects. Some of the labs may benefit from establishing closer collaboration with industry which may help their plans be more focused and applicable. The project portfolio is thorough and broad around HEV and PHEV. However, it may be helpful to add near term goals and allocate budgets towards research for developing higher capacity batteries for EVs. This is particularly important given the industry shifts to pure EVs and latest announcements of various OEMs around the world (including conservative companies such as VW and Mercedes) to join venture with battery vendors on pure EV projects. This reviewer went on to say in addition, it will be helpful to add to the portfolio some research focused on building appropriate infrastructure. A well-designed charging (and battery exchange) infrastructure and new business models may address some of the major technology and cost barriers and enable a faster transition from ICE to pure EVs. With current recovery act to add significant manufacturing capacities in the US, it may be helpful to allocate some budgets towards deeper manufacturability studies promoting high yields and efficient processing. It may be also helpful to add to the program industry leaders in capital equipment for battery manufacturing. Other R&D studies can be added such as optimization of charging technologies, battery-to-grid capabilities, recycling and packaging. Another reviewer commented Howell commented in the presentation that HEV type batteries are likely suitable also for low range PHEV 10 and 20 batteries. At the same time Santini clearly showed that an average use of any batteries, including PHEV 10 and PHEV 20, are used more in energy mode than in power mode. One other reviewer noted more material companies need to be grown in US; hopefully VTP can cover the area. Also manufacturing engineering for lithium ion cell, materials and equipments are lacking in US.

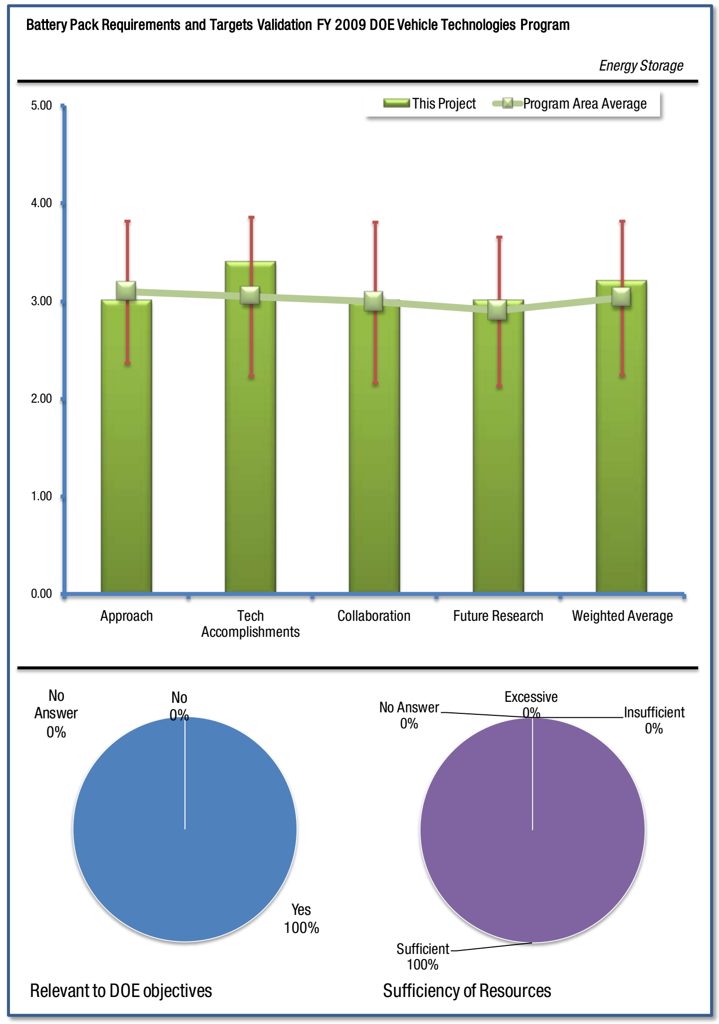
3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

A reviewer stated the program is focused. It needs to continue the venture into new areas on an exploratory basis. Another reviewer commented the sub-program is focused on the critical technological issues in developing batteries for three types of vehicles. To ensure success and to mitigate risk, it is developing various candidate Li-ion systems with different cathodes (and anodes). It is being managed quite effectively and efficiently with good coordination among academia, National Laboratories and industry, while utilizing all the available resources nationally to fulfill the needs of the DOE VTP. One reviewer noted the Sub-program is well organized and adequately managed with a good structured approach to meet VTP goals. Comments from another reviewer stated yes almost all presentations were relevant to addressing technology gaps that will better enable the vehicle technologies mission. Concern as noted above on actual benefit to U.S. of Argonne development and licensing activity and detriment to U.S. based industry. Six other reviewers all answered yes, with one also stating the EV targets for performance and cost will need to be revisited. Another reviewer who answered yes also said the only thing they would add is that it might be good to show a list of who is working on which material - some of the PIs are working on the same areas and it's not always clear if they are or even should be cooperating more (some competition within the program is OK as well).

4. Other comments:

A reviewer stated the DOE developments efforts in the energy storage program do not appear to be as well tied to the industry efforts in some areas, to facilitate a more rapid incorporation of the technology developments for facilitating the PHEVs and EVs. Also, there are substantial efforts being undertaken by other government agencies (e.g., in battery testing) which may provide some leverage to the DOE researchers, for example in performance assessment and modeling. Another reviewer commented they were very impressed with the breadth and quality of the reviews. One thought and because they have not been asked to represent at a review, but they wonder if there could be a list of what should be covered (ideally keyed off of areas reviewers are asked to comment on) in each presentation sent out to presenters so they could present their technologies in a fashion that would allow for better assessment/review of the technologies. Most presentations were excellent, however, some seemed to be less reviewable and more like sales pitches. They believe the above could help keep content relevant for review. One other reviewer noted with growing DOE funding opportunities supporting multi lab R&D efforts, advancements and innovations in the battery area will hopefully keep emerging in the USA. Significant applied and fundamental research progress has been made in the last few years (from MIT, ANL, BAAT, NREL, etc), and the industry is expecting it will make its way into commercialization in the next five years. To be competitive with the evolving battery industry in Asia, closer interaction between academia and industry is imperative in the US. This reviewer went on to say it may also be helpful to promote R&D collaborations with Asian battery vendors or research labs. In summary, cost and energy density of lithium ion batteries are still a challenge although most fundamental materials and basic science aspects have been resolved. With some engineering work, and establishment of the right charging infrastructure, the first generation batteries are ready to be implemented in vehicles. There is clearly much room for improvement for next generation batteries which should keep key topics DOE R&D programs. Another reviewer commented cost goals for PHEV are frankly beyond aggressive. Some more realistic discussions on long term costs need to be going to ensure that we don't stop work in an area due to an unrealistic cost constraint. Things like costs with subsidies, higher cost of gasoline down the road need to be factored in. Just meeting the performance goals is going to be tough. Also, while they realize it doesn't help reduce US oil consumption, if the inventions end up being implemented in other countries with a higher gas price base, then at least we could all benefit from the reduction in greenhouse gas emissions. Comments from another reviewer noted the project portfolio could more clearly open after lithium electrochemical couples while starting with some basic studies. One reviewer stated that it was a very nice presentation, while another reviewer said the target costs are unrealistically low.

Battery Pack Requirements and Targets Validation FY 2009 DOE Vehicle Technologies Program: Dan Santini (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is quite relevant since this project yields a cost/benefit analysis for the various xEVs being developed. Another reviewer noted the goals of the study were not clearly defined. One reviewer commented it provides a view of the characteristics of cost/performance to help set goals for batteries for transportation. Comments from another reviewer mentioned the project shows various objectives were not all well described. The presentation is very dense with some difficulties in following clearly the huge amount of results and the basic hypotheses. However, the conclusions derived from the various simulations are clearly analyzed. Another reviewer stated work focused on the cost of this technology path and the impact of blended operation.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the data presented seems scattered and that goes with not having a well-defined objective up front. Another reviewer noted there is a good approach aimed at analyzing the needs for a wider application. One reviewer commented it was very traditional in concept then went on to add the following observations from the presentation:

- Net present value benefit estimates
- Driving –dense urban to intra-city limited access highways
- Examine design of PHEVs to fit existing infrastructure
- Overnight charging @ 110 V standard plugs, some 220 V
- Distribution of existing garages and carports
- Evolution of dwelling units –garages per new dwelling unit
- Examine design of PHEVs to match pattern of driving
- Fully deplete battery on nearly all days after overnight charge, best 2/day charge options
- Engine downsizing in cars vs. constant peak engine power in trucks
- Interaction of charging strategy with generating unit type

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated a lot of good results have been obtained which are very useful for understanding the various vehicle/gas price/kWh scenarios. Another reviewer commented that good data was presented. One reviewer noted there was good progress to separate out the differentiation in various vehicles, EV, PHEV HEV etc. and the differences in each were highlighted. Comments from another reviewer said the results are very interesting and favor the discussion on the ways batteries can be better used in new hybrid vehicles.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the team members were knowledgeable in the various works in the area. They were knowledgeable in the organization and the people working in the area and their publications. Another reviewer noted the Electric Power Research Institute and the IEA HEV and EV Implementing Agreement. One reviewer commented the collaborations are adequate. Comments from another reviewer said EPRI was the only other institution mentioned, but it was not clear how well coordinated it was based on the presentation.

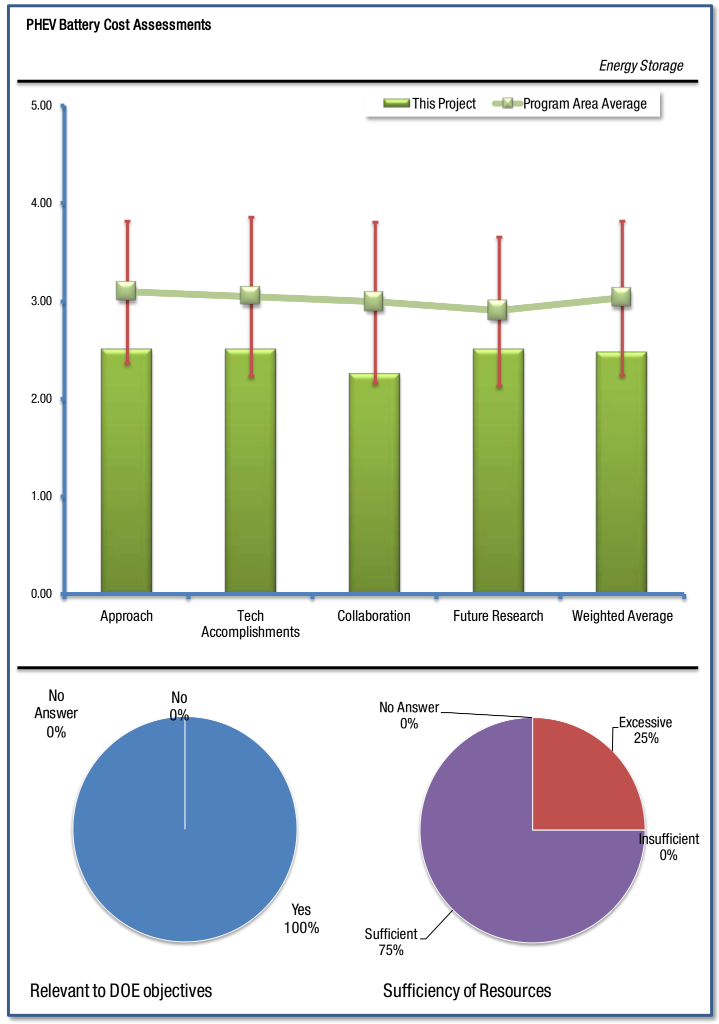
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would be interested to see the effect on these studies on any residual value of the batteries at the end of their useful life. Another reviewer commented it was not clearly laid out. One reviewer mentioned marketability, cost, various tradeoffs of cost, range, and other characteristics. The cost benefits analysis points towards the future directions. Comments from another reviewer noted the future plan is well consistent with the achieved results. Another reviewer stated future cost/benefit work should include separate a separate assessment of societal costs to contribute to the development of effective climate change policy. This should include estimates that have been established for the social costs of carbon, which are currently estimated to be $68/ton @ 2% discount or $40/ton @ 3% discount rate.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it was difficult to judge as there was little discussion on the details of gathering data for the study. Another reviewer noted the resources seem adequate.

PHEV Battery Cost Assessments: Brian Barnett (TIAX LLC)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the project addresses the critical need of "estimating the battery costs" for HEVs and PHEVs. Cost is an important parameter in determining the widespread use of these advanced Li-ion batteries in the energy-efficient and environmentally-friendly automotives (HEVs and PHEVs). Replacement of conventional gasoline-based vehicle with these vehicles will considerably bring down the consumption and demand on petroleum and decrease our national dependence. Another reviewer noted the business case for selecting a battery and a supplier depends on the cost of the batteries. One reviewer mentioned the project involves battery cost assessment for PHEV. This study may assist DOE in understanding cost barriers for vehicle electrification implementation and will potentially help the industry identifying battery components, materials, designs, and manufacturing processes in which cost optimization is inevitable. Comments from one reviewer mentioned it seems to them that the current Li-Ion technology is actually quite capable of meeting many of the goals for the program, although safety and lifetime metrics are maybe not as clear. However, the real killer to market introduction is simply cost and, in view of the vast scale of the consumer electronics business, they do not expect that costing to get much of a boost from the additional HEV market. Thus, this type of study is critical to setting realistic direction.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project is well designed, focused and integrated with other efforts and developments. It does contribute to understanding the impact of one of the crucial barriers (cost) and is being well implemented. However, it could be expanded and improved further to make it widely applicable. Another reviewer noted the model (detailed and assumptions are not described) depends upon inputs and outputs. One reviewer mentioned TIAX developed a unique cost calculation platform and assessed evolving battery cost at a high level view. The goal was to evaluate the benefits of alternative chemistries which are a critical decision to battery vendors when planning for high capacity manufacturing plants. Comments from one reviewer said a broad range of input parameters were used and implemented in order to build practical analysis via multi-variable sensitivity approach. Some inaccuracies in the model may be related to some critical fixed and variable costs components that are not clearly discussed in the model (e.g. R&D, energy input, plant maintenance, depreciation, sales, admin, and others). Those components may add up to %tens and can change the price range per KWh. The capital costs assumptions were not discussed. Another reviewer stated it’s not a bad approach and they realize that a lot of actual hard data is unavailable. However, their slides states that they do not expect some of their designs to meet the stated power requirements. Shouldn't this just result in them specifying a larger and more expensive battery to meet the goals? The approach is based on sizing the battery for energy whereas power seems to be equally if not more important.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that some interesting findings emerged from this cost analysis; i) the cost of the material (cathode is not as significant as the electrode thickness and ii) the speed of cell fabrication and the separator cost are more critical. However, there are a few shortcomings as well in this approach: i) the cost analysis was performed on 18650 cells which are not quite the prototypic model for HEV and PHEV batteries either in size, quantity or manufacturability; ii) the analysis included several performance targets such as capacity fade (life), and power (a thick cathode is not an option if it doesn't meet the required power) which are being independently tracked in the program. This reviewer went on to say a better analysis, they believe, would be the cost of the battery at the beginning of life, with no reference to its life and how often it needs to be replaced in a lifetime of the vehicle. Instead it should focus on the cost variations arising out of availability or modification of materials, either in composition or processing (e.g., surface coatings). Another reviewer mentioned a calculated sensitivity of single input which will help with battery development projects. One reviewer noted technical barriers are addressed to a good degree. The model is thorough and could potentially be applied to different battery designs. The choice of cathode chemistries and loadings was well analyzed. Other important costs parameters were evaluated such as "made in China" and processing speeds. Some inaccuracies in addition to the missing cost components (see above question), include:

- Assuming 80% SOC for all chemistries is inaccurate. In practice, optimal SOC may vary to a larger extent in between the alternative chemistries while lifecycle is directly correlated. Both SOC and lifecycle are important cost components which have not been analyzed deeply
- The cell design studied in this model is cylindrical. Although the model verifies existing cost numbers for those cells (mostly used for consumer electronic) the results are not practical for future PHEV, HEV, and EVs.
- Manufacturing costs are influenced by energy density, total energy capacity and the ratio of power to energy. Will be helpful to add those factors to the model when discussing the effect of alternative chemistries

Comments from another reviewer said some of the points seem interesting and it's a worthwhile independent view of costing. Certainly, there is value in pointing out that reducing costs does not necessarily mean working on the cheapest materials - it's value not cost that is the critical factor. However, the level of detail they can include in such a study is too limited in my view. What you really need is an estimate of the cost for the size of battery to meet the DOE power and energy goals (and others) and this doesn't do that. Another reviewer stated they fear that the conclusions are simply wrong because of the oversimplification involved. For example, some of the lower cost cathodes also seem to have great power, cycle life and safety and these all help reduce cost. But on an energy basis, which TIAX used to size the battery, they get unfairly clobbered.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the project needs to collaborate more with the current USABC battery manufacturers to get their inputs into the cost model. As well, the analysis model (being paid by the DOE) will have to be available for the battery companies for their use in the HEVs and PHEVs batteries. Another reviewer commented they need more coordination with battery developers. One reviewer noted no collaboration has been mentioned and collaboration with industry is critical in this case for the practicality of the study. Comments from another reviewer mentioned it was nice to see some real costs of these materials as such data is hard to come by.

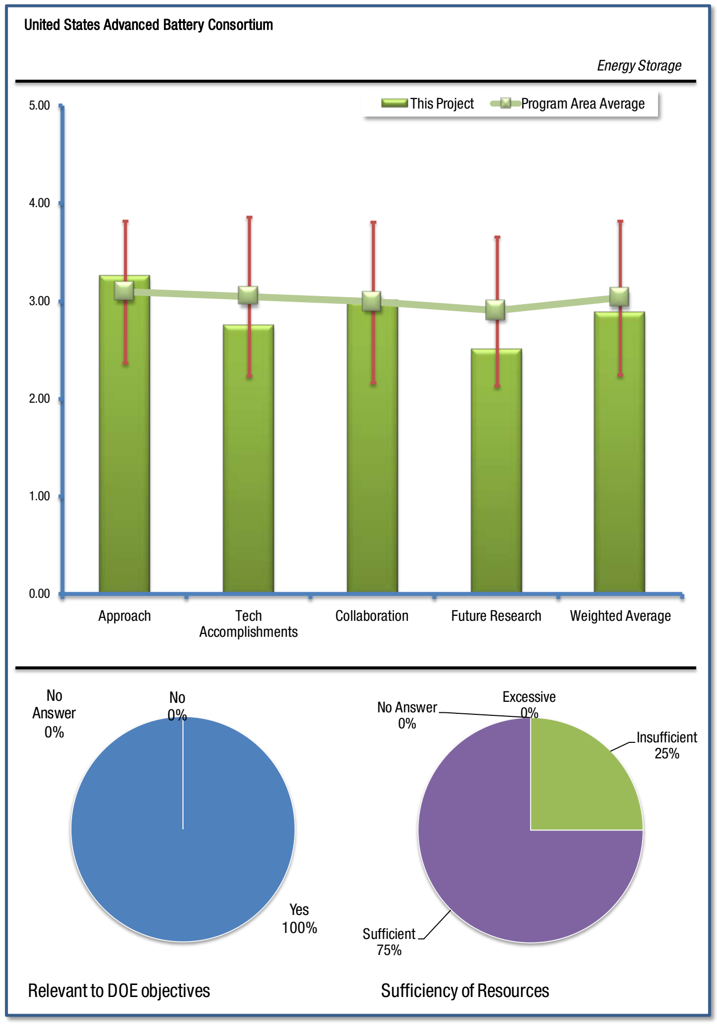
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the planned extension to the prismatic cells is acceptable. As well, it should be extended to the likely designs/chemistries of the PHEV batteries. Another reviewer noted the project should include all costs associated with battery and system manufacturing to align with DOE system goals. One reviewer commented the future research directions have not been directly pointed during the presentation. It may be useful to evaluate the cost of prismatic cells, different sizes of particles, loads, and more advanced chemistries. As mentioned above, the effect of increasing the energy capacity of packs, and manufacturing throughputs on the battery cost is critical to the industry and be useful to investigate it. It will be interesting to see the cost evaluation for EVs. Comments from another review mentioned if this work is to be continued/expanded, they must do more to get more realistic estimates of the required battery cost for each system. The reviewer thinks this is far more important than looking at other cell sizes. They will never be able to get accurate estimates and that isn't even the goal, but without a much more realistic estimate and attempt to size the battery for the DOE power goals, these estimates are so far of they are misleading and dangerous.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate. Another reviewer noted while this was an interesting first step, they think it needs more focus on factoring in real design constraints before expanding this to other cell sizes, etc. Only if they can get a more reliable estimate of the impact, or lack of impact, of the cathode chemistry on costs, this would provide very valuable guidance to the program. As it stands now, they don't have a high level of confidence in their conclusions. Unless they can undertake to address my concerns, the reviewer would not fund this work. Wrong answers are worse than no answers in their view.

United States Advanced Battery Consortium: Kent Snyder (Ford Motor Company)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated a co-operation of the vehicle manufacturers with the government in a partnership operation. Sometimes have unrealistic outlook on the real problem areas and set unrealistic goals. Another reviewer commented the project is a key support to the overall DOE objectives. The USABC clearly contributes to identify technology requirements and ways to measure them. One reviewer mentioned it supports improved efficiency through increased electrification of drive systems. Comments from another reviewer noted PHEV vehicles in particular can lower use of gasoline and limit CO_2 emissions. This program develops batteries for those applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated there is a need to include the battery industry in the operations and program development, not just the car manufacturers. Also need a "systems approach" to developing an improved battery performance not piecemeal outlook at single variables/materials. Another reviewer mentioned the USABC activities are well focused with an adequate approach to the main aspects of an applied research aimed at developing battery for practical and cost-effective use in vehicles. One reviewer commented very good progress on HEV battery development. Comments from another reviewer noted given the environmental concerns and government subsidized electrified vehicles, USABC should consider revising the cost goals upwards, while these programs are in place. Cost goals are intended to be such that PHEV and HEV are made competitive in the market place. The subsidies will offset cost of vehicles and therefore cost goals can be adjusted in short term. The relative improvements in last year appear not significantly better/different than previous year activities. The same issues exist and have not been resolved. This reviewer went on to say it is noted that PHEV development is being emphasized showing alignment with DOE goals and that is a sound direction change. However, the fitting of HEV type batteries for PHEV without significant change is a bit disappointing as much more can be done in terms of optimizing designs towards high energy. This force fitting that is pursued within the program for systems having intrinsically low performance are a high risk in the PHEV segment.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated they have established performance criteria for the various vehicle types. Need more emphasis on electrochemical capacitors for the longer term. It is encouraging to have a more realistic approach to batteries than in the past. Another reviewer commented the results of USABC projects are a reference for any battery developer of battery for vehicle applications. The progress has been interesting with continuous update of the technical and economical targets for various battery applications. The relation to the assessment studies at ANL and TIAX is not clear to better tune battery requirements. The technical progress is well described with respect to the technology targets. One reviewer noted little progress in last year towards PHEV goals and new ideas need to be pursued.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated it has greatly improved over the past. They have moved from a dictatorship that does not listen to the technology developers to listening to the real world and some co-operation. Past projections for costs and performance have been unrealistic and based on wishes and not facts. This is changing, but slowly. Another reviewer mentioned there is a very balanced contribution of key stakeholders. The roles of each participant are effective and well coordinated with an effective example of good public-private partnership. One reviewer noted the battery companies should be more tightly integrated into this partnership. Comments from another reviewer said very little progress has been made that shows significant progress towards the PHEV goals which seems to be main focus of DOE efforts. Verification measurements do show progress, while no fundamental progress has been made towards fundamentally higher energy. It would be nice to see improvements/change of direction that allows more of a step change and not "more of the same" as what has been done when focus was on HEV. It is understood that it is hard to change direction quickly, but if PHEV goals are to be achieved the program should consider take into considerations more designs geared toward energy rather than power. The PHEV goal of 150Wh/kg is significantly behind and still the consortium is betting on technologies that are at those numbers on the cell level, so a fundamental change will be needed in order to reach the target set. This might take a new look at available materials and cell design.

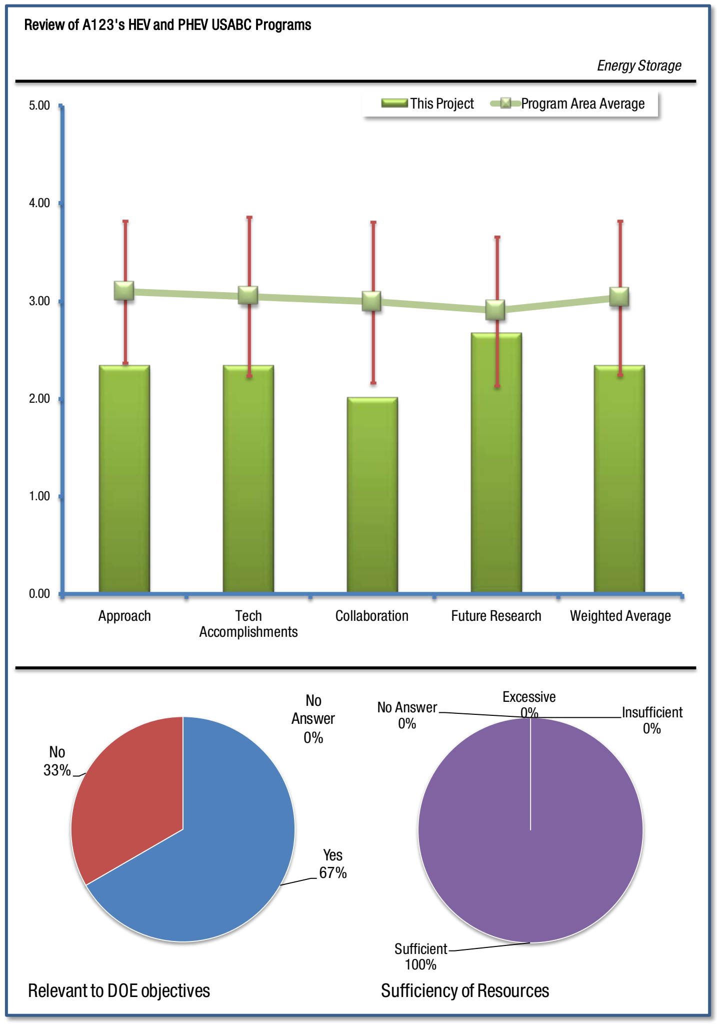
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the project has improved but now a more realistic view of is emerging. Another reviewer mentioned there is a perception of the main challenges and barriers but there is not a clear description of the future plans to overcome them, even if new projects have been granted. One reviewer commented a shift in focus of battery research from HEV/PHEV to PHEV/EV is entirely appropriate and is consistent with broad direction that the battery development is heading within the industry, particularly considering the 2011-2013 introductions of 100-mile range EV LDV platforms from Nissan, Mitsubishi and Ford and the introduction of the GM Volt PHEV. EV battery targets should be substantially updated. The current AABC cost and performance targets would be different if chosen today. Comments from another reviewer noted fundamental changes are needed to meet the PHEV goals. Right now the program is betting on chemistries that on cell level are at about or less than the 150WH/kg stated. Unless the goal is changed that direction will ultimately lead to a failure and hence a "poor" rating is given.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the battery manufacturing for vehicle applications espoused by the USABC exists to a very limited extent in the U.S. It will be 2 - 3 years before the effect of the stimulus package will be felt. Another reviewer mentioned there is an intuitive evaluation of the resources by considering the new projects funded. One reviewer noted an increase in the funding levels might be necessary to keep on track with the new emphasis on PHEV/EV energy-optimized battery development.

Review of A123's HEV and PHEV USABC Programs: Ric Fulop (A123Systems)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated Li-ion batteries utilizing the nano-phase $LiFePO_4$ cathode have impressive performance characteristics (calendar life, cycle life) and safety and are viable candidates for electric vehicles, especially HEVs and possibly PHEVs. A123 systems successfully developed this technology for commercial applications (power drills) and are in the process of developing suitable cell/module designs for the HEVS and PHEV that would meet the DOE objectives for Energy Storage technologies under the VTP, which is aimed at reducing the consumption of petroleum and thus our national dependence on its (foreign) sources. Another reviewer mentioned the presentation shows no actual data that is reviewable, else than pictures of modules. There is only relative data, but no actual numbers and therefore the relevance cannot be assessed. One reviewer commented A123 is developing batteries for HEVs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?

Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the use of nanophase (and suitably doped, as being claimed) LiFePO4 as cathode has resulted in substantial gains in the power density over the oxide counterparts, albeit at low specific energies. Also, partly due to reduced (oxidative) degradation of electrolyte at the (low) charge potentials of $LiFePO_4$, the cyclic stability and calendar life are equally impressive. These attributes combined with the safety make this approach attractive for HEV needs. For PHEVs, however, the requirement is a higher specific energy, which makes this approach less attractive. An improvement of ~ 30% has been accomplished in the recent cell design, mainly by modifying the anode. Details on the latter haven't been presented. Another reviewer noted the program manager shows that issues exist with anode degradation. In particular for deep discharge scenarios, this is the use case for PHEV. This anode degradation leads to excessive lithium available in system and is a very big safety concern, since phosphate runaway reactions are very quick during overcharge, in particular. These need to be addressed to properly address safety before work on optimizing separators and other less important areas are addressed. This is fundamental to Li-ion design and is especially important for long cycle life systems. One reviewer commented it is not clear that A123 is doing what is necessary to overcome the gaps they identified that exist between their current capabilities and the FreedomCar 25 kw goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated significant technical accomplishments include an impressive cycle life of ~ 10,000 (at 50% DOD), good calendar life, pulse power capability and low temperature performance in cylindrical cells. The battery system using such cells meets or slightly exceeds the DOE targets for the HEV in performance, but falls short in mass, volume and cost (even after 40% reduction in the cell cost). Prismatic cell design with higher capacity (20 Ah) and modular stack designs are being developed for PHEVs, which may marginally improve the specific energy. An unspecified modification of the will improve the specific energy by 30%. It is unclear what the targeted specific energy of the PHEV cells. Also unclear are: i) whether the large format cells need to have (additional) safety features or ii) if the PHEV cells can be operated without individual cell-level charge control, especially since the deep discharge cycling causes greater cell dispersion. No details were provided on the redox shuttles mentioned as proven. Another reviewer mentioned it was impossible to assess as no actual numbers only relative numbers, are given in presentation. This does not allow the reviewer enough insight into the data. However, it is well known that $LiFePO_4$ systems have issues in reaching the 150Wh/kg and volumetric targets that USABC and DOE is developing against. PI show no progress or direction towards how those goals will be achieved. PI also stated that they are reaching the cost goals, but that was later discredited by DOE representative, which again gives no insight on how to assess progress toward cost goals and puts in question the validity of other data, which again was not shown.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated yes, good collaborations exist with the auto manufacturers and national laboratories, though more interactions are to be established. Another reviewer noted no information on this, so have to assume it does not exist. One reviewer mentioned A123's work with Sandia is good and the same for their work with NREL. However, A123 is apparently not working with anyone to overcome the gaps identified by A123.

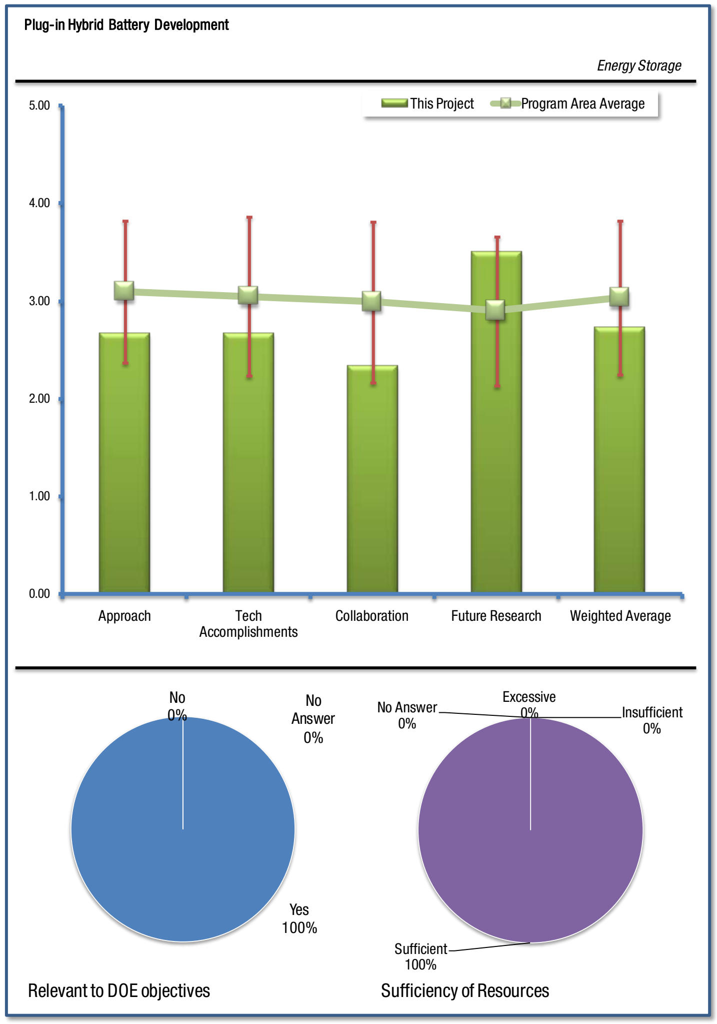
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future work on large format prismatic cells and the modular stack designs are encouraging towards improving the specific energy for the PHEV needs. However, the issues associated with large cells and the need for suitable charge control for deep-discharge cycling need to be addressed. Also, it is important to establish that the (marginal) 30% improvement in specific energy achieved with modifying the anode will not pose additional safety or performance issues. Another reviewer mentioned it is a good idea to work on anode cycle life. However, the PI should consider working with other materials or maybe blend in other materials, as capacity is too low for the DOE goals for electrification of longer range. One reviewer commented A123 did not present sufficient information about their future plans to predict what success they might have. However, they have made significant progress in the past and will probably continue to improve their batteries.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate. Another reviewer commented A123 is apparently making progress based on the awards that they have received recently. The funding they have received appears to be sufficient.

Plug-in Hybrid Battery Development: Cyrus Ashtiani (Enerdel)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the energy for a titanate anode system is relatively low compared to a graphite anode system due to the low voltage of the system. However, the system can make up for this deficiency if the cycle life is sufficiently high and the power capability is high enough. This barrier makes the likelihood of success considerably lower than with other chemistries, however. Another reviewer commented the project is developing batteries for PHEV.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The effort does not seem to make a strong effort to overcome the limitations mentioned above. The HEV cell has in the Gap Analysis only 34 Wh/kg, while the specific power is only 1300 W/kg. These values are lower than the presently used NIMH, while the costs and safety properties are not as good. The values are considerably lower than any other lithium ion chemistry using graphite as an anode. Another reviewer commented that they need to develop full size HEV cells (~4-6Ah cell), demonstrate performance, demonstrate life, demonstrate safety, and provide cost basis and module design & development.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the system work (scale up in size) is nearly complete according to the contract, but the properties are still far from being defined for either the HEV or PHEV batteries. Another reviewer mentioned cell scale up proved that a ~5 Ah cell fully meets/exceeds USABC HEV requirements. The scale up to ~5Ah Gen2/Gen3 accompanied with a 14% performance improvement. It has the best-in-class low temperature performance and unparallel abuse-tolerance with the full size cell. It also has ~13 years life projected at RT. HT calendar life enhanced. One reviewer commented good cold-crank HEV performance. There wasn't sufficient information on battery life.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaborations seem to be limited to the USABC and DOE administration. Another reviewer mentioned that co-operation was mainly with ANL. One reviewer commented good coordination with National Laboratories - they would like to see more involvement with automotive OEMs. They would also like to see how EnerDel will be integrating their cells on a pack level and/or see better coordination with a systems integrator for cell integration into packs.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

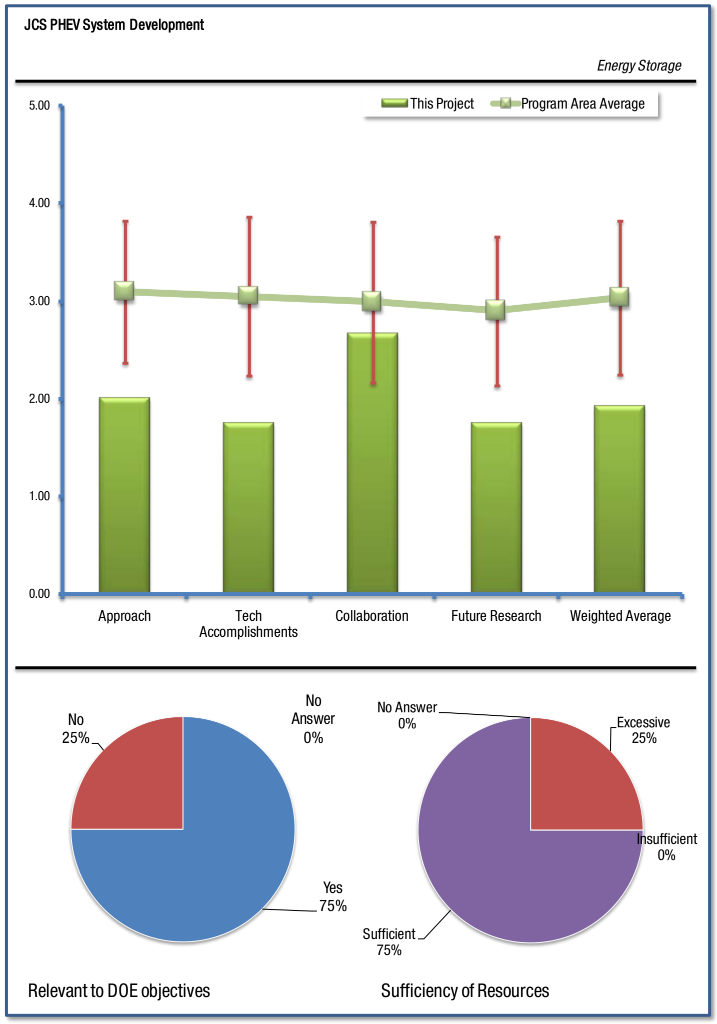
A reviewer stated continued focus on titanate anode with higher energy density cathode may lead to a substantial breakthrough for PHEV/EV batteries. This is exactly the sort of high-risk, high-payoff work that should be focused on. Another reviewer mentioned the following things:

- Task 1 –Cell development
- Gen 3 of 4 cell generations (Gen2, -3, -4)
- Use gen2 testing for benchmarking & assessment
- Gen3 design & development in parallel
- Gen4 design & development from mid-program using latest findings
- Determine-Safety / Life, Abuse testing, Cycle & calendar life testing
- Prismatic pouch life testing assessment
- Module Design & Development
- Preliminary module design & development
- Will use latest available cells (Gen3)
- Modules will be subjected to performance characterization (INL), thermal characterization (NRL)

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources seem to be well designed for the challenges of the program. Another reviewer mentioned they were reasonable for level of effort. One reviewer commented while the funding is likely sufficient for the planned work, EnerDel is making good progress in a relatively unique area - titanate anodes. A funding increase would likely accelerate work in this area.

JCS PHEV System Development: Scott Engstrom (Johnson Controls-Saft)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated Li-ion batteries are being developed by Johnson Control-SAFT, with their impressive cycle life, calendar life and more importantly high specific energy densities are strong candidates for PHEVs. This technology displayed impressive performance characteristics, durability and reliability in several non-vehicular applications. Their batteries show good promise in meeting the DOE objectives for Energy Storage technologies under the VTP, and can contribute to a significant reduction in the consumption of petroleum, and thus in our national dependence on its (foreign) sources. Another reviewer noted JCS has shown good progress towards functional HEV systems and PHEV is early yet. One reviewer commented the work is targeting the demonstration of cells and system designs to meet USABC targets. Optimizing thermal management solutions and cathode materials are critical challenges in the process of battery implementation in PHEV. Comments from another reviewer said in principle it does support DOE objectives, but in practice this effort seems to be so ineffective that it is not actually supporting the DOE program at all. This reviewer recommends killing this program.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach being adopted by JCS appears sound and feasible. Among the various options available for the cathode and anode materials, lithium nickel cobalt aluminum oxide (NCA) and graphitic carbon form the most durable system with possibly the highest specific energy, in large format cells, as required for the PHEVs. Though JCS optimized the cylindrical cell designs for the early use, prismatic designs are being developed as well for improved packaging. Further developments are in progress to boost the specific energy and reduce the cost. Another reviewer commented JCS will have some issues as batteries start storing at high voltage, required for PHEV applications. Ni-based chemistries have traditionally been shown to have issues with high temperature performance. The presentation does not show that progress toward the storage is being worked on and is a high risk issue as the calendar life degradation would prohibit long life and be a warranty issue risk in commercialization. This reviewer went on to say abuse tolerance testing should be expanded to internal short similar to what is Japanese law (PSE test)and extended overcharge periods, likely to be adopted by rest of world for Li-ion batteries. This could otherwise be a significant commercialization hurdle down the road. Earlier presentation by this group has shown more data, but this particular presentation showed no progress or no data, so rating becomes low due to this. One reviewer mentioned the approach is not very clear. The presenter mentioned optimization work on cells, systems, and manufacturing levels without getting into much quantitative/experimental details on procedures and analysis. One of the few examples given during the talk was JC-SAFT work on chemistries besides NCA, such as LiFePOx but with no technical specs supporting it. Comments from another reviewer said it was hard to answer as the talk was so vague, but their disclosure that they are working on $LiFePO_4$ and NMC instead of their NCA chemistry is encouraging.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated specific details haven't been lacking on the technical accomplishments. However based on their earlier presentations, it is clear the JCS (SAFT) cells have impressive specific energies, cycle and calendar life and low temperature performance. Further improvements in the performance and costs are being pursued. As well, system level safety and thermal issues are being addressed and the cell assembly processes are being improved. It would have been helpful, if JCS presented the technology gaps between their current progress and targeted performance. Another reviewer commented JCS gives no data for which technical achievements can be measured and hence a poor rating. This was essentially a waste of reviewer time, unfortunate for what appears to be a solid effort. One reviewer commented accomplishments and progress were mentioned, but the presenter sounded somewhat pessimistic with regard to meeting battery cost and volumetric energy density targets. Assessing general thermal abuse tolerance with USABC, developing testing and abuse methodologies with failure analysis for PHEV was achieved. The status of the other accomplishments such as core system software development, thermal management models, cost model, assembly process improvement, and new cell chemistries was not reported clearly enough to be properly evaluated. Comments from one reviewer said they saw no evidence of any real accomplishments presented at all. The speaker stated that they cannot meet the cost, weight or volume goals. While the cost goals are very aggressive (maybe unrealistic), at this stage of development they should be able to meet the size and weight goals. Since SAFT has shown data in technical talks with very high power capabilities, they are very disappointed that they have not made more concrete progress in meeting the DOE goals. At the very least, they could have showed data for how their systems compared to the DOE goals.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated yes, they do collaborate with the auto manufacturers and the USABC partners. They also have a more direct collaboration with the SAFT facility in US and benefited from the advancements made at SAFT-France. More collaboration with the national labs would be helpful. Another reviewer mentioned that it was not reviewed as no information was given in presentation. One reviewer noted they collaborated with USABC. Comments from one reviewer said they seem to be working well with Sandia. Also, cost information and goals being discussed with DOE.

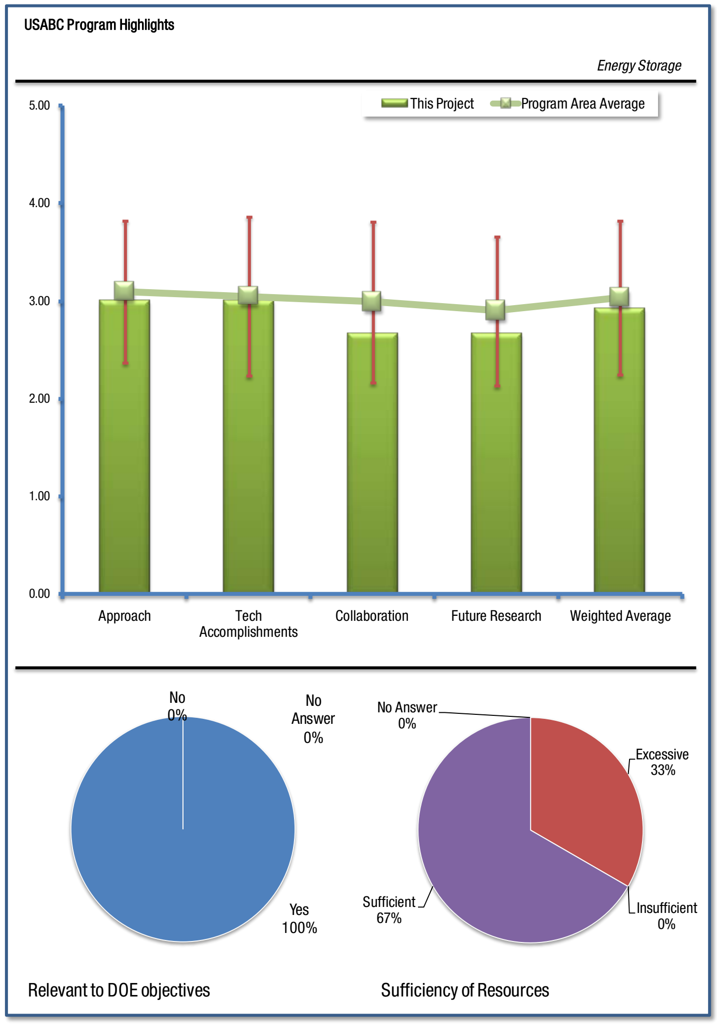
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future research is focused on further improving the specific energy, reducing the cost and delivering the product for the PHEV-10 and PHEV -40 demonstrations. Another reviewer commented again - very little specifics, it appears program is ending? One reviewer mentioned since all aspects of the project are still "in progress" and has not yet met DOE goals; at this point there is no room for future research. It may be helpful to refine cell performances for 10 and 40 miles systems and work on getting closer to the DOE cost targets. It will be helpful to present experimental data at future meetings. Comments from another reviewer noted they were equally vague about their future plans.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate for the contracted efforts. Another reviewer commented unless there's a whole bunch of good stuff they are doing that they cannot present in an open forum, they see absolutely no technical justification for continuing to fund these companies. They just seem to be poking about or trying to play catch-up rather than moving the technology forward. The reviewer was very disappointed in the presentation.

USABC Program Highlights: Mohamed Alamgir (Compact Power)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the program directly impacts the PHEV program to provide a full performance battery system. The combination cathode gives the required energy storage capability. Another reviewer noted the activities are clearly addressed to batteries for vehicle applications. One reviewer commented that while they believe this work meets the over goals and CPI certainly has developed their cell, module, pack and BMS to a level sufficient to generate confidence of a major US OEM PHEV application (GM), they are concerned that there should be more of a focus, a secondary goal if you will, of promoting the development of battery IP and manufacturing in the U.S. The reviewer's concern is that U.S. tax dollars are funding development of automotive battery technology by a wholly-owned subsidiary of LG Chem and the impact that this may have on the development of a domestic, advanced automotive battery industry. Based on the speaker's response to questions, LG Chem does not appear to have a significant interest in producing batteries in the U.S. absent high levels of public funding and subsidization of manufacturing.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project objectives are looking at key barriers: life, cost and abuse tolerance. The approach seems reasonable but not clearly described. Another reviewer went on to mention the following:

- Battery Pack Production and Support
- Battery Program Management for US Customers
- Pack-level Analysis, Validation, and Verification
  - Prototype development and qualification Battery Pack Concepts and Designs
  - Power & Signal Architectures
  - Packaging
  - Thermal Management
- Battery Management Systems
  - Charge control algorithms (State-of-Charge estimation)
  - Vehicle interface Diagnostics (State-of-Health estimation)

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated GM selected LG Chem to be the cell as well as the electronics supplier for the Volt program (January 2009). GM will produce the packs in high volume. The initial packs will be manufactured by CPI/LGC and will launch November 2010. Another reviewer mentioned the significant progress of the previous HEV project has not been similarly presented for the ongoing project. Safety measures such as thermal management are well analyzed and developed. There is a clear appraisal of the technical barriers. One reviewer commented good progress on HEV battery life, PHEV and HEV packaging and BMS and with improving Spinel cathode chemistry.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated they collaborated and coordinated with USABC. Another reviewer noted the collaborations are not well presented and may be extrapolated from some references in the presentation. The coordination seems adequate. One reviewer mentioned coordination with National Labs mentioned, but outside collaboration with U.S. OEMs seems limited to GM.

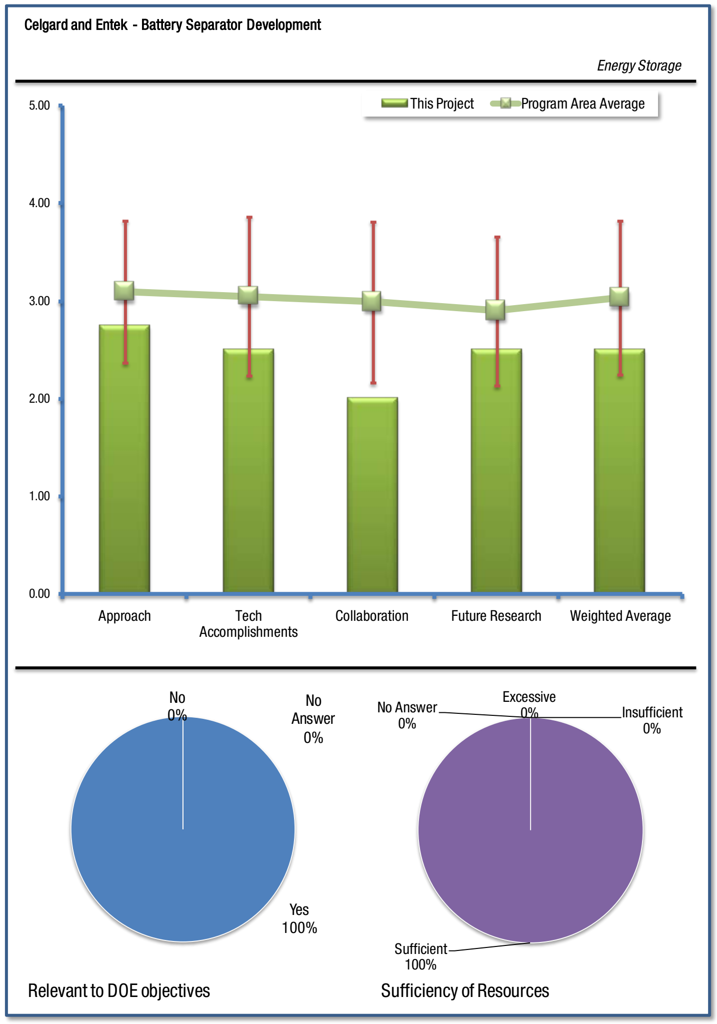
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the project should translate the development work into a production mode. Another reviewer commented the future work requires better specifications and details: no specific indications are given in describing the next year plan.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the budget and resources seem quite appropriate with some collaboration from national labs, which must be better clarified and improved. Another reviewer commented while CPI is making good progress, they would like to reiterate that they are concerned that U.S. tax dollars are funding development of automotive battery technology by a wholly-owned subsidiary of LG Chem of South Korea and the impact that this may have on the development of a domestic, advanced automotive battery industry. The reviewer would like to see this work redirected towards US Tier 1 suppliers unless there is a greater commitment from LG Chem to invest in U.S. battery production. Based on the speaker's response to questions, LG Chem does not appear to have any significant interest in producing batteries in the U.S. absent high levels of public funding and subsidization of manufacturing.

Celgard and Entek - Battery Separator Development: Harshad Tataria (Celgard and Entek)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated for a wide spread use of Li-ion batteries, it is crucial to have adequate safety established and demonstrated. It is well known that the polymeric separator (that insulates the anode and the cathode) tends to shrivel and crumble at high temperatures, which exacerbates the thermal runaway problem. Mechanically robust separators mitigate this problem and enable the use of batteries in PHEVs, which reduces the petroleum dependence. Another reviewer mentioned low cost separators with increased safety towards, especially, internal puncture shorts are very important to meet the goal of DOE. One reviewer commented optimizing mechanical integrity of lithium ion battery separators at elevated temperatures is the key to ensure cells safety, which is part of DOE requirements implementing high performance batteries in PHEV and HEV. Comments from another reviewer noted Celgard and Entek are working together to develop a separator with mechanical integrity at high temperatures (220ºC). This characteristic may provide separation between the electrodes after melting of Celgard's polymeric separator.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach looks feasible and involves i) the use of inorganic fillers to improve mechanical properties at high temperatures', ii) develop standards for the assessing the separators, especially for High temperature melt integrity, iii) establish correlation between the membrane properties and cell performance and iv) develop new separators. Another reviewer commented mechanical stability, shrinkage, is important. However, puncture strength is even more important for battery manufacturers and no data presented here about this property and not even mentioned as a property for testing, which is alarming. For program size, good value, but performance factors needs review. One reviewer mentioned it is not clear which FreedomCAR barrier is being addressed in this project. It appears that the development of this separator is for safety purposes. However, the specific characteristics of the desired separator are not clearly defined. Comments from another reviewer noted the following:

Entek: Good quantitative approaches. Tested wide range of filler materials (did not mention which materials specifically) while incorporating interesting experimental validation techniques. Issue may be related to the current environmental conditions tested, which are somewhat impractical as it does not represent real life conditions of a battery.

Celgard LLC: Testing approach is thorough. Important work in developing standards HTMI testing (mechanical, strength, stability) which is critical for the industry. The approach and plan for correlating film tests to battery performances (temp and mechanical) was not clear.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the technical accomplishments are sufficiently significant. With the incorporation of inorganic filler (~50%), good mechanical integrity and reduced thermal shrinkage demonstrated at 200°C. Further preliminary results have been generated in formulating standard evaluation tests for separators, especially relative to high temperature melt integrity and in comparing different polypropylene microporous separators. Their performance in Li-ion cells is yet to be established. Another reviewer noted there were promising first results on shrinkage for 200°C. One reviewer commented Celgard and Entek have made progress toward using a filler material for Celgard's separator. However, the details of the testing used to establish the success of their project were not presented clearly. It would be useful to see a comparison between their proposed separator and those from others on the market (tonen, eg). Comments from one reviewer mentioned development activities are at very early stages and went on to state the following:

Entek: High filler loadings achieved, good mechanical integrity achieved. The results are very preliminary, work needs to be done to optimize separators at extreme conditions and inside a practical prismatic cell to ensure mechanical stability during cycling. Overall, detailed technical results are missing: will be helpful to focus on modeling cell characteristics at various environments.

Celgard: Overall accomplishments and work progress is fair, again not much technical data has been shown.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated Entek has collaboration with the Portland State University, while Celgard hasn't listed any collaboration. Another reviewer noted there were none available to review. One reviewer mentioned that there is collaboration with Portland State University and EMI for processing equipment. There will be collaboration with USABC battery vendors on future integration and testing. It may be helpful to start collaboration with battery vendors/industry at an earlier stage. Comments from another reviewer said it is not clear that any interaction has occurred with other interested parties such as battery manufacturers.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

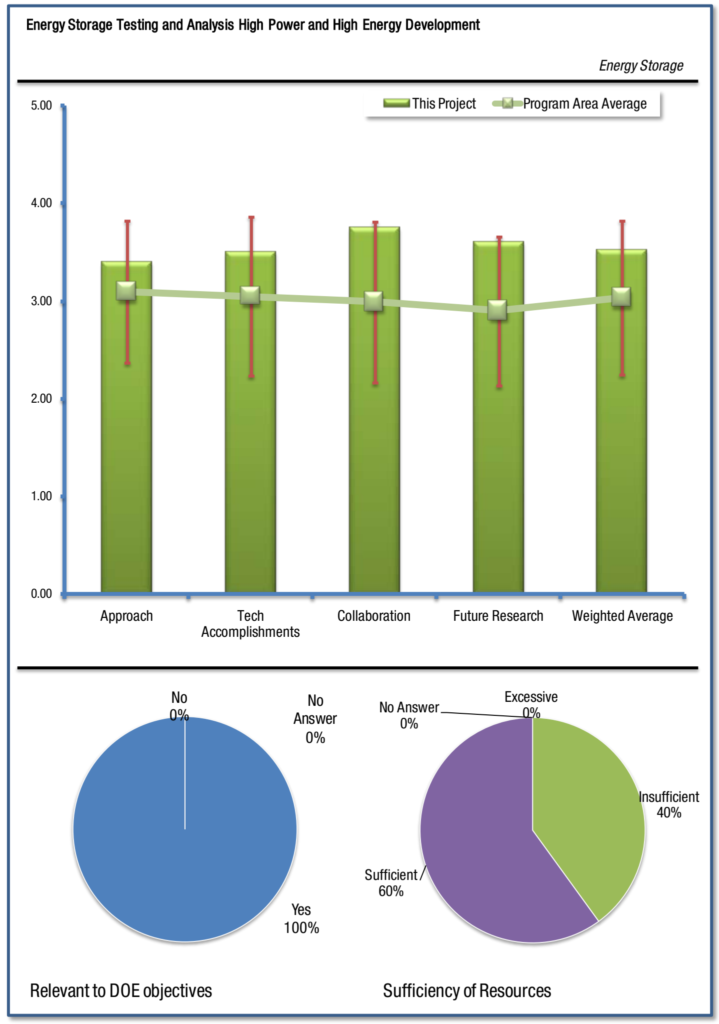
A reviewer stated the future activities include: i) scale up of the fillers-based membranes to commercial production, ii) supply of the sample to USABC partners, iii) Assessment of Celgard polymers in cells and correlate the separator properties to cell performance. Another reviewer commented the future should focus on puncture strength, qualification, comparison with competition and improvement of deficient factors found in this benchmarking. Celgard has some development in other products with regards to this, but not reflected in this work with DOE. Apparently this was captured under Z direction strength, but no properties given for this so hard to assess this very important factor in this presentation, which leads one to believe it is severely deficient with this method. One reviewer mentioned their plans have not presented clearly. Comments from one reviewer said the following:

Entek and Celgard LLC: Additional mechanical testing at high temp conditions, while correlating film characteristics to cell performance are required. As minor mechanical deformations during operation may cause severe lifecycle degradation, this aspect needs to be tested more extensively.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate both at Entek and Celgard. Another reviewer noted the project seems to have proper funding level. As the pilot phase is entered, funding will need to increase and also staffing. One reviewer commented the resources are sufficient for both. Comments from one reviewer mentioned this is a new project, which is funded at a sufficient level at this time.

Energy Storage Testing and Analysis High Power and High Energy Development: Tim Murphy (INL, ANL, and SNL)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated absolutely, INL provides the best independent evaluation of batteries in the US. Another reviewer commented it is critical to establish reference for testing & benchmarking technologies. One reviewer mentioned the group has taken the lead in developing the critical tests for performance and lifetime in vehicle applications. The only difficulty is the lack of dissemination of data produced by the group due to proprietary restrictions placed by submitters. Comments from another reviewer noted it provides the basis for battery powered vehicles. Another reviewer stated standardized battery testing provides an important, neutral "yardstick" by which we can measure progress in the development of advanced automotive batteries.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated INL has continuously improved their methodologies and approaches to characterize batteries. Another reviewer mentioned the only item that reduced the rating from outstanding is TLVT. There's a critical need to establish reliable ways of establishing life expectancy. One reviewer commented the approaches to the various measurements seem to be consistent in addressing technical barriers. It would be useful to the battery community to establish state of the art in the various properties. This could be done without violating security of the submitters. Comments from one reviewer noted surveys and evaluations of usage data while another reviewer said the only improvement they can think of is to expand program resources to allow more testing.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the group continues to make good progress on DOE goals. Actual progress of manufacturers in achieving DOE goals might be able to be disseminated. Another reviewer noted benchmark testing of available batteries and systems, diagnostic testing for USABC, etc. life testing, and battery monitor development.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated it's a great lab to work with. Another reviewer commented INL and Argonne seem to have very good coordination and complement each other in the various types of measurements. One reviewer mentioned excellent coordination of work with other National Labs, USABC and battery manufacturers. Comments from another reviewer noted the following:

- Argonne National Laboratory - Procedures, Analysis, Applied Research, Life Prediction Tools

- Sandia National Laboratories - Abuse Tolerance, Life Validation Methods
- National Renewable Energy Laboratory - Thermal Imaging, Analysis, Models
- USABC- Energy Storage Technical group

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

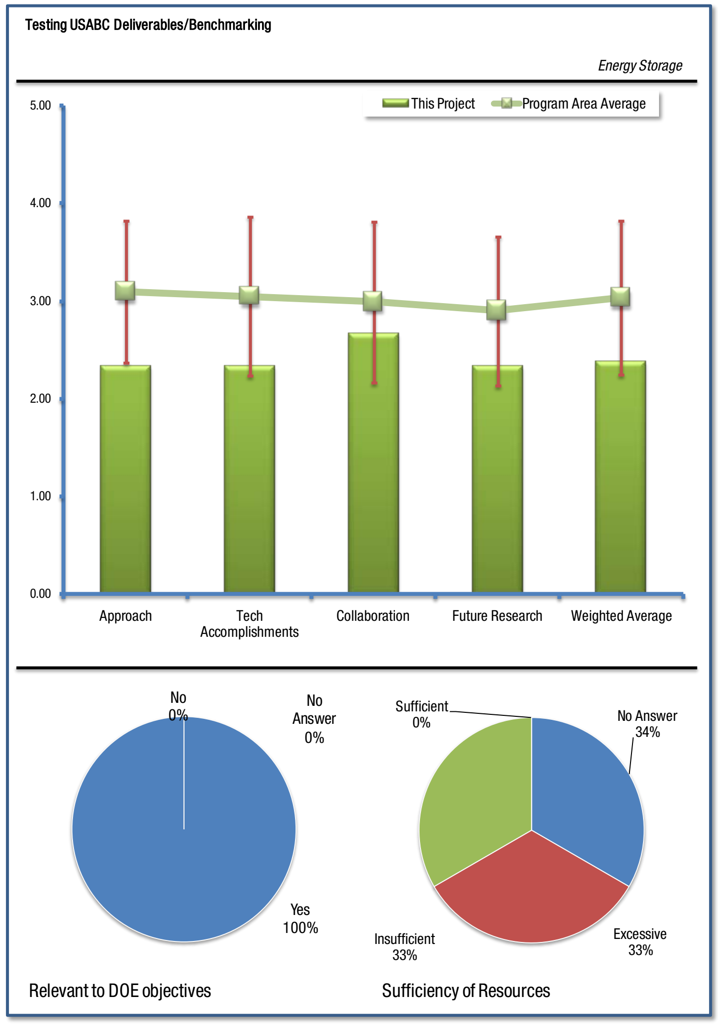
A reviewer stated they have reservations though with respect to electrolyte work. Another reviewer commented future work planned is well thought out, relevant and moves in a direction that will support future automotive battery development. It sounds like INL will continue improving the available "toolbox" for automotive battery benchmarking. One reviewer noted manuals for Testing, Analysis, and Life Predictions focused on supporting technology development aimed at meeting the DOE/United States Advanced Battery Consortium (USABC) Technical Targets for batteries. This reviewer went on to mention the following:

- Plug-in HEV procedures manual (rev. 0) published 2008
- Testing of Program Energy Storage Device Deliverables
- Annual testing status report on all testing projects to DOE in November.
- Quarterly testing status reports to USABC Tech Team.
- Diagnostic Testing and Applied Research activities
- Reported under Applied Battery Research

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated they always had issues with channel allocations at INL. Now that DOE is awash with funds, maybe it is the time to add those channels. Another reviewer noted the resources are reasonable. One reviewer mentioned funding is likely sufficient for the planned work, but funding should probably be increased to allow an expansion of independent analyses of competitive Li-ion and DCL energy storage devices, test development and diagnostics development.

Testing USABC Deliverables/Benchmarking: Ira Bloom (Argonne National Laboratory (ANL))



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated performance assessment of prototype cells and battery modules either from the USABC contractors or from other sources (termed here benchmarking) is a critical step (precursor) for incorporating such batteries into the vehicles. Such assessment and understanding the calendar and cycle life implications will pave way for a rapid insertion of these technologies in the desired application and thus minimize the petroleum consumption and dependence. Another reviewer commented its critical work to get an independent estimate of how the batteries being developed by developers/partners really work and also to track the state of the art from other manufacturers. One reviewer noted Bloom et al. are attempting to determine the life of cells and batteries.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the approach involves; i) standardizing the assessment procedures and preparing manual either for benchmarking non-DOE battery technologies or to assess the contract deliverables from the USABC partners, ii) performing assessment tests on cells and battery, modules, iii) Identifying appropriate acceleration methods for calendar life and cycle life and iv) developing models to understand the experimental trends and predict performance. It wasn't clear as to how comprehensive this test program is, i.e., details are lacking on how many cell/modules are being tested from what manufacturers and under what test conditions. Another reviewer mentioned the system seems to be very well thought out using a "stress test" to get a quick picture of a technology rather than relying on industry standard tests that take too long. Eventually, you obviously need both types of tests, but the stress test approach is much better suited for screening and exploratory work. Use the standard tests for validating performance of winners and a few key benchmarking studies. They really liked the efforts to understand the data using differential capacity plots and reference electrodes, rather than just reporting curve shapes. One reviewer commented Bloom et al. apparently do not incorporate the work of others in their work. It appears that they do not work closely with Dees at ANL for example. Bloom et al. should improve their approach to analysis. It seems that INL is doing what Bloom et al. are trying to do.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated some interesting test data are emerging, but nothing yet that correlates clearly with the requirements of high specific energy, good cycle life and long calendar life (and even the tolerance to high temperature, low temperature performance, safety) as derived in PHEVs. Also, it wouldn't be helpful for the reviewers, if cell details were not presented. Some of inconsistent conclusions are i) the ASI doesn't change with cycle life, yet the capacity at

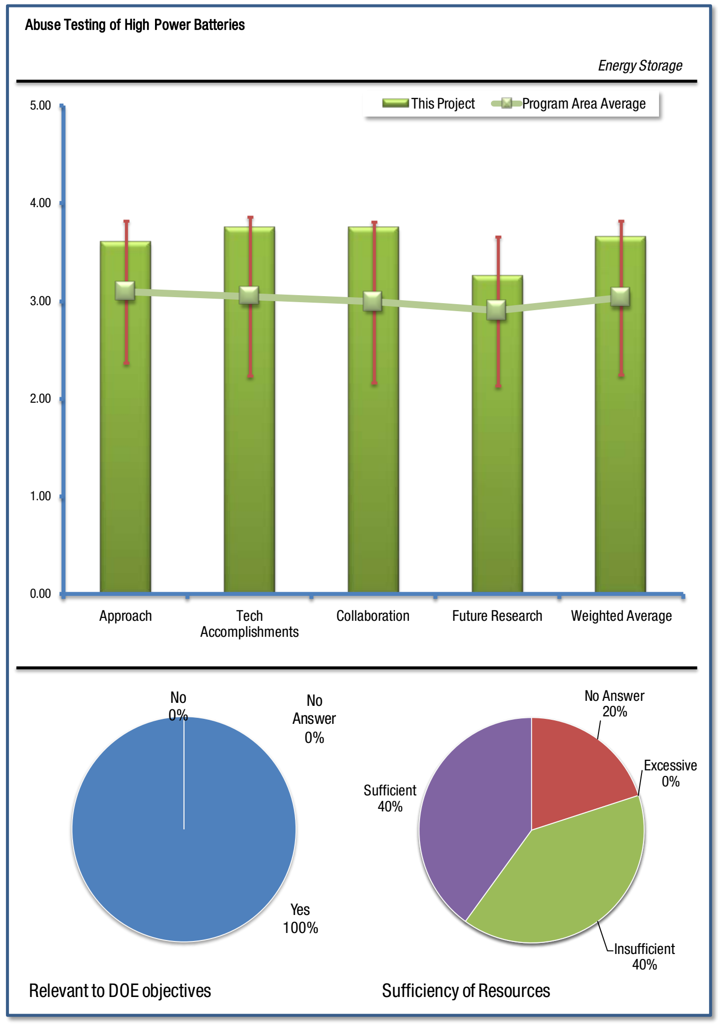
high rate drops gradually (almost linearly with cycling). More extensive data are being generated in aerospace labs at partial DOD cycling than presented here (termed as LEO cycling) - worth comparing the notes. Attempts to correlate capacity fade to peak shifts in dQ/dV data from half cells is a rather low TRL (too academic) effort for this task. Another reviewer noted if, as they claim, they can tailor the stress test to the particular chemistry, this is a very important ability. This presumably permits them to focus in on the most critical test for a particular chemistry to more quickly see if the new cells are truly improved. One reviewer commented Bloom et al. are behind the work being done at INL. Consequently, Bloom et al. should work closely with personnel at INL to update Bloom et al.'s approach at ANL so that Bloom et al. can accomplish more. It seems that Bloom et al. are not familiar with the open literature where explanations exist for the data they have obtained. Bloom et al. should present arguments supporting their interpretation of their data relative to explanations of similar data published by others.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated yes, collaborations with national labs (DOE) appear reasonable. It may be extended to the laboratories from other agencies. Another reviewer commented they are obviously working hand-in-glove with Idaho. They are doing a good job of balancing confidentiality with a multitude of clients. They sem to have interlab reproducibility well established, which is very hard to do and maintain. One reviewer noted Bloom et al. should work more closely with others at INL to help them analyze their data to a greater extent.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the proposed future activities are on the same lines and include: continued testing of the (HEV and PHEV) contract deliverables and benchmarking batteries from different non-USABC battery manufacturers. As mentioned above, this is an important activity, which needs to be continued for several years, as the battery technologies are fast changing. Another reviewer mentioned going forward, they would ask that they summarize and publish the general cell behavior they observe by chemistry. For example, is the sqrt(t) relationship they showed common to some, most or all chemistries? This would be very helpful for developers. Basically, if they could share how they tailor the testing for different materials, then the materials companies and cell builders could do a much better job at screening their own cells before the cells even reach ANL/Idaho. (It may even reduce ANL/Idaho's workload.) They did not see any linkage between the fade behavior they observe and the cell modelers. This presumably happens behind the scenes. One reviewer noted Bloom et al. have not formulated a plan to work more closely with others who could help them analyze their data more completely.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the resources are adequate for a comprehensive test program. Another reviewer commented if you currently have to delay testing or pick whose cells to test, they suspect this will only become more limiting as this business gets closer to implementation. Thus, they would expect testing needs to increase not decrease. One reviewer mentioned Bloom et al. are being supported to do work that is being done better at other labs and by others (Dees) within ANL.

Abuse Testing of High Power Batteries: Peter Roth (Sandia National Laboratory (SNL))



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated this project is very relevant. SNL provides the most unbiased evaluation of abuse-tolerance of cells and batteries. Another reviewer mentioned this is an integral part of any Li-ion battery development – Critical. One reviewer commented the safety area is very important to DOE goals. The limits of safety for each battery type are important to obtaining guidelines for DOE uses. This group does a wide range of safety and abuse testing. Comments from another reviewer noted abuse testing is central in battery development and in DOE program objectives. The role of an independent testing laboratory is functional in verifying technology maturity for electric transportation modes. Another reviewer stated safety is a significant issue for automotive Li-ion batteries, particularly as these expand to larger PHEV and EV formats. Sandia provides the tools and expertise to independently evaluate Li-ion safety.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated SNL is at the cutting-edge of abuse-testing. They are actually coming out with innovative ways to carry out these tests. Another reviewer noted SNL is unquestionably the leader in Li-ion battery abuse testing. One reviewer mentioned the approach is clear and well supported by confidentiality reasons with technical barriers included in the test protocol. Feedbacks to battery developers may help in overcoming limitations. Vibration tests do not seem to be used for abuse analysis.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated there are always high quality results. Another reviewer mentioned the achievements may be evaluated extremely interesting even if presented in general terms for confidentiality reasons. The statistics used in abuse testing is not analyzed and the number of cells and modules described seems not adequate to cover all testing sequence. One reviewer noted it's a one-stop-shop for cell abuse/destructive testing.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the collaboration is limited to developers and SAE inputs. Collaboration with accelerated testing laboratories would be beneficial in better defining deterioration mechanisms and identifying abuse procedures. Another reviewer commented there was good coordination with National Laboratories and USABC.

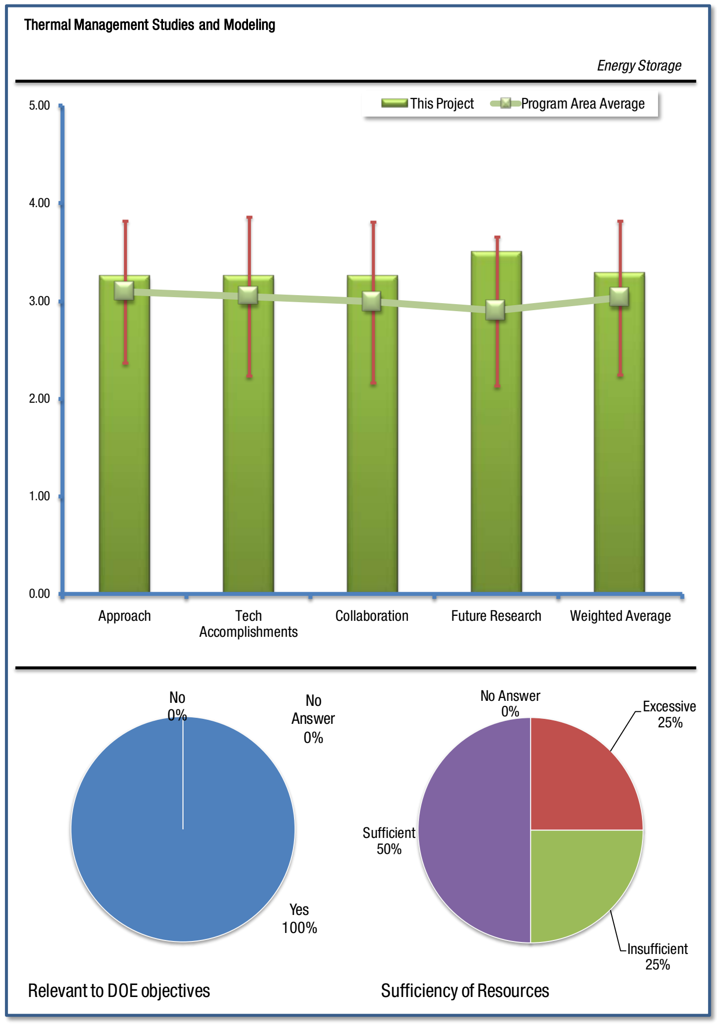
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would like SNL to be proficient also in testing various platforms of cells such as polymer. Another reviewer noted the description of future work is very limited but substantially depends on new cells availability.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated SNL should be equipped with additional analytical tools such as in-line testing of gases and liquids collected during abuse-testing. They should also be able to monitor the mechanical expansion/pressure of the cells during tests. Another reviewer mentioned they need to think about succession and training additional people to carry on the effort. One reviewer added the resources are related to the number of tests to be carried out and there is no clear schedule of cells/module supply from other DOE projects. Comments from another reviewer noted funding is probably sufficient for the work as planned, but work should be funded at a higher level to allow further laboratory upgrades for pack level testing, to increase test throughput and independent testing of competitive battery technology and to continue/further development of standardized abuse and destructive test procedures.

Thermal Management Studies and Modeling: Ahmad Pesaran (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated in order to understand and predict the life-limiting processes of lithium-ion batteries, it is useful define the thermal environments prevailing inside the cells, since some of the failure originate from thermal non-uniformities. Thermal modeling of Li-ion cells and batteries is thus useful both from performance and safety stand point. Currently, safety is a serious impediment to a widespread use of Li-ion batteries in vehicles, which otherwise would have reduced the consumption and demand of petroleum. Another reviewer commented thermal performances of battery packs are important for long life and high safety. The analysis performed in this program enhances the understanding of battery pack construction and allows construction of better packs having more low temperature gradients and lower general temperatures. This allows higher safety and better life cycles. One reviewer noted thermal modeling seems a critical aspect of pack design and the associated cooling systems. These in turn are critical for ensuring adequate safety and also impact the size, cost and complexity of the battery system. Comments from another reviewer said Pesaran et al. are studying the thermal aspects of battery packs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is effective and involves detailed thermal characterization (using calorimetry and thermal imaging), performance evaluation, and modeling of cells, modules, and packs received from the USBAC manufacturers and provide appropriate feedback to the developers on battery thermal management and performance. Some of the possible improvements could be: i) extend the thermal imaging to cells or modules cycled sufficiently. Upon cycling (use) the impedance will increase which in turn increases the heat generation within the cells/modules. ii) thermal modeling seems to be redundant in the context detailed thermal imaging and characterization, iii) Performance models are to be substantiated with adequate cell/module test data, iv) the thermal modeling needs to be coupled with the performance (electrochemical) model to describe the thermal effects on capacity fade, v) the modeling of "internal shorts' is rather vague, especially with ceramic coated electrodes/separators. Finally, the modeling efforts across DOE and other agencies (e.g., DOD and industry) need to be better coordinated. Another reviewer commented the program studies effect of cooling methods on performance which is good. Li-ion is typically exothermal during discharge and endothermal during charge. It would have been interesting to see the thermal efficiency during charge/discharge cycles due to these reactions and de convolute how much comes from the chemistry versus IR heating. That could yield further insights into what is going on inside the cell and how easily heat is transferred on cell level and pack level. This is especially important for polymer cells that could easily overheat at center of construction unless cooling channels are available, especially at higher temperature also with potential for more rapid degradation due to impedance imbalance due to thermal gradients. One reviewer noted there were high quality studies, taking into account such things as heat sink effects from high current leads, etc. It was an interesting use of C/D heat efficiency as a measure of polarization in the cell. Comments from one reviewer mentioned Pesaran et al. are utilizing experimental data and mathematical modeling to "look inside" the cells in battery packs. This information will help battery manufacturers develop batteries that have a longer life since they will be able to design cooling methods to remove the heat from packs.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated significant accomplishments include thermal characterization (calorimetry) and imaging of various cells and modules from the USABC developers, (SAFT and Compact power) which aligns this task well with the overall development. It is useful to be able to characterize large format cells and battery modules. The performance model provides a good analysis of the storage and cycle data available at different laboratories. The approach is empirical as with the models from the manufacturers. Another reviewer noted the thermal modeling tools available could be beneficial for companies developing packs, especially if cell heating models are available. The creation of this tool is important for effective thermal development of packs. One reviewer commented they are providing valuable and practical direction on pack design. Also, they have built a unique capability in their large calorimeter unit. They think the thermal modeling work will become more and more critical as the program moves from cell to pack designs. Comments from another reviewer noted Pesaran et al. have made significant progress and have published their results in the open literature.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated excellent collaboration was shown with USABC developers. Similar collaboration with other model developers, as well with laboratories generating performance data, within or outside DOE would be beneficial. Another reviewer commented it appears that collaboration with companies doing add-on modeling is being made, allowing multi-physical modeling; that is a good development. One reviewer mentioned since getting additional funding for custom work, obviously supplying a valuable service to the battery community. They seem to be trying to link in to ANL and Idaho in developing their model. Comments from another reviewer said Pesaran et al. are working with several battery manufacturers. However, it may be useful for Pesaran et al. to work with INL personnel on the 10^{10} length scale to help bridge the gap between the nano scale modeling and the macro scale modeling.

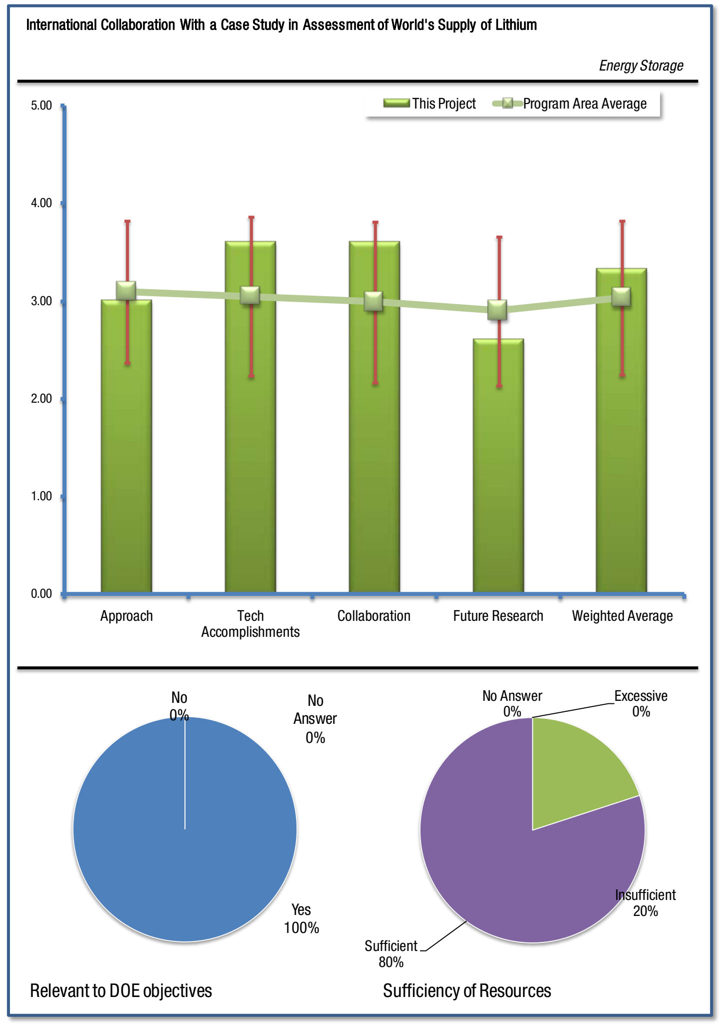
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future plans to continue the thermal characterization of future cells and models as well as the modeling efforts to understand/predict the lifetimes are quite useful. Simulation of 'internal short' could be a challenge, however. Another reviewer noted it is a good idea to go towards multi-physics models for studying thermal behavior, cooling/heating scenarios, etc. One reviewer likes the approach of getting thermocouples into cells to try and get real internal temperature readings. They think this is especially important as unit cells get larger and case temperatures measurable by thermal imaging cameras become less and less representative of internal temperatures. It's hard to tell how successful their modeling will be - they suspect it will depend in large part on close collaboration with Dees and Bloom at ANL. Comments from another reviewer mentioned Pesaran et al. are planning to continue to improve their understanding of the thermal and life aspects of lithium ion cells.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources seem to be slightly more than required for the proposed/on-going efforts. Another reviewer noted the resources appear sufficient and good progress has been made. One reviewer noted they are doing a great job with what they have, and getting additional funding from developers. Comments from another reviewer mentioned Pesaran et al. are doing an outstanding job and should be funded at a higher level. Perhaps Bloom et al. should spend some time working with Pesaran et al.

International Collaboration with a Case Study in Assessment of World's Supply of Lithium: James Barnes (US DOE/ ANL)



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the project was highly relevant. Another reviewer noted rumors about shortages of Li supply are rampant. An independent study by DOE can put the rumors to rest. One reviewer commented this work is highly relevant and should continue to be refined as more information becomes available. Comments from another reviewer mentioned the availability of Li is key in the implementation strategy for a larger use of electrically powered vehicles using lithium batteries. Another reviewer stated this is important work. Lithium supply and location of lithium supply has been raised as a national policy issue with respect to increased electrification of the automotive fleet. They need to answer the question regarding whether or not we are trading one energy security issue for another.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?
Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the barriers were very well addressed. There are some other barriers that were not included such as heavy vehicles such as trucks and buses and use of lithium ion in stationary energy storage, both on and off grid. The model should be refined to include these sources using the best available projections. Another reviewer mentioned Jim Barnes has clearly identified the technical barriers by promoting a systematic study based on some assumptions that should be more extended to various vehicle technologies. A parallel market study should better support and give more data to the supply needs. One reviewer commented it's a very good approach. They would like to see a sensitivity analysis that looks at more and less conservative cases, including the impact of petroleum costs on vehicle size and the truck/car fleet mix.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated it is very nice and pertinent data and very instructive and useful to developers. Another reviewer noted this work has moved quickly and had very sensible results. The program however should be continued to take other uses of lithium into account as noted above. Improvements in the hybrid concept should also be projected as more information becomes available. One reviewer commented the work started in an IEA Annex is growing in a significant way taking into account the time spent and the late start. The progress is interesting.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated excellent collaboration between DOE/ANL. The team will try to suggest developing some type of collaboration with minerals, recycling companies. Another reviewer commented it's a good international breath for

collaboration. One reviewer noted good collaboration has been demonstrated. More information exchange with the battery industry would be helpful, however. Comments from another reviewer mentioned the contribution coming from the other organizations involved in the Annex meeting is not fully apparent even if the IEA channel is a good way to guarantee an international collaboration. Another reviewer stated the work was well coordinated internationally.

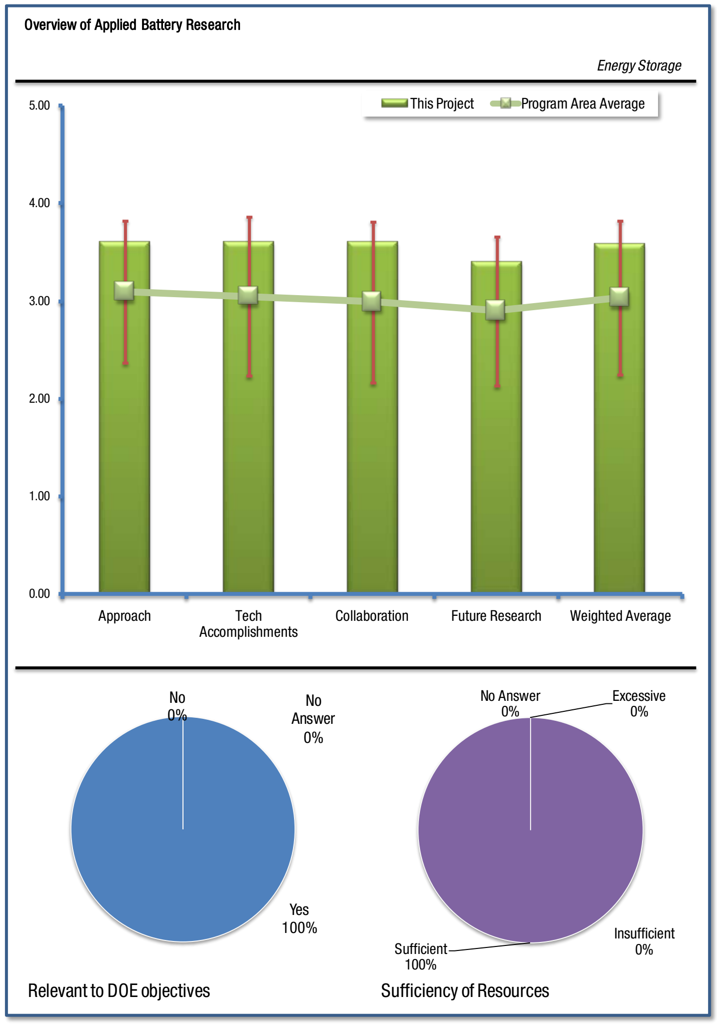
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future work should model using the lowered vehicle volumes: data in the table assumes 17 million. The vehicle sales this year is only 10 million. Other items will be to use the new 2016 CAFE standard. Also, use an improved fleet mix. Another reviewer commented since this is such a critical topic, it will be useful to continue this project for another year at least to get another iteration of these projections. One reviewer noted the future work was not elaborated on. Comments from another reviewer said it was not clear how much future work will be done on this project, but it seems like it would be quite valuable to refine the model as noted above. Another reviewer stated the future work requires better specifications but the ANL involvement give substance to the prosecution of the project. One reviewer noted they weren’t certain how to rate this category - they didn’t know if additional work is planned. The reviewer thinks this work should be continued.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated if elaborations are in the works, it might be useful to have a modest increase in the size of the effort. Another reviewer commented the resources needed are not yet fully clear because are mostly dependent on the complexity of the study to be performed.

Overview of Applied Battery Research: Gary Henriksen (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer mentioned the state of art lithium-ion technology is not quite adequate in meeting the requirements of PHEVs. Significant development in the materials and enhancements in the performance and safety are therefore warranted for making this technology viable for PHEVs and thereby reduce the consumption and demand on petroleum resources. Another reviewer stated the Applied Battery Research has multiple programs that are of very high standards and will lead to new materials important for electrification of vehicles. One reviewer noted it's critical for higher range PHEV and EV cars as current systems don't have the legs to get the range needed. Comments from one reviewer said Henriksen et al. are working on improving the capabilities of the anodes and cathodes for lithium ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated with the objective of assisting the USABC developers to enhance the specific energy, life, abuse tolerance and cost, the approaches being adopted in the Applied Battery research program include i) development of new electrode and electrolyte materials and demonstrate the performance enhancements in laboratory / prototype cells for understanding the life-limiting processes. The program is quite comprehensive and covers a good variety of research and engineering aspects. The only drawback is that there is no information associated with how and when the ABRP program findings will feed into the developers' manufacturing processes. Another reviewer noted focus in on "next generation" which is a good focus. It will be hard to achieve acceptance for pure Lithium by battery manufacturing companies, as that is seen as a difficult value proposition. The heat generated during redox couples believed to improve overcharge will also be a hard sell for most battery companies. The work on active materials, anode and cathode has traditionally been of high quality and continue to be so. Overall all programs have high standard. One improvement could be to try streamlining the materials selection process and providing hierarchy in how to select continued research, with clear go/nogo gates. The reviewer also said this will lead to quicker research progress from a programmatic goal point of view (certainly easier management), but is a minor comment. More focus on high temperature performance would be prudent, as that seems to be a general limitation for all chemistries, but no tasks for this direct correlation is evident from presentation. One reviewer commented they were very happy to hear that they will be bringing cell making in-house. Relying upon outside companies to supply quality cells in previous years did not work due to "awful" quality control on the part of the contracted companies. The methodology is very clear, logical and well mapped out. They like the clear linkage to modeling and fundamental work. Comments from another reviewer said Henriksen et al. have made and continue to make significant contributions to the development of lithium ion cells because of the fundamental approach taken by them. It is perhaps worth mentioning that the 15 year lifetime for lithium ion cells in unnecessary and unrealistic. This goal should be reconsidered.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated impressive results have been obtained in several categories: i) High capacity cathodes from in-house studies (210 mAh/g at C rate in over-lithiated metal oxide cathodes) and with several overseas cathode materials being evaluated, ii) further improvements in the Cu_6Sn_5 anodes $BaLi_2Ti_6O_{14}$ and ii) establishment of in-house cell fabrication capability. However, it may be advisable to seek the assistance of industrial partners for the test/prototype cell fabrication, since there are several intricate aspects to the cell manufacturing that DOE should not be bothered about. Another reviewer mentioned they were impressed with how many new possibilities they are working on in terms of higher energy anodes and cathodes (even if only 1 in 10 works out, they should have a winner). One reviewer noted the long list of accomplishments is tremendous and a credit to the PI's and the management. Comments from another reviewer said Henriksen et al. have contributed the titanate anode for example. This anode is currently being used commercially by Enerdel, which is a truly useful accomplishment.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated yes, there is indeed good multi-laboratory and inter-agency collaboration (in electrolytes) strategy being adopted here. Another reviewer mentioned collaboration has significantly improved during the past 2-3 years, which is noticeable on results and also more consistent direction between laboratories, still allowing healthy individualism. Probably still some issue, but in large it appears to be very good collaboration with multiple institutions. One reviewer commented a good plan and roles and goals laid out for each institution. Comments from one reviewer noted linkage to material suppliers and vendors is also a key aspect for screening new materials. Developing these relationships is a very important, albeit challenging task. Another reviewer stated Henriksen et al. work closely with other national labs and industry. It may be useful for them to work more closely with the NREL personnel.

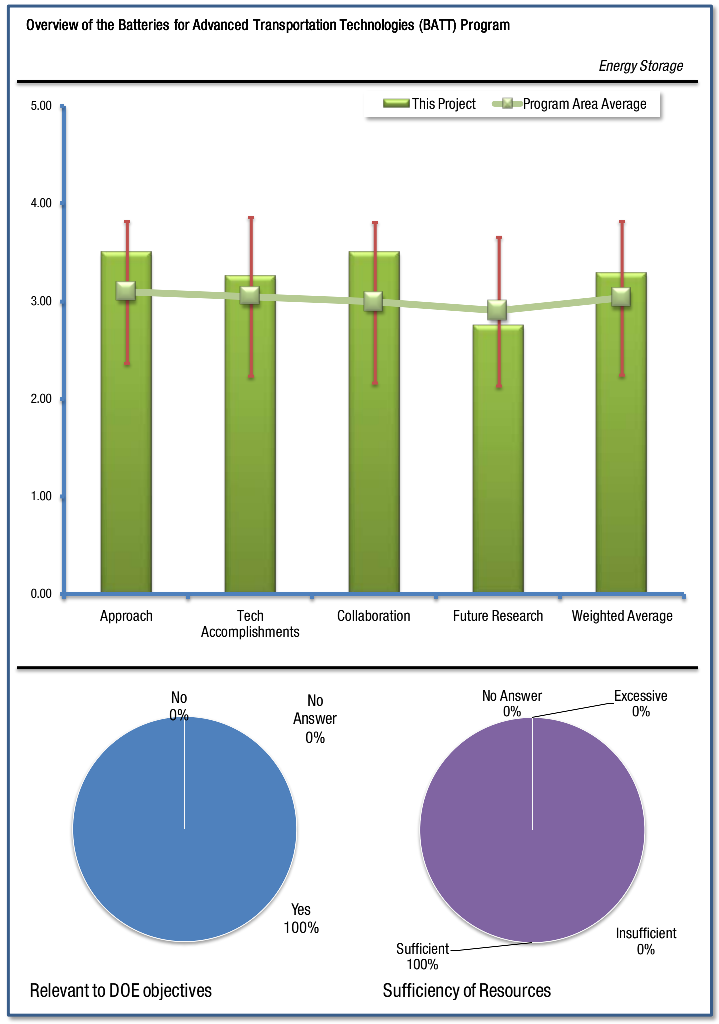
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the proposed future activities of continued material development, performance assessment and demonstration, and study of life and abuse tolerance characteristics are quite relevant to the overall technology development for PHEV. Another reviewer commented since the laboratory is developing manufacturing capability of cells, a program studying production techniques and how to get high yields is important, even if in pilot mode. Otherwise, there is a very high risk that cells out will have very varying performance, which down the road will be the greatest criticism to such a program. By establishing good quality control parameters for the production line, even performance can be established and actual facts studied without looking at artifacts from manufacturing. The lab should reach out to battery mfg industry to get this expertise or hire staff with this general experience. Rigorous quality gates will be necessary to accomplish good pilot facility. One reviewer mentioned there was a good plan going forward. Comments from another reviewer noted while they may not meet their long term goals any time soon, they seem well positioned with a portfolio of very interesting options, a number of which could significantly advance the field. Another reviewer stated Henriksen et al. are proposing to continue to develop new anodes and cathodes, which should continue to help meet the FreedomCAR goals.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are commensurate with the scope of the program. Another reviewer mentioned the program has increased in funding by a factor of nine, which is a very rapid expansion, maybe a consolidation? Normally inefficiencies come with too much expansion, but future will tell. Streamlined goals with subgroups and expectation setting of increased deliverables with this increase in funding are likely rolled out and there will be an expectance of some major breakthrough and faster progress next year due to this increase. Funding might appear high, but since the lab has started to make actual cells, these funds will be needed. One reviewer commented they are doing well with what they have. They are a little concerned that the new cell-making ability will require a lot more resources than expected to bring on line. The reviewer thinks it is very important that this longer term work be well-funded, in part because industry can take up any slack for the near term. The longer term, more aggressive performance goals are what the DOE labs are best used for. Comments from another reviewer noted that funding for Henriksen et al. is sufficient.

Overview of the Batteries for Advanced Transportation Technologies (BATT) Program: Venkat Srinivasan (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the overall BATT program is certainly relevant to DOE objectives. Some of the programs are more relevant than others, but that will come out in reviews of the individual programs. Another reviewer mentioned that fundamental research is a pillar of the development of breakthrough batteries to achieve DOE objectives. The strict connection between the diverse branches of the sub-program from BATT up to industrial development is instrumental in accelerating the battery development. One reviewer commented the group bridges the areas from theoretical modeling to Li-ion cells, developing new methods for modeling, and new materials. This activity is important for discovering new materials and designs that lead to higher energy density, which is a very important goal for PHEV. Comments from another reviewer noted this project focuses on the four most critical challenges for introduction of Li-ion batteries in automotive market:

- Cost
- Life (especially calendar life is good)
- Abuse tolerance
- Performance

As a general remark, focus on calendar life is good and it is unfortunate that topics is not more developed in related programs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this is a comprehensive effort which tries to challenge in a basic way all of the most important problem areas that are poorly understood at this time. The effort is constantly evolving as new problem areas emerge. The team seems to be able to handle this in a strong way. Another reviewer commented that looking at the relation between material and electrode fabrication is important and it is good to see that it is approached here. The move to new materials is interesting but calendar life, cost and performance are not solved for current materials. One reviewer mentioned the technical barriers are well identified with a dynamic adaptation to the new scientific options. The technical targets for the specific materials and components must be better specified to relate them more closely to the battery targets. The approach is adequate from material research to cell development. Comments from another reviewer noted that the materials research performed has discovered many new avenues for improvements. These ideas appear to have promise for improved systems and the investigators are using good synthetic and testing techniques to verify performance attributes. Approach for studying Li deposition is a great start, but many variances can be done and continuation will be useful for manufacturers and cell designers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that not a lot of progress was shown, but it is normal considering the general nature of the presentation. Another reviewer mentioned the scientific and technological results are outstanding with a quick transfer to the industry. There is a very good integration of basic research with an adequate sensitivity of the application implications. One reviewer commented the new materials shows promise, but aren't ready for deployment into real batteries. Investigators should be allowed to take this one step further and try scale reactions so that sub optimization on electrode level (formulation) can assess how far from target the systems are in terms of cycling, hi and low temps, and efficiencies. The modeling on anode extension of 0.5mm is important for battery manufacturers that typically build anode larger than cathode and that overlap has some tolerances in mass production machinery. However this reviewer says, limits are unknown and industry would benefit from sensitivity of thickness or materials loading, plus rate of Li-ion transfer comparisons answering questions such as - will the 0.5mm overlap change when design factors change, a sensitivity analysis. In particular, manufacturing defects can be studied is very useful answering questions such as "what is likelihood of failure, given a certain manufacturing situation, winding, coating, pressing etc., which can all make differences to design targets", very good start here and expansion would be great. The empirical studies of battery electrodes should focus on lowering binder in anode, which is much higher than what industry is using (+10%).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the coordination between PIs is good. Another reviewer noted the presentation has shown a good integration expertise of resources and competence in the BATT structure with a selected distribution of activities. The industry is considered as an end-user of the major activities. One reviewer mentioned it's not clear if the electrode manufacturing and cell making team is fully integrated. They can for instance verify the modeling overlap studies of Li deposition in mismatched cells. They could also work with the actual materials that were research by the materials synthesis efforts (but maybe done?).

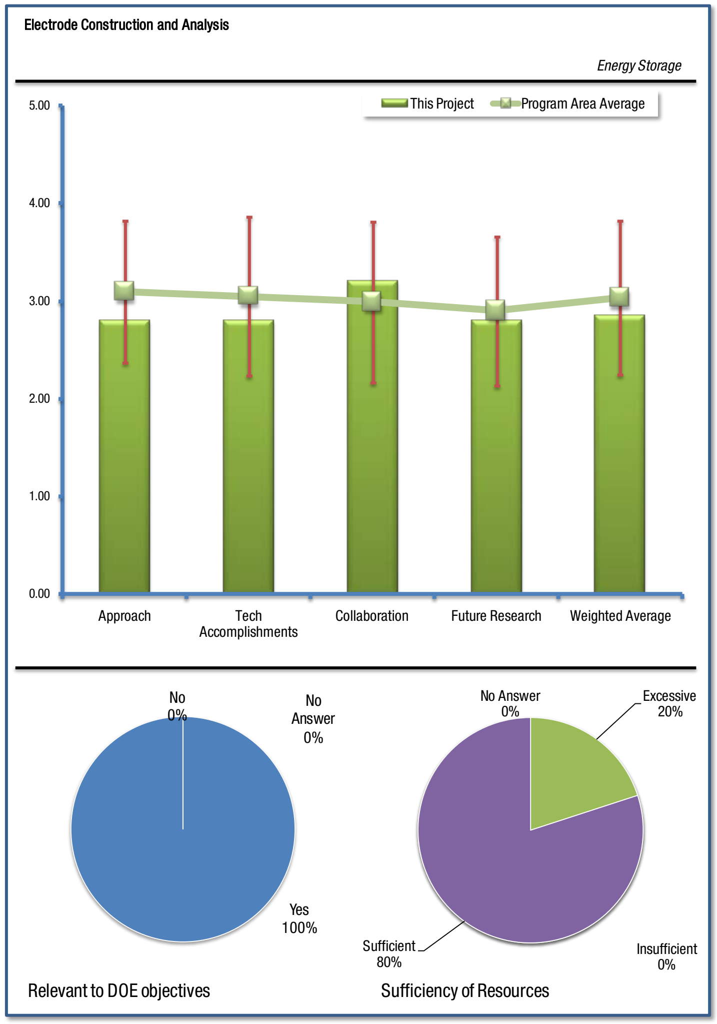
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer asked if DOE and National Labs organize brainstorming sessions with some key players. It would be interesting to involve more battery developers to better understand what the product limitations to overcome the barriers are. Another reviewer stated the description has been limited and general in giving comprehensive directions of future activities. The focus on Li-air should be extended to a more general classes of metal-air systems: the long-term exploratory research must be more ambitious with a wider screening of options. One reviewer mentioned that the short term focus is good. Long term Li-S and Li-air is probably too exploratory at this time and should be defocused. The new cell designs are fine. Future work for electrode making group - it would benefit program if they are integrated more into the materials synthesis for promising materials once comfort around the commercial materials have been established, this would allow synthetic efforts to see sensitivity to formulation and maybe also electrolyte variances, which can be good for tweaking materials. Performing some formulation sensitivity analysis and aim at verify some of the modeling efforts, which would allow calibration of unknown parameters or allow the cell making to be improved (as modeling shows a certain result would be expected).

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the presentation has not given sufficient information on such criterion. Another reviewer commented the process of assessing commercial materials is important. It seems like a lot of analysis is made and that is good, to verify material makers claims. If the team has not yet done it, it is recommended that the same process is used to streamline this analysis. This way multiple materials can be studied from multiple vendors and compared on the same basis and selection for study be made from that initial analysis. For instance, if an impurity is found electrochemical testing should not commence and materials sent back to supplier and ask for next improvement. These types of processes will help expedite more materials to be studied and then focus can commence on those materials of special interest, which is also where PIs time is best spent.

Electrode Construction and Analysis: Vince Battaglia (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the development of alternate (to MCMB) anode materials and development of efficient binders for Si are relevant to the overall DOE objective of developing high specific energy Li-ion cells for PHEVs to reduce petroleum consumption and demand. However, the relevance of this effort of optimizing the electrode fabrication processes in a DOE laboratory is not as clear. Another reviewer commented this work is very relevant to vehicle technologies because it focuses on optimizing commercially viable materials for improved cycle life and ability to meet PHEV requirements. One reviewer mentioned it is important for establishing lifetime for all HEV, PHEV cells and to reach energy/cost goals for PHEV. Comments from another reviewer noted Battaglia et al. are attempting to optimize the fabrication process of the electrodes of lithium ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach in seeking alternate anode material is well justified, possibly in the context of MCMB not being available from its original source (Japan). However, the effort on optimizing the electrode fabrication process, the ratio of binder to acetylene black, the thickness of coating etc are expectedly done at the manufacturing facility, since there is some specificity associated with the manufacturing equipment. They believe a DOE laboratory should not be involved in such activity, but in the development of advanced materials. Further, VC is being routine used by an industrial partner and trying to establish its electrochemical stability through CV looks out of context. The identification of electro-active binder for Si, on the other hand, is relevant and looks promising. Another reviewer noted the results particularly with regard to binder efforts and laminate thickness support the validity of the approach. There is a need to progress to larger cells to verify. One reviewer commented the work in this project is well-designed and well-integrated with other efforts, and advances general understanding within the confines of the overall BATT program, but much of the work duplicates routine activity which occurs on an ongoing, repetitive and highly efficient basis at viable mass-production suppliers of Li-ion battery technology and many of the findings of this work would be of an obvious nature to current mass-production Li-ion battery suppliers. Comments from another reviewer mentioned that the approach seems very well organized. While the approach is largely empirical, this is how industry does it as well. Another reviewer stated Battaglia et al. are experimentally trying different combinations of conductive additives and binders to find the best capacity retention of a lithium ion cell, for example. They may be able to improve their methodology by extending Newman's models to include the details associated with conductive additives and binders. The use of theoretical models to design experiments is superior to a purely experimental approach. It is not clear that they worked closely with industry to understand the history of the manufacturing techniques used in practice.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there are some interesting results in the optimization of electrode fabrication parameters, such as the ratio of binder to the conductive diluents, thickness of the coating etc, (and the coin cell cycle life data are useful in term of material assessment), but it is not clear how far these results are applicable to the battery manufacturer's processes. The studies on VC may be redundant, unless they are for optimizing its content for a particular carbon. The conductive binder for Si looks promising. Another reviewer noted it was very sound work -specifically mapping out electrode parameters, such as thickness, binder influence and VC additive is good. One reviewer commented the focus on columbic efficiency effects of additives for high-energy batteries is good. Comments from another reviewer mentioned the results are very worthwhile in that they state that they can get very high cycle life from their electrodes and that these correlate to larger cells. This is important because much of the prior development work in this program has been hampered by poor electrode fabrication and design. The goal should be to get optimized quality electrodes that can generate reliable and repeatable results, not necessarily to match the best industrial performance. The silicon work is very promising, especially in light of the lack of C-coating on the Si. Some understanding of electrode structure is shown, linking adhesion to cycle life. However, much more in this area is needed as this work goes forward. Another reviewer stated Battaglia et al. have made significant contributions concerning the design and construction of electrodes for PHEVs.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that some of the collaborations exist across different DDE laboratories. It is not clear however, where such collaboration benefited the present studies. Another reviewer commented it is an excellent laboratory and industrial collaboration - best in class. One reviewer noted Sastry and work at ANL needs to be factored into this and vice versa, which they think is going on. The later talk by Sastry talked about good collaboration with LBNL, but it's really hard to tell. Over the next year, it is very important to roll this work into ANL cell building pilot line and the related work by Jansen and Lu at ANL; also continue working with Sastry. Comments from another reviewer noted Battaglia et al. would benefit from studying the existing manufacturing techniques used to produce lithium ion cells. Also, they may benefit from discussions with Gering at INL.

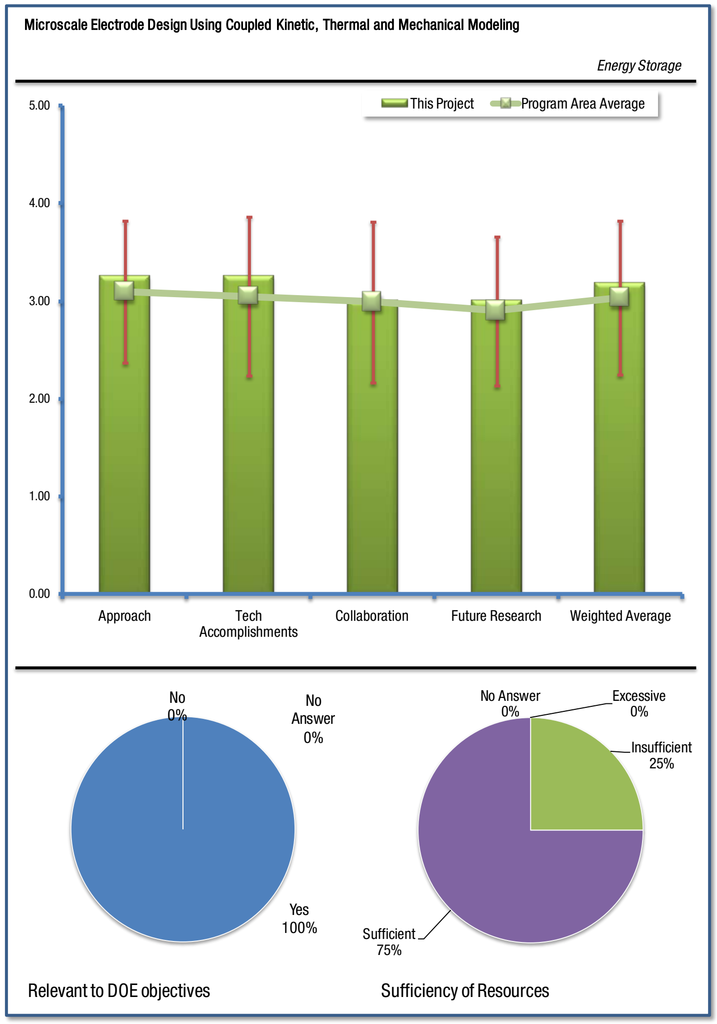
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future studies on developing new binders (continued work on the conductive binder) are useful. The electrode optimization studies are however not as well justified in a DOE laboratory, especially at a stage where the material selection is not complete and the pursuit for new carbon anodes is still on-going. Another reviewer mentioned that regarding future task 2.1: Study of constant power vs. constant current cycling effects does not seem relevant from an actual vehicle usage perspective, unless the constant current mode will be limited to simulation of the plug-in charging mode (i.e., real-world PHEV's would not be expected to use the battery in a constant current mode during actual driving). Regarding future task 3.1: Determination of oxidation and reduction potentials of VC has surely already been accomplished by others, and has presumably already been reported elsewhere? If so, is there some other reason to duplicate earlier observations? Also, regarding future task 3.2: Determination of VC effects on formation processes has presumably been studied in depth at many other institutions and seems redundant here, but specific focus on the impact on long term efficiency is useful. This reviewer also said slide 14 apparently represents efficiency in an anode/Li half cell. It would be useful to show how this efficiency relates to the overall efficiency in a full cell. It would also be useful to observe any effects of VC or other additives on the rate dependency of the longer-term efficiency in full cells. Movement toward study of SBR and CMC binders is long overdue, but good. T his movement should be accelerated. LBNL surely has other capabilities of value to globally viable Li-ion cell mass-producers or their parent companies, and these capabilities should be offered in order to achieve collaboration with regards to this project. One reviewer commented while the approach is fine and seems to have been successful; they also think that the group should be using all of the supporting data and analysis to explain in detail WHY good formulations are preferred. They are doing some of that, but need to do much more now that they have gotten a handle on making good electrodes. Very important to roll this work into ANL cell building pilot line and work by Jansen and Lu at ANL and continue working with Sastry. Comments from another reviewer noted Battaglia et al. have listed some plans for next year; however, it is not clear what they hope to accomplish. It would be useful for them to seek guidance from industry and other government labs.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that resources are a little bit excessive, especially due to the non-relevance of the electrode optimization studies. Another reviewer noted in the absence of collaboration with a globally viable mass-production battery supplier, consideration should be given to reduction in project scope and/or or resources, or to increased focus on only niche areas of production-type parameter optimization. One reviewer commented it seems to be making good progress in manufacturing electrodes. Modest progress in understanding and it's quite a large group. They should be able to get an understanding and knowledge creation more in the coming years. Comments from another reviewer noted Battaglia et al. are funded at a sufficient level.

Microscale Electrode Design Using Coupled Kinetic, Thermal and Mechanical Modeling: Ann Marie Sastry (University of Michigan)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the micro scale is an important aspect of electrode design that has not received much emphasis in the past. These studies fit into the overall electrode design program. Another reviewer noted Ann Marie Sastry and al. look at the mechanisms that impact electrodes performance and life. One reviewer commented this project deals directly with understanding the physical and performance of particles, their size and their shape. To optimize the performance of any cathode or anode, this information is critical in arriving at the proper composition, particle size and porosity. Comments from another reviewer mentioned the electrode part is one of the most complicated parts to understand. They don't think this modeling solve all issues but still help understand some issues.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated there are many ways to approach problems of these types with various levels of computational and mathematical difficulty. The work seems to focus more on small sample size problems rather than pushing toward large sample size. The other approach of using large computers for a larger sample size might be worth investigating for the information obtainable. Another reviewer mentioned that looking of how materials self-assemble in electrodes is of critical importance. Usually research tends to omit that aspect of the electrochemistry which is as important as the material themselves. The study looks at the different aspects of the barriers from the particle to the electrode assembly. One reviewer commented the approach to the problem of electrode composition depends on particle shape porosity as well as the transport properties of the electrolyte. The details are studied carefully and thoughtfully. The team has a great grasp of the mechanical as well as the electrochemistry involved. Comments from one reviewer noted that inadequate power is closely related to diffusion and conduction process for sure. However it is not clear why the short lifetime is closely related the electrode composition etc that PI mentioned as barrier. Also it seems difficult to apply this model for life prediction.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that since this is a difficult and novel approach to electrochemistry, the results are ground breaking and have given new insights. Another reviewer commented that their only concern is that they don't really understand how the electrode design optimization will support the battery industry. This seems far from real battery world. One reviewer mentioned the surface, mechanical and kinetic behavior of cathode materials are affected by the aspect ratio of the particles. Investigations indicate the microstructure of the particles have significant influence on performance in a cathode matrix. The shape, size and physical surface properties determine the cathode performance in an electrode structure. Comments from another reviewer noted the accomplishment is focusing on the power and it is OK for the beginning of life. They haven't seen any data relating to lifetime and there is a need to compare the experimental data and it would be the future work.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that as a theoretical electrochemical/mechanical approach, the interaction with knowledgeable experimentalists is very important. The PI should continue to try to develop relationships at this level to impact the orientation of the work to important battery related problems. Another reviewer commented that the collaboration is good. Even auto industry is involved (Ford, GM) which is an indication of the high level of quality of the work. One reviewer noted the project works with several National Labs and auto companies to accomplish the goal of understanding particle effects on performance. The work and collaborators in the other institutions are recognized appreciated and acknowledged appreciated. Work with GM labs is especially important as they learn about the practical aspects of battery performance. A comment from one reviewer mentions they can see some collaboration in the presentation. However the cell experimental data is not enough to verify the modeling.

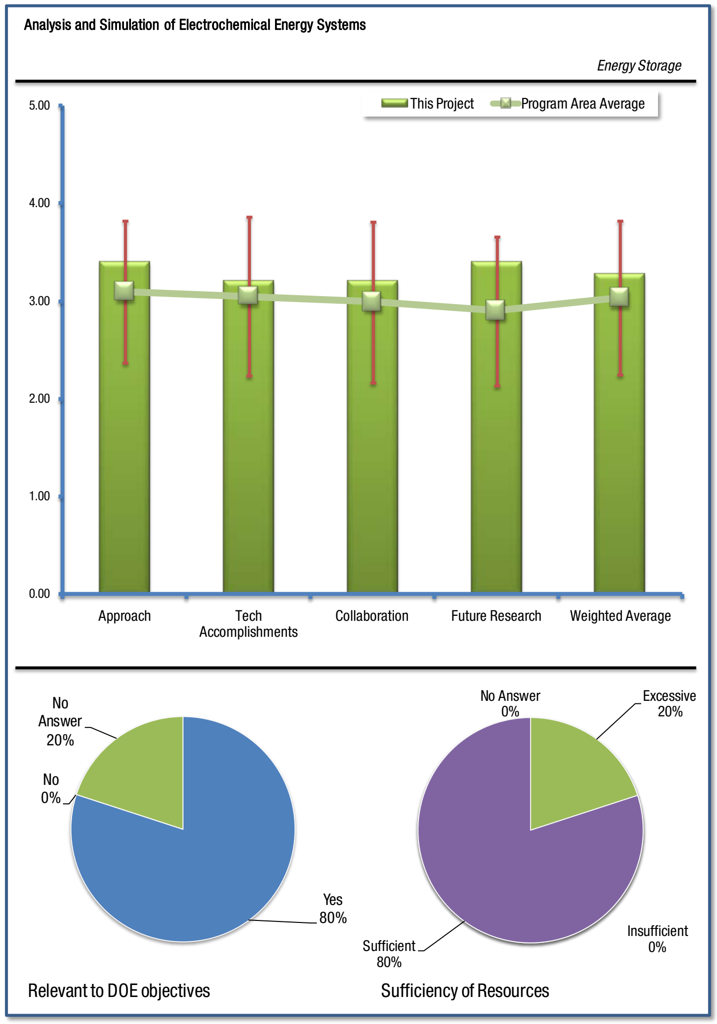
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated that particle aggregation is a very important point. The PI should work with a group that understand electrode engineering in order to help to understand what are the critical parameters that lead to a good electrode quality. Another reviewer noted the inclusion of surface structure and SEI layers on the anode and cathode will be significant as will the study on the effect of intercalation on the properties of the anode and cathode materials. This is a must-do next step. One reviewer commented the cell experimental data is not enough to verify the modeling.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated if the author moves in the direction of larger computations, it may be necessary to take advantage of larger computing facilities such as the Oak Ridge supercomputer. Another reviewer mentioned this is a great work that should continue to be well funded. One reviewer commented that resources seem adequate, but the total effort could be increased to the benefit of the project. Comments from another reviewer noted the cell experimental data is not enough to verify the modeling.

Analysis and Simulation of Electrochemical Energy Systems: John Newman (University of California - Berkeley)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the mathematical models based on first principles are quite helpful in providing a phenomenological understanding of the processes occurring in Li-ion cells under various conditions, including normal and abnormal conditions of operation and will contribute to an advancement of Li-ion battery technology, which is primed to be used in HEVs and PHEVs and helps in the reduction of petroleum consumption and demand. Another reviewer noted that generally relevant electrode design to present lithium plating - shuttle work could be relevant to safety also with regard to overcharge protection. One reviewer commented the type of modeling made will greatly enhance industry in its ability to look at manufacturing tolerances for Li deposition and understand these - are they fundamental vs. temporary manufacturing issues. This type of modeling is very useful. Comments from another reviewer mentioned this project helps to enhance abuse tolerance and reduce failure modes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach specific to the current effort looks to be effective and involves an understanding of two critical issues: i) the deposition of Li on the carbon anode likely to be favored over Li intercalation at rapid charge as a function of anode/cathode geometries and ii) the effect of redox shuttles, being examined for overcharge protection, on the SEI characteristics. Another reviewer mentioned the sophistication of models presented seems to be way behind the actual implementation knowledge of cell manufacturers to enable progress. One reviewer commented it's a good approach and please do expand on this type of modeling, introducing more parameters, both geometrical design and use scenarios. Comments from one reviewer noted the modeling of Li deposition effects / electrode configuration is of great value, and may be novel (beyond significant applied studies outside of U.S.). Another reviewer stated it explains optimization of negative electrode extension which helps to maximize cell volume efficiency, capacity ratio optimization with different thickness electrodes. Overcharge protection - provides trades off of shuttles reactions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated an interesting finding emerged from the model on Li plating, i.e., the extra length of the anode is helpful to avoid Li plating occurring due to higher concentrations at the edges, more than a higher capacity ratio (in the form of thicker anode). It would be helpful to have quantitative information on the relative kinetics of Li intercalation and Li plating. The results from the redox shuttle simulations, however, are not that clear. For example, what is the redox shuttle that is being modeled here? Probably more of experimental studies would be helpful here to characterize the SEI in the presence of a redox shuttle. Another reviewer commented that relevancy of actual models presented to making a difference is not obvious - in case of electrodes not sure there is a practical barrier for industry and level of detail of redox shuttle model presented does not seem to enable further material use or design. Trade-off of overcharge protection vs. energy storage presented is questionable. It is also based only on one material system and voltage range which is not universally applicable. One reviewer noted the modeling shows exactly the areas that are suspect from Li-ion tear apart analysis when design is off (which is case from some manufacturers). The work on shuttles is interesting, although shuttles tend to be overemphasized in general by researchers at national laboratories. In industry overcharge protection is normally accomplished by use of current interrupt devices and thermal fuses. The shuttles develop too much heat right now and have stability issues, in addition to being rate limited. Comments from another reviewer mentioned it is unclear if any of the outcomes of modeling of Li deposition effects / electrode configuration have been experimentally verified in any way. Another reviewer commented that the results of longer and thicker negative electrode and shuttle trade-off provide better understanding for the cell design.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated collaborations have been mentioned with several LBL colleagues. It is however difficult to deduce their contributions. Another reviewer commented they could consider including K Amine redox shuttle work to compliment models and make more relevant. One reviewer noted collaboration was mainly internal, but that is ok in this instance.

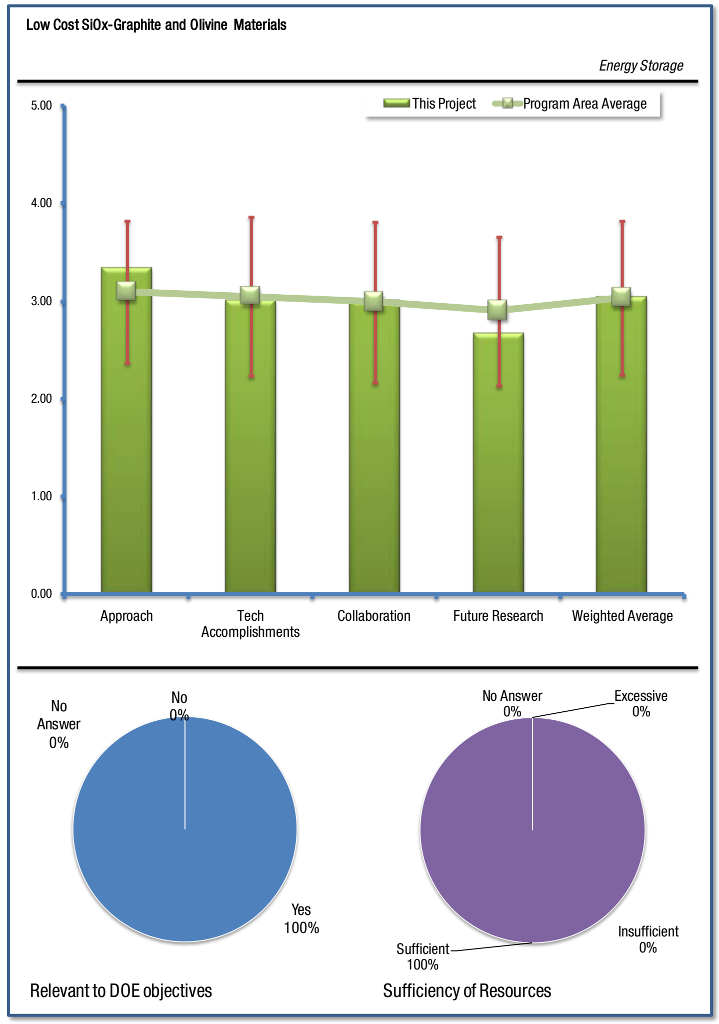
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future work justifiably focuses more on understanding the transport and kinetics of the redox shuttles and to substantiate with some experimental studies to understand the interface. The proposed work on block copolymers does not seen as well connected with the overall program. Another reviewer noted that lithium deposition modeling is good but potentially could look at other safety issues such as Fe impurities. One reviewer commented the work on Li deposition is important. This work can be expanded to other ions, such as Mn or Fe that can be available as free ions inside a cell. That would provide some answers to one of the biggest concern in the industry, which is what happens when impurities enter the system. For instance, how fast could deposition occur and where should one look to find these impurities and then how could electrode construction prevent that when these items enter the manufacturing stream, likelihood of failure through "hot spots" that these would represent? That would lead to identification of potential points where dendrites (which can short) can be formed and hot spots can be avoided through design techniques, manufacturing and cell design, areas around edges, but also areas around tabs and uneven areas where stack pressure can be slightly higher. Comments from another reviewer mentioned the work involved in developing the 2D model that explains edge effects, N/P ratio, and electrode thickness effects on lithium deposition during charging should be continued and expanded to include other relevant dependencies (effect on rate capability?, effect on efficiency?, effect on temperature gradients at high rates?, etc). Some level of experimental verification of model results of the current or potential future work in this area would be desirable as well. Redox shuttle modeling and verification is useful and should be pursued, but focus on couples other than and more tangible than $TiO/FePO_4$ and $C/FePO_4$ would be desirable. Another reviewer stated that continuation of modeling and more complicated model will enhance cell design.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate. Another reviewer commented that fiscal support seems very high in light of other programs funding relative to, head count, theoretical nature, and output.

Low Cost SiOx-Graphite and Olivine Materials: Karim Zaghib (Hydro-Quebec)



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the project has high relevance because of the practical nature of the studies. If the electrode composition is improved by the work, it will contribute to improved batteries. Another reviewer mentioned that developing new phosphate materials and a better understanding of the SEI layer are key issues in improving Li-Ion performance. One reviewer noted the project is aimed at very key aspects of increased energy and life of LI batteries. The use of abundant and cheap materials is also addressing cost aspects.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the approach is valid for the barriers as far as can be ascertained. However, the degree of secrecy involved because of the company restrictions make it somewhat difficult to evaluate. For example, the binder studies are sensitive to the exact type of binder as well as the concentration, but the binder types are not disclosed. Another reviewer noted Karim will develop the best way to synthesize $LiMnPO_4$ using high temperature, solid state and molten salt techniques. Surface coating with SiOx to improve performance of phosphate materials as well as evaluate SiOx-graphite with different binders for optimum performance is needed. One reviewer commented the approach is adequate in looking at new anode and cathode materials to solve the identified technical barriers. Carbob coating and the use of new binders is also a good compliment in the process to research new materials and electrode preparations.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated they like the approach, there is a problem in assessing the level of progress without better definition of the actual work because of proprietary factors. However, the data presented gives definite progress on the goals. Another reviewer mentioned that additives and electrolyte composition had a strong effect on the graphite and performance. The SEI was structure was strongly influenced by electrolyte additives. Preparation of $LiMnPO_4$ was explored with the hydrothermal process giving the best results. One reviewer noted there are results promising for SiO_2 based anodes and less for the $LiMnPO_4$ cathodes. The use of different aqueous binders gives interesting results. The potential impact on complete cells with improved performances must be carefully analyzed. Finally, the progress must be better measured with respect to measureable objectives.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that interactions with LBL, John Goodenough, Pete Roth (SNL) and C. Julien-A Mauger at University of Paris have been made. Another reviewer mentioned the collaboration with other BATT participant is well established with good integration. The feedback from the other participant activities is not evident.

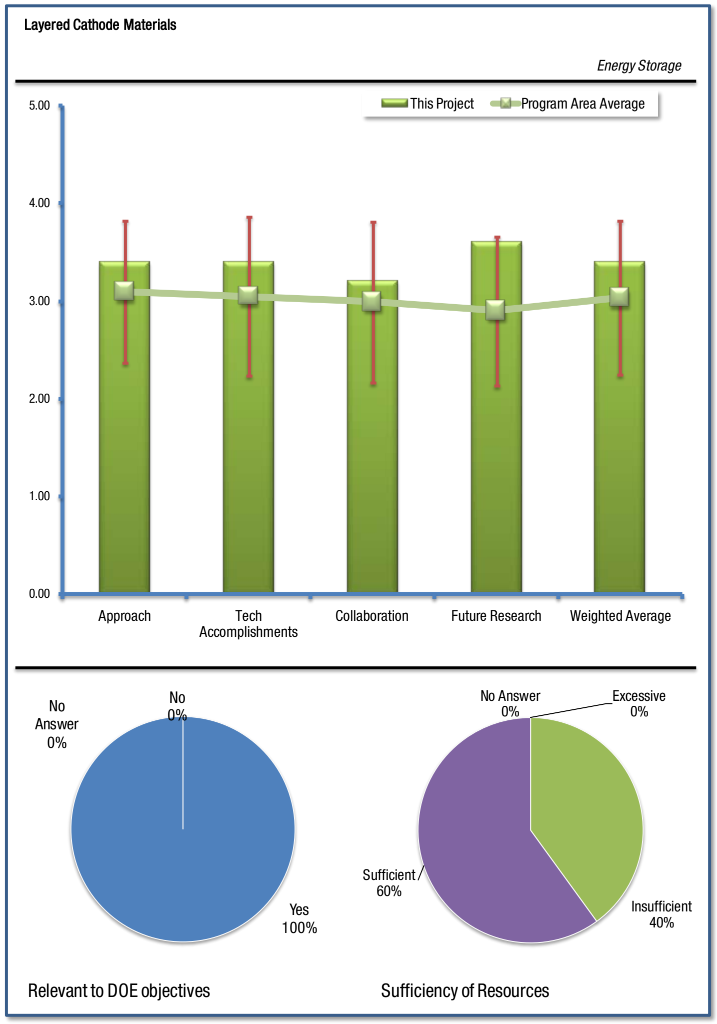
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated future work is to continue studies on the best method to prepare the olivine materials and continue work on SiO-graphite materials as the synthesis of olivines for other investigators, prepare 18650 cells for others on request. Another reviewer noted the proposed plan is quite generic and some choices, particularly on the cathode materials, need better explanations. The low performances of the cathode materials at RT do not open the way to clear progress with the proposed future activities. The proposed activities do not clearly explain how performances for cathode material mixtures may improve the present results also at RT.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the project has efficient operations and the funding is sufficient. Another reviewer commented the level of resources may be more than adequate in view of the in-kind similar contribution put by HQ.

Layered Cathode Materials: Michael Thackeray (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that layered positive materials are clearly a topic that needs extensive effort. Another reviewer commented one notable deficiency of the state of art Li-ion batteries is their low specific energy to meet the PHEV-40 targets. A focused development on new cathode (and anode) materials of high specific energy is thus warranted for making the Li-ion batteries viable for PHEVs and EVs and thereby reduces the consumption and demand on petroleum. The present task is therefore well tuned to the DOE's objectives. One reviewer mentioned the objective of cathode materials with > 200 mAh/g is in line with vehicle technologies objectives. Comments from another reviewer noted that energy density, cost and abuse tolerance is critical.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project has very well defined objectives and ways to achieve them. Prevent oxygen evolution at surface of material as well as stabilization of this surface (dissolution) is of great importance as they impact directly on performance, life and abuse tolerance. Another reviewer noted the approach is sound and effective. This is probably the most plausible approach to develop high specific energy (high voltage as well as high capacity) cathodes. New cathode formulations based on solid solutions of layered ($LiMnO_3$) and layered ($LiMO_2$) compounds are being developed by various researchers elsewhere. Extension of this concept to layers-spinel and spinel-olivine does not seem to be successful. Finally, the approach of stabilizing the surface with a surface coating to improve its rate capability is also consistent with the efforts elsewhere. One reviewer commented that the given capacity accomplishments approach is promising. There is a need to continue exploring cycle life and rate impact of surface modification as planned and presented. Comments from one reviewer mentioned that synthesis and modeling has the synergy.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer asked is there new materials for coating? Is there a new method? $LiFePO_4$ and spinel are both low energy density materials. Spinel-Olivine intergrowth structure does not seem to be the right direction to go. They would suggest doing more storage test instead of cycling and looking at solubility of metal (by post-mortem analysis for example). In a lot of applications, calendar life is more limiting that cycling life. Also there should be a correlation between cycling and storage life. Another reviewer mentioned the capacities obtained with the layered-layered solid solutions are encouraging, but the rate capability needs further improvement. Is this an inherent limitation arising from the surface (being enriched with metal which impedes Li diffusion), or the surface condition being not favorable for Li intercalation due to oxidative degradation of the electrolyte (at high potentials) or the bulk diffusion (for Li+) in these materials? The results from $LiNiPO_4$ coatings look promising. A better understanding of the surface coatings (should they be solid electrolytes?) would be helpful to design more effective coatings. The modeling effort to understand the solubility of $LiMn_2O_4$ is not connected with the overall objective. One reviewer commented there is good performance at meeting capacity targets and cycling as demonstrated in coin cells - as stated improvement in rate is critical. Comments from another reviewer noted that surface stabilization and integrated olivine spinal structures were implemented.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that maybe more collaboration with Sastry or Battaglia's group would be useful. Another reviewer noted there are several good collaborations with several researchers within DOE as well as outside. One reviewer commented that a lot of collaborative aspects of this project - modeling, synthesis and evaluation. Comment from one reviewer mentioned that collaboration with major materials supplier or globally viable Li-ion cell mass-producer(s) would be of great benefit for this project, while another reviewer said SUNY, BNL and material supplier adds value to the development work.

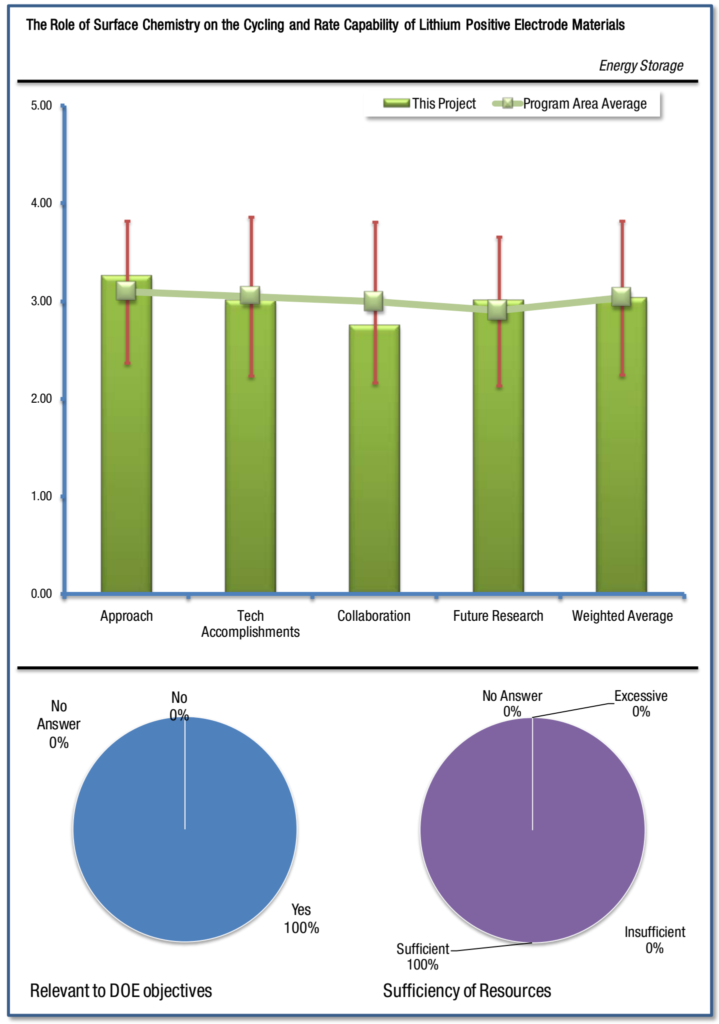
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated that in the future apply modernization to new system to correlate with metal solubilization during cycling or storage. Another reviewer noted the proposed future efforts to continue i) development of new high specific energy cathodes as well as to focus on surface studies to improve stability and rate capability are quite appropriate for the overall objective. One reviewer commented there is a good direction focusing on understanding surface modification impact on cycle life and rate. Also new mfg methods are useful as significant impact on morphology which likely will play a role in addressing rate and cycle life. Comments from one reviewer mentioned the proposed future research is excellent as is. As a suggestion, realizing that future work can further optimize the rate capability of the $Li\text{-}Ni\text{-}PO_4$ treated $0.5Li_2MnO_3{\bullet}0.5LiNi_{0.44}Co_{0.25}Mn_{0.31}O_2$ material, it may also be useful to begin investigating differences in the ratio of charge vs. discharge rate capability of the treated or untreated material relative to other more established cathode materials. Collaboration with major materials supplier or globally viable Li-ion cell mass-producer(s) would be of great benefit for this project. Another reviewer stated that synthesizing and improvement of performance, coating enhancement, and cheaper synthesis route will be beneficial.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that material development such as being done here is critical to advance the technology. The resources may be augmented with additional funding (50 %!). Another reviewer noted that funding for this project should be increased.

The Role of Surface Chemistry on the Cycling and Rate Capability of Lithium Positive Electrode Materials: Yang Shao-Horn (Massachusetts Institute of Technology)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the surface chemistry is very important to the stability and long term behavior of battery active materials. These studies bring the most powerful surface sensitive methods to bear on important battery materials. Another reviewer commented that this project is coating cobalt materials to improve their stability. The coated cobalt materials have better performance than the untreated cobalt materials. This project is developing a better understanding of the cathode-electrolyte interface. One reviewer noted Shao-Horn et al. are to improve the cycle life of cathode materials in lithium ion cells by studying the stability of the surfaces of these materials. Comments from another reviewer mentioned the interface between the electrolyte and active material is one of the most important issues.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the use of surface coatings has led to improved performance of a number of materials that are subject to higher charging voltage. Without the coatings, the performance decays quickly with increasing cycles. With the coatings, the performance is maintained for much longer cycling. There has not been a satisfactory explanation of this phenomenon until this work. Now it appears that the surface chemistry is complex and is all important for the behavior of layered structure cathode materials as exemplified by $LiCoO_2$ and $LiMn_{0.5}Ni_{0.5}O_2$. The work should continue with other more promising materials to address the barriers of higher voltage cycling. Another reviewer noted that they are using advanced x-ray photoelectron spectroscopy, etc. to understand the structure and operation of advance cathode materials leading to better materials for Li-Ion batteries for transportation applications. One reviewer commented that Shao-Horn et al. are using various surface probing techniques to establish whether or not mixing Al_2O_3 with the cathode material upon preparation will provide longer cycle life to cell. They are also using standard tests and surface probes to study the preparation technique (quenched or annealed) used to prepare other cathode materials. Comments from another reviewer mentioned the surface of the active material is very sensitive in case the samples are exposed to the air. They believe this is one of the reasons why not a lot of people are using XPS to analyze the surface of active material after cycling. If the PI can develop in-situ surface analysis method, it would be greatly helpful for these studies, but the result seems reasonable.

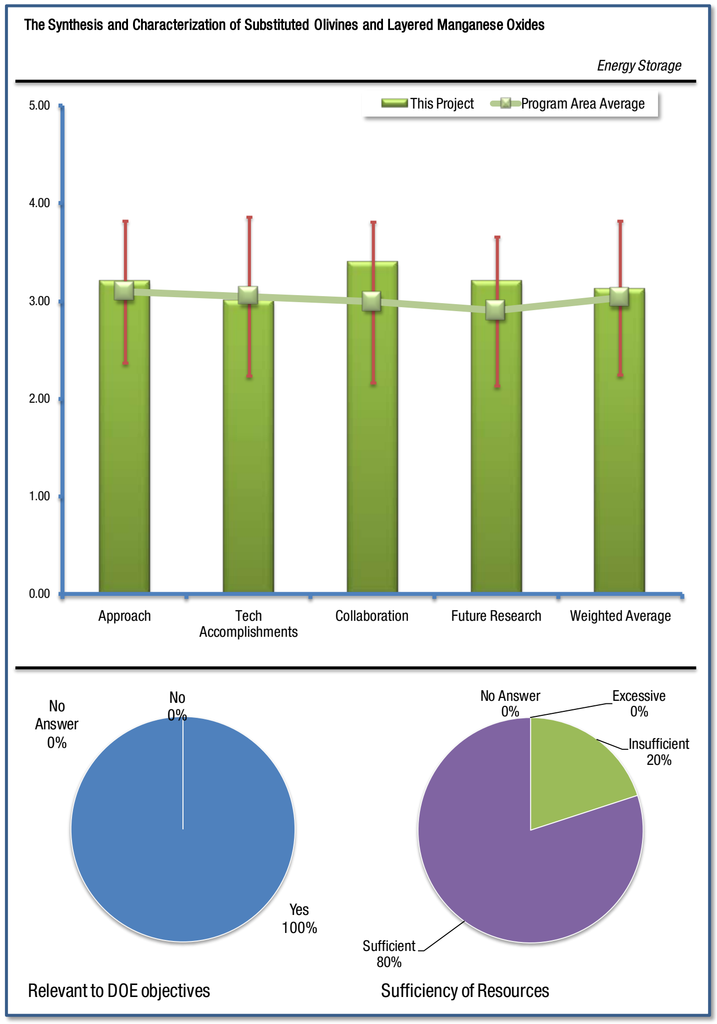
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the progress is excellent to date on the cathode materials studied. The surface chemistry of these has been well demonstrated. Another reviewer mentioned that surface coatings on cathode materials were shown to improve performance and stability especially aluminum oxyflorides Co-Al-O-F and developed improved surface structure of $LiNiMnO_2$. One reviewer commented that Shao-Horn et al. have obtained results that suggest that using an additive to coat the active material ($LiCoO_2$) leads to longer cycle life. They have also obtained results that indicate that annealing $LiNi_{0.5}Mn_{0.5}O_2$ leads to better cycle life. Comments from one reviewer noted the results for $AlPO_3$ is fine. However regarding to $LiNi_{0.5}Mn_{0.5}O_2$, just comparing quenching and annealing is not new and enough results.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated that this study has been a model of collaborative work, employing the PI with the Naval Research Laboratory as well as DOE workers and workers in Korea. Another reviewer commented that the work with Monsour at Naval Research has been especially successful. One reviewer mentioned that Shao-Horn et al. should consider working with companies to determine if their studies have been considered in practice. It may be that the costs associated with their processing steps may be too costly to implement. Comments from another reviewer noted they cannot see any collaboration in the presentation.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated that in addition to the proposed work, they would like to see further work also extended to more promising cathode materials like NMC and NCA which would allow higher voltage charging and concomitant higher capacities. Another reviewer noted they will continue with surface modifications and functionalized carbon nanotubes to improve performance of cathode materials. One reviewer commented Shao-Horn et al. have proposed work that will probably not yield useful new information. She may want to study instead the calendar life of the materials she has already made. Comments from another reviewer mentioned that if PI can develop in-situ surface analysis method, it would be greatly helpful for this study.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the facilities are sufficient as long as the collaboration goes on with NRL. If that is no longer possible, collaboration with another surface materials lab would be necessary to add or other methods would have to be developed. Another reviewer mentioned the resources are adequate for the project. One reviewer commented that Shao-Horn et al. have received sufficient funding. Comment from one reviewer noted there is a lot of data, achievement and they are reasonable.

The Synthesis and Characterization of Substituted Olivines and Layered Manganese Oxides: Stanley Whittingham (SUNY-Binghamton)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the objective of the project is to develop low cost and high capacity cathode materials that are also environmentally benign. Such cathodes will contribute to an enhanced specific energy for Li-ion batteries to make them viable for HEVs and PHEVs, which would in turn reduce the petroleum consumption, demand and (national) dependence. Another reviewer noted the improvements of cathode materials are a key factor in reaching DOE objectives. One reviewer commented that lower cost and high capacity cathodes will make the battery pack more affordable.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this is good to look at different NMC formulation that 1/1/1 and to minimize use of Co. What are the parameters that will help to determine the best composition? Another reviewer commented the approach looks reasonable and feasible, especially the part that focuses on identifying new cathodes with more than one lithium per metal. Specifically it involves manganese–rich and low-cobalt layered oxides and substituted metal phosphate that may help to explore high specific energy lithium metal phosphates. One reviewer mentioned the barriers are well identified and addressed with focus on scientific and practical aspects related to the modifications of cathode materials to improve their performances. The target of more than 200 mA/g gives a way to evaluate effective progress. Comments from another reviewer noted it keeps Co content very low to reduce cost.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the conclusion on capacity fade seems a little "quick". The difference is not significant and the number of cycle low. They should collaborate with people working on electrode optimization. Materials have different conductivity and may require different electrode formulation. It is interesting not to observe capacity fading of LFP material, it needs be assessed vs. a carbon negative electrode. Again, storage is as important as cycle life and don't forget that aspect. The Ah/cc differences shown are due to carbon content... what about tests with same amount of carbon? LFP/titanate does not seem to be realistic system for PHEV or EV applications. Another reviewer commented there a couple of interesting findings on the optimization of Mn, Ni and Co content in $LiMO_2$ as well in the substitution of lithium metal phosphates with vanadium. Even though the capacities are not high enough to be attractive for PHEV needs, the vanadium substitution may allow for the formation nanophases, which may help high specific energy phosphates (Mn) to be feasible. The results on the multi-valence cathodes are not encouraging yet in terms of specific capacity. One reviewer mentioned the progress is significant but not yet reaching the proposed target, mainly in terms of specific capacity. The work on substituted Mn-based materials is valuable as well as that on olivine, but the options for further improvements to reach target seem not clearly identified. Comments from one reviewer noted that low-cost Olivines will help to reduce battery cost.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is on-going collaboration with the University of Maryland. Another reviewer noted the collaborations are well described and partially motivated with good coordination. One reviewer mentioned that collaboration with the universities, National Labs, and material supplier will enhance the value of the development work.

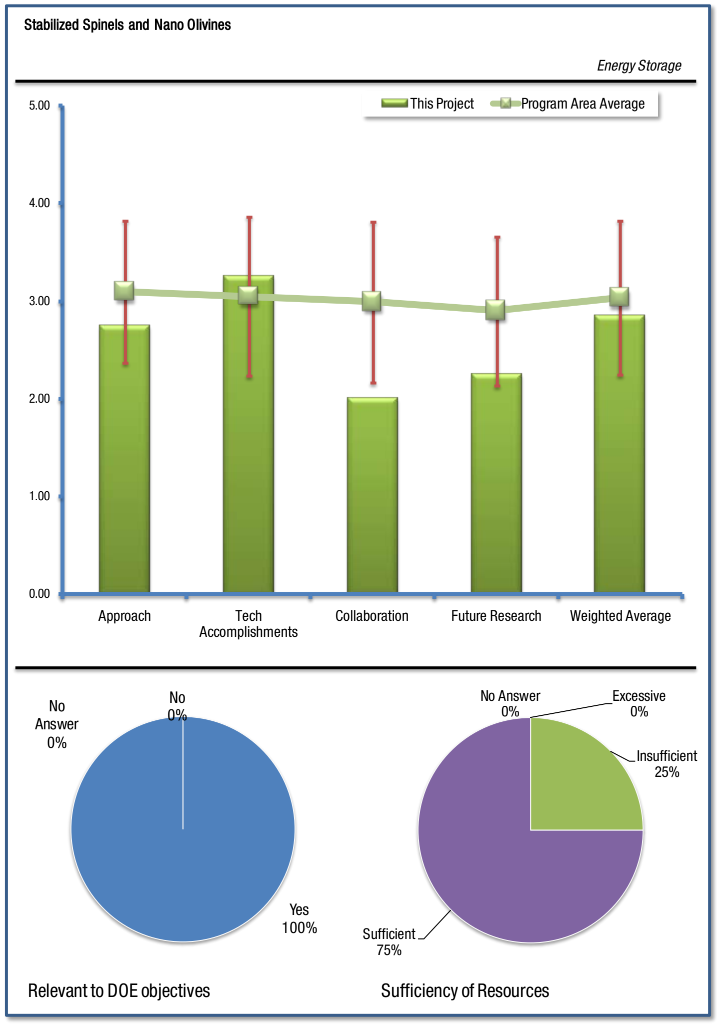
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated it was interesting to see that you are looking at the role of Al. Another reviewer noted the proposed future work on substituted lithium metal phosphates with higher Li content and cathodes with more than one Li per metal looks interesting and relevant. One reviewer commented the future plan is appropriate to reach the main scope of scientific comprehension of some working mechanisms in various cathode materials. Anyhow, the practical improvements aimed at improving the cathode performances require more specifications. Comments from another reviewer mentioned the pursuit of Vanadium-containing compounds should not be pursued, unless it can be shown that better understanding of Vanadium-containing compounds is a very critical key to understanding other compounds which do not contain Vanadium. Focus on further work with $LiMO_2$ forms, new alternatives, and limit/eliminate further significant work on phosphates. Another reviewer stated the understanding of the stability of low-cost cathodes, investigation of other phosphates will help with the cost reduction.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate. Another reviewer mentioned the planned work and the resources and budget declared seem not sufficient to perform the work planned.

Stabilized Spinels and Nano Olivines: Arumugam Manthiram (University of Texas at Austin)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the work on substituted spinels and nano olivenes has the potential of improved cathodes for vehicle batteries. They need further improvement, however, before they will have a real chance for success. Another reviewer noted that higher capacity spinel based materials are relevant to achieving PHEV40 objectives. Also surface modifications which enable higher Voltage are likely to have a very positive impact on vehicle applications. One reviewer commented that Manthiram is developing high voltage (5 Volts) cathodes for lithium ion cells, which may increase the energy density of lithium ion cells. Comments from another reviewer mentioned the continuous study for new positive active material is necessary.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach has given improvements on high voltage Mn-Ni oxides, but they are not yet good enough for commercial use, particularly in cycle life. This is also true of the modified spinels. Concentration on the best coating materials to optimize the coating level would be useful to test the limit of improvement. Another reviewer commented this is excellent work on both composition optimization and surface stabilization - the achievements validate the approach. One reviewer mentioned that Manthiram's approach appears to be empirical without consideration of the work by others such as that at MIT. He may be able to make more progress by working with others sponsored by the DOE. However, he seems to have made progress in his coating work of spinels and his production techniques for olivines. Comments from another reviewer noted the target is vague. What is "acceptable cycle life", "low manufacturing cost" or "increased energy and power"? A more concrete target is necessary.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there are definite accomplishments during the year, but more focus on promising coatings and substituent’s needs to occur. Another reviewer noted this is very good progress with demonstrated results in stabilizing spinel materials both by composition and surface modification impact on Bi_2O_3 very significant. Preliminary work on Microwave assisted olivine synthesis is promising for reducing manufacturing costs. One reviewer mentioned Manthiram seems to have made progress in his coating work of spinels and his production techniques for olivines. However, his use of carbon nano tubes will probably not produce a cost effective cathode due to the cost of carbon nano tubes. Also, it appears that his materials do not have sufficient cycle life. Comments from one reviewer mentioned that regarding to stabilize 4V spinel catode, a lot of research was done and the substitution is well-known. There are a lot of results; however they expected more fundamental research at University.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaboration seems to be limited to DOE LBL lab personnel. Another reviewer commented that Manthiram apparently does not work with others at the University of Texas at Austin such as J. Goodenough. Perhaps Manthiram should be encouraged to discuss his experimental work with others. One reviewer noted they don't see the collaboration in the presentation.

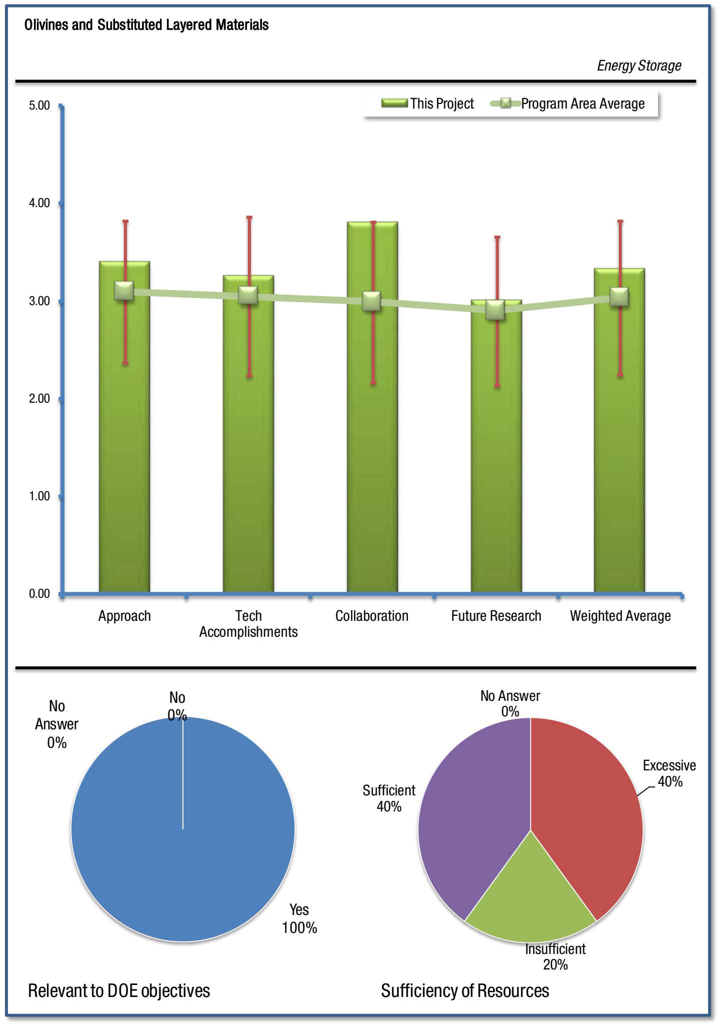
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they need to carefully evaluate the future program to focus on highest likelihood of success areas. Another reviewer mentioned the microwave assistance work is very good and should be applied to new cathode compositions with polyanions. $LiMPO_4$ work is interesting; however, commercial fate of those materials may be on edge. Continued effort on surface coating is extremely promising. One reviewer commented Manthiram is planning to continue his current work next year. It is not clear that his microwave heating approach will be practical for application in industry. Comments from one reviewer noted that they will focus on more fundamental research to understand the mechanism. For example, they want to understand the mechanism of how the coating works, or how F doping works.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this work is very relevant and has yielded strong results - relative to other initiatives it could be funded more, particularly if scope was expanded to evaluate impact of surface modifications on other cathode materials. Another reviewer noted Manthiram has received sufficient funding. One reviewer mentioned the quantity of the results is a lot.

Olivines and Substituted Layered Materials: Marca Doeff (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that low cost, benign and high performance material is what they need. Another reviewer commented the work is directed at developing lower cost materials for Li-Ion batteries that are safer and have higher performance. One reviewer noted the project is aiming to develop low cost (low-cobalt) and high capacity and environmental benign cathode materials, by substituting Co with various other metals. If successful, these studies will result in enhanced specific energy and reduced cost for Li-ion batteries to make them viable for PHEVs, which would in turn reduce the petroleum consumption, demand and (national) dependence. Comments from another reviewer mentioned improvements of cathode materials are essential in reaching DOE objectives. The focus here is on two interesting materials with some interesting results. Another reviewer stated that this project advances understanding of alternative cathode materials for vehicle applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated please do not focus on cycle life only but push the material to the limits and look how well it sustains storage. It is good to see a go/no go decision on $LiMnPO_4$. This promising material may remain an eternal promise. Another reviewer noted creative synthesis of new materials, especially the NMC and PO_4 materials. These have good promise to improve the performance of Li-Ion batteries with good safety characteristics. The work uses the appropriate experimental approach to understand cathode operation, Raman, TEM etc. One reviewer commented the approach of substituting Co with several other metals to bring down the cost, and yet retain high capacity, looks feasible, but the capacity improvement isn't substantial. Likewise, there wasn't much success with the nanostructured $LiMnPO_4$/C composites, but the synthesis methods may be applicable to other high space energy cathode materials. Comments from another reviewer mentioned the approach is reasonable and mainly based on the cost, performance and stability proposing some interesting changes in two material classes. The identified barriers and the route proposed are acceptable with complete electrochemical characterization.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated it is very surprising to see discharge rate increase when Al increases. Is it true or is it somewhat an artifact? It would be interesting to see how the diffusion coefficient changes after several cycles. Another reviewer commented the work on Manganese phosphate has shown that it has little promise as a cathode material for use in the HEV, PHEV applications. The NMC compounds show greater promise. The reduction of Co contents shows good promise to lower cost while improving performance. One reviewer mentioned substitution of Co with Al has been studied in great detail, both from performance and structural points of view. Al substitution in general decreases the capacity, but improves rate at low contents. It also permits charging to higher voltages, which results in a capacity increase, but with increased capacity fade. Not surprisingly, the optimum Al content is 0.05, like in the NCA material It is not clear as to why the diffusion coefficient is lowered upon Al substitution, even though the rate capability if improved. Overall, the three substituent's studied (Al, Ti and Fe) do not seem to be best choices from performance stand point. Comments from another reviewer noted the work on $LiMnPO_4$ seems less interesting with results not positive for a further use of such material. Much more valuable is with work with manganese compounds by substituting Co with other materials. Another reviewer stated there was good progress with substituted NCM's.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that there are good working arrangements and collaboration with fellow co-workers at LBL. There is also significant co-operation with Whittingham, Grey, and Cairns among others. Another reviewer noted there are a few good collaborative efforts in this project. One reviewer commented the collaborations are well motivated and integrated to support the development of new materials. Comments from another reviewer mentioned via collaboration with SNL or via examination within the project, investigation of the relative thermal stability of the $LiMnPO_4$ material, or of any of the other materials, by DSC or ARC may be a useful additional parameter to consider in further work towards $LiMnPO_4$ or any of the other materials in this project. Collaboration with globally viable battery materials supplier(s) could improve focus and value.

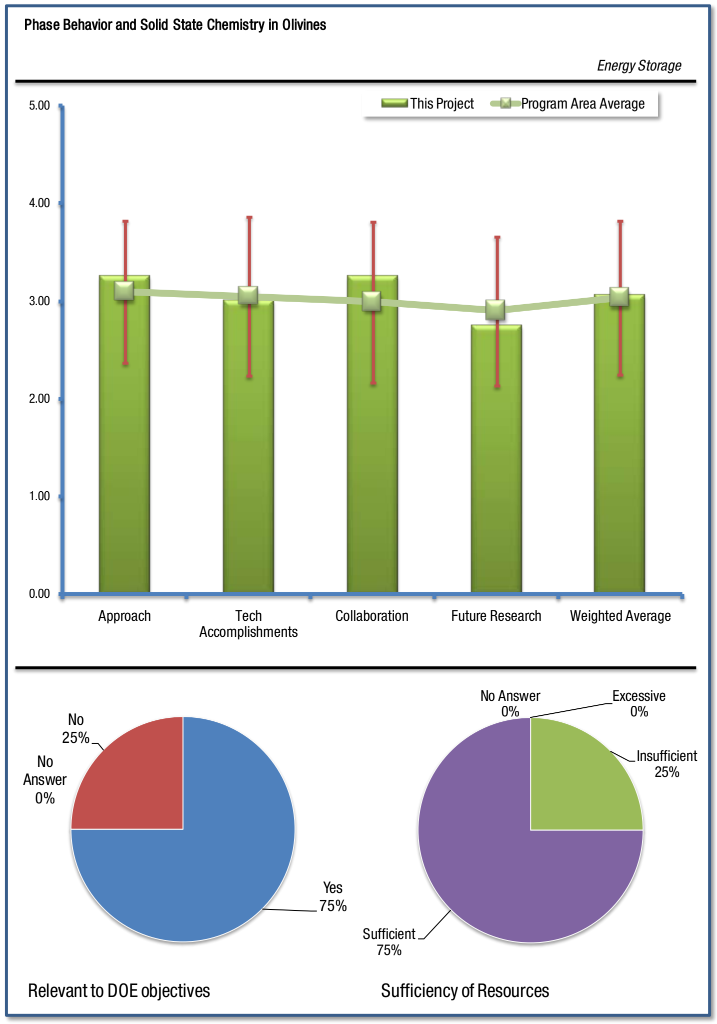
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated there are a lot of interesting results but a lot of questions remain unanswered. Need to be careful about the objective for next year and focus on the main questions. Another reviewer commented the future work clearly understands the direction to go and builds on previous success. Substitutions in the crystal lattice to change properties are the specific area of expertise. One reviewer mentioned the future work is aimed at understanding the structural and functional aspects the substituent's (for Co) to develop low-cost cathode materials, as required for PHEVs. Comments from another reviewer noted the activities on new materials must be further developed with the assistance of the proposed collaborations, as clearly proposed, with emphasis on Al substitution. Technical targets must be better defined eventually separating exploratory work on new materials and research on material improvements. Another reviewer stated the focus on $LiMnPO_4$ should be reduced for now, and focus on substituted NCM's and further tangible improvements to substituted NCM's should be increased.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the project has no resource limitations that are obvious. Another reviewer mentioned the resources are adequate. One reviewer commented the described delays and limited results on one of the materials under investigation make the planned budget overestimated, even if there is no clear view on the way this will be used. Comments from another reviewer noted the project should redirect resources more towards substituted NCM's and/or other new alternative materials and minimize or eliminate effort on $LiMnPO_4$.

Phase Behavior and Solid State Chemistry in Olivines: Thomas Richardson (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that barriers being addressed are relevant to DOE applications - capacity, cycle life and stability. Another reviewer noted the energy density improvement will reduce weight and volume of the battery packs. One reviewer commented Richardson et al. are producing new cathode materials that may be useful in lithium ion cells. Comments from another reviewer mentioned this kind of fundamental study is very valuable as the National Lab work.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the investigation of the relationships of structure, morphology and performance of electrode materials, with emphasis on phosphates and intermetallics has some value if the knowledge can be transferred to practice of manufacturing the materials. Another reviewer commented Richardson et al. are using focused experiments and analysis techniques such as XRD FTIR to understand the material that they are producing. Also, Richardson is careful to validate his techniques relative to those of others (Whittingham, eg). One reviewer mentioned it's a very good approach to understand the mechanism for olivine materials. The challenge for Li-Mg is "difficult to make it", "Potential too close to Li" in the presentation but there are more critical issues to be solved for Li alloy anode in the industry.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the results do not stand out except for in -situ lithium preparation from Li_3N with Mg or Al. Another reviewer noted Richardson et al. have made material that appears may have utility as a high voltage cathode material, if stability problems can be overcome. They have also produced interesting new materials which might be useful as anodes. One reviewer commented they can see a lot of data to support the mechanism for the olivine but didn't see so much electrochemical data for Li alloy.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is excellent collaboration including industry as well as National Labs. Another reviewer mentioned Richardson et al. have begun interaction with industry, which should help them focus their work to be more supportive of the activities underway by battery companies. One reviewer noted that based on the results, they believe there are some collaboration with others.

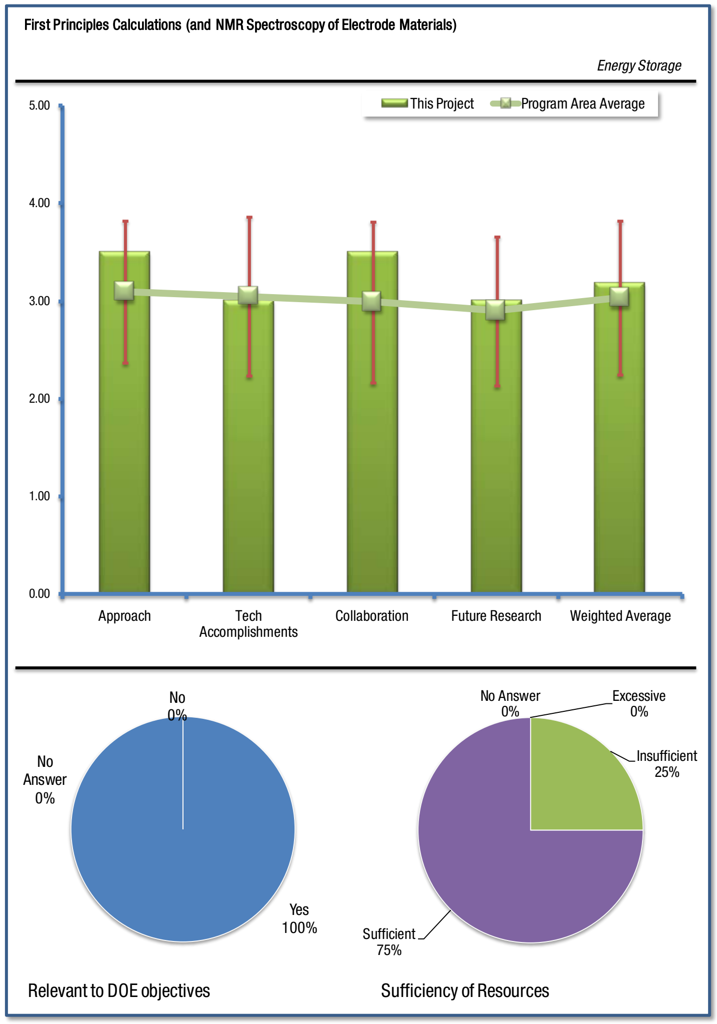
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated Richardson et al. have plans to continue their work in directions that should be useful to lithium ion battery manufactures. Another reviewer commented please complete the olivine study and suggest the approach for the new positive active material. Regarding to anode, please focus on the issues that the industry has.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated Richardson et al. are receiving sufficient funding for this project. Another reviewer noted that probably more resource is needed for the anode study.

First Principles Calculations (and NMR Spectroscopy of Electrode Materials): Gerbrand Ceder (MIT/SUNY-Stony Brook)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that for performance, life and stability it is very important to understand electrochemical particles and to predict the reactivity with the electrolyte. This is what that project addresses. Another reviewer noted the first principles calculations will help not only in understanding unexpected experimental observations (such as hysteresis, phase transformations etc) but also in identifying new materials, for example with high specific energy as required by the PHEVs. Replacement of conventional vehicles with electric vehicles will reduce the consumption and demand of petroleum. One reviewer commented the use of calculations to screen materials before their practical production and experimental analysis addresses some key objectives of improved materials for Li batteries. Comments from another reviewer mentioned the presenter understands what the problems are about the battery for vehicle usage. R&D in the battery business usually does not dig into detail about active material itself. In other words, optimization only from DOE (design of experiment) is the normal trial to reach costumer target. This research shows very well about mechanism for each material and the entire research will be a big help to accelerate R&D for battery manufacturers in the US.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated there is a relation between structure stability and rate capability, which enables better prediction of oxidation and reduction. Another reviewer commented the approach is fairly effective, providing clues in understanding stabilities of different structures ay high state so charge, correlation between structure and its electrochemical properties and in identifying newer materials with improved specific energy. One caveat is that some of the successful solutions (e.g., non-equilibrium phases, kinetically stabilized systems. SEI) are not often predictable by theory. One reviewer mentioned the approach systematically looks at key technical barriers by screening cathode materials using computational methods. The selection focuses on key materials features. Comments from another reviewer noted this research approach is very simple and common sense, but many of the research are not following like this research as below:

- find the base and determine the effect from material point of view.
- find and determine mechanism to reach the target.
- provide the new material chemistry based on the result and develop.

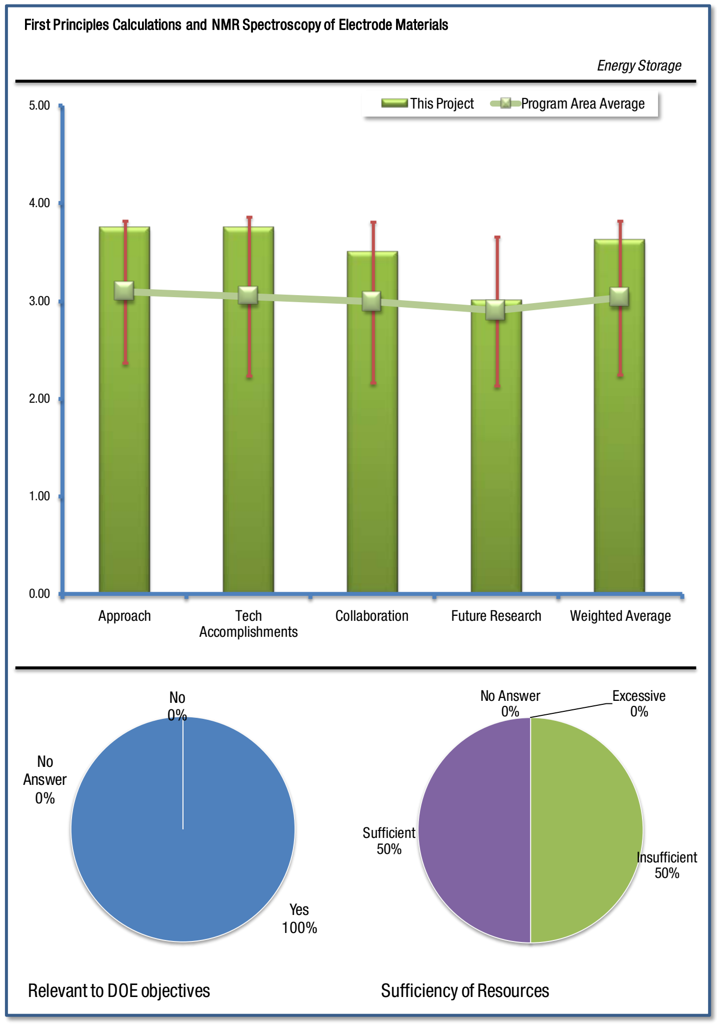
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the demonstration that nano material with optimized surface treatment has fast kinetics is nice, but what are the true limitations? As far as they know this is true for a lot of other material not only $LiFePO_4$. Does that mean that the true limitation is electronic? Good work showing that synthesis conditions (oxidation condition) lead to different morphology and performance. The theory of lithiation of surface as an interpretation of the extension of solid state surface is interesting. How to demonstrate it by experiment and what does that mean in term of material morphology optimization? Another reviewer mentioned that impressive rates are being claimed with olivine cathodes and a useful simulation model has been developed to study the mixed olivines, especially the plateau potentials and the hysteresis in the FeF3 cathode, among other things. Finally, it is being claimed that both voltages and capacities have computed for several new compounds, though there wasn't any information on them. One reviewer commented the presentation mostly concentrates on describing the methodology with limited space in presenting the most interesting configurations and structures. The use of ab initio calculation must give clear indications in improving existing structures or selecting new ones. Comments from another reviewer noted the information was provided as addressed in the objectives. What is happening to material, why, particle affect what, and possibility of future material? Altogether, this is an excellent result.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated there is good collaboration with the DOE researchers and researchers elsewhere. Another reviewer noted the collaborations presented in one slide apparently do not show up in the presentation of the work. The level and type of collaborations should be better described. One reviewer mentioned which parts was collaboration work and done.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated that understanding the kinetics of phosphate materials does not seem to be the priority now. They think it would be more interesting to look at material structure and surface stability (or other mechanisms) that impact the life. Another reviewer commented the proposed future work appropriately focuses on continuing the modeling approach to identify new materials and understand the effects of nanomorphologies, and also undertake experimental studies to verify one such advanced material. One reviewer mentioned the proposed activities are consistent with the first principle calculation application with integration of experimental work. Comments from another reviewer noted that the future work was addressed based on the result and confirmation work is also mentioned. All of the addressed future works are along with approach and towards target.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the resources are adequate. Another reviewer noted the timely and productive completion of the planned activities is strongly related to the resources of the PI together with the defined collaboration. One reviewer noted to explore new material, this research may need more budget so that the possibility for new material will expand more and may add great value to the US battery business.

First Principles Calculations and NMR Spectroscopy of Electrode Materials: Clare Grey (SUNY-Stony Brook)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated Si based anodes are one of most promising materials to dramatically improve capacity of batteries and also address cost - cycle life is a key parameter and concern with Si materials this work allows both fundamental understanding but also practical way to look at impact of binder. Si and future electrolyte efforts seem more relevant than conversion reaction efforts. Another reviewer mentioned this project is generating a tremendous amount of understanding on new high energy materials and existing key materials. One reviewer noted NMR was not used so much to evaluate the structure but it would be the good especially to understand the amorphous structure.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that coupling ex situ and in-situ advanced spectroscopic techniques is very valuable and particularly relevant to overcoming barriers of addressing system deficiencies and not just evaluating material on its own. It is very nice to see intersection of spectroscopic methods and ability to implement and measure in real cells. Another reviewer commented the PI does pioneering work in NMR methods - world class work. Equally important is that she takes a holistic approach and includes other techniques such as diffraction, X-ray Pair Distribution Function Analysis (PDF) and electrochemistry to try and get a complete picture of what's going on. They appreciate the PI's insistence of taking the time to properly design comprehensive studies on some of these new materials rather than just starting in on data collection. One reviewer mentioned it is a good approach to understand the structure change by NMR.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated they think strong foundation for Si anode work has been laid and will be able to be utilized to speed real applications of Si anode. They also see potential for similar effort results in electrolyte work. Another reviewer mentioned that in a relatively short time frame this group has provided new insight on the charge/discharge of silicon anodes and also cathode coatings. They are very impressed with the speed at which they have addressed new materials; they seem to bring new insight into every area they touch and they expect this to continue. One reviewer noted there is a lot of previous work for Li-Si. If PI can compare the results with the previous work, it would be better.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer suggests seeking additional partners regarding Si based anodes to address key challenges with implementing. Another reviewer stated they think the PI is extremely well connected to the rest of the program and is extremely effective at linking her work to the other National Labs, MIT's modeling work under Gerd Ceder, and other institutions. In terms of completing her own tasks, they would rate this PI's collaboration as outstanding. One reviewer mentioned they do think that the other labs could use her help more to answer their own needs more than they do. With so much of the recent work relying on nanomaterials and coatings, diffraction studies often miss the key features that define system stability and that NMR can offer key insights they need. Comments from another reviewer noted that collaboration with the industry is recommended.

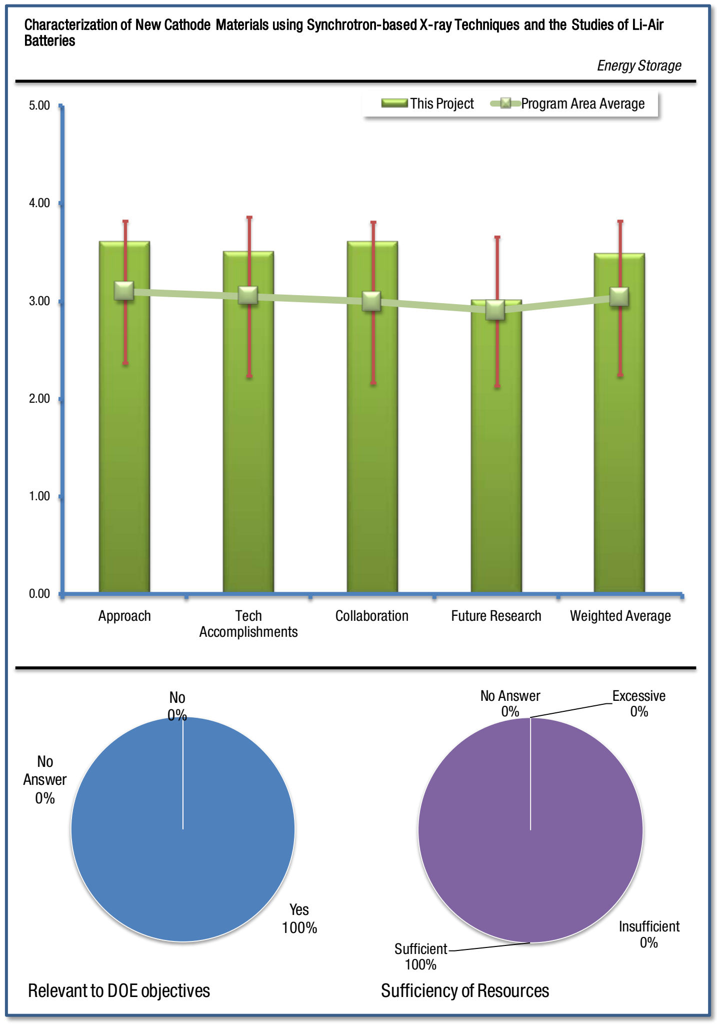
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the impact of binder on Si based anodes has been shown to be critical to cycle life also most Si based anode materials are blended with graphite 1:1 - studying these parameters in system could prove both scientifically valuable as well as worthwhile to applications of Si anode technology. Another reviewer commented the focus on conversion materials is aimed at a new class of materials (at least new for this program), and it is refreshing to see how well the PI has moved onto new topics. One reviewer noted the MRI imaging work looks interesting. They are not sure that the spatial resolution will ever be good enough, but in principle such work could be a tremendous adjunct to the electrochemical modeling and electrode design and characterization. Comments from another reviewer mentioned that if the PI can suggest the improvement on the materials based on the NMP results, it would be good.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that on a relative basis to other work reviewed, they believe accelerating the in-situ work of this group would have large practical benefits and should be considered. Another reviewer noted this PI seems to them to be the most effective at creating truly new understanding on key materials, but yet gets less funding than many others. They strongly recommend boosting her funding to at least $600K/year.

Characterization of New Cathode Materials using Synchrotron-based X-ray Techniques and the Studies of Li-Air Batteries: Xiao-Qing Yang (Brookhaven National Laboratory (BNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the work involves a number of DOE programs and provides unique structural information on changes during charge and discharge. Another reviewer mentioned the X-ray analysis of advanced cathode materials during charge and discharge to understand the reaction products that form and when they form. Has excellent insight of the cathode operations and mastered the experimental techniques. The materials form the basis for Li-Ion batteries for HEV, PHEV and EV applications. One reviewer commented the objective of this project is to develop and understanding on the surface and bulk properties of electrode materials upon cycling, storage and thermal abuse and thus contribute to the development of long-life Li-ion batteries for PHEVs. A widespread use of Li-ion batteries will reduce the petroleum consumption and demand. Comments from another reviewer noted the structural studies of materials are functional to the development of batteries meeting DOE objectives. Another reviewer stated Crystallographic studies of cathode and anode materials are important to study the structure property relationships as materials are charged and discharged. This leads to enhanced ability to design better performing materials necessary for high energy batteries. Also high temperature stability can be studied and improved upon by information gathered through these characterization techniques, allowing tailoring of structures for better high temperature performance necessary in the nickel systems.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the group has access to a unique facility which produces monochromatic x-rays which can be used for diffraction experiments, absorption experiments in a very exact way. The time resolution is much better than any other method so that the structural changes with time of charge or discharge can be measured. The choice of materials seems to be close to DOE goals. Another reviewer commented they are able to use advanced techniques to understand the reaction mechanisms in an efficient manner. Not wedded to one technique but applies the appropriate one. Works well with others that supply new materials and concepts. Focus on understanding specific problems and developing the best techniques to help understand electrode operations. One reviewer noted a combination of in-situ and ex-situ techniques will be utilized to derive information on the solid electrolyte interface, morphological and compositional changes in the electrodes upon cycling. These methods are being used by these researchers and others successfully. In addition, new electrolyte system for lithium-air system (a long-term option) will be designed, using boron-based anion receptors that can dissolve lithium peroxide. Comments from another reviewer mentioned the approach is very appropriate in using synchrotron studies and other advanced crystallographic studies to characterize the behavior of various Li systems. For Li-air the experimental activities combined with molecular design may give quick answer on the system potentialities. Another reviewer said synchrotron data is utilized to study phase transitions in situ and exsitu. Further temperature dependence and electrochemical reaction paths are studied. This is a great approach to learn about phase transitions in the materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the identification of reaction intermediates in the cathode reactions is quick and accurate. Can separate the contributions of each element in the cathode and when it enters the reaction scheme. Electrolyte studies for Li-Air are creative and essential to the eventual commercialization of the system. Another reviewer noted that distinct intermediate phases and solid solutions regions were identified through in-situ XRD in mixed olivine systems Li(Fe,Co,Mn, Ni)PO_4 that are typically absent in pristine $LiFePO_4$ system. The X-Ray near edge spectra provide confirmatory evidence that the extra capacity for $Li_{1.2}Mn_{0.4}Ni_{0.4}O_2$ is not contributed by Ni and that in over-lithiated layered -layered solid solutions, the Li_2MnO_3-like phase activates during first high charge at high voltage. There may be some reservations on the use of TEM and Electron Diffraction, being ex-situ techniques for studying the SEI. The results on the electrolytes for Li-air system are quite encouraging. It may be useful to assess the stability and longevity of the anion receptor TPFPB. One reviewer commented the progress is relevant and well described. The association of in situ measurements and electrochemical behavior is effective in identifying mechanisms and optimizing material composition and cell design. The screening capacity of the methodology is adequately outlined. Comments from another reviewer mentioned that significant progress has been made, but no surprises have been detected. The verification that substitutional chemistry can stabilize up to 5V is a significant progress against achieving high voltage stability. Also the verification of solid solution regions in the phosphate systems is notable.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the group uses a large base of collaborators, both among DOE researchers, contractors and non-DOE contractors. Another reviewer mentioned that most of his work is getting experimental materials from others and helping them define the operation of the new materials. They can work with small samples that are produced in the laboratory techniques. The electrolyte work is quite creative. One reviewer commented there are on-going collaborations on different topics. Comments from another reviewer noted there are effective collaborations on key materials and activities. All the contributions and collaborations are well coordinated.

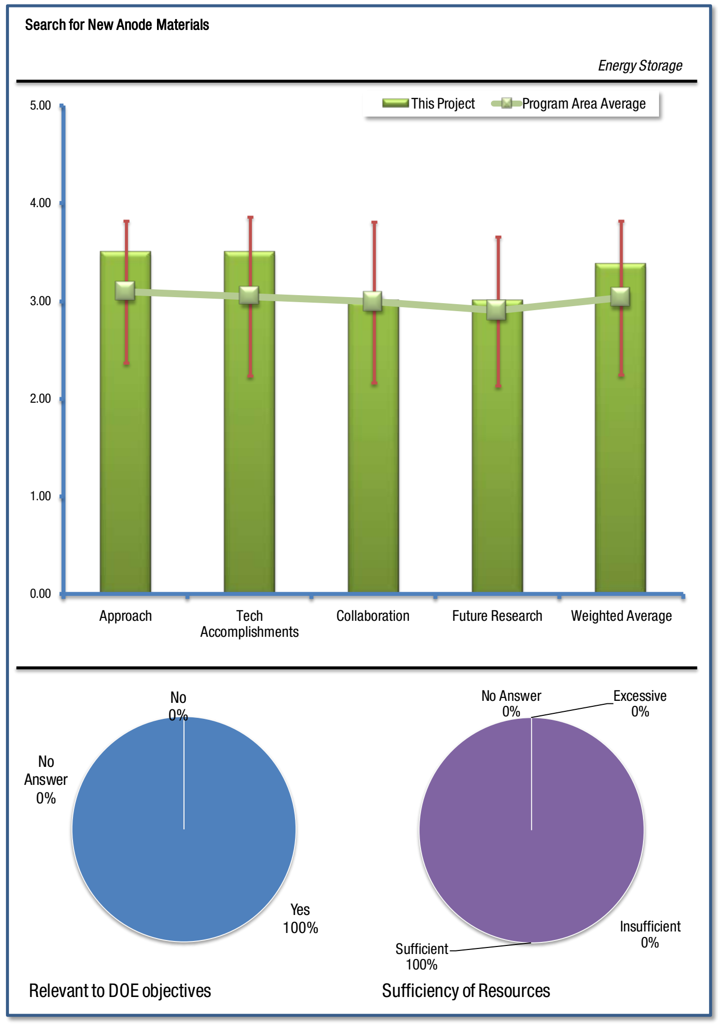
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated a good plan of important projects is indicated. An effort in establishing the structure relationships in $LiFePO_4$ cycling in nanosized materials would be important. Another reviewer commented the collaboration with outside labs to help them understand reaction processes including HydroQuebec materials. Develop new experimental techniques of use with Army Research and UMass for Li-Air development. One reviewer noted the future proposed topics of continuing the diagnostic studies on different anode and cathode materials and in developing novel electrolyte systems (for Li-air) are relevant to the DOE objectives. Comments from another reviewer mentioned the future work plan is quite ambitious and broad but it is substantially based on the application of a continuously updated characterization technique. In addition, the work on Li-air system with the study of new electrolytes may have some positive feedback. Eventually the introduction of a bi-functional air electrode study should be considered. Another reviewer stated the program appears a little bit spread in effort with no clear focus, many systems in play. Coordination with some of the newer systems that show promise could reveal some important information that would overcome barriers for higher capacity materials, rather than stay with the phosphate systems that are lower in performance.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the project can use additional people to assist in the experimental work. Another reviewer noted the resources are adequate. One reviewer mentioned the resources seem hardly adequate to the ambitious work plan, but the use of collaborations may be beneficial in levelizing needs.

Search for New Anode Materials: John Goodenough (University of Texas at Austin)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that new anode materials, particularly intercalation materials which have advantages of cycle life and rate are very relevant to DOE objectives. Another reviewer commented the project is looking for new high energy materials that might enable a paradigm shift in the industry. One reviewer mentioned Goodenough et al. are developing new anode material for lithium ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated although interesting from academic perspective sulfide based materials would not be practical from a manufacturing cost perspective. Another reviewer noted an excellent understanding and attempts to design and screen the universe of materials, although Cr seems a non-starter on environmental grounds. One reviewer commented Goodenough et al. are utilizing information in the literature to help them focus on finding anode material.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated a lot of sound academic studies completed. Results related to SEI layer blocking Li+ are interesting. Another reviewer added some interesting materials found, such as the high capacity $LiTi_2(PS_4)_3$. While recognizing that solubility issues are important, I would not worry too much about them at this stage. As long as the structure doesn't disintegrate during C/D some kind of "magic" as-yet-to-be-invented coating could help. One reviewer mentioned Goodenough et al. have produced material that may lead them to a new anode for lithium ion cells.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

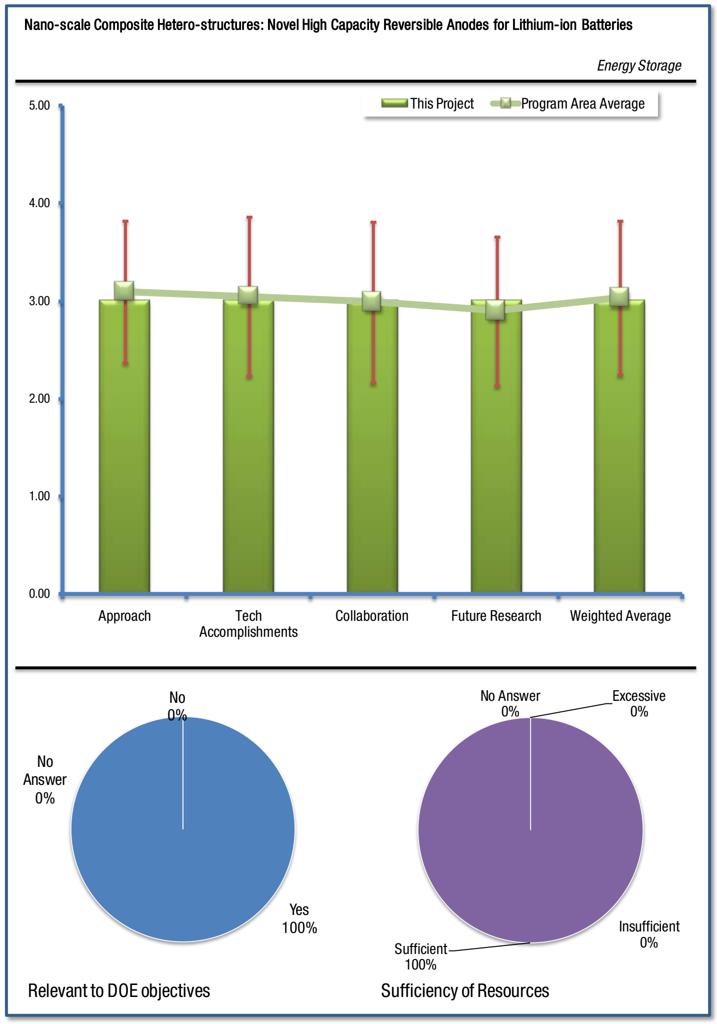
A reviewer stated PI is very aware of what everyone else has done. This program really does not require much collaboration at this exploratory stage. The reviewer recommended that DOE "Just leave him alone to get on with it." Another reviewer noted Goodenough et al. are cooperating with a company to help find a new anode for lithium ion cells.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated future work is nebulous - new oxide anodes, new cathodes, and new oxides for both cathodes and anodes. Another reviewer commented while one never quite knows what direction this PI is going to go, they think that's a good thing. They recommend letting him have a fairly free rein to explore things. One reviewer mentioned Goodenough et al. have proposed to continue their search for new intercalation anode materials for lithium ion cells.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the likelihood of success in such an endeavor in inevitably low. There is a need to go fairly slowly with the current modest level of funding until and unless something pops up that looks exciting. Another reviewer mentioned Goodenough et al.'s funding is sufficient for this project.

Nano-scale Composite Hetero-structures: Novel High Capacity Reversible Anodes for Lithium-ion Batteries: Prashant Kumta (University of Pittsburgh)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this project has very high relevance because of the high capacity observed and good cycle life to date. This could be a major step forward in lithium ion technology. Another reviewer noted this work is important because we need alternatives to the carbon materials we use today, especially to improve the energy density and decrease the reactivity. One reviewer commented the objective of the present project is to develop new anode materials, alternate to graphite, of high gravimetric and volumetric energy density with the overall objective of enchanting the specific energy of Li-ion cell and batteries and make them viable for a widespread application, such as PHEVs and other electric vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that there is very logical progression of steps as experiments proceed. The work is sharply focused on the barriers as they are developed. The next steps will require substantial collaboration on cell tests made by others using anode materials developed by the PI. Another reviewer commented be careful to identify the right barriers. Specific energy and energy density are the main ones. Irreversible loss and cycle life are secondary. If the new Si based anodes show same irreversible loss and cycle life that current graphite but with two to three times the energy, it is a real breakthrough. One reviewer noted the approach is generally effective and involves the synthesis, characterization and assessment of composite of nanophase silicon and graphite, prepared by high energy ball milling with different amounts of graphite. Also examined are lithiated Si for reduced volume change and improved cycle life and thin film electrodes of amorphous silicon and carbon, which look promising.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the progress to date has been substantial with a number of the goals already reached. Another reviewer commented at the beginning they were confused by charge and discharge nomenclature that is the opposite way that the battery system. These materials need to test vs. a cathode material. What is the efficiency of the system? One reviewer added that useful results have been obtained from the high-energy ball milled composites of Si and graphite with polymer additions for eliminating Si-C formation at the interface. The cycle life is encouraging with low Si content, and the capacity is over 600 mAh/g, which is near 100% gain over carbon anodes. Likewise, the approach to limit the charging to low Li contents in the composite such that a-$Li_{3.5}$Si formation is prevented for reduced volume change may be a good compromise between cycle life and capacity. The coatings of a-Si on carbon nanotubes look promising.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that collaborations with Ford and LBNL have been substantial. It might be useful to look at a subgroup of the anode people in the ES program to meet occasionally and stimulate each other's programs. Another reviewer noted good collaborations are on-going.

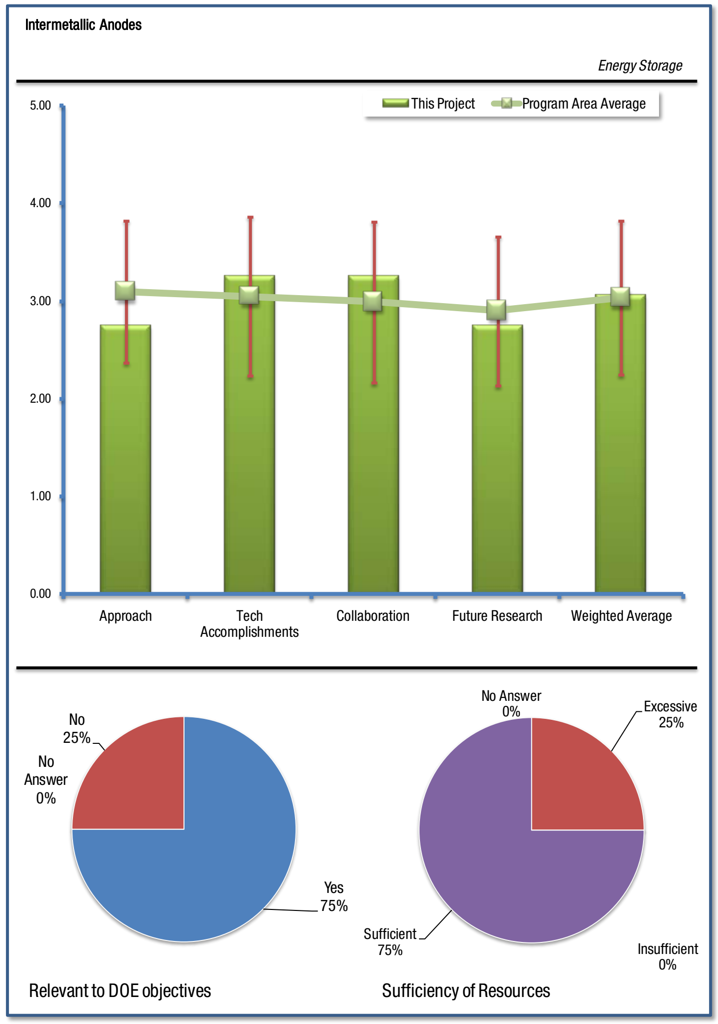
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the full cell testing should begin on materials which meet the energy goals so that a more realistic view of cycle life. Another reviewer mentioned that also stability of the passivation layer on these materials needs to be investigated for both life and abuse tolerance. Some DSC experiment for example would be very useful. If we form SiO_2 at the surface of the material, what is the reaction with HF? One reviewer commented the proposed future work on further improving synthetic methods to get Si-C composites that provide good capacity/cycle life, minimizing the irreversible capacity losses and understanding the interfacial properties of these composite anodes (SEI) are quite relevant to the DOE objectives.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate.

Intermetallic Anodes: Michael Thackeray (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that improved anode over graphite is important to vehicle applications but high Sn compositions are highly questionable for environmental and cost per capacity reasons. The $LaSn_3$ materials are pyrophoric and use in a manufacturing process seems extremely improbable. Another reviewer noted the high capacity anodes offer the more likely promise of getting to significantly higher energy density systems required for PHEV. (These would also be very useful for high energy consumer applications such as laptop computers, camcorders). One reviewer mentioned Thackeray et al. are searching for better anode materials for lithium ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the advantages of Cu_6Sn_6/Sn/Cu similar to Na/$NiCl_2$ in regard to volume expansion are accurate; however, environmental, cost and not cutting edge performance make approach less relevant to objectives for PHEV. Same with $LaSn_3$ - cost and theoretical capacity minimize relevance. Also $LaSn_3$ is not suitable for manufacturing. Another reviewer added this is a good study and closure on La system. Other findings seem also quite good in a difficult area. Many problems obviously remain with these types of anodes. One reviewer noted Thackeray et al. are utilizing modeling to help them direct their experimental work. They are trying to find Sn based materials with short diffusion lengths for lithium ions in the solid phases of the material. They are using modern methods and classical methods in their experimental work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that good progress towards objectives laid out in proposal regarding capacity of > 400 mAh/g, but PHEV 40 objectives are really not addressed with current work. Another reviewer noted exploring the La system has obviously taken time away from the Si/Sn work. Nevertheless, this was an worthwhile study that showed this to be a dead end - good study and good closure. Other findings seem also quite good in a difficult area. Many problems obviously remain with these types of anodes. However, the ball-milled material is giving better reversible capacity than other bulk forms of this material. Like Kumta, they are starting to realize the benefits of thin film type materials in "real" materials. They were somewhat disturbed by the rather sharp drop in capacity after 30 cycles or so. If this is related to their anode material, and they suggested it was actually a reflection on their counter electrode, it needs much further study. If it really is a counter electrode issue then it would seem they need a better way to test their materials to get at the longer cycle life measurements of their anodes. One reviewer mentioned Thackeray et al. have produced some interesting materials that may be useful as anode materials in lithium ion cells.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the project is utilizing other organizations and Universities. Another reviewer added it seems like they could do well to work more closely with Kumta and vice versa. Didn't seem much evidence that this is happening, but they could be wrong. One reviewer noted Thackeray et al. are working with others in both industry and universities.

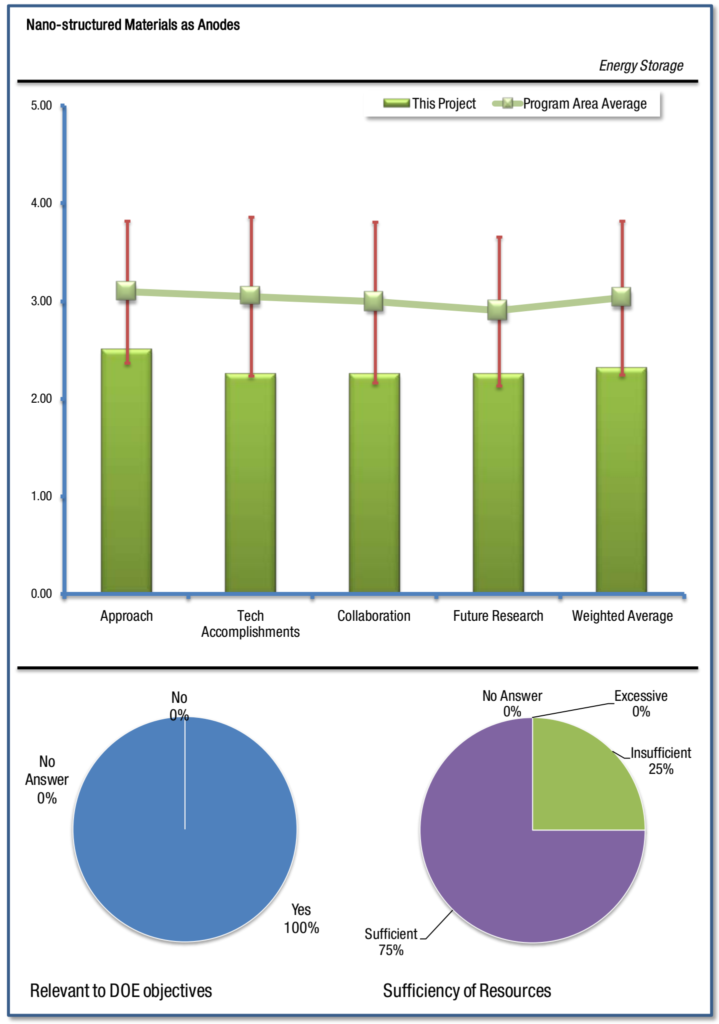
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the project should shift focus to materials and processes that at least theoretically will meet PHEV 40 goals. Another reviewer commented the greatest benefits from the current and future activity by this group may be in improved understanding/discovery of improved active materials. The efforts on substrate development are valuable but may detract from more beneficial work that could be performed by this group in the area of improved active materials at the fundamental level. One reviewer mentioned the new electrode manufacturing system looks very intriguing. Again, this should be shared with and compared to the approaches being explored by Kumta's group. The PI commented on the safety concerns with some of these new anode materials. Agree that some DSC/ARC studies should be done if they have not already been well studied (the reviewer is not that familiar with the literature in this aspect). Maybe look at packing density of these anodes? Comments from another reviewer noted Thackeray et al. have well developed plans for next year. Their plans for the copper foams may produce useful anodes.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that relative to other programs presented this is not a good investment - if not focused on more relevant systems (Si) other programs seem much more promising to meet PHEV 40 goals. Another reviewer noted this is a big task and needs a substantial amount of funding, which it gets. One reviewer commented that funding for Thackeray et al. is sufficient.

Nano-structured Materials as Anodes: Stanley Whittingham (SUNY-Binghamton)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated because most of the anodes studied are only marginally better than carbon or even poorer than carbon on a gravimetric basis, the emphasis should be made on high gravimetric aspect unless there is an important concept involved. Another reviewer added this work is focused on developing new nanostructured materials to replace current anode materials using carbon. One reviewer noted the development of high volumetric energy density anode compatible with low cost cathode materials is highly supporting the DOE objectives. Comments from another reviewer mentioned that nano and amorphous material comparison is interesting topic.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the comment made under relevance is very important in establishing the approach. The specific capacity of materials that are emphasized should be clearly superior to graphite. This is a much more important property than the capacity density. Most of the reported materials are either deficient in this property or barely better than graphite. Furthermore, the addition of other metals or phases should be included in the weight of the anode to determine the specific capacity, so that a fair comparison can be made. Also, the charging efficiency should be carefully evaluated with each material and this aspect should have a high priority in studies of the most promising materials if the charging efficiency is less than 100%. In full cell studies, charging inefficiency results in rapid capacity loss which is not observed with a lithium counter electrode. Another reviewer mentioned the approach is reasonable with identified barriers but needs better specifications on the materials or solutions that will be investigated. One reviewer commented even though the topic is interesting, they don't think the approach is not proper as well as the results. Please focus on more fundamental things that only academic can focus on to understand the mechanism different between amorphous and nanomaterials.

Comments from another reviewer noted the approach is good is general. The titanium oxide material is probably more suitable for HEV than PHEV and EV applications. In that matter it would be very interesting to see studies about:

- how to reduce the cost of this material
- how those materials behave on calendar life.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the low gravimetric efficiency of most materials studied has limited the progress. There are some good fundamental studies and the effort to find the importance of amorphous structure versus the crystallite size is important to establish. Another reviewer asked is the lithium deposition on carbon really the main issue for safety? It seems that stability of the passivation layer is the most important. That is why titanate electrode are superior to carbon ones. Study of the stability of the passivation layer on these nanostructed anodes is of great interest and they would like to see more. That passivation plays a role both on life and abuse tolerance of the cell. This reviewer also asked does really Nexelion meet technical needs for PHEV: low T, life, power...?? One reviewer noted the experimental results are quite clear and give indications on the next research steps with focus on better materials and structures (amorphous and/nano). Comments from another reviewer mentioned they were working on amorphous tin 10 years ago. They cannot see any new finding in this presentation.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there doesn't seem to be a high level of collaboration with other institutions other than DOE labs. It could be quite useful to collaborate with other BATT PIs such as NMR studies with Prof. Grey at SUNY Stonybrook or structure studies with Prof. Shao-Horn at MIT to settle the issue of the importance of amorphous phases. Another reviewer mentioned this work would probably benefit from more collaboration with partner having surface analysis capabilities. One reviewer commented the level of collaboration is adequate to the project with key contributors for completing material characterizations. Comments from another reviewer noted they can see the partners but they cannot see how the collaboration works according to the achievement level.

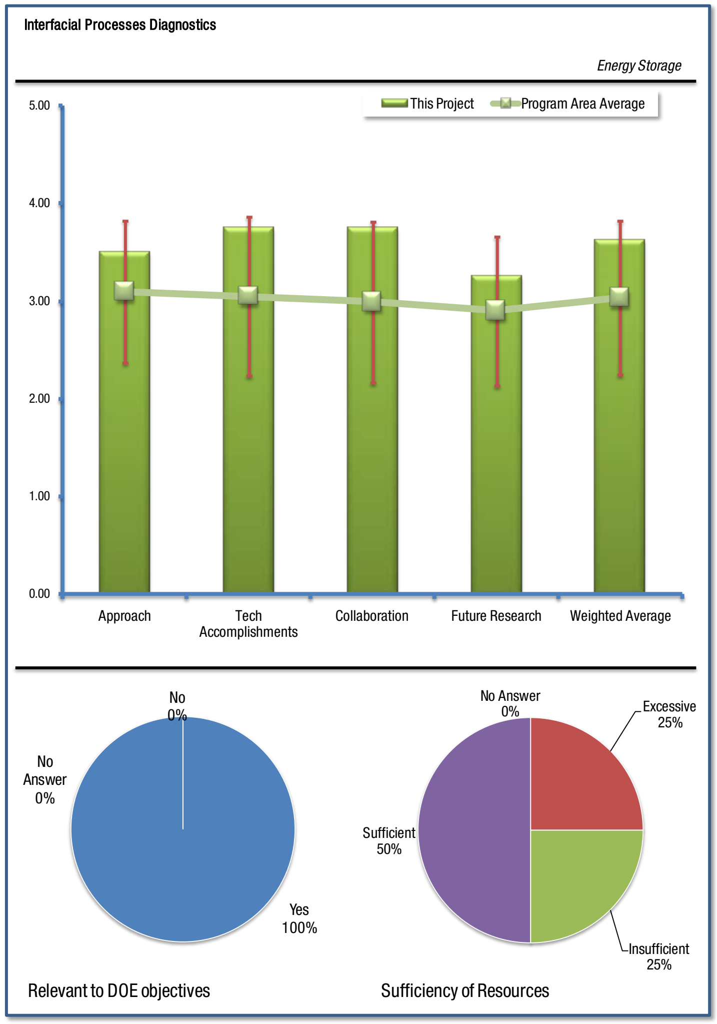
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would like to see an emphasis on high specific capacity materials in future work. Another reviewer added they don't understand why amorphous nano-tin is the direction to go? Capacity is higher than carbon but not as high as Si. Where is the demonstration that this is safer than carbon? What is the power performance and life in a full cell? What is the cost? These questions need answer before we can say this is the direction to go vs. Si. One reviewer commented the future plan is consistent with the previous year’s results. Better materials will be further analyzed and developed for aiming at better performances. Comments from another reviewer mentioned they would like to see a focus on more fundamental research.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate to the proposed activities. Another reviewer noted the test data is just cell cycle data and XRD. This is not enough to discuss about the topic.

Interfacial Processes Diagnostics: Robert Kostecki (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the in-situ studies of this work are laying key foundation needed to address new materials with lower cost/capacity and higher capacity materials - very relevant to vehicle technology and DOE objectives of petroleum displacement. Another reviewer mentioned this project helps to diagnose the limiting properties and end of life of electrodes. One reviewer commented diffusion work deals with high rate anodes for HEV/PHEV cells. Surface studies may also provide the key to understanding new anode stability.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated based on successful completion of milestones approach is successful and on time. They applaud ability to implement approach and results delivered by approach. Another reviewer commented the approach involved in the investigation of lithium diffusion in graphitic carbons is good and should be further developed and expanded (to include, for example: determination of diffusion rates for other carbons most importantly, as well as temperature dependency, rate or applied current dependency, other electrolyte compositions, etc). Further with regards to the lithium diffusion investigations, collaboration with a major producer(s) of Li-ion anode carbons/graphites could usefully increase the impact of further work in this area. One reviewer noted the design and use of new cells to study the in-situ transport mechanism is excellent. Comments from another reviewer mentioned the electrochemical method for measuring plane-specific diffusion characteristics is unusual and well thought out. Good approach to the Sn anode work as well.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer states the goals have excellent progress with meaningful results presented - particularly in in-situ work. Another reviewer noted that there is excellent progress in the investigation of lithium diffusion in graphitic carbons and fundamental understanding in this area. One reviewer commented conclusions of the diffusion in graphite which may help with the design of anodes for high rate electrodes. Comments from another reviewer mentioned that the methods used here seem to provide "real" values of diffusion values, although maybe on a limited sample set. Better than the more commonly used methods that seem to provide widely inaccurate values on a wider set of materials. Good fundamental support for carbon anodes. The surface studies on the Sn materials look to provide a key to ensuring long term stability with these materials. This is very interesting and needs a lot of follow up work. On the down side, the accomplishments seem rather modest in view of the effort involved.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a lot of solid collaboration on this project. Another reviewer mentioned that collaboration with the BATT groups is beneficial to the program. One reviewer noted the project is working with ANL and LBNL. They suggest they also start looking at Kumta's materials.

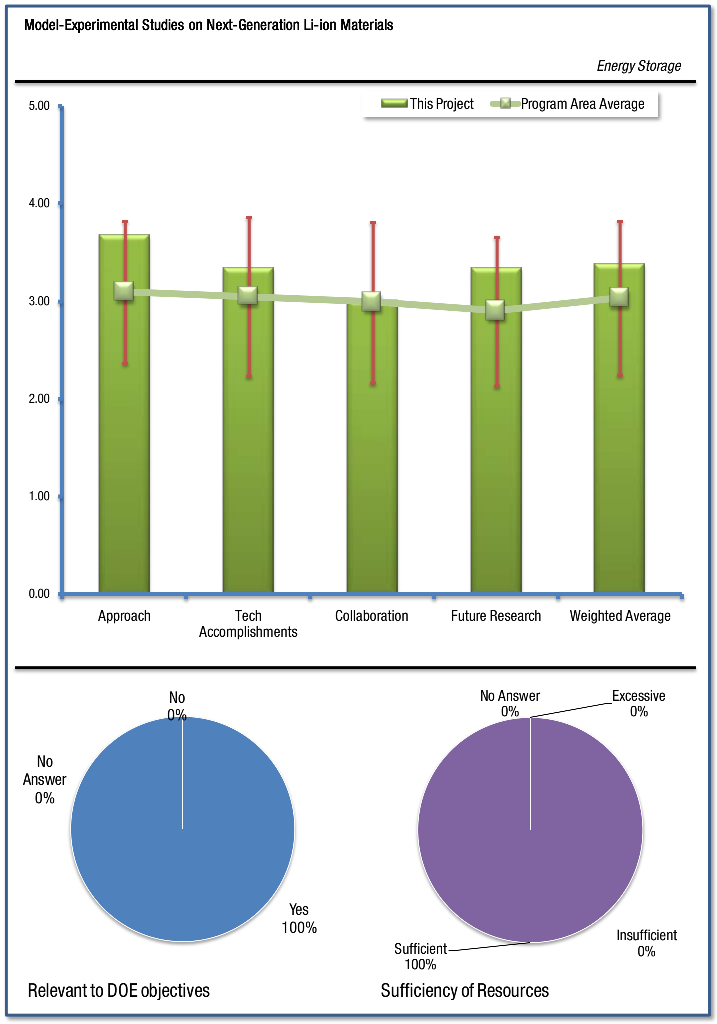
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the project really should apply excellent in-situ methods to other common materials particularly Si materials. Another reviewer noted it's a good plan as is. Only suggestion would be to maintain/enhance focus on mass and charge transfer mechanisms in/on the electrode/electrolyte interface in graphite/carbon anode materials as priority over other activity. One reviewer commented the future work is an experimental set up to study kinetics. Comments from another reviewer mentioned it would be good to look at the change in Li diffusion in carbon as a state of charge if possible. Also plans to look at Si surface and stability look promising. The reviewer suggests they work with Kumta as well as ANL. The surface studies could be especially valuable if the work could explain some of the effects noted. For example, why is PC better than EC and/or amorphous Sn better than crystalline Sn? This is obviously much harder to do, and needs a lot of collaboration with other researchers, but in the long run this may lead to better design of materials and systems for long life.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the team is meeting goals on time so resources are adequate for plan however, they think on a relative basis there is high merit to this work and additional funding could increase scope in a positive way. Another reviewer mentioned the funding level seems quite high for this work. The quality of the work is very good, but they are not sure that the pace of this work is really where it needs to be.

Model-Experimental Studies on Next-Generation Li-ion Materials: Venkat Srinivasan (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated understanding the limitation of the Si system is very importance to increase the energy density of batteries. Another reviewer noted that constructive characterization and associated modeling of silicon anodes (or other higher capacity anode materials) is useful in considering direction toward potential long-term increases in energy density for hybrid and electric vehicles. One reviewer commented that testing and modeling helps to determine effects of various parameters. This will help to improve the efficiency and energy density.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is very good. They really like the combination of modeling and experimental data. Another reviewer commented the general approach is good, and focus on silicon is good. However, the planned sole focus on $LiMnPO_4$ as cathode seems too limited. Further work on other candidate cathode materials would be desirable. One reviewer noted the use of a model to optimize battery design and evaluate ability to satisfy vehicular needs is considered to meet the DOE goals.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the corrections for the side reaction via modeling and use of additives. Another reviewer noted that now with such a low energy efficiency at rate as low as C/2 (in half cell), this type of electrode will be difficult to use for EV or PHEV. So it is important to understand what are the true limitations (side reactions or other)? Does that model allow to evaluate the stability if the passivation? Are the side reactions an instability of that passivation layer? This reviewer went on to list the following:

- The study of hysteresis which show the limitations of the electrode is very interesting
- Identification of side reactions: OCV does not collapse
- Can extract kinetics parameters to predict charge/discharge curves
- Hysteresis of the system make SOC management difficult

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated even if number of partner is shown, the interaction with them is not clear. More collaboration is shown for next fiscal year. Another reviewer mentioned some level of collaboration with globally viable battery developers would be desirable. One reviewer commented that collaboration with BATT groups and industry is valuable.

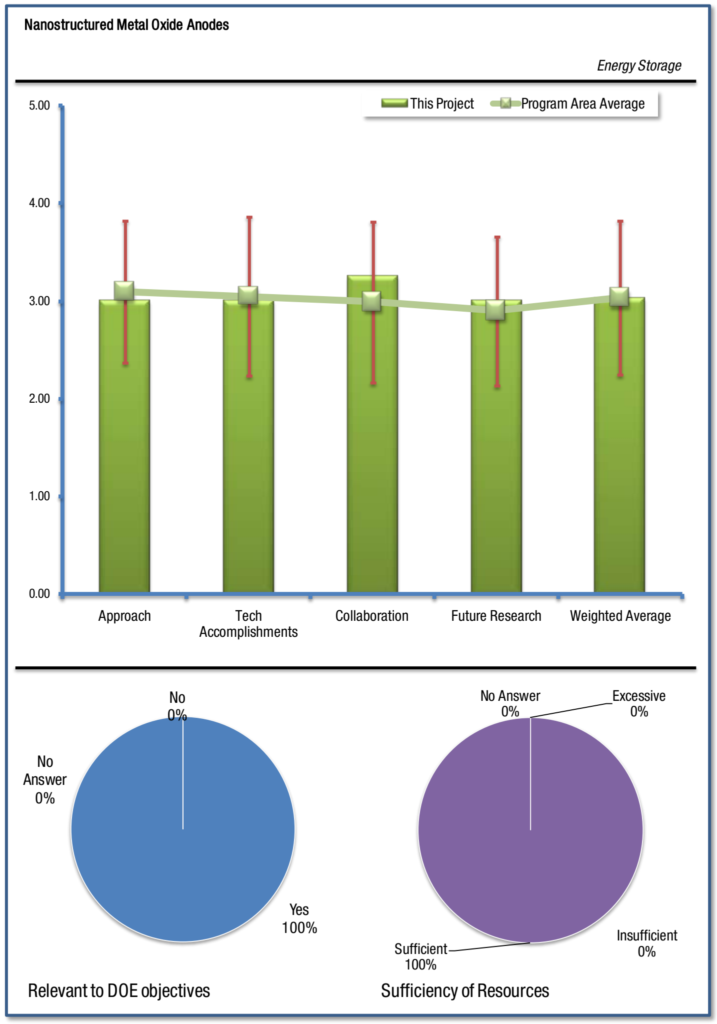
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated it is good to look at the complete cell modeling. Another reviewer noted that greater focus on fundamental rate capability (or rate capability limitations) in Sn anodes (in the place of some of the emphasis on $LiMnPO_4$ cathodes or otherwise) would be desirable. One reviewer mentioned the project will incorporate the kinetic and mass transfer models into a porous electrode model and simulate the performance of a NMC/Si cell under PHEV conditions.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments were made by the reviewers.

Nanostructured Metal Oxide Anodes: A.C. Dillon (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this work is different from other anode work in that it uses heavy metal oxides as anode materials and relies on the high valence state of the metal (Mo has a valence of 6 in the example given) in order to have a multiple electron change in contrast to graphite with a small valence change with a light element. This requires a displacement reaction to obtain the high valence change. Another reviewer commented the development of the MoO_3 materials demonstrates a new method to produce small particle-size cathode materials. The project demonstrated cycling of cathode materials from ANL. One reviewer noted Dillon et al. are trying to develop anodes for lithium ion cells. Comments from another reviewer mentioned that the metal oxide negative electrode is one of the candidates instead of graphite negative electrode.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The approach in using MoO_3 as the material of first choice leads to a low average voltage system with a very large voltage range. This is the only way to obtain the high specific capacity of the material. If a smaller voltage range is used, the specific capacity will be significantly lower. One difficulty with the approach is the low average voltage of the system which leads to a low specific energy. Other studies have used lighter materials such as oxides of iron, cobalt, and chromium to limit the voltage change of the displacement reactions. Another reviewer had several recommendations for activities, including developing hot wire chemical vapor deposition to produce metal oxide, MoO_3, nanostructured electrode materials for HEVs and PHEVs. Compare MoO_3 nanoparticle electrodes to the results for electrophoretically deposited thin film MoO_3 electrodes. Use first principles calculations to obtain better understanding of Li-insertion processes and for the prediction of new materials. Evaluate differences between Li extraction from MoO_3 nanoparticles with Li extraction with other metal oxide nanostructures. Make thin film electrodes for use in coin cells. One reviewer commented Dillon et al. are trying to find nano scale metal oxide materials by using hot wire chemical vapor deposition, which may be too expensive for industry. However, their approach includes the utilization of modeling (VASP) to help direct their development work. Comments from another reviewer asked to please identify what are pros and cons for MoO_3 and what and how you will improve.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that because of the high irreversible capacity and low average voltage of MoO_3 cells, the progress toward materials selection has been modest. The methodology of making nanomaterials is interesting however and should be pursued with a better selection of materials. Another reviewer noted MoO_3 nanoparticles (nano-rods and -

spheroids) have been produced using hot-wire chemical vapor deposition at different reactor pressures. Improved cycling stability was achieved for both cathode and anode by applying the thin Atomic Layer Deposition coatings. Achieve close to theoretical capacity from the ALD cobalt materials. One reviewer commented Dillon et al. have produced metal oxides that appear to have promise as anodes for lithium ion cells. Their thin films (approximately two microns) are yielding outstanding results for a small number of cycles. Comments from another reviewer mentioned the results are very difficult to understand because some of tests were done with CVD electrode and some of test was done with regular electrode. The cycle life for $LiCoO_2$ and graphite without ALD on slide 20 seems too bad. Please conduct more than 50-100 cycles for cycle life test for the full cell.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated ANL electrodes evaluated to establish a baseline performance. The project is working with Fortu (Switzerland) to develop high-voltage cell. A reviewer recommended the team evaluate materials from Whittingham at SUNY and Lee at University of Colorado as well as ANL. Another reviewer commented Dillon et al. are working closely with other national labs and industry. One reviewer noted they can see some collaboration.

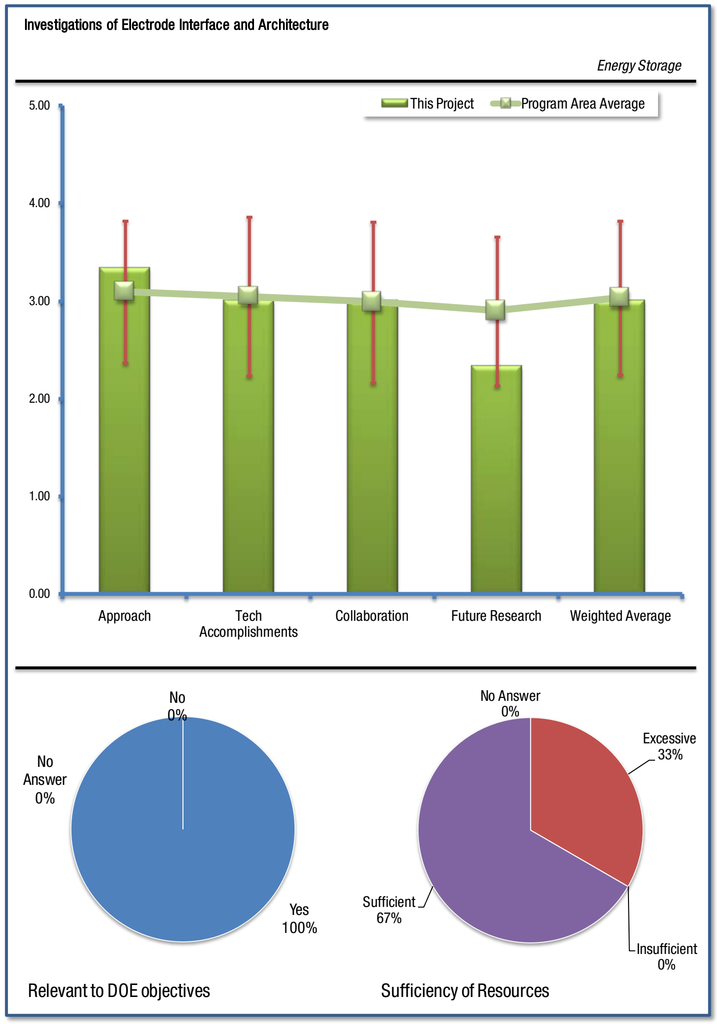
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the different material choices indicated in future work should be emphasized over any elaboration of work with MoO_3. Another reviewer mentioned the project is optimizing full cells with ANL cathodes to improve durable capacity and rate capability. Perform theoretical calculations to understand the hysteresis of the charge/discharge for the MoO_3 nanoparticles. Use theoretical calculations to identify composition and orientation of economical oxide nanopaticles with more desirable voltage profiles. Synthesis of alternative nanostructures made from Fe_2O_3, Fe_3O_4, and MnO_2 will be explored. Inexpensive synthesis routes–including HWCVD, hydrothermal techniques, and electro deposition–will be employed. Apply a protective atomic layer deposition coating on graphite nanoparticles to eliminate surface degradation mechanisms and improve rate capability. One reviewer commented Dillon et al. have a well defined plan for next year. Their planned work with ADLs may yield useful anodes if the manufacturing costs can be shown to be cost effective. Comments from another reviewer noted it is not clear what is needed to optimize MoO_3.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated Dillon et al.'s funding is sufficient.

Investigations of Electrode Interface and Architecture: Nancy Dudney (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this work tries to improve the efficiency and cost of the Li-ion batteries. Another reviewer noted the work is focused on key technical aspects for favoring a larger use of Li batteries in transport.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated it's an interesting approach to remove current collector. Another reviewer mentioned the technical barriers are well analyzed and addressed with a convincing approach. The substitution of Al current collector is a challenging issue. One reviewer noted the portion of the work on graphite-based current collectors is of value.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the following:

- 2 to 7 cents/g => 20 to 70 $/kg which is still expensive
- The active material loading needs to approach 90% with 30 to 40% porosity
- The mechanical strength of these electrodes needs to be better understood.
- They are not convinced that so much effort should be put understand Li metal anode.

Another reviewer noted the progress is really interesting with good chances to overcome defined technical barriers. The cost aspects needs to be further elaborated as well as the vis-a-vis comparison with conventional Al current collectors. The work on SEI at anode must be compared with similar activities in BATT. One reviewer mentioned the portion of the work regarding Li metal SEI does not appear to be useful to Li-ion or otherwise.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaborations are adequate to the needs of the project, particularly on current collector work.

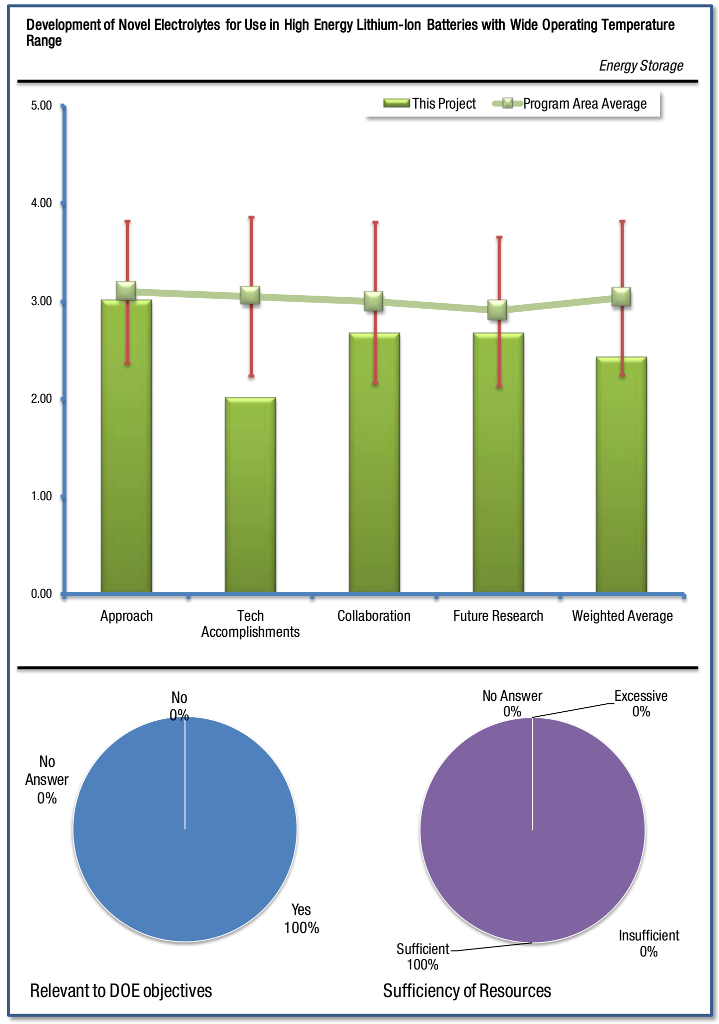
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated again, what is the interest to put so much effort on Li metal? They are not convinced that work done on Li metal is directly applicable to carbon or Me alloys SEI that have different composition and structure. Also Li metal SEI is continuously rebuilt which is not the case of an intercalation material SEI. Another reviewer commented the future work is always limited to investigate the use of the new current collectors with $LiFePO_4$. It would be interesting to experimentally verify the compatibility with other cathode materials. One reviewer mentioned to terminate work on Li-metal interface. Inclusion at least of concepts and preliminary demonstration of some tabbing/attachment method(s) to graphite current collector should be added.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources and efforts are sufficiently balanced. Another reviewer noted that there are sufficient resources if re-directed towards graphite current collector and away from Li-metal studies.

Development of Novel Electrolytes for Use in High Energy Lithium-Ion Batteries with Wide Operating Temperature Range: Marshall Smart (California Institute of Technology)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the electrolyte is a critical phase in determining the capability and stability of lithium ion batteries. This is a new project which is well oriented to make an important contribution to the DOE objectives. Another reviewer mentioned this project supports search for higher voltage cathodes, longer life systems and maybe lowers costs, although they are not optimistic that these new electrolytes will actually lower costs much. Mainly the reviewer sees them as an enabler for higher voltage/energy and better life. One reviewer commented the salt is one of the most difficult to replace. The industry keeps using $LiPF_6$ for long time.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the initial approach looks very promising in accomplishing the objectives and overcoming important barriers in the electrolyte-electrode interface. A lot of work has been done on the active materials, but this program should fill an important gap in battery studies. Another reviewer noted LiBOB is not new electrolyte salt so they are not sure how they can find new things. One reviewer went on to say the following:

Smart: Excellent list of collaborators. The reviewer must question how much can really be gained by relooking at mixtures of carbonates and esters (the latter of which seem to really hurt cycle life). Instead they urge them to try and focus on the more novel approaches they listed. They already have a long history of evaluating electrolytes for the space program and should do well in terms of being able to evaluate new materials. The hard part will be to develop those new materials.

Henderson: The reviewer has some concern about the toxicity of the cyano-containing materials, but assumes they have already considered that. (At least people don't swallow car batteries!) The ionic liquid work seems interesting and worthwhile. While low temperature may be difficult to attain, it offers the potential for being a game changer in terms of cycle life and lifetime. This should be interesting.

Lucht: The reviewer liked the collaboration with Yardney; being so close by is a major advantage. They would prefer to see a focus on high voltage materials to facilitate PHEV goals. The reviewer is also concerned about the search for additives. This can suck up huge amounts of time if care is not exercised. Unless they have a plan to design an appropriate additive, I am pessimistic that this will bear much fruit. Basically, they need to identify before they start doing lab work what are they trying to accomplish with an additive and what structures are likely to accomplish these goals. Hopefully, they have already done this. If not, they may also want to carefully peruse the patent literature and do some paper studies and reviews before starting in on lab work.

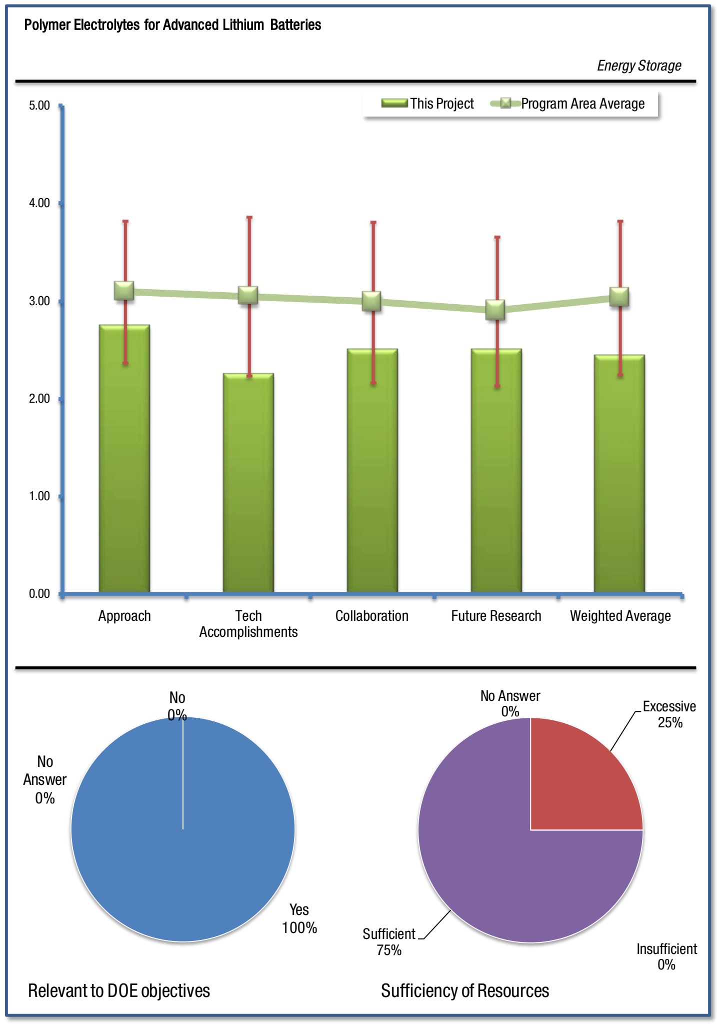
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
All three reviewers noted there was no progress as this is a new program.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the groups are starting with a good level of collaboration. Another reviewer mentioned not a very high level of collaboration, but they think this is appropriate for such exploratory studies. One reviewer noted the program just started, so there is no progress.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the proposed work is well designed to tackle the problems of electrolytes in lithium ion batteries. Another reviewer noted the program just started, so there is no progress.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated funding a little for an extended period seems very appropriate for such work. We have basically been using the same electrolyte for Li-Ion cells for the past 20 years. Major advances in this area will not come quickly. The project would need a boost if and when they find something.

Polymer Electrolytes for Advanced Lithium Batteries: Nitash Balsara (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that electrolyte is part of the limitation of the current Li-ion batteries. It is very important to overcome these barriers. Another reviewer noted that there are new polymer electrolytes with reasonably good conductivity for use in advanced Li- and Li-Ion cells. Polymer electrolytes provide a new dimension for construction of HEV and PHEV battery systems. One reviewer commented electrolyte and separator are one of the key components for cell performance. If battery manufacturers can replace this from conventional separator and electrolyte and this will be impact for them to reduce its cost.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that decouple mechanical and chemical properties is an interesting approach. However they don't understand the concept of stabilization of interface by using polymer electrolyte. The reviewer may have missed something in the explanation. Another reviewer commented it is unclear that fundamental limitations of metallic Li as anode are being significantly reduced in this work. One reviewer mentioned there must be target to accomplish HEV/PHEV requirement for electrolyte and separator point of view, but they did not see any target for this research. Comments from another noted synthesize block copolymers to produce novel materials and electrolytes by self-assembly of block copolymer/salt mixtures. This reviewer went on to add the following:

- Study the relationship between morphology, thermodynamics, and transport (conductivity, diffusion coefficient, transference number, salt activity).
- Understand the thermodynamics of system.
- Predict the behavior of full cells.
- Build full cells and test predictions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the conductivity is too low for automotive applications. How can we increase it? That material looks more like a separator membrane. Increasing the transference number seems to be the key and it is probably where you want to focus the work. Also, the safety concept needs to be verified in full cell. Another reviewer noted the conductivity of dry nanostructured electrolytes has been determined as well as transference numbers and diffusion coefficients. MW helps. The project developed a solid-state rechargeable batteries system with a block copolymers electrolyte that can operate at room temperature and below. Initiated the determination of the transport properties including conductivity, transference number and diffusion coefficient of electrolytes. Electrolyte salt precipitates and increases resistivity at high temperatures, a shut-down mechanism. One reviewer commented actual tangible accomplishments of this work are unclear. Comments from another reviewer noted this research result seems like only experimental tests, it needs to dig into more detail exploration to clarify mechanism.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the main interaction is with the start-up. This work would benefit to have more interaction with other teams. Another reviewer commented there is a co-operation with Smith (Utah).

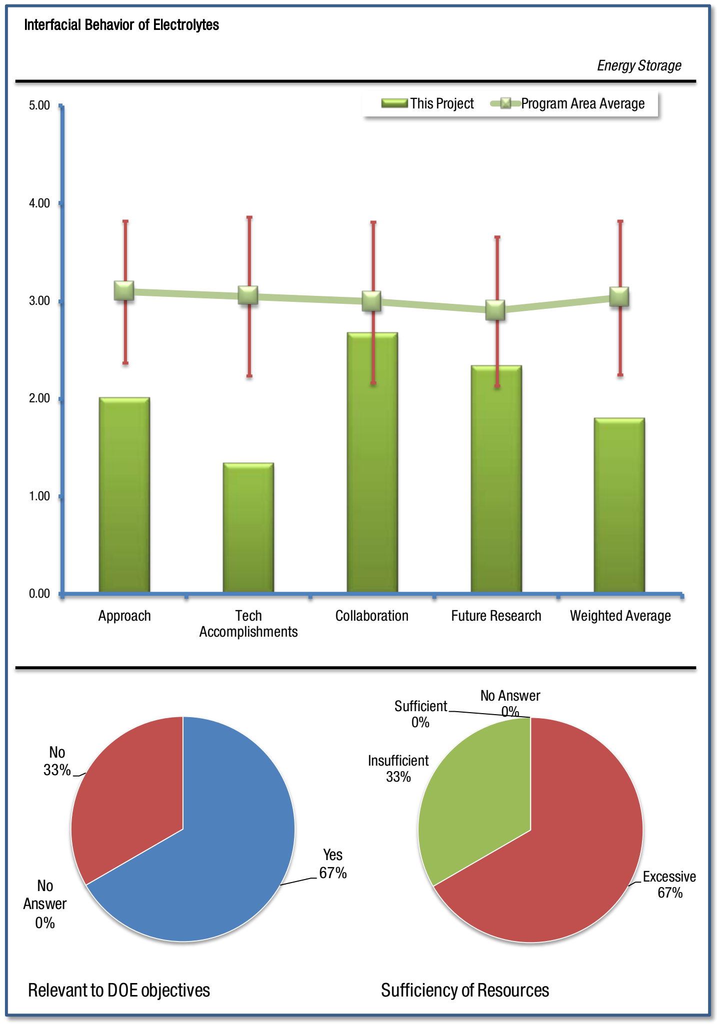
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they are not sure if they have effectively planned future work. This material does not seem to be very different from the work on polymer membrane that has been done so far. They guess the limited quantity of information which had been provided because of confidentiality (which they understand) does not help to have a clear understanding of the future work. Another reviewer mentioned in the future the project will establish the ability to cast reasonable quantities of the polymer films for the first generation of SEEO polymer electrolytes. With the assistance Smith (Utah) establish the basis for the coordination of lithium ions and block copolymer chains and implication on transport, phase behavior. Continue determination of transport properties. One reviewer commented there is no evidence of intent to demonstrate dendrite growth suppression or reduce other fundamental limitations of metallic Li-anode systems. Abuse tolerance improvement is mentioned by there is not significant evidence of viable potential routes to achieve this. Comments from another reviewer noted they felt this research needs to set target. From this experiment, what is the actual problem (i.e. from conductivity, shutdown mechanism) in existing Li ion battery and how this research can be connected to solve it for Li ion battery? This project needs to add to dig into mechanism research not only from experiment, material combination result.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources seem reasonable for the project. Another reviewer noted the resources should be reduced.

Interfacial Behavior of Electrolytes: John Kerr (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated a better understanding of interfaces could be very useful. Polymer/ionic electrolyte work may now make more sense if the -30C requirements have been relaxed. Otherwise, likelihood of success and applicability seem rather low. The reviewer guesses that they could in principle use polymer electrolytes or ionomers as protective coatings, where conductivity requirements would be less stringent. Another reviewer noted Kerr et al. are studying interfacial phenomena associated with electrolytes in lithium ion cells. Their studies may lead to better lithium ion cells. One reviewer commented they are not sure what we are looking for from this research.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated their focus on the interfacial as opposed to bulk properties of the polymer electrolytes is certainly well-placed. This is a very difficult area to work in. They think their plans to look at three anodes and three cathodes is way too aggressive at this stage. The reviewer suggested they pick one composite electrode of each at most. Another reviewer commented Kerr et al. are using a number of different experimental and theoretical (MD) approaches to gain a better understanding of the reactions at the surfaces of the electrodes. However, it is not clear how they have used MD in their work. One reviewer noted the PI should focus on more fundamental things.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the project spent a lot of time on method development and dealing with effects of water. Unfortunately, they saw few signs of any concrete findings from this work; many of the deadlines have been delayed. Work seems to be plagued by experimental problems, which are not necessarily the fault of the PI of course. Having said that, this reviewer feels overall progress just seems too slow. Also worrisome is that they still have not gotten their method development issues resolved yet. Another reviewer noted Kerr et al. have made some useful observations concerning water content in the electrolyte. However, it is not clear that they have contributed new information. One reviewer added they don't know what the new finding is from the test with wet and dry electrolyte. It is not clear that the expected structure for single ion conductors were successfully prepared.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the PI stated that he needed a lot of help, but it sounds like he isn't getting much, if any? ANL should be able to help with cell design and reference electrode development they would have thought. This seems like a critical gap and needs to be resolved ASAP if this work is to move forward. Talked about collaboration, but not sure it's really happening, maybe just not enough time to discuss in his 20 minutes. Maybe this is coming in future work? Another reviewer commented Kerr et al. have worked with others, but they have not apparently worked closely with people in industry to help them focus their research. One reviewer noted they can see some collaboration.

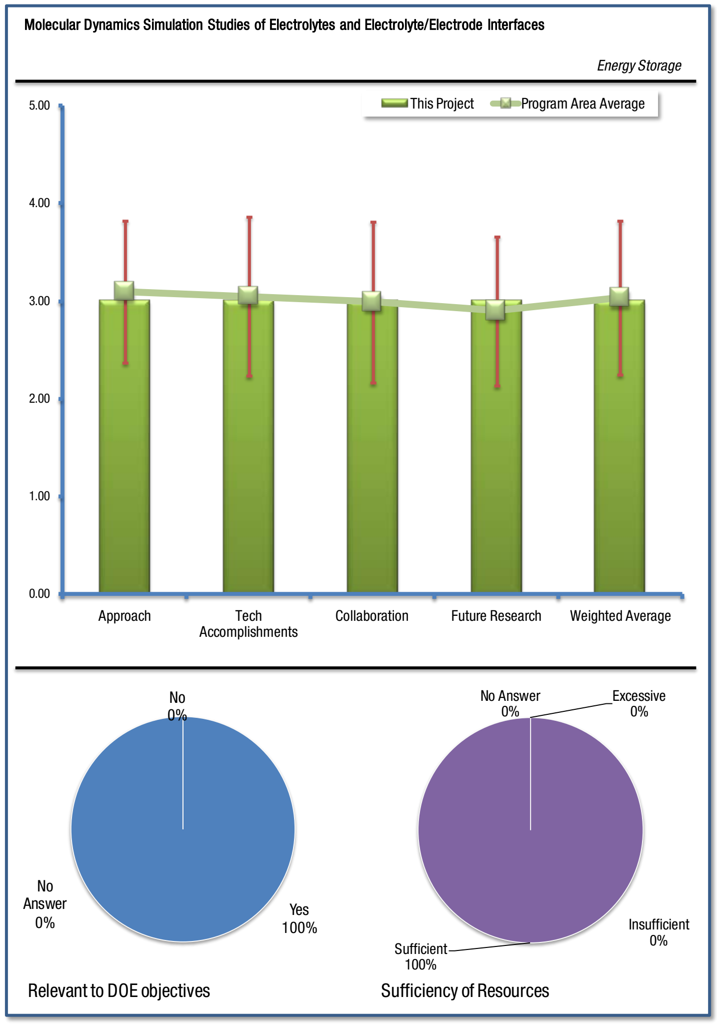
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer suggests the project use a cell with some kind of bridge to isolate the lithium reference from direct contact with the electrolyte contacting the working electrode. With polymers, this separation might only need to be spatial for a short experiment. They are pretty pessimistic about the likelihood of GBL working out well. It has been looked at before and generally leads to poor cycle life. A lot depends on close collaboration with the new PI's being brought on line and resolution of the methods issues this PI has run up against. Maybe use thin film electrodes to avoid the composite electrode complications? Another reviewer added Kerr et al. have plans for next year that is similar to previous work except for their plans to interact with the new groups that will be developing new electrolyte material. This interaction may be fruitful. One reviewer mentioned that based on this year’s presentation, all work seems just engineering work and PI should focus on more fundamental mechanism for interfacial behavior.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it is hard to justify this funding level in light of the results to date. However, if this PI is really going cover all he has on his plate, cutting funding isn't going to help and he seems to be an important player in the new electrolyte initiative. So, a better approach might be to keep the funding, but bring in more help and narrow the focus more to enable the PI to generate some concrete results. The team may be spread too thin at present, but really needs to start "delivering" more. Another reviewer noted that Kerr et al. seem to be funded at a level that is higher than necessary. One reviewer commented these results are not enough to determine if the resources are sufficient enough for this project.

Molecular Dynamics Simulation Studies of Electrolytes and Electrolyte/Electrode Interfaces: Grant Smith (University of Utah)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this project contributes mainly to understanding of the nature of electrolyte problems in lithium ion batteries. Another reviewer noted the project is directed at developing a fundamental understanding of the materials and processes involved in lithium-ion battery chemistry and operation. One reviewer commented that basic research by using advanced simulation models are well part of the sub-program to improve knowledge and key performances of Li batteries to get DOE objectives. Comments from another reviewer mentioned that battery manufacturers need to design cells and confirm the cell performance quickly. Experimental base, actual cell performance result and optimization are always taken at manufacturers. Simulation indication will accelerate the cell design and fewer experiments to finalize the design.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?

Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach to the modeling of electrolytes is very sound. It has taken time to evolve, but now seems to be making definite contributions to understanding. Another reviewer added that molecular level modeling is used to predict properties of electrolyte. One reviewer noted that molecular level modeling of structure, transport and mechanical properties: to understand the properties of bulk electrolytes, to model SEI compounds, develop understanding of electrode/electrolyte interfaces and model Li+ intercalation. Comments from another reviewer mentioned the approach is really largely comprehensive of major technical barriers of Li batteries toward which the project proposes to develop and apply a molecular dynamic simulation tool to assist materials, components and cell development. Another reviewer commented that the simulation modeling must be confirmed with actual experiment and used existing commonly known material is ideal to build more accurate simulation modeling.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the evaluation of EC-DMC electrolytes is a substantial contribution. Also, the modeling of SEI formers has shed light on these problems. The modeling of room temperature ionic liquids has led to better understanding. Another reviewer noted there is a good agreement between experiment and simulation. What is the role of EC? Experience shows that we need EC, so what should we do? IL electrolyte is less efficient than organic liquid electrolyte. Mobility of Li at the surface of LFP is very low. What will we learn from this work? It is a very good work but the way it will help battery industry is not clear. One reviewer commented the amount of work is impressive with a large investigation via simulations of various key internal cell mechanisms. There is an unclear correlation to experimental results with the necessity of model validations. The planned collaboration should be highly functional to confirm most of the simulation results. Comments from another reviewer mentioned the accomplishments reached normal and commonly known results in the battery business. Another reviewer added the following:

- Use molecular simulations to predict the chemical composition and structure of SEI layers and graphite and Sn-based intermetallic anodes.
- Predict temperature dependence and gain molecular level understanding of the structure, mechanical properties and Li+cation transport in SEI layers.
- Gain molecular level understanding of Li+cation transport mechanisms in liquid and ionic liquid electrolytes.
- Gain molecular level understanding of Li+intercalation/de-intercalation from/into graphite anode and model cathode materials.
- Develop and apply simulation methods for electro-active interfaces that allow explicitly for charge transfer processes and controlled potential.
- Develop an atomistic model for simulations of Sn-based intermetallic anodes.
- Provide guidance for design of electrolytes with improved lithium transport, reduced interfacial resistance and/or improved electrochemical stability.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the planned collaborations are essential in completing the simulation work with major role directed toward experimental verification and validation of the simulation results. Another reviewer mentioned the following collaborations this project is working with: U.C. Berkeley
CSIRO (T. Hollenkamp); Lawrence Berkeley National Laboratory (J. Kerr, R. Kostecki); Royal Melbourne Institute of Technology (S. Russo); Penn State University (A. van Duin); Army Research Lab (R. Jow); and NCSU (W. Henderson).

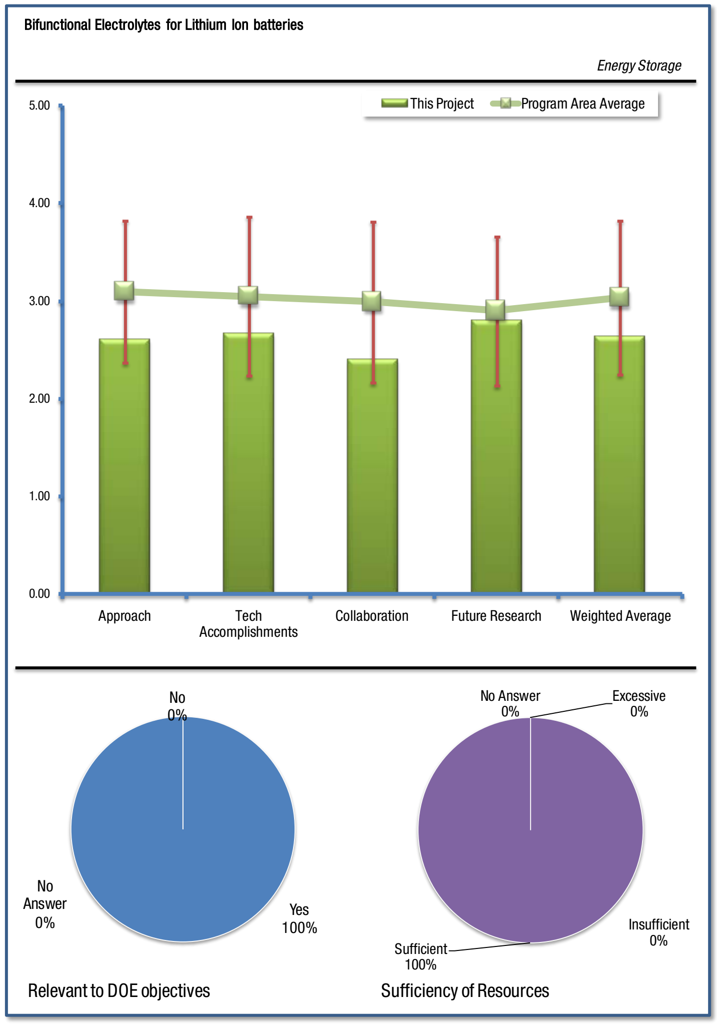
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the proposed work is in important areas of electrolyte research. Another reviewer asked can this work help to understand SEI stability that is crucial for both life and safety? Also the mechanism of lithium deposition would be interesting to investigate as well as the limitation of Li diffusion through the SEI at low temperature. One reviewer noted the planned work is mostly based on the past results but more focus should be more explicitly given to simulation validation. Comments from another reviewer mentioned the project needs to confirm with other material or new material combination to confirm how the simulation is achieved to use in R&D cell design. This result may also be very different based on the electrode quality. Another reviewer added the following:

- Improve $LiFePO_4$ model to allow Li+ intercalation
- Study $Li_4P_2O_7$ coated $LiFePO_4$ interface with electrolytes
- Investigate novel electrolytes in collaboration with NCSU team (Henderson).
- Study trialkyl phosphate-based electrolytes
- Study desolvation for Li+in IL/solvent mixtures at the $LiFePO_4$ interface (Kerr)
- Utilize electroactive interface model with realistic electrodes, electrolytes, and SEI layers to accurately model influence of potential on interface structure and dynamics as well as Li+desolvation and -intercalation with electron transfer
- Study SEI layers (conductivity, mechanical properties) comprised of siloxanes
- Use ReaxFF to SEI layer formation at graphite-based and Sn-based intermetallic electrodes as a function of electrolyte composition (EC, VC, DMC, PC, salts).

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are reasonable for the projects. The PI is outstanding in his ability to relate fundamentals of a material of process into computer predictions to extend the knowledge of battery systems. The question is: if he had more resources (money) would he be even more productive? Another reviewer mentioned the resources seem adequate if well integrated with the collaborations.

Bifunctional Electrolytes for Lithium Ion batteries: Daniel Scherson (Case Western Reserve University)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that looking at abuse tolerance is great! Another reviewer added it is important to archive better abuse tolerance for battery especially used for vehicle. One reviewer noted the project is aimed at addressing improved safety and/or cycle life. Comments from another reviewer mentioned this review is for two projects that are just starting. The first project is at Case Western with Scherson et al. and the second is at ANL with Amine et al. Both projects will probably yield useful results in the quest to develop better electrolytes for lithium ion cells. Another reviewer commented the salt is one of the most difficult to replace. The industry keeps using $LiPF_6$ for long time.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the most important approach is to look at how to stabilize the SEI at elevated temperature. The cycle life and calendar life study can be long, be careful to select only the additives that show clear abuse tolerance improvement. This reviewer went on to add the following: Bi-functional electrolyte have more than one function; flame retardant ions; and flame retardant overcharge protector. Another reviewer noted the project needed to provide more specific information on how this research will be done with which specific material, what is the schedule to archive objective until the end of the date? It is always good to see more specific explanation and presentation instead of only phrases like in page 4 & 5. One reviewer commented it's hard to judge approach in light of level of detail that can be communicated in such short talks. This reviewer also went on to say the following:

Scherson: Seems OK. Some concern that some of the bi-functional materials may end up with high mol. wt. that would result in high cost/mole and poor transport properties at low temperature. However, if the electrolyte is an enabler for a safer cell and/or combines the function of two electrolyte components, this could be very useful.

Curtis: Like the pairing up of modeling and experimentalists. Essential to have good cycling protocols for experimentalists to see advances from additives. It is easy to tell a bad system from a good one, but much harder to tell a good system from a better one. Comments from another reviewer mentioned the two projects are both using novel approaches to solve the problem of finding a better electrolyte. Amine and Curtis may be able to make rapid progress due to possibility of a strong, complimentary interaction. Another reviewer added they cannot tell what kind of chemistry they will focus on yet. There is a lot of study about the oxidation/reduction windows for electrolyte. They hope the study can find new things and propose new electrolyte system.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
All five reviewers agreed that there are no results yet as the program was just started in April 2009.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated there was no collaboration and coordination presented in the presentation. Another reviewer added the following:

Scherson: There is not much sign of collaboration, but then such an exploratory project doesn't need much.

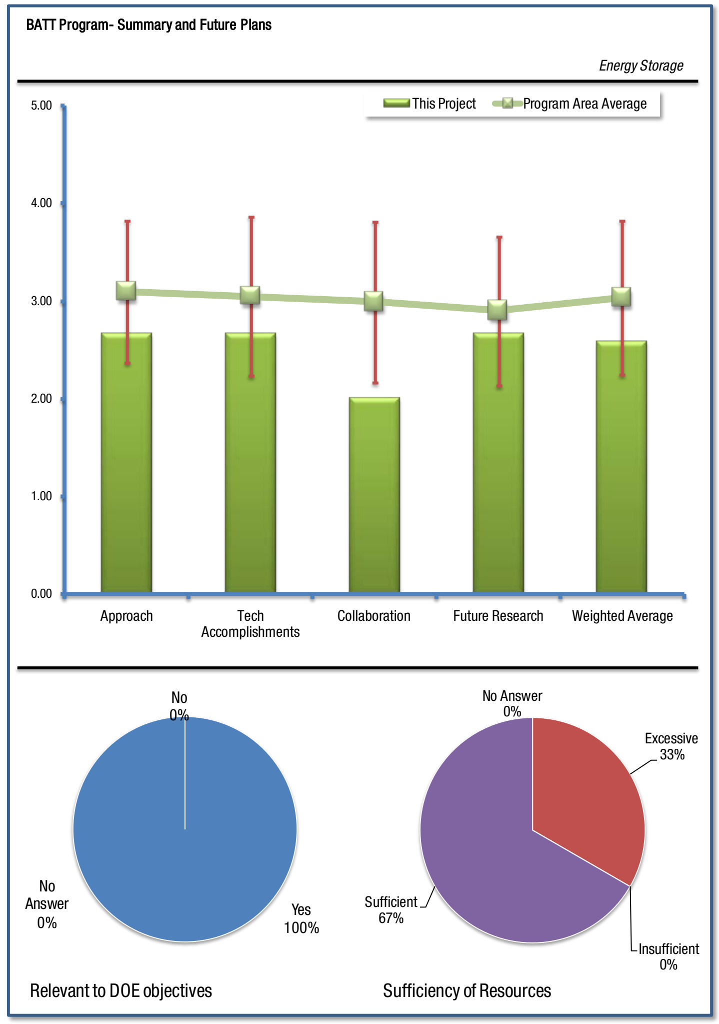
Curtis: Higher level of collaboration, but then the need is greater as it is essential to link up theoretical investigators with experimentalists.

In both cases, collaboration becomes more important for follow-up work. One reviewer noted it is probable that both teams will interact with interested parties. Comments from another reviewer mentioned the program just started, so there is no progress.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated there were not many details given for future work. Another reviewer mentioned that both teams have exciting plans for next year.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated this is exploratory work and LOS must be viewed as rather low. Funding level is fine for such work. This project would need a boost if and when they find something. Another reviewer noted that both teams have been funded at a sufficient level. One reviewer commented the program just started so they aren’t able to determine how sufficient the resources are for this project.

BATT Program- Summary and Future Plans: Venkat Srinivasan (Lawrence Berkeley National Laboratory (LBNL))



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the BATT is the exploratory and the most innovative branch of the Subprogram to fully meet DOE objectives. Another reviewer mentioned the BATT program performs fundamental research in support of the DOE to develop batteries for vehicle applications. This work aims at developing a high-energy battery with enhanced safety and long life characteristics to meet DOE goals. Fundamental research related to battery materials and cell design is clearly supporting DOE goals to facilitate advancements in commercializing PHEV and EVs. One reviewer noted the entire research is towards the DOE objectives such as high energy, safe and long life battery development.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the BATT manages a very advanced network of high level expertise covering all the technical barriers. There is the need to better support the identification of more exploratory areas beyond Li systems. Another reviewer commented the program demonstrated strong quantitative empirical and theoretical diagnostic capabilities. State of the art research was conducted by BATT, from basic materials to integration in state of the art electrodes, to cell design. Good choice of critical problems has been identified. However, future goals should be better identified. Closer collaboration with US battery vendors may be helpful in selecting the right materials, optimizing designs, and battery performances.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the results are of high values and well coordinated. Another reviewer added the following comments about the important accomplishments:

- Creating innovative IP and licensing to several spin-outs
- Good range of publications
- Good progress across different battery research themes
- Unique testing and characterization methodologies

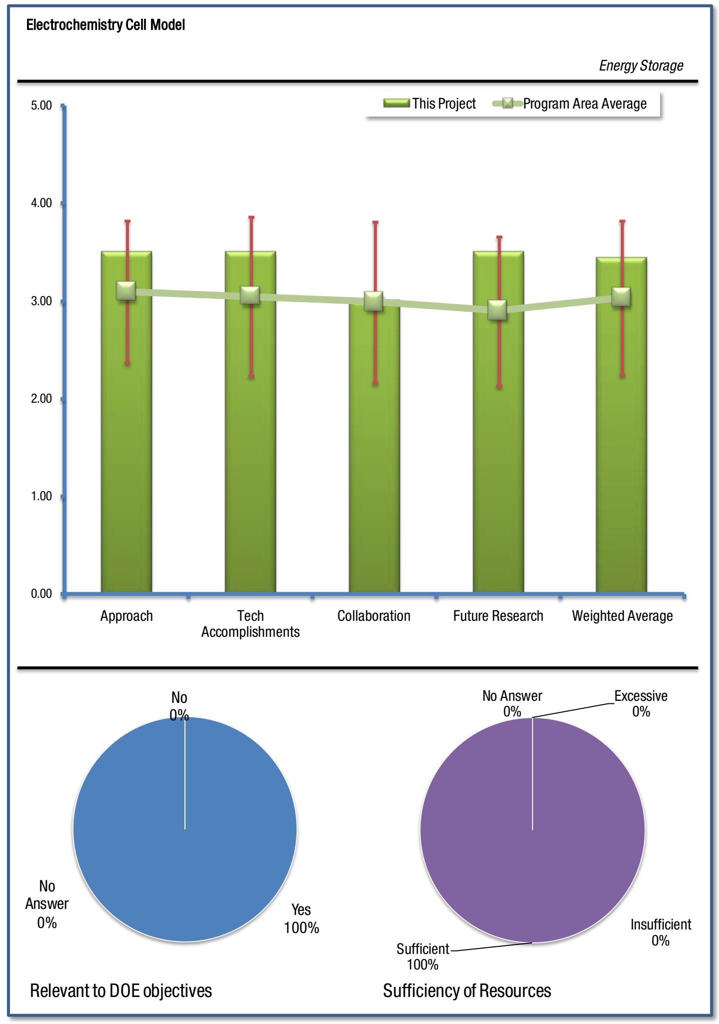
Some experimental conditions and cell designs are not very practical, as mentioned above, closer collaboration with industry is advisable. One reviewer noted they must address very poorly especially towards optimization anode work. MCMB has been gone in the battery business (Osaka gas stopped their production and none of the same material exist exactly the same as MCMB; similar material exist). No one picks 15% binder amount in conventional available battery and the money should not be used for this type of optimization work. Blending existing cathode material is also not research level and research lab must know what the requirements are in Li ion battery business.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the collaborations are very good but they should be further described and made effective in order to increase synergy and accrue project results. Another reviewer noted the PI did not address any other institutions in the presentation.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated BATT still has a clear frontier role in investigating and solving Li systems barriers but the role of exploratory research should be increased in a more systematic way beyond Li. Another reviewer added the BATT Program addresses the fundamental problems of lithium ion batteries and optimize costs, lifetimes, and safety. The proposed four areas of future focus are well defined. Additional details should have been supplied on the research experimental approach. Searching for proposals from the industry and community is a great idea. One reviewer noted the proposed future plan in 10 years is reasonable in Li ion battery. The PI needed to provide how the new system and cell design can add value to battery business.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the resources are quite large and should be adapted to the dynamic evolution of BATT. The coordination work is valuable. Another reviewer commented they did not see any benefit for try and error formulation study for both of anode and cathode.

Electrochemistry Cell Model: Dennis Dees (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this project adds to basic understanding of Li ion electrodes. Another reviewer noted the modeling done in this program is a good complement to the experimental programs on new electrode materials. It provides interpretation of experimental results and gives guidance to electrode development. One reviewer commented the model that Dennis developed to predict cell (battery) performance is very powerful and can serve to accelerate the development of new high power battery systems. Comments from another reviewer mentioned that the actual performance in battery is critical but costly and time consuming - particularly cycle life a key parameter but is extremely long to evaluate - accelerated test methods are a key to speeding up, and this work to develop models and link to accelerated test methods and actual aging is yet another way to increase speed of identifying promising new materials.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the work is very focused on understanding the behavior of Li ion electrodes from ground up. Another reviewer commented the technical barriers are addressed in an improved model. This allows more rapid assessment of parameters and a more adequate data fit. The model is subject to further development. One reviewer mentioned the model is based on first principles. It also uses impedance as a powerful tool for determining the reaction kinetics of the reactions. Comments from another reviewer noted that all theoretical modeling proof is in the pudding after a lot of correlation. Generally however adapting model to PHEV, new material sets and also looking at electrode thickness impact very positive approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that Dennis has made consistent progress in analyzing/determining the various parameters that dictate the performance of the electrodes. They are puzzled though by his counterintuitive finding that with higher loading the ASI of the electrode goes down (slide 10). Another reviewer added the program has already given interesting results on electrode thickness related to electrode impedance for NCA electrodes. It has also given a reasonable interpretation of two phase behavior for graphite electrodes. These studies should be valuable in designing electrodes for a desired level of capacity versus power. One reviewer commented the preliminary trials have given good results and confirmed the accuracy of the system. Good correlation of predictive power and actual cell performance. The project developed an equivalent circuit model to speed correlations and a new diffusion model to better understand concentration phenomena. Comments from another reviewer mentioned that correlation will be the key and they really like the extension of work to multiple materials.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated they would suggest additional collaboration with university or commercial partner (under an NDA). That would really allow the author to test the validity of the models in real life products. Otherwise, this is an open-ended research. Another reviewer noted the level of collaboration needs to be continued at a high level so as to make the most of the theoretical developments. One reviewer mentioned the models are a personal thing. Dennis has built on the work of others doing similar work at LBL, but the model is his. They particularly like the inclusion of impedance as an added tool to include an experimental measure of the parameters.

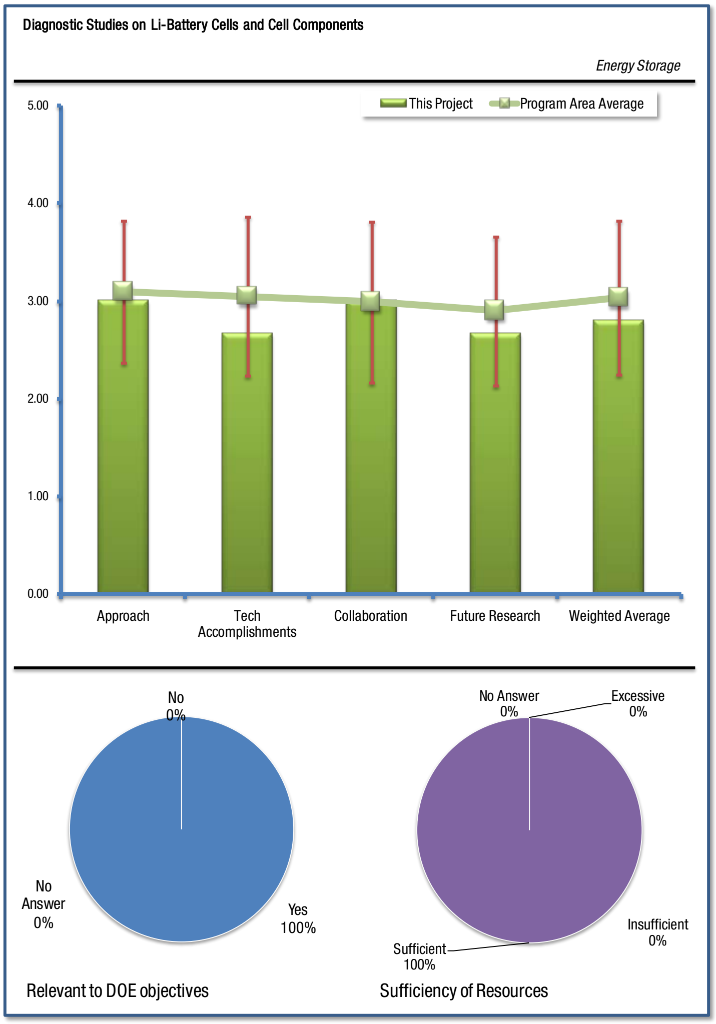
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would like to have few additional items addressed: 1. Clearly identify the processes corresponding to the various arcs/semicircles on the impedance plots. 2. Model behavior of electrodes having nanophase materials such olivine. Another reviewer added the plans for future research are appropriate. One reviewer noted the work will complete the parameter fitting methods and develop a two phase active material model development, as well as continued development of PHEV focused models. The application of the model will accelerate the progress of the program. Comments from another reviewer mentioned the project is looking for model refinement and correlation to actual performance data.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are minimal as a good computer and an active mind are all that is needed.

Diagnostic Studies on Li-Battery Cells and Cell Components: Daniel Abraham (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the work is focused around identifying and understanding processes to optimize cell life and performance by reducing degradation processes. The work is part of the DOE basic research objectives aiming at the improvement of battery materials and optimizing lifecycle and reducing cost. Another reviewer mentioned knowing the material properties to confirm what the root cause for cell performance such as cycle life.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated that given the limitations of working with Gen3 materials rather than materials/electrodes from a viable industrial battery partner, the effort has produced valuable results and methodology which should be useful for general application. Inclusion of multiple cell configurations should be very valuable, but there is no apparent reporting of observed differences between cell configurations. Partnership with a globally viable battery producer would have been/be desirable. Another reviewer noted the work has been designed very well. Various cell structures have been tested. Wide range of experiments and characterization techniques were used to evaluate cell degradation mechanisms. This is an interesting, but not so innovative approach to shed light on aging formation mechanisms. The approach is empirical, may be useful to add modeling for deeper dive and prediction of other again mechanisms. One reviewer commented the approach studies material properties before and after cycle life to find the difference is OK but need to analyze how it can be protect with suggestion. There is no detail explanation how this study/survey can be used for improvement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated that useful progress has been made towards improved general understanding of failure mechanisms and isolation of failure mechanisms within cell. Another reviewer added the work progress is good, focusing around demonstrating the feasibility of the inspection technique. It also includes preliminary analysis and testing on various surface films. However, the cells were not tested in real cycling conditions and only a restricted number of chemistries were investigated.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated there is a great collaboration with academia, will be helpful to work closely with industry and analyze real cells. Another reviewer commented that material investigation has been done with involving other institutions.

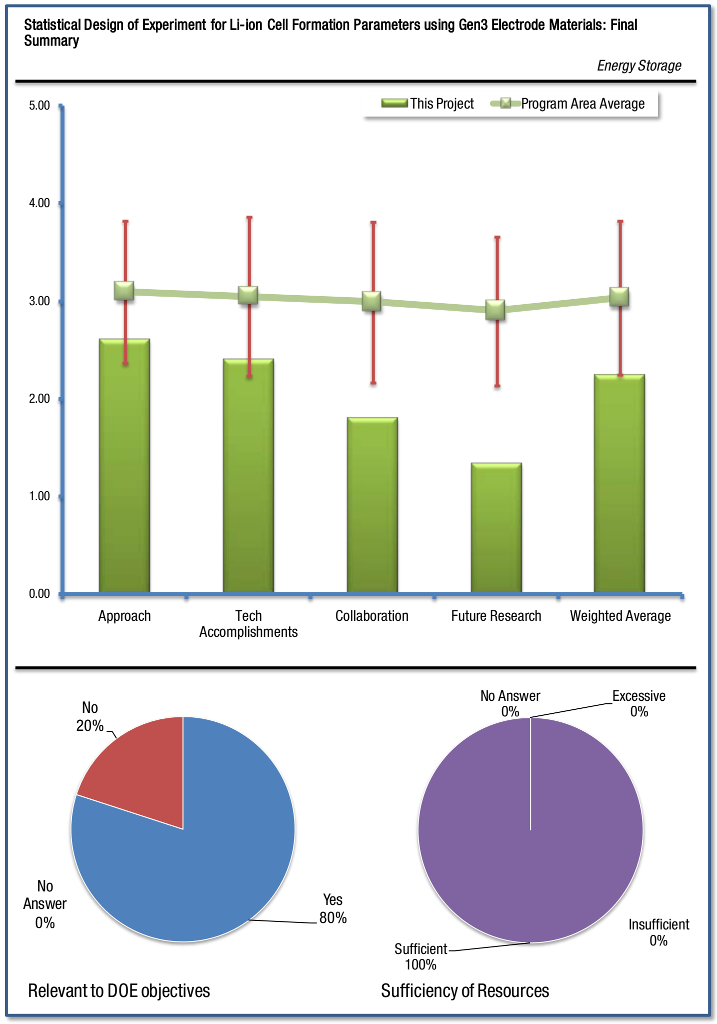
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated a partnership with a globally viable battery producer and with electrodes/cells outside of DOE would be beneficial. Inclusion of observed differences among different cell configurations would be extremely valuable for future! Another reviewer commented the project is looking into aging mechanisms across wide range of chemistries, cell structures, and real cycling conditions, is critical to identifying factors that contribute to cell performance, and degradation characteristics. One reviewer noted the project only addressed investigation material analysis for PHEV cells in the future. There is no specific items listed "How to suggest to improve cell performance”? Need to add why and how the material was formed and effect cell performance, how it can be removed for better cell performance? Only the material analysis cannot provide suggestion for improvement.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this is sufficient to the analyses work to know the material composition.

Statistical Design of Experiment for Li-ion Cell Formation Parameters using Gen3 Electrode Materials: Final Summary: Kevin Gering (Idaho National Laboratory (INL)) - POSTER



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that from cell design point of view, design of experiment will help to decide which condition is the suitable for cell formation. This may accelerate for decision making about condition to provide faster delivery time finally. But, if the objectives are improvement for cell performance including cost and pack volume, they would say this is not following objectives from my understanding. Another reviewer noted this project addresses important issue of relating formation procedure to cycle life. One reviewer mentioned that Gering is using a statistical method of experimental design to determine optimum conditions for formation of lithium ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that given the limitations of working with Gen3 materials rather than materials/electrodes from a viable industrial battery partner, the effort has produced useful results and methodology which would be useful for general application. Partnership with a globally viable battery producer would have been desirable and would allow for comparison with practical real world formation parameters. Another reviewer mentioned the approach had better tried with other formulation of at least two. One reviewer commented the approach seems very complete and organized design of experiments to what is typically studied in purely empirical manner. Comments from another reviewer noted Gering's approach is apparently directed toward reducing the cost of lithium ion cells by finding optimum conditions for cell formation. His approach could be enhanced by utilizing the modeling efforts.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the project provided a target as set. 186 cells for study since 2005 must be built limited assembly ability. Providing only one formulation result is not outstanding. The case study must be evaluated and confirmed with actual cell from the entire result. This result shows only suggestion regarding to the question. Another reviewer noted identified formation conditions that appeared to make a major difference in cycle life and also optimized for total formation time. Lacking actual industrial experience in this area, such work could be very helpful in ensuring that the cells made in the program are of decent quality. Results are only applicable to one cathode chemistry, but methodology could be applied elsewhere. However, this work never seemed to go anywhere, so it's hard to value it much. One reviewer noted Gering has obtained interesting results that should be vetted in industry.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the lack of collaboration with globally viable battery producer limits potential applied utility of work. Another reviewer noted that only one was addressed for one issue. One reviewer commented this work does not seem to have been picked up and used by the rest of the program and the general feeling seems to be that it may not be right. If so, this is more likely a reflection of other issues with making and testing cells rather than the methodology per se. So maybe this reflects technical issues with the results rather than poor collaboration. Comments from another reviewer mentioned Gering has worked with ANL to some extent, but he should work more with industry.

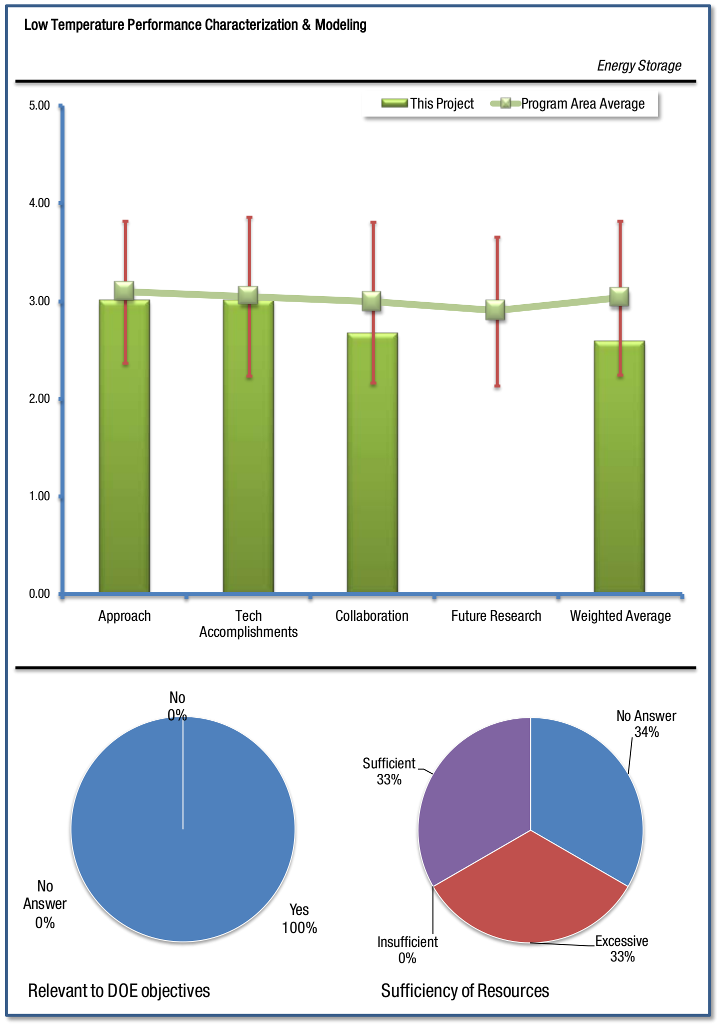
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated there was no specific material, system or etc mentioned as future work. There must be addressed as "need to check correlation between button cell and (at least) 18650 or laminate prismatic cell". Another reviewer commented no future work in this area seems planned. They think that once improvements in making cells are upgraded, that approaches such as this be revisited (Unless additional practical guidance can be obtained from industry). Three other reviewers noted this question does not apply as the project is completed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that once improvements in making cells are upgraded, that approaches such as this be revisited. Unless additional practical guidance can be obtained from industry (which may be possible), someone needs to be looking at formation for this and the other cell systems. Another reviewer commented that Gering had sufficient funding for this work.

Low Temperature Performance Characterization & Modeling: Andrew Jansen (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the program was in support of the low temperature goal of the present year. However, the goal has changed and the project was brought to a close in September 2008.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach was solid in identifying the temperature limitations.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the progress was limited because new electrolytes were not found to be better than the standard electrolyte. This was an interesting result because the standard electrolyte has high capability.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated partnership with a globally viable battery producer would have been desirable and may have allowed for more tangible studies with more relevant electrodes/cells.

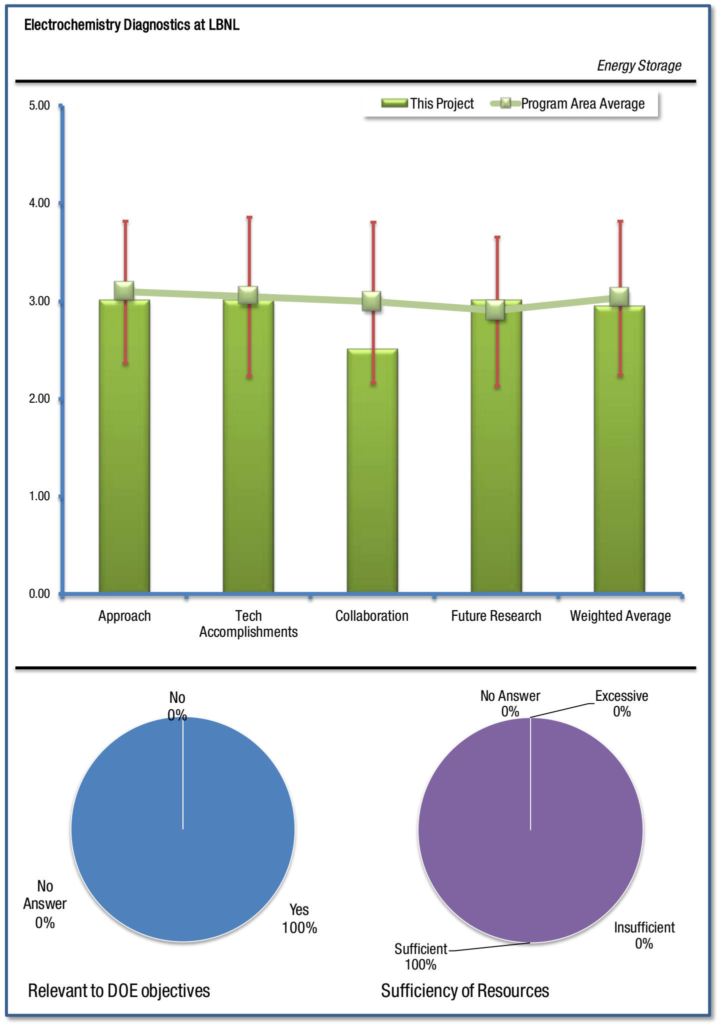
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Two reviewers agreed this question does not apply as the project is complete.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated partnership with a globally viable battery producer would have been desirable and may have allowed for reduced project cost and/or more tangible studies with a greater variety of more relevant electrodes/cells at the same project cost.

Electrochemistry Diagnostics at LBNL: Frank McLarnon (Lawrence Berkeley National Laboratory (LBNL)) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated that graphite is the most prevalent anode material understanding degradation and factors impacting degradation rate are important to cycle life and overall costs. Mechanisms for cycle life fade are more and more important as migration from HEV to PHEV and EV occurs - this work addresses understanding commercially viable materials. Another reviewer noted the research addressed objectives and barriers to match the requirement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the study of impact of transition metals on anode and impact cycle life is right on target and focus on very relevant materials graphite, NCA and NMC is excellent. Another reviewer mentioned the approach of checking the material properties before and after cycle is good to know but this approach is similar to other researches. Need to address what and how the research will go to get stable cell performance based on the analysis.

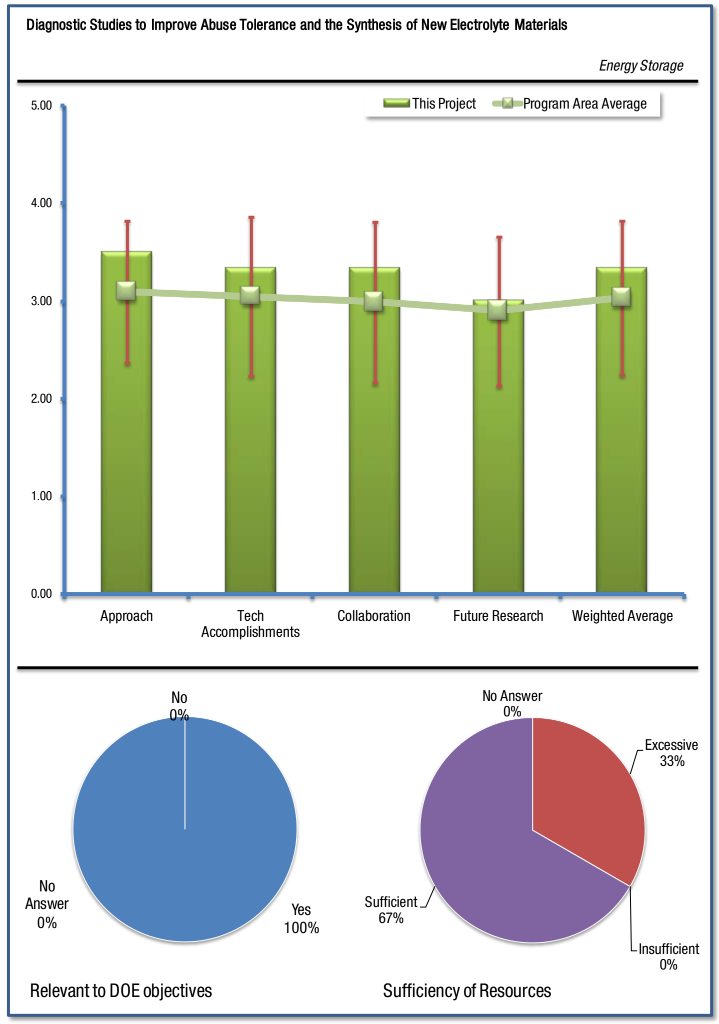
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated these are very solid results - fade of Gen 3 cathode cells however, no appreciable deposition of transition metals or electrode damage. There is further evidence of Mn poisoning of graphite.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated very good National Lab coordination - seeking an industrial partner would be beneficial. Another reviewer added that other institutions are mentioned but there was a lack of information which part was done with other institutions.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated that continued efforts to understand SEI formation/stabilization has potential to really accelerate vehicle applications and dramatically improve performance of lithium ion batteries. For most relevance scale-up activities of promising materials should be done with U.S. manufacturing partner. Another reviewer noted the project needed to address how these activities will be connected to future target as cell improvement from material and chemical point of view.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no comments for this question from the reviewers.

Diagnostic Studies to Improve Abuse Tolerance and the Synthesis of New Electrolyte Materials: Xiao-Qing Yang (Brookhaven National Laboratory (BNL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the project is very relevant in order to have a fundamental understanding of the electrode processes. Another reviewer commented as part of the material development for high specific energy anodes and cathodes, it is important to have proper diagnostic techniques, either in-situ or ex-situ, that will help us understand the chemical changes, both surface and bulk, occurring in these materials, as is being carried out in this project. Globally speaking, the development of high specific energy Li-ion cells for PHEVs will contribute to their widespread use and reduce our petroleum consumption and demand. One reviewer mentioned that abuse tolerance and life are important items for vehicle usage.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated there are excellent approaches to understand key material properties. They are not sure how BNL got to work on electrolyte salts and additives. They look to BNL more for diagnostic work than for these results. Another reviewer noted the approach involves in-situ XRD and X-ray Absorption Spectroscopy to track the change (electronic states) in the transition metals from the cathode materials. This project is much similar to another project from the same researchers, except that this deals with the behavior of cathodes in conjunction with electrolytes and during thermal abuse. Is there any reason that these two can't be combined to make a more cohesive project?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there are very good results on key materials characteristics. These are solid clues into the behavior of important battery materials achievable thanks to the powerful technique BNL uses. They are less thrilled with the salt/additive results, except the results with the Li/LiCoO2 cells. Another reviewer added there are some useful data on the structural changes in the spinel-layered mixed cathodes, which may help design a mixed cathode. Also, there is additional structural information on the thermal stability of Gen and Gen 3 cathodes, which corroborate the precious observation (by several others) that Mn-rich layered compounds have superior thermal stability compared to Ni-rich or Co-rich analogues. Finally, some new electrolyte systems have been identified based on the boron-based anion receptors. One reviewer noted that the cathode material thermal stability result is quite reasonable. The expansion and usage of the method at different lab is also the right action and the result with electrolyte additive provides a good result.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a great collaboration on this project. Another reviewer noted there is on-going collaboration with several other laboratories and battery companies. One reviewer mentioned the project collaborated good to reach the target and confirm the result. It is quite important to exchange the information and technologies between companies and/or institutions.

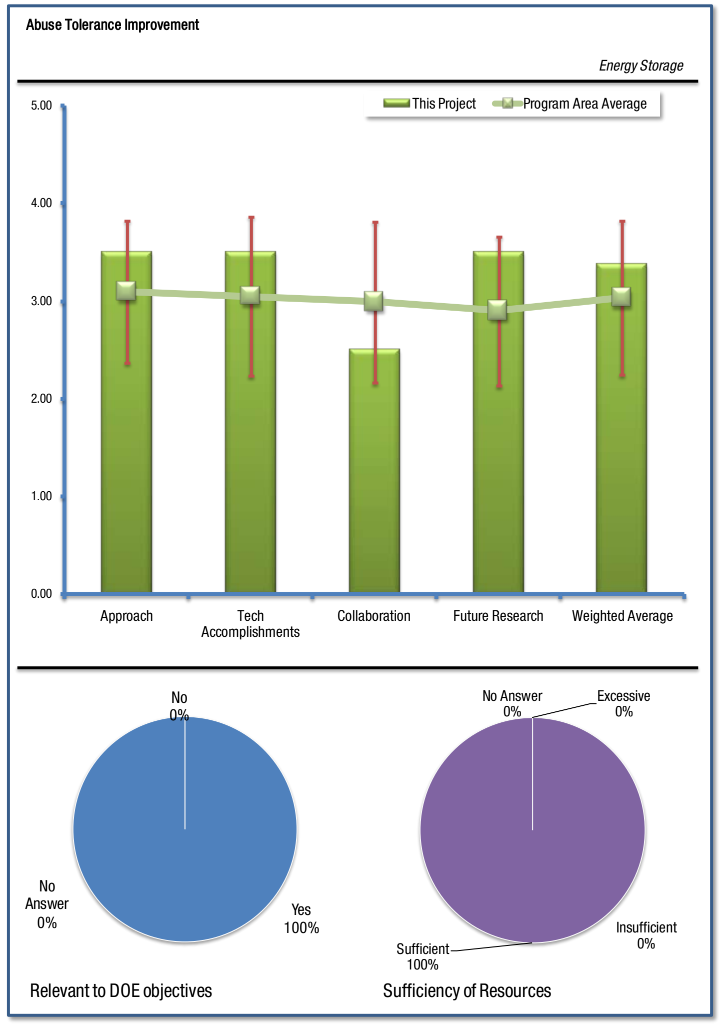
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated that BNL should diagnose as many cathode/anode materials as possible for fostering deeper understanding of these materials. They don't think the salt/electrolyte data looks appealing or unique enough for additional work to be continued. Another reviewer added the proposed future studies of continuing such diagnostics studies to understand the performance-limiting processes within the cathode structures and their thermal abuse characteristics and to develop new boron-based anion receptors for Li battery electrolytes is relevant to the overall DOE goals. One reviewer noted that most of the future work addressed are based on the past progress and expansion to the others.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that resources may be slightly in excess, particularly if this project is combined with the other project on cathodes (consolidation).

Abuse Tolerance Improvement: Peter Roth (Sandia National Laboratory (SNL)) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated that abuse tolerance is important in assuring a full application of Li batteries. Another reviewer noted this work is critical to the commercialization of automotive Li-ion batteries.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the approach is interesting in identifying some of the key abuse parameters. These technical barriers are not exclusive and might be integrated with those of mechanical nature.

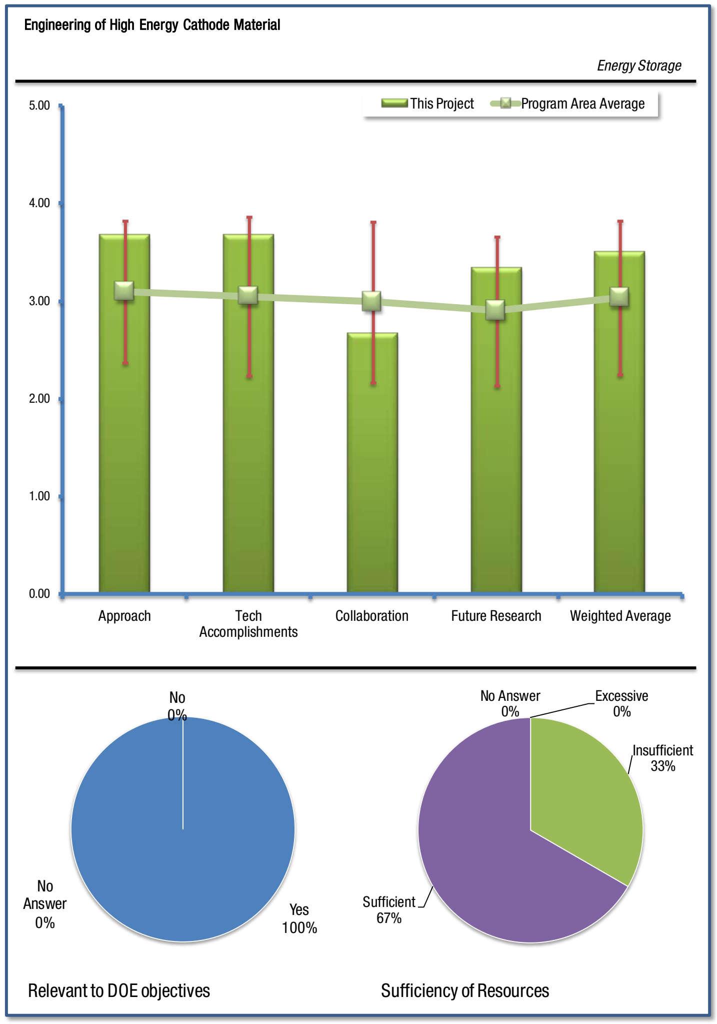
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the results are interesting and a good relation with the various cells. The general values of some of the conclusions/results may be beneficial to improve cell and material preparation. The use of the experimental results in simulation models would be of further value. Another reviewer mentioned that clearly Dr. Roth is an international leader in this field.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated there is no clear indication on collaborations. The collaboration with materials and cell modelers would be mutually beneficial.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the proposed future planning to PHEV system is acceptable in relation to the good results achieved and the expertise acquired on previous Li systems.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the evaluation of adequacy is only partial because there is no clear perception of the number of systems/designs will be analyzed. Another reviewer added that while the funding is sufficient for Dr. Roth to do excellent work, just think what could be done if funding and manpower could be increased for this project.

Engineering of High Energy Cathode Material: Khalil Amine (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated these materials as presented offer very nice rate capability and capacity - both key objectives for vehicle applications. Also 0 cobalt compositions may have intrinsic materials cost benefits also a key need for automotive applications. Another reviewer noted the increased energy density and cheaper synthesis process will make the cost of the cathode material more affordable. One reviewer commented that Amine et al. are developing new materials to improve the energy density, e.g., for electrodes in lithium ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?

Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is solid - although material sets are not that novel the carbonate precursor formation methods appears to enable morphology advantages and application to vehicle application performance testing is spot on. They think 18650 size evaluations for cycle life will be a key to establishing materials. Another reviewer mentioned the ANL designed continuous process will help with the objectives. One reviewer noted Amine et al. utilize an experimental approach which works well. However, they may be able to improve their success by utilizing modeling to optimize their preparation techniques.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated these are very promising results so far - next steps of surface modification and 18650 confirmation will be key. Another reviewer added the rate capability and first cycle loss may not be acceptable. One reviewer commented Amine et al. have had tremendous success in their work in the past and have continued to be successful.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaboration with a large American cathode manufacturing company will help with the ultimate cost reduction. Another reviewer mentioned Amine et al. may benefit from collaboration with industry.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

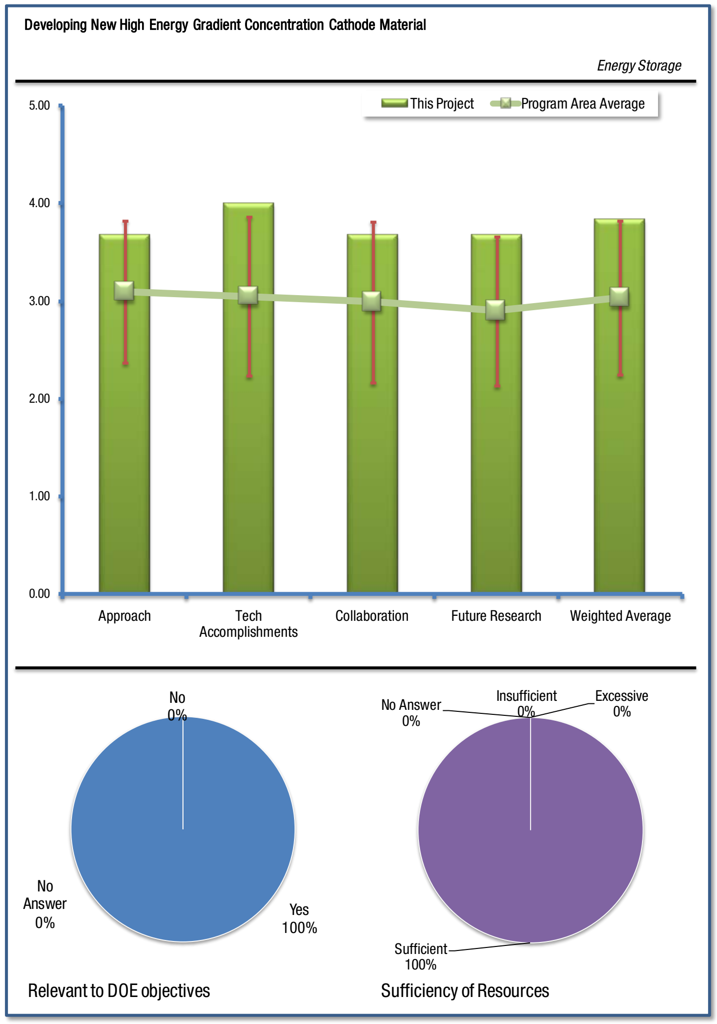
A reviewer stated the project is on the right track but they did not see 18650 size cycle life called out - coin cell data looks good but proof is in 18650s with each new material set. Another reviewer noted the program will end in

September 2009 and may not have enough time to improve the material. One reviewer commented Amine et al. have outstanding plans for the future that are well defined.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated Amine et al. should be funded at a higher level to help them produce even more useful material for lithium ion cells.

Developing New High Energy Gradient Concentration Cathode Material: Khalil Amine (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the project is a key part of identifying new high performance materials with 200 mAh/g or more. Higher capacity materials are essential to meet the future needs. Two reviewers noted the project is highly relevant. A higher performance cathode is critical for next generation Li ion batteries with good thermal stability.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this is a very novel idea. They love the approach and are hoping that this approach opens up a lot of opportunities to engineer new materials with superior properties. The reviewer does have a concern about the cost of preparing such materials. Another reviewer noted the gradient concentration materials discovered by Professor Sun have great promise to solve the capacity limitations of layered materials. The approach so far has been material preparation oriented and now should be devoted to optimizing the composition and gradient characteristics for electrochemical performance such as rate capability and cyclability. A later stage should be to develop cost effective methods of preparation of the most promising materials. One reviewer mentioned this is a cleaver technique for making new cathode materials with higher voltage and mAh/g. The concept of coating one material with another is very innovative and clever. The resulting core-shell materials have unique performance characteristics.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated this is very nice work and excellent results and they are looking forward to seeing future results. Another reviewer commented the results have been outstanding to date on this class of materials. One reviewer noted the co-precipitation process actually works and can be translated into practice and small quantities of a high energy gradient concentration precursor and cathode material are available for evaluation/characterization. The material has gradient concentration with changing concentration of Ni, Mn and Co within each particle. The performance was demonstrated experimentally to have high capacity, good cycle life and excellent abuse tolerance.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the Hanyang University/ANL collaboration is very good and should be further developed. Another reviewer mentioned the work requires interacting with others on the ANL staff.

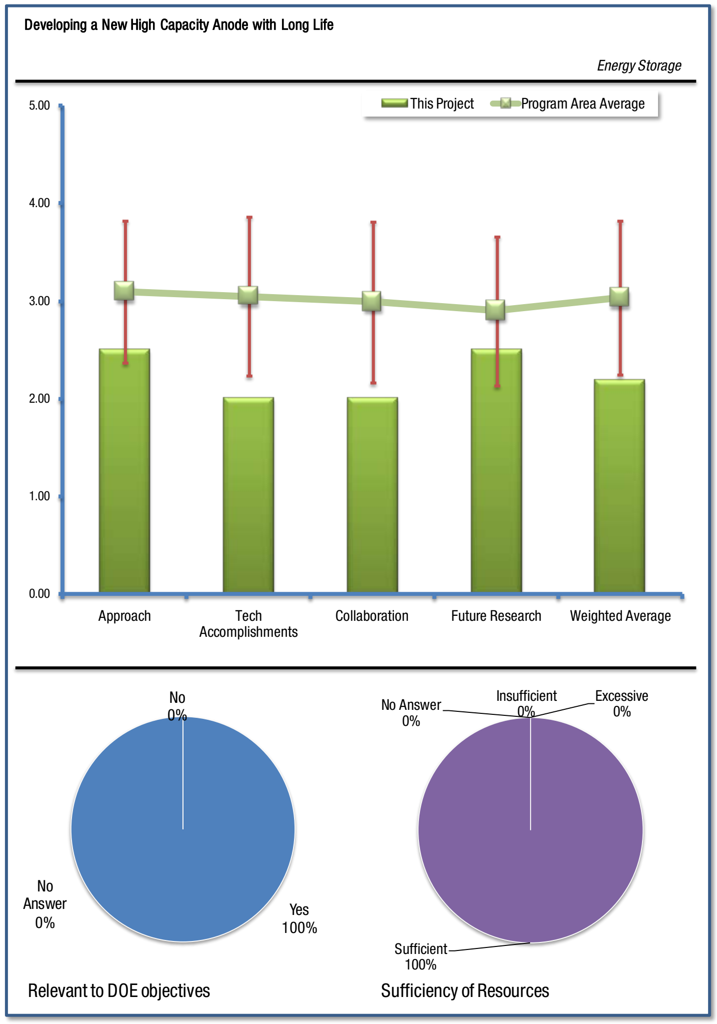
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the authors have a lot of experience to really exploit this technique for the synthesis and characterization of these next generation materials. Another reviewer added the barriers should be carefully assessed and systematically approached. Cell development should be pursued to make good assessments of these new materials. One reviewer commented that actually making sufficient amounts of the materials will confirm the initial work. Putting the material in real cells for testing is essential. Additional materials will be prepared and characterized, including ARC safety testing.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the equipment and lab assistance is sufficient.

Developing a New High Capacity Anode with Long Life: Khalil Amine (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this project address the need to develop new anode materials with high specific energy for improving the specific energy of Li-ion batteries to make them viable for PHEVs, which will minimize our petroleum consumption and reduce emissions. Another reviewer added the project addresses the safety aspects and specific performances of anodes that will favor the reach of DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach of trying to improve the synthetic routes for TiO_2 to get sub-micron particle size looks reasonable. However, TiO_2 is not an attractive candidate due to its low capacity and high potential, such that the payoff isn't significant. Its advantages over lithium titanate anode, which is fairly mature, are not persuasive. Another reviewer noted the clear approach is based on an acceptable analysis of the technical barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there are useful results on the effects of additives on the particle agglomeration of TiO2. The data indicate a low capacity (200-250 mAh/g) even at moderate rates compared to a theoretical value of 330 mh/g – not particularly encouraging, especially with a high potential. Another reviewer mentioned the results are interesting but not yet allowing for a progress consistent with the planned objectives. More work is awaited on stability and performances verification.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is no external collaboration while another reviewer noted that collaborations are very limited, but sufficient for the ongoing work.

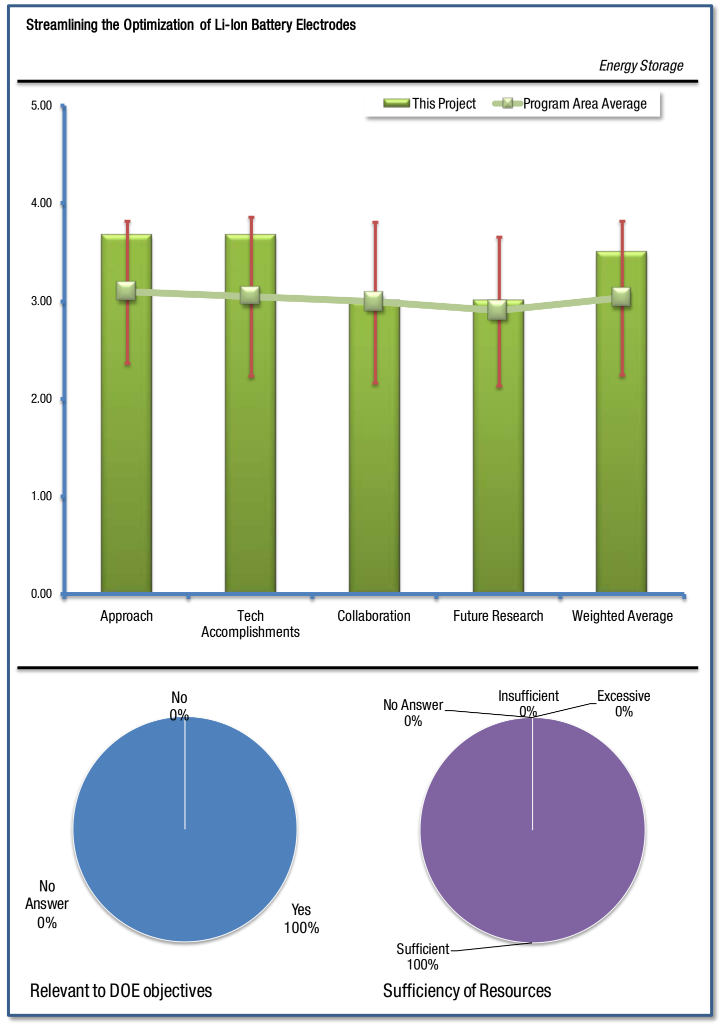
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the proposed studies of continuing to improve the synthesis reduce the irreversible loss, explore carbon coating look acceptable. Even if successful, however, these efforts will have not helped the DOE goals significantly (low pay off). Another reviewer added the future work is well defined but the focus on complete verification of project targets is not indicated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate while another reviewer mentioned the resources seem consistent with the planned activities.

Streamlining the Optimization of Li-Ion Battery Electrodes: Wenquan Lu (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the modeling and simulation of the battery performance based on the material properties and processing will reduce the long wait associated with the new materials. Another reviewer noted that electrode manufacturing and design is the key to meaningful evaluations of materials and setting direction for the program. One reviewer mentioned that Lu is trying to reduce the time necessary to produce an optimized electrode in a lithium ion cell.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the study of properties and characteristics of the material for electronic conductivities is a new approach. Another reviewer mentioned they were very impressed with the approach taken in trying to measure key electrode properties (such as electronic and ionic conductivity). One reviewer noted that Lu is working on understanding the conductivity of electrode materials and the aging process in these cells by carrying out EIS studies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the electronic conductivity of various electrode material and information on aging of the electrodes helps with the understanding of the aging phenomena. Another reviewer commented that in a very short time, the PI has already demonstrated some useful learning's about electrode designs and conductivity. One reviewer added Lu has found that a particular combination of active material, conductive additive, and binder provide the lowest electrode impedance at the beginning of life and after cycling for a particular cathode. He has also made progress in determining the conductivity of various cathode powders.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the collaboration with cell modeler and using available S/W may add to the value of the development work. Another reviewer added there is an excellent linkage to Dees modeling and Jansen's new pilot line. It seems to the reviewer that this PI's work might benefit from consultation and/or collaboration with Prof. Sastry in Michigan, whose group has in the past done some great modeling work on electrode conductivity for the ATD/BATT programs. One reviewer noted Lu appears to be working with Dees at ANL, which is useful. It is not clear that he is working with others as he should be.

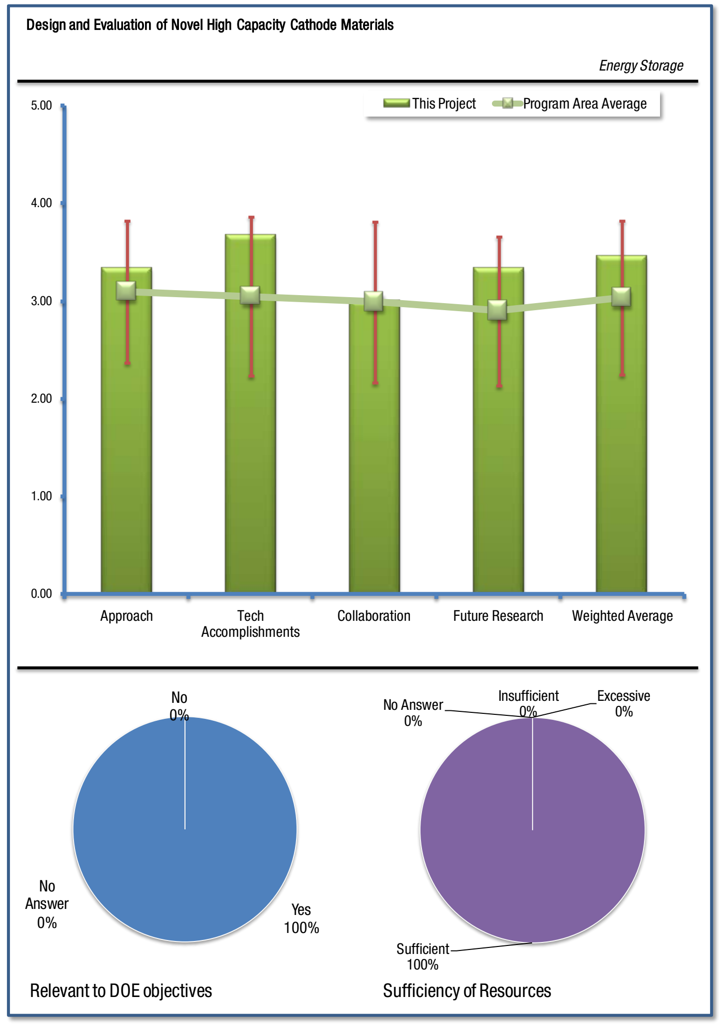
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated that continuation of the development work is promising. Another reviewer mentioned that good plans are in place. While studies that are planned to look at binder, carbon loadings, etc. may to a large extent be empirical; this is often how battery developers really get things done, even if they aren't very proud of it. One reviewer commented that Lu's plans for future work are reasonable expect for the need to develop the capability of predicting the outcome of his experimental plans. He should consider working more closely with Dees and others.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the project seems to be very focused and working well with others. Another reviewer noted Lu has received sufficient funding.

Design and Evaluation of Novel High Capacity Cathode Materials: Michael Thackeray (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated there is a need for high energy (voltage & capacity) material desperately! Another reviewer noted this project will synthesize high energy cathode materials for PHEV applications and determine the physical and chemical properties of these new materials. One reviewer mentioned the objective of the research is matched to DOE's.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that most applications outside consumer electronics for high E/P applications require a rate between 1C & 5C. This needs to be taken this into account for rate capability assessment. Another reviewer commented the approach is to develop new avenues to prepare new cathode materials with 4 volts or higher to prepare new high energy battery systems. Develop procedures to use surplus lithium to load intercalation/alloy anodes. Evaluate the use of the stabilized lithium metal powder from FMC Corporation. One reviewer added as mentioned in approach slide, investigation and analysis of mechanism are important rather than optimization work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the project demonstrated over 500 mAh/g in Li_5FeO_4 materials, and over 300 mAh/g in vanadium materials. These offer high capacity at reasonable cost. The work involved high Li_2O content and anti-fluorite structures. Another reviewer noted it seems a lot of work has been done to address and reach objectives.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that most of the work involves in-house equipment. Another reviewer noted that only one source was mentioned and could not find collaboration work in the presentation.

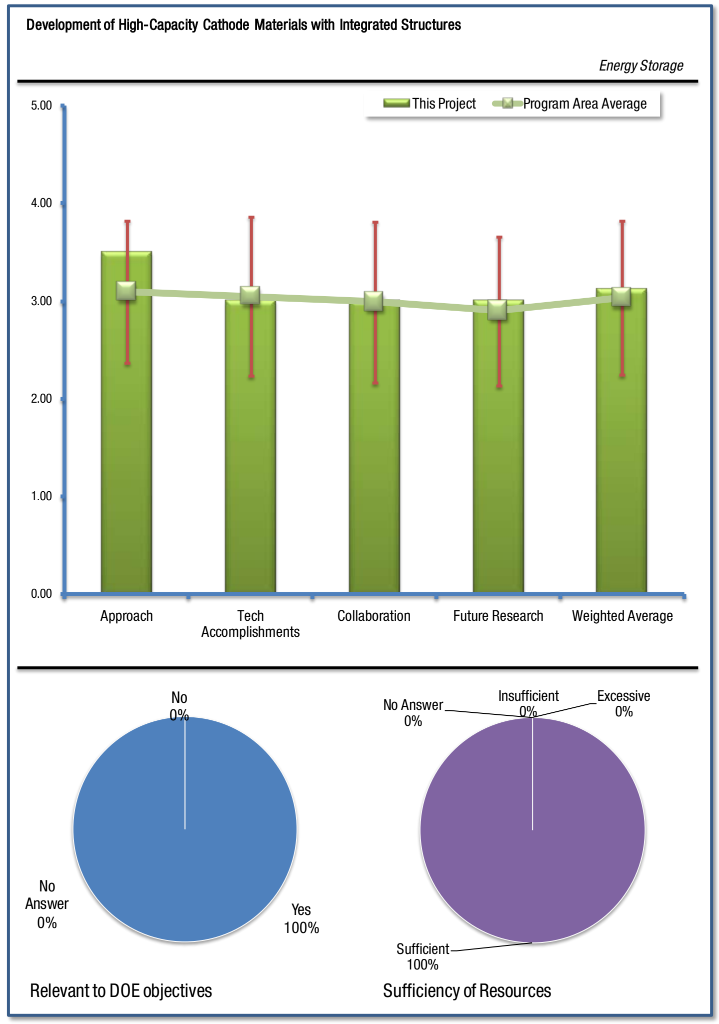
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the project will evaluate properties of Li-rich anti-fluorite structures for their electrochemical and chemical as well as thermal stability in charged and discharged states. Determine structural properties by XRD, XAS and other spectroscopic methods. Extend studies to include manganese, nickel and cobalt. Another reviewer commented the future work addressed is based on the past result and reasonable to reach the target.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that sufficient resources are available for the proposed work.

Development of High-Capacity Cathode Materials with Integrated Structures: Sun-Ho Kang (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that high capacity and high voltage cathodes will contribute to an enhancement in the specific energy of Li-ion batteries, which makes them viable for PHEVs and reduce petroleum consumption and demand. Another reviewer noted this project addresses key barriers to enable broader implementation of lithium ion technology and therefore meet DOE objectives. Specifically, the project is improving energy density and overall cost including lifetime and safety.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated it's a good approach to combine spinel-layered; may not a single phase, but may have synergistic effect on rate and capacity. Another reviewer mentioned there is a good synergy leveraging other BATT program findings and developing method to address gaps. Cycling results at high voltage verify the success of this approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the structural features as well as discharge curves indicate integrated phases of spinel and layered phases. The capacities are approaching 250 mAh/g in some cases, which is quite interesting. Another reviewer comments the results are very nice so far, however, need to move from coin cell evaluation to larger cells, such as 18650 to really validate energy improvements and cycle life for these materials.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer states there is a good collaboration with ANL.

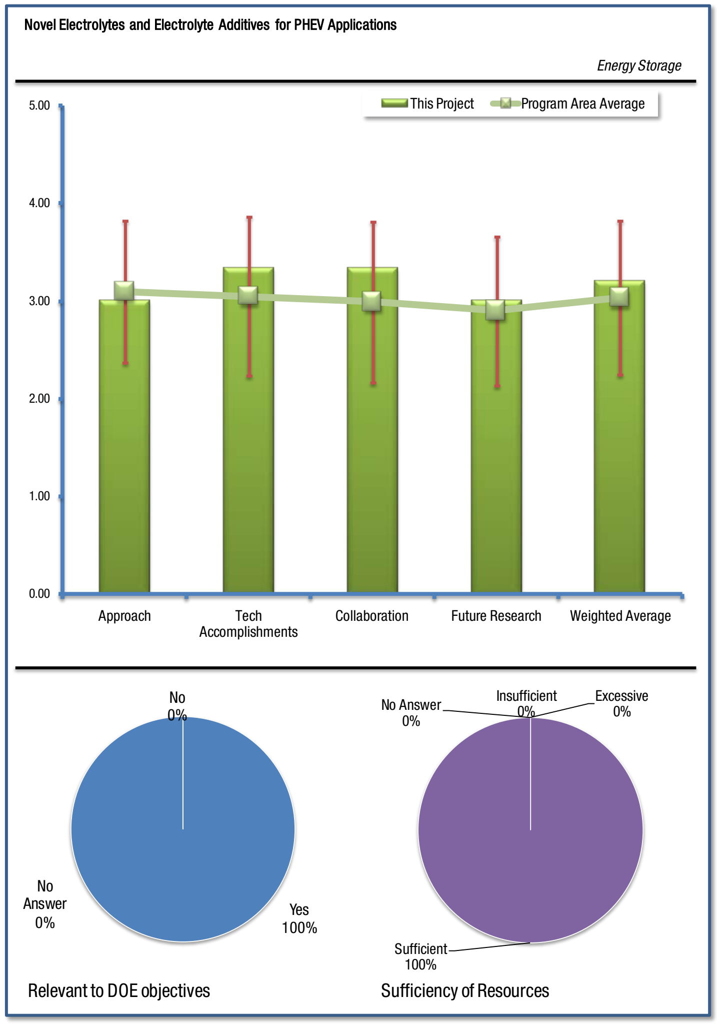
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated it is worth pursuing the proposed studies to optimize the cathode materials further, study the effect of dopants and demonstrate their performance in full cells. Another reviewer noted there is a need to move from coin cell studies to larger cells with appropriate balance of electrolyte in order to continue to confirm progress and relevancy.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are adequate for this project.

Novel Electrolytes and Electrolyte Additives for PHEV Applications: Daniel Abraham (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the anode failure modes include the loss of lithium or SEI instability which may be reduced with the use of additives and/or new electrolytes. Another reviewer noted that new electrolytes could be an enabler for higher voltage cathodes and also maybe better cycle life. However, LOS seems very low. One reviewer mentioned Abraham is attempting to find an electrolyte additive to improve the performance capability of lithium ion cells with high voltage cathodes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the use of new electrolyte and additives will help with the expected improvements. Another reviewer commented the strategy is not very clear, although the approach based on LUMO/HOMO calculations discussed by the presenter (not shown in poster) seem reasonable and is leading them to evaluate glycerol carbonate and some additives. However, in the reviewers view low temperature performance is likely to be very poor with the glycerol carbonate they are working on due to its high viscosity. However, the search for a new electrolyte is going to be very hard and they are not sure what advantage this group or approach has over anyone else. One reviewer noted that Abraham has not presented his literature survey that he probably conducted before selecting glycerol carbonates for further study. Also, it is not clear that he will be able to determine the effect of the additives based on cycling the anode/cathode pair he selected to 4.5 V. He should consider using a lower end of charge voltage or a different anode/cathode pair that would include a higher voltage cathode.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the results show the additives may be helpful in improving the life of the batteries. Another reviewer noted as a new project, can't expect much at this time. Positive results with glycerol carbonate are very surprising in view of uncapped alcohol group. One reviewer mentioned that Abraham has obtained useful results and published them with Dees et al.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that CSIRO will improve the probability of success. Another reviewer commented this exploratory work does not really need much coordination with other institutions. If they find anything, collaboration would become more important for follow-up work. Approaching others who are working in this area and asking to evaluate their materials under a non-analysis agreement might be worthwhile. One reviewer added Abraham is working closely with Dees and publishing with him. This collaboration has generated useful results. It would be helpful if they could work with someone in industry.

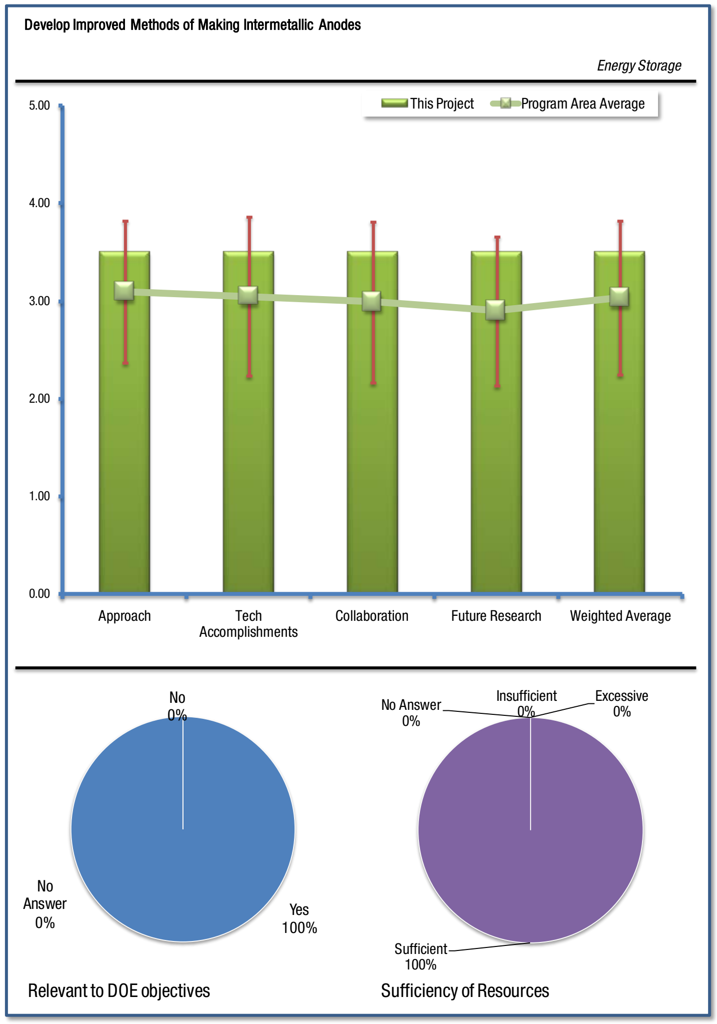
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future research should include the graphite instability exploration with the PHEV application and make the graphite more stable. Another reviewer noted it seems OK, but again the likelihood of success seems pretty low. One reviewer commented Abraham's plans for the future are reasonable. However, it is not clear why he has chosen the ionic liquids that he is planning to study next year. He may want to reconsider this aspect of his future studies.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated they agree to fund this work only at a low level. Another reviewer mentioned Abraham's funding is sufficient for his project.

Develop Improved Methods of Making Intermetallic Anodes: Andrew Jansen (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the project is very relevant. A higher performance anode can significantly improve the current generation of Li ion batteries. Another reviewer noted that higher capacity than the present carbon anode materials is needed for the longer term.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is a qualified good. They are quite skeptic about the success of most of the approaches pursued in the project thus far. They also believe the stability of these anodes will have to stem from the material itself, not from binders, additives. Many such approaches have already been reported without any major results. Nevertheless, for a long-term project as this one, they are ok with establishing baseline data like the ones the authors have obtained. Another reviewer mentioned the addition of elastic/inert binders to accommodate the large volume changes with alloy anodes is essential to their application in a practical cell. Another approach is the use if inert components in the alloy to control the particle size of the alloy element.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated given the long-term nature of the project, they think the authors were able to establish some good baseline data. Another reviewer commented that developed coating process to make electrodes with varying thickness of Cu_6Sn_5 to establish baseline. The accomplishments identified metals supplier to help in development of intermetallic alloys of varying particle size and morphology. The project evaluated the influence of conductive and resistive additives to electrode powder mix in an attempt to minimize copper migration. It expanded Argonne's Battery Design Model to assess the benefit of using intermetallic alloys in PHEV batteries. The project also obtained numerous samples of electrode binders for binder optimization study.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is very good collaboration with other workers. Another reviewer added that the project is mainly working with in-house experts.

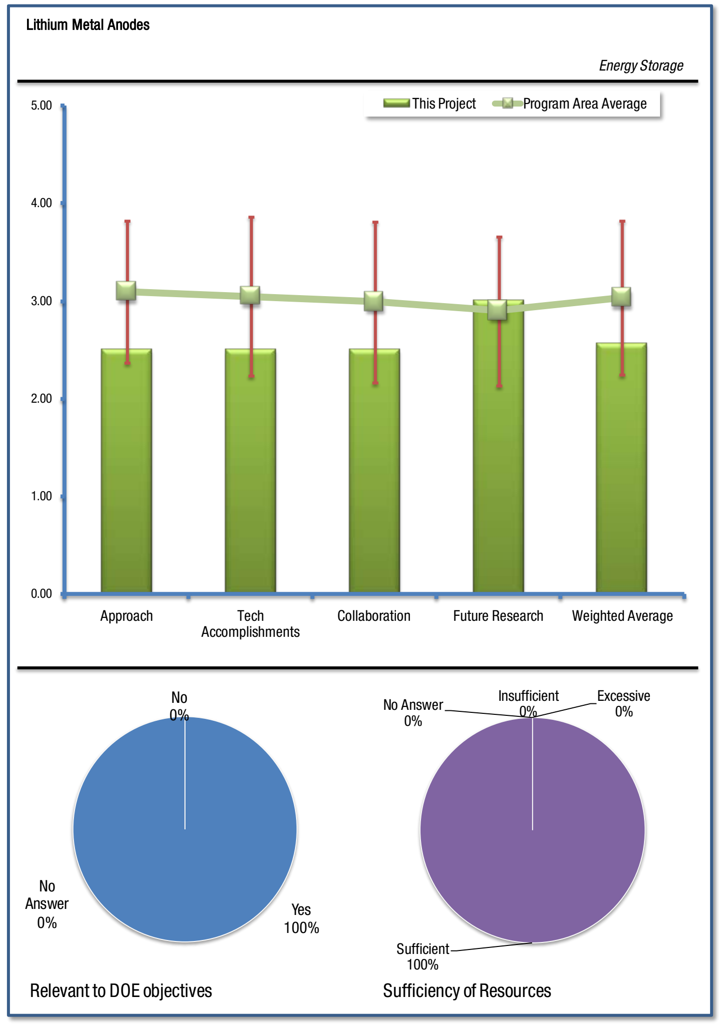
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they are very curious to see how the approach following Huggin's concepts pan out. The focus should be more on materials with new properties than working with different binders. Another reviewer noted the project will continue investigation of elastic binders for intermetallics. It will obtain and study vendor made samples of Cu_6Sn_5 samples made with varying particle size and substituted metal species in the $Li_xM_yCu_5Sn_5$ system, copper rich Cu_6Sn_5, and partial iron substitution of copper. Explore the subject of critical particle size based on Huggins work by making alloy casts of lithiated intermetallic alloys and evaluating their mechanical properties. Continue search for additives that promote copper retention at the particle level and electrode level. Initiate electrolyte additive study to enhance SEI formation for intermetallic electrodes.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are ok as is for the project.

Lithium Metal Anodes: Jack Vaughey (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the use of Li metal anode will improve the specific energy of Li-ion batteries. Another reviewer noted the project is looking at solving a key problem of Li metal anode with a potential high impact on DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the technical barriers are clearly selected with an adequate approach. The combination of models and experimental work is valuable.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the Zintl metal coating shows some promise. Another reviewer mentioned there are very good results and potential good feedback for improving thermal stability.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaboration is adequate for the needs.

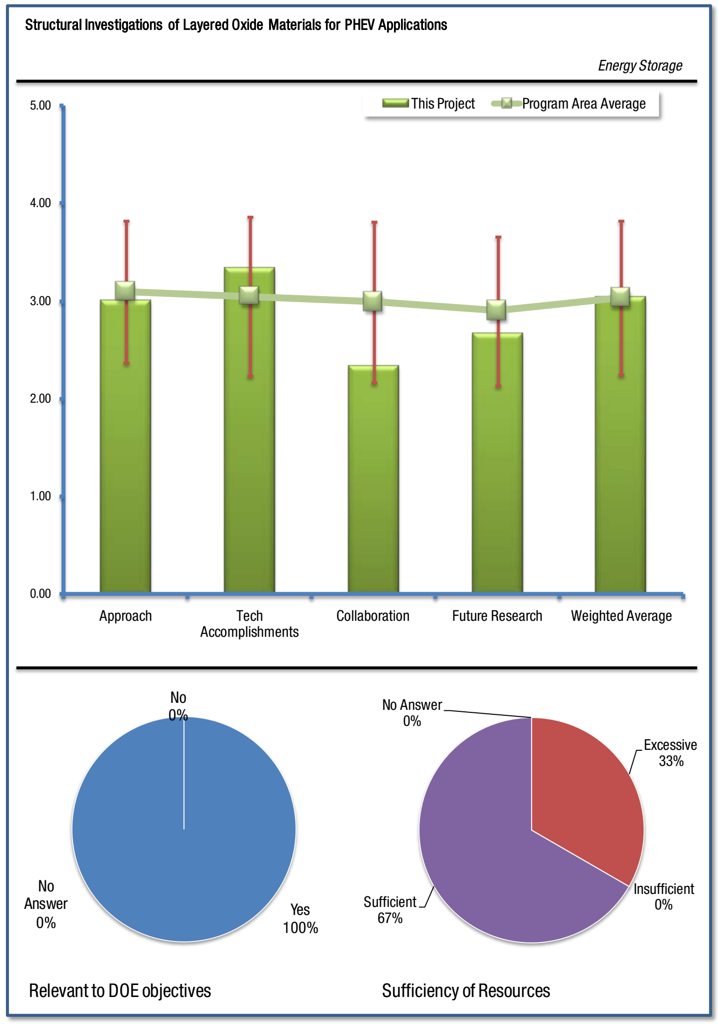
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the project is still focused on the main technical barriers of Li metal with adequate progress and future work based on effective results.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources seem consistent with the effort and the work planned.

Structural Investigations of Layered Oxide Materials for PHEV Applications: Daniel Abraham (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the need for higher energy content electrode is observed in the automotive application. Another reviewer noted the project helps with understanding high energy cathodes important for meeting PHEV goals. One reviewer commented Abraham et al. are studying the fundamentals associate with oxides for lithium ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the high voltage layered compound will deliver higher energy content. The cost may be reduced with low-cost metals. Another reviewer mentioned that really good analytical techniques and use of Cr as a model element to probe the mechanism and structural changes occurring during discharge of the MnNi oxide. One reviewer noted Abraham et al. seem to be reinventing the wheel in this project. It is not clear what new information they have developed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the study of various cathode materials and success look promising. Another reviewer noted the project has accomplished a lot in a relatively short time (new program). Seem to have established some of the mechanistic details of some key materials already and providing valuable insights. One reviewer commented Abraham et al. have obtained interesting results, but again it is not clear what is new in their work. It would be helpful if they would review the literature as part of their work.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaboration with universities will help. Another reviewer mentioned it seems to be mainly an ANL activity (they did not explore with the PI collaboration with the partners listed). They didn't see any linkage with modeling work either (Ceder), which would seem to be an important adjunct to such experimental studies. One reviewer noted Abraham et al. have listed collaborators, but it is not clear what these collaborators have contributed to this project or how they have used the results obtained in this project.

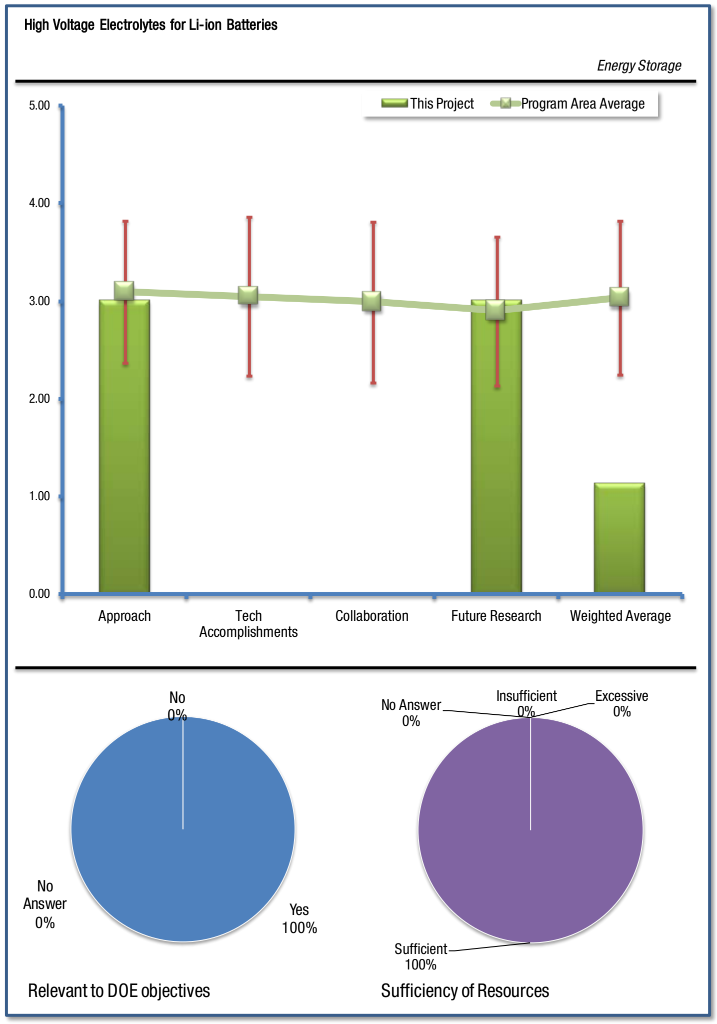
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the continuation of the development will lead to the energy and cost improvements. Another reviewer comments the plans seem to be aimed at answering important questions in key materials. If they understand this correctly, we still don't have a good explanation for the unusually high discharge capacity of ANL's material. The team will need to answer this question as the program gets going. The reviewer also wonders whether working with Clare Grey on NMR would also be helpful for this project, especially as some of the findings are that the materials are not always showing a well-ordered structure. NMR is well suited for studying the chemistry of disordered material. One reviewer mentioned Abraham et al. seem to be planning to do more work next year that will be repetitive in nature relative to what has already been published.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated they have a difficult task and are doing well with modest funding. The PI needs to make sure they leverage the program partners. Another reviewer added Abraham et al. should be encouraged to direct their efforts toward producing new materials for lithium ion cells.

High Voltage Electrolytes for Li-ion Batteries: Richard Jow (Army Research Laboratory) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the project will help develop high voltage electrolytes to accommodate the high voltage cathodes for HEV applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the approach explores asymmetric sulfone that has various functional groups for lower melting points and low viscosity, various functional groups containing un-saturated bonds. Explore non-sulfone based additives in combination with sulfone solvents for improved performance. Carry out quantum mechanical calculations based on HOMO/LUMO calculations.

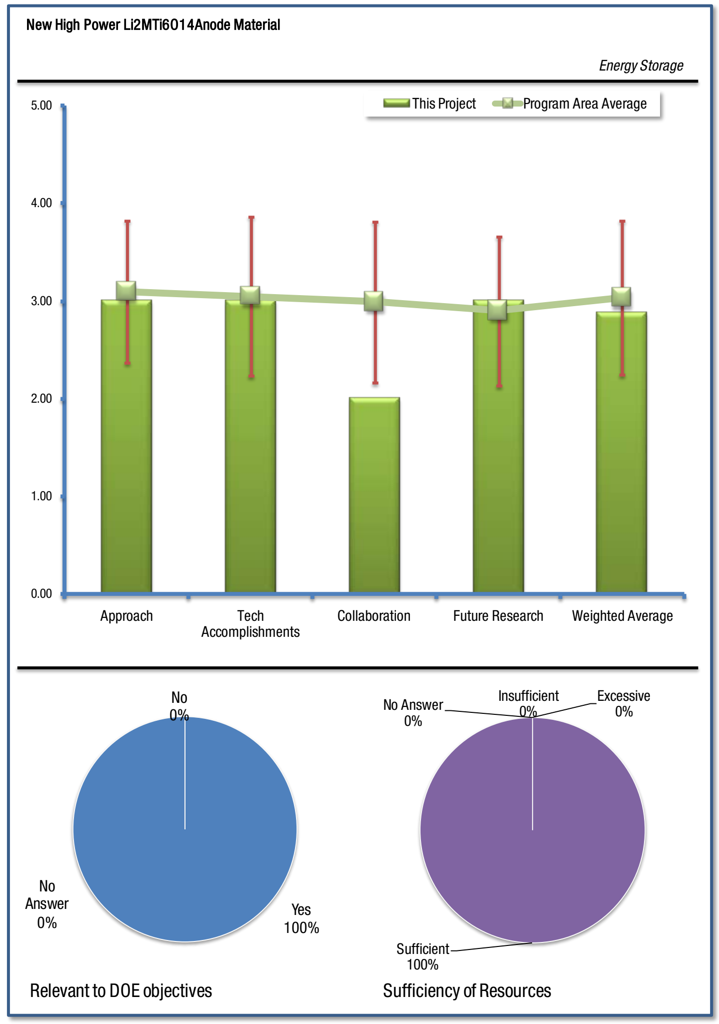
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the high voltage electrolytes development has been focused on the development of anodically more stable sulfone based than currently used carbonate based solvent systems. Sulfone with different functional groups will be explored and synthesized as improved solvents and additives for Li-ion batteries. The formulated electrolytes containing developed sulfone based solvents in combination with other solvents will be evaluated with the high voltage cathodes in Li-ion cells.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated there is collaboration with Maryland for the calculations of HOMO/LUMO and the correlation coefficients between LUMO/reduction or HOMO.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the work to synthesize of the sulfones with new functional groups and the electrochemical and physicochemical characterizations of $LiPF_6$ in these solvents. Evaluate LiPF6 in conventional carbonate solvents and sulfone solvents with and without VC additives in cells containing high voltage cathodes.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the resources for this project seem sufficient for the work proposed.

New High Power $Li_2MTi_6O_{14}$ Anode Material: Khalil Amine (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the work on alternative anodes is supportive of the DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is well defined with a clear view of the technical barriers to be analyzed and solved. The higher capacity of the new titanate integrated by the positive performances of the conventional titanate anode materials is a premium factor to be pursued in a clearly designed approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the results are very promising but needs further verification.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaborations are very limited.

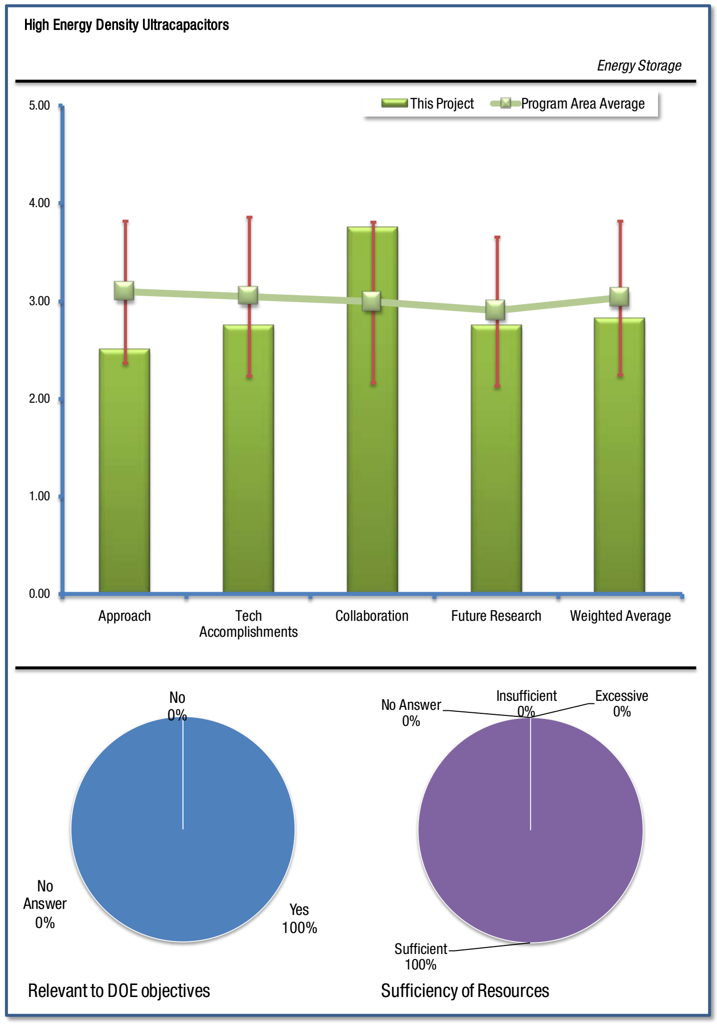
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future plan is good by combining process improvement and materials performance investigations.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources seem adequate, even if further work on complete cell realization and testing would be beneficial in accelerating the achievement of the results.

High Energy Density Ultracapacitors: Patricia Smith (Naval Surface Warfare Center) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated there is significant potential to improve Li-ion battery life in automotive applications using a coupled capacitor/battery energy storage system. This could both improve battery life during charge-sustaining operation and improve brake-energy recovery. Another reviewer noted the high energy ultracapacitors may be able to reduce the energy storage cost. One reviewer commented that while this technology does not have the energy to do PHEV or even HEV, super caps and especially their asymmetric ones, might find use in capturing the energy from regenerative braking. However, the increasing power capability of high rate Li-Ion cells is making this much less certain in their view. Comments from another reviewer mentioned Smith et al. are trying to produce high energy density ultracapacitors, which could be used in vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the electrolyte and the electrodes investigations may lead to the optimum combinations to reduce the cost, self-discharge, and energy density limitations. Another reviewer mentioned this is a good approach to evaluating new materials. Seem to know what they are doing and how to look for signs of degradation in the cells. Seem to be an expert in their field, very knowledgeable. One reviewer noted Smith et al. appear to be working on a project that may have limited utility because of the possibly low cycle life.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the data with various carbons, electrolyte, and electrode material will lead to understanding of the limitations created by the components. Another reviewer commented that while, they are not very far along with the project, most of their main findings are pretty well-known in the industry. While they seem technically very astute, the reviewer is concerned they offer little in the way of true innovation as they are basically evaluating materials that others are making, and maybe that's all we are asking of them. One reviewer mentioned Smith et al. have accomplished little relative to what was known before they started this project.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that collaboration with the innovative developers will help to improve the existing ultracapacitors. Another reviewer added the project appears to be linked in to a wide range of carbon sources. One reviewer noted Smith et al. are collaborating with a university worker and a company representative.

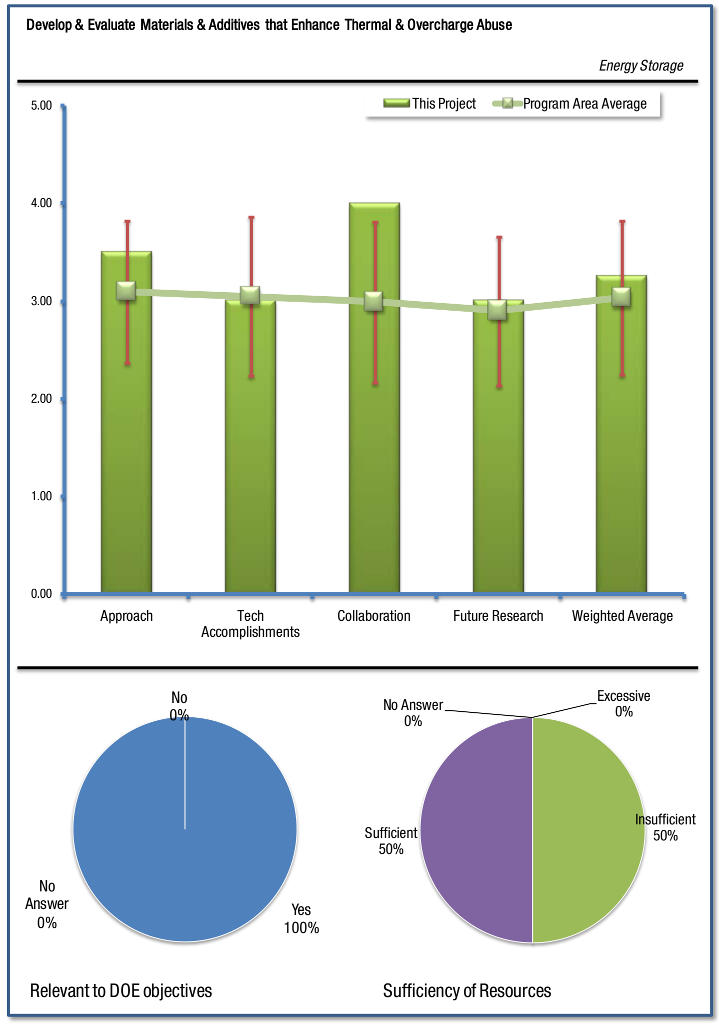
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the continuation of the development work will lead to improve the energy density of the ultracapacitors. Another reviewer mentioned if this work is aimed at evaluating where the technology can play in HEV/PHEV, they should do a very good job. They are concerned the project offers little in the way of true innovation as they are basically evaluating materials that others are making. The reviewer saw no technology plan to improve on current materials. If the DOE is expecting them to significantly advance the state of the art, then they fear this group will not succeed. One reviewer commented Smith et al. will probably not develop a device that will meet their projected energy and power densities that will have a useful cycle life for vehicle applications.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the cost share by Nay provides the sufficient funding. Another reviewer noted Smith et al.'s funding is sufficient for this project.

Develop & Evaluate Materials & Additives that Enhance Thermal & Overcharge Abuse: Khalil Amine (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this project supports the overall DOE objective of petroleum displacement. Another reviewer noted the project is directly related to improving abuse resistance of Li-Ion cells.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated they are not that convinced that the approaches pursued here will lead to any effective solutions to the problems addressed. The reviewer has seen these approaches followed for quite some time now but have not seen any real breakthroughs. Most of the approaches are variations on a theme and they are incremental with respect to benefits. The reviewer likes the idea of additives much better than coatings which are again band-aids. The shuttle concept is sexy on paper but has proven to be impractical in real systems. Besides, these systems often rely on low rate processes, which have no bearing on high-rate hybrid or PHEV systems. They however might be effective in EVs. This reviewer goes on to say they think the authors are stretched too thin. They are all over the map and I am not sure they can address all these issues in such a short period of time. Another reviewer noted the approach correlates the loss of oxygen from the charged cathode NCA and NMC, $LiMn_2O_4$, and $LiFePO_4$ the heat generated from the high rate discharge and oxidation of the electrolyte. Investigate the effect of surface area and morphology of cathodes on the safety of the cell. Determine the relationship between the surface area and morphology of the carbon and the heat from the SEI breakdown and quantify the role of the SEI breakdown by studding anodes that doesn't require SEI. Investigate the possible oxidation of the separator from the oxygen release.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the authors have produced a lot of results but the only result considered significant is the stability of the resistance for cells using LiDFOB. Even that might not hold in longer-term storage studies. Most of the other results are not significant to me or too early to draw any reasonable conclusions. The reviewer has seen many such improvements disappear during long-term cycling or storage.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer states there are very good collaborations within the project.

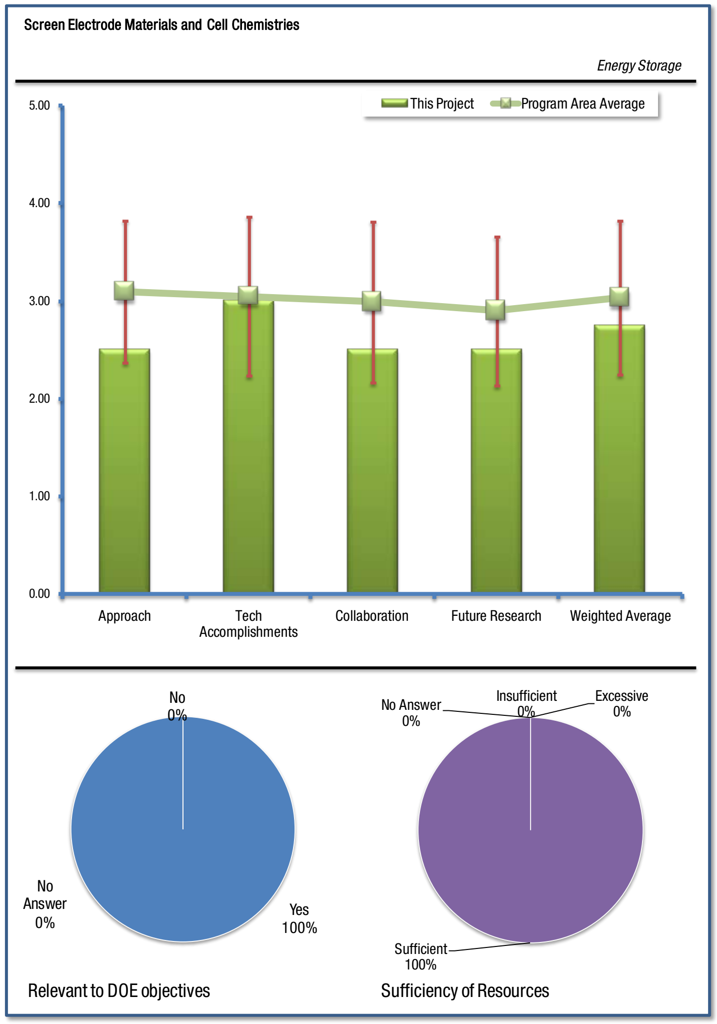
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would suggest focusing away from coatings and to some degree additives. It is easy to do a lot of work using such approaches but again the benefits have been incremental, if any. Some of the approaches proposed such as ALD is very attractive but is expensive and they often lead to lower power. May be authors can come up with an elegant and inexpensive way of achieving this objective. This reviewer would have loved to see more focused work. They are fighting too many fires within this project. Another reviewer mentioned the project will investigate the effect of more additives and surface coatings on the safety of lithium batteries. Exploring 3M's redox shuttles potential on preventing overcharge. Investigate the effect fluorinated carbonates, ionic liquids on the safety of lithium batteries. Investigate effect of and morphology of carbon.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated if we want the authors to pursue all the items they have listed, then the fund is not sufficient. Another reviewer noted the resources are reasonable but it is an ambitious program.

Screen Electrode Materials and Cell Chemistries: Wenquan Lu (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the scientific and technological benchmarking is instrumental in supporting right choices for better reaching DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is good, without any specific original research activities, but clearly addressing key technical and economical barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the results are really good and easily repeatable thanks to the preparatory work in defining specific test procedures for material screening.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there are no evident collaborations but probably there are not yet necessary at this stage.

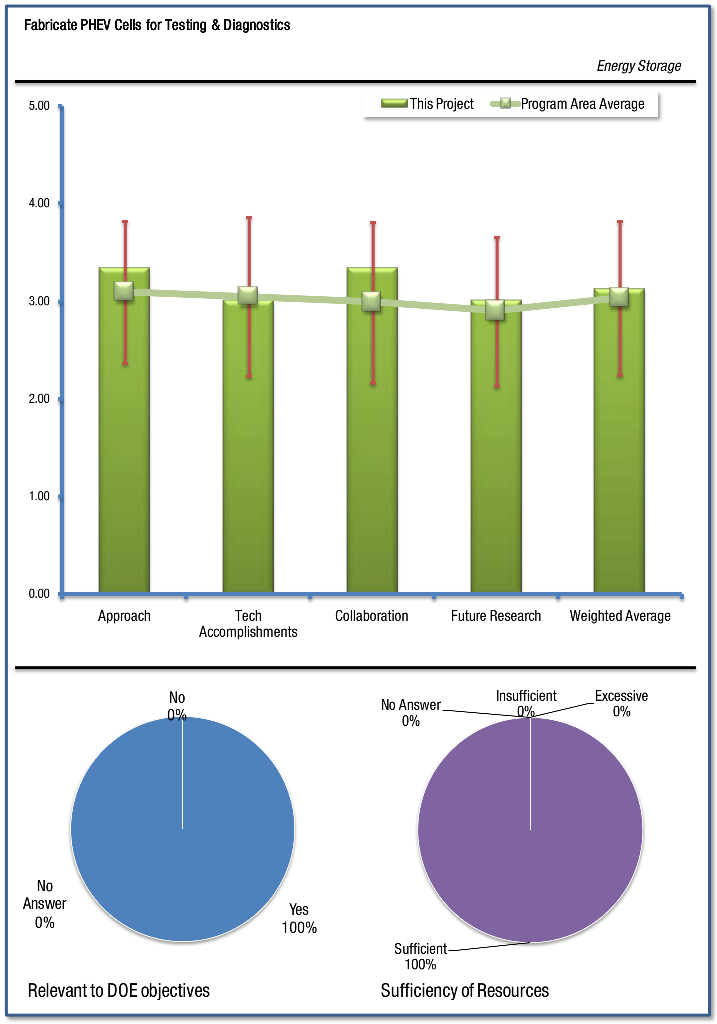
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the activities seem to be quite well in place with clear vision of the steps to continue the work. It is not completely clear the way the results are compared with those of the innovative materials under development in BATT.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources should be flexibly adapted to the yearly testing plan and evaluation/assessment work.

Fabricate PHEV Cells for Testing & Diagnostics: Andrew Jansen (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated it is very critical to validate the performance of the PHEV batteries by first modeling and then actual cell testing. Another reviewer noted the plan to bring cell manufacturing in-house is critical if this program is ever to generate real cells for cycle life and lifetime assessments. Also, for the first time, they are starting to get down into the nuts and bolts of electrode manufacturing.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that making electrodes will require many experiments and coating equipments to optimize the process. There is not enough detail on the electrode manufacturing. Another reviewer mentioned they really liked the focus on basic design factors of the electrodes and linking them to models and performance. The cell line seems well thought out.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that depending on the electrode and cell manufacturing vendors was not successful in the past. There is a need for an industry expert working at ANL for a successful outcome. Another reviewer commented the accomplishments already identified some useful constraints on electrode thickness and loading. It is still too early in the project to expect much else.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there may be some lessons learned from the cell building operations at LBNL. Another reviewer noted they were very pleased to see good co-operation between the modeling work, fundamentals measurements on cells and formulation experts. Make sure they work with Sandia for best shared practices and try to tap in to "friendly" experts in the field who might be willing to impart helpful tips on cell manufacturing that are hard to find out any other way. (The reviewer knew this is hard to do.)

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the dry room operation will add the value to the success of the program. Another reviewer noted they think when this work gets going it could become a key link in moving ideas from the lab to real prototypes. The reviewer liked their plan to use commercially made Gen2 cathode materials as a validation for this new electrode manufacturing line.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated they suspect that getting this line up and running will be fraught with many difficulties and is a major undertaking that is not fully appreciated. While the reviewer is somewhat heartened by plans to hire a process engineer, the prove-in of this line will likely be much longer and more expensive than expected. Thus, while the resources may be OK, this program step may need considerable patience to bring the production system on-line. Meeting the desired timeline for making good electrodes would be a miracle in this reviewer's opinion. Whoever has control over this facility needs to have authority to enforce a rigorous and disciplined usage (probably needs a thick skin as well). Management support is going to be the key in this area or pretty soon all you will have is a contaminated mess on your hands.

3. Power Electronics & Electrical Machines Technologies

Introduction

Advanced electric drive vehicles such as hybrid-electric vehicles, plug-in hybrid electric vehicles, fuel cell electric vehicles, and pure electric vehicles, require power electronics and electrical machines (PEEM) to function. These devices allow the vehicle to use energy from the battery to assist in the propulsion of the vehicle, either on their own or in combination with an engine. Advanced technology vehicles such as hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), fuel cell hybrid electric vehicles (FCHEVs), and electric vehicles (EVs) can help meet important DOE goals, such as petroleum reduction. However, modern day PEEM technology is not sufficient to enable market-viable PHEVs, FCHEVs, and EVs. So, the Vehicle Technologies Program aims to develop these technologies by setting strategic goals for PEEM, and undertaking research projects that are carried out through collaboration among government, national laboratories, academia, and industry partners. Achieving the PEEM goals will require the development of new technologies. These new technologies must be compatible with high-volume manufacturing and must ensure high reliability, efficiency, and ruggedness. These technologies must also reduce cost, weight, and volume. Of all these challenges, cost is the greatest. PEEM project partners work together to ensure that technical attributes, vehicle-scale manufacturing, and cost sensitivities are addressed in a timely fashion and that the resulting technologies can be adopted by companies willing and able to supply products to automakers.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
An Active Filter Approach to the Reduction of the DC Link Capacitor	Burak Ozpineci (Oak Ridge National Laboratory (ORNL))	3-6	2.83	2.50	2.50	2.83	2.63
Current Source Inverters for HEVs and FCVs	Gui-Jia Su (Oak Ridge National Laboratory (ORNL))	3-9	3.00	3.20	3.00	2.80	3.08
High Temperature, High Voltage Fully Integrated Gate Driver Circuit	Laura Marlino (Oak Ridge National Laboratory (ORNL))	3-12	3.50	3.38	3.50	3.75	3.47
Utilizing the Traction Drive Power Electronics System to Provide Plug-in Capability for PHEVs	Gui-Jia Su (Oak Ridge National Laboratory (ORNL))	3-16	2.75	3.00	2.25	3.00	2.84
High Dielectric Constant Capacitors for Power Electronic Systems	U. Balachandran (Argonne National Laboratory (ANL))	3-18	2.67	3.00	3.67	3.33	3.04
Advanced Soft Switching Inverter for Reducing Switching and Power Losses	Jason Lai (Virginia Tech)	3-20	3.50	3.17	3.33	3.50	3.31
Development, Test, and Demonstration of a Cost Effective, Lightweight, and Scalable	Ralph Taylor (Delphi)	3-22	3.43	2.86	3.57	2.83	3.09
Scalable, Low-Cost, High Performance IPM Motor for Hybrid Vehicles	Ayman El-Refaie (General Electric Global)	3-25	3.00	3.00	3.00	2.60	2.95
Advanced Integrated Electric Traction System	Greg Smith (General Motors Corporation)	3-28	2.00	2.33	3.00	2.33	2.33

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Advanced Thermal Interface Materials (TIMs) for Power Electronics	Sreekant Narumanchi (National Renewable Energy Laboratory (NREL))	3-30	3.33	3.33	2.67	3.00	3.21
Characterization and Development of Advanced Heat Transfer Technologies	Kenneth Kelly (National Renewable Energy Laboratory (NREL))	3-32	2.67	3.00	3.00	3.00	2.92
Air Cooling Technology for Advanced Power Electronics and Electric Machines	Desikan Bharathan (National Renewable Energy Laboratory (NREL))	3-34	3.00	3.00	2.80	2.60	2.93
Power Electronic Thermal System Performance and Integration	Kevin Bennion (National Renewable Energy Laboratory (NREL))	3-36	3.20	2.60	3.00	2.80	2.83
Thermal Stress and Reliability for Advanced Power Electronics and Electric Machines	Michael O'Keefe (National Renewable Energy Laboratory (NREL))	3-38	3.60	3.40	3.20	3.20	3.40
A New Class of Switched Reluctance Motors	*Tim Burress (Oak Ridge National Laboratory (ORNL))*	*3-40*	*3.00*	*2.40*	*2.20*	*3.00*	*2.60*
Benchmarking of Competitive Technologies	*Tim Burress (Oak Ridge National Laboratory (ORNL))*	*3-42*	*3.75*	*3.25*	*3.00*	*3.50*	*3.38*
Wide Bandgap Power Electronics	*Madhu Chinthavali (Oak Ridge National Laboratory (ORNL))*	*3-44*	*3.14*	*3.00*	*3.14*	*3.00*	*3.05*
High Temperature Thin Film Polymer Dielectric Based Capacitors for HEV Power Electronic Systems	*Shawn Dirk (Sandia National Laboratory (SNL))*	*3-46*	*3.33*	*3.00*	*2.67*	*3.00*	*3.04*
Bi-directional DC-DC Converter	*Abas Goodarzi (U.S. Hybrid)*	*3-49*	*2.25*	*2.50*	*1.75*	*2.75*	*2.38*
Novel Flux Coupling Machine without Permanent Magnets - U Machine	*John Hsu (Oak Ridge National Laboratory (ORNL))*	*3-51*	*3.25*	*3.00*	*1.50*	*2.50*	*2.81*
A Segmented Drive System with a Small DC Bus Capacitor	*Gui-Jia Su (Oak Ridge National Laboratory (ORNL))*	*3-53*	*2.75*	*2.50*	*2.25*	*3.00*	*2.59*
Direct Cooled Power Electronics Substrate	*Randy Wiles (Oak Ridge National Laboratory (ORNL))*	*3-55*	*3.17*	*3.17*	*3.17*	*2.83*	*3.13*
OVERALL AVERAGE FOR PEEM			3.10	2.95	2.88	2.99	2.99

NOTE: Italics denote poster presentations.

Overview of Advanced Power Electronics

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated that given this was an overview, no details were presented. It appeared to them that the outlined program met the goals. Certainly the issues raised were valid, with progress to be defined in more detail. Wrestling with size, cost, and weight issues are not new, but planned work appeared constructive. Another reviewer noted the sub-program area covers a broad area of topics that are necessary to reach the DOE goal in PHEV/HEV. One other reviewer said yes, the sub-program does an excellent job of addressing a broad set of technology needs and then connecting these efforts with the user to push development. It was not readily apparent that there is a significant pull from the users (i.e., US automakers) to obtain a gauge of their current technology with an emphasis on their current limitations. It may help to provide a comparison of the US hybrid technology to what has been observed with the foreign hybrid technology.

A reviewer stated that as a program overall APEEM is doing very well to address the issues. Another reviewer said that this was their first time attending this review. The sub-program goals were covered in appropriate depth and detail. The programmatic goals were clearly presented by the speaker and in the presentation materials. This reviewer went on to say that significant results were presented; they were able to discern relevant progress even though they have not previously attended the Program Review. One reviewer noted that the activities of the sub-program were adequately covered. The various teams seem to have a good understanding of the challenges and barriers. Based on the presentations, it seems there is a lot of progress compared to the previous year. Another reviewer stated that overall there was a great job of translating the goal of reduced dependence on oil into logical APEEM programs. Important issues were identified, and strategies were given to address them, with some contingency planning as well. Clear accomplishments were shown in power electronics, motor design, and thermal management. One reviewer noted that the full range of issues and challenges were covered by the sub-program, ranging from the development of high voltage switching devices and high temperature electronic devices for gate drives to advanced packaging, thermal management, and vehicle system integration. Progress was clearly demonstrated in all presentations. It was especially nice to have the previous year slides provided to the reviewers to gauge the current year accomplishments.

Another reviewer noted the sub-program covered all the important areas. The challenges were identified very clearly and the important issues were addressed. They were very impressed by the progress the sub-program made over the last couple of years. Two of the reviewers mentioned Susan's presentation, with one saying the presentation was very concise and addressed the critical technological focus areas of the PEEM programs. The slides presented explicitly demonstrated progress and achievements over the previous two years. The other reviewer who mentioned Susan's presentation went on to say the presentation provided a good overview of the Power Electronics and Electric Motor program and goals. Susan addressed key issues and challenges such as cost, power density, and materials. She also showed key accomplishments for the past year in terms of CSI, IPM and integration which demonstrated good progress toward system goals. There were two other reviewers who said yes, with one saying yes to all of the questions, and the other reviewer who said the objectives and rational were adequately covered and progress was alluded to, but they didn't see a cogent, easy to understand, description of relative progress.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated that the number one gap to be addressed is the cost reduction necessary in electric drives; more could be done in this area. Another reviewer noted that the plans were well thought out. They include multiple development directions in high risk areas (e.g., developing PM and non-PM motors, considering the risk of PM availability and price escalation). This multi-pronged approach avoids putting "all the eggs in one basket". This reviewer went on to say that some of the gaps that they are concerned about have to do with problem definition and target metrics in electric machine development. Currently, the focus is on motor power density, with the assumption that a gear box will provide the necessary output torque to drive the vehicle. However, torque is a better indicator of motor volume, not power. Driving to higher power density levels without constraining torque will drive cost into the mechanical drive train (gears, bearings, clutches, etc). In the worst case, it could result in a drive train that is impractical to manufacture, making commercialization unlikely. Also, it may make sense to add the gear train cost into the $/kW or $/N-m objective. This would capture the total cost impact to the consumer, and would avoid the "squeezing the balloon" effect of sub optimization. Another thing this reviewer said was they think that any motor development should have a torque ripple constraint, if it is to be used in automotive markets. Without this constraint, there are many motor technologies that would be attractive for reaching DOE goals for cost (like switched-reluctance), that would probably have too much audible noise for market acceptance in hybrid cars. This should be built into the project from the beginning, and not become an afterthought. Finally, this reviewer stated that the motor development problem definition starts with the assumption that the motor uses 105 C WEG cooling. However, they don't think this is consistent with achieving the highest power or torque density. Spray oil cooling (usually 90-100 C maximum oil temperature in today's transmissions) generally provides more effective heat transfer. In particular, it is significantly better in getting heat out of the rotor, which is essential for induction motors, to avoid bearing damage. Also, with the DOE's drive for higher speed machines, it is likely that oil will have to be pumped to the motor bearings anyway, so why not use it to cool the machine? Another reviewer noted that the plans identified for addressing the issues and challenges are overall good. There are some gaps. There should be more projects on component and subsystem reliability.

A reviewer stated the program appears to be robust and aggressive; it addresses the greatest technical challenges. They can think of no significant gaps. Another reviewer said they believe the project portfolio covered all the necessary technical areas. Most of the projects have good plans and path forward in terms of addressing the issues and challenges. Six other reviewers all stated the plans for addressing the issues and challenges were identified and there were no gaps. One of the six reviewers also commented that an important advantage was recognizing that technological advances and materials sourcing issues require changing research direction. This is important to avoiding investigatory dead ends…with resulting people and funds misdirected. Another of the six reviewers added that what they saw looked like something that was consistent with a long-term philosophy that might be getting a little dated. Is the program keeping pace with events? Comments from another one of the six reviewers added that the plans for addressing issues and challenges were identified in both the introductory address and the individual presentations. Each presentation clearly presented the current challenges and the plans for addressing them. While some programs could be wider in scope, there are no gaps in the overall program portfolio. The last of the six reviewers added there were no details shown due to the limited time.

A reviewer stated that most of the focus in this category was focused on motor technology considerations with respect to PM versus induction machines, permanent magnet materials availability and associated costs. Adequate focus appears to be placed on the traction drive subsystem (inverter, converter power electronics). Another reviewer commented that there may be a need to increase the efforts in developing high temperature, high energy density dielectric materials with an emphasis on improving the capability to scale-up the technology to the industrial scale. It would help to gain an understanding of commercially available capacitor technology, current capacitor R&D, and the common barriers to technology development. This reviewer went on to say there are a few efforts focused on reducing the requirements for the DC-link capacitor, but it was unclear as to how this would affect the capacitor (i.e., new requirements?) or whether this approach led to a lower cost and higher performance. The packaging of the capacitor was not addressed, is that of concern? One other reviewer stated that the issues are well addressed. As thermal control improves, higher current densities will be power in power inverters. These challenges will need to be quantified. How much current can the silicon handle under varying conditions as thermal systems become capable of dissipating up to 400 watts/cm^2? This reviewer went on to say that documenting the performance of state of the art PEEM systems is very useful. It would be even more useful if the concepts presented show the projected end of life performance along with the initial performance.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

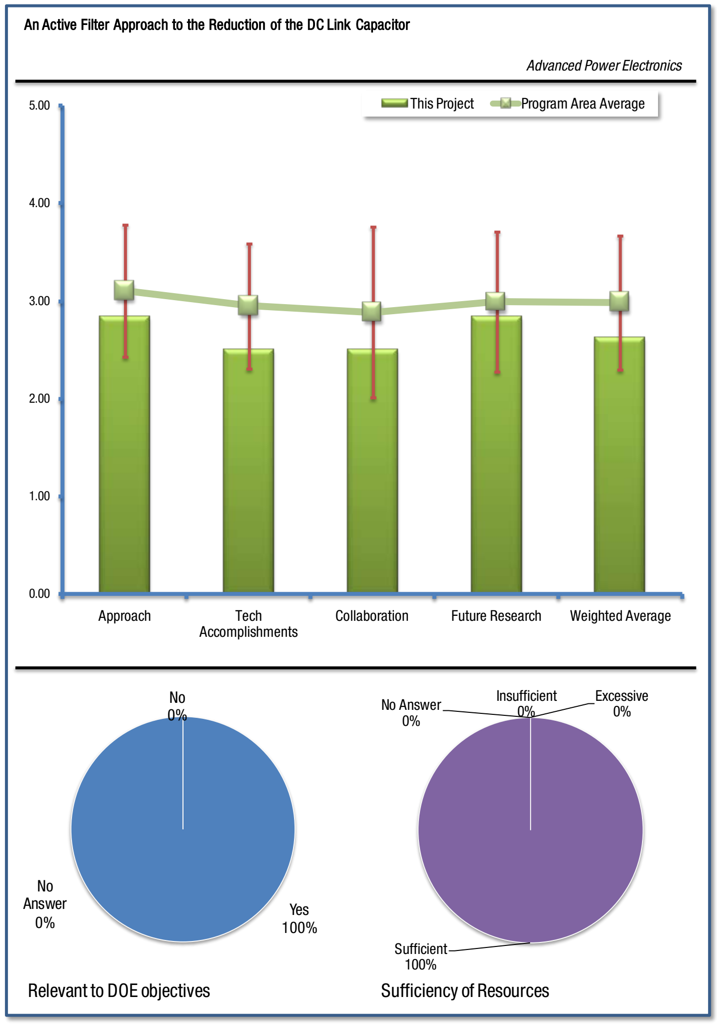
A reviewer stated that APEEM has a good focus going forward. Another reviewer commented the program has identified clear and relevant goals. It appears to be focused and well managed. There are significant technical results. The program appears to be open to changing technical needs. It also appears to be capable of responding to changing political/technology priorities. Comments from another reviewer said yes, the program is focused and well-managed. There is a good portfolio of projects as well as a challenging set of goals that should ultimately meet the DOE VTP R&D needs. One reviewer stated that overall, the program looks well-managed. The accomplishments to date show a productive track record, and justify continued spending and resources in these areas. They are very impressed with the whole program. Another reviewer shared that the sub-program appears focused and well managed in terms of addressing FreedomCAR challenges, but there is a lack of understanding on how the program compares to the domestic state-of-the-art in Electric or Hybrid Electric Vehicles. A reviewer stated the sub-program is extremely well focused, well-managed, and effective in addressing the R&D needs. The sub-program is very efficient in generating results with the current funding, and, as it contains some of the most critical technologies to advancing the DOE VTP, it could have even more impact if more resources could be allocated to this area. One reviewer said that it is focused, well managed and effective. The ultimate test is if one or more of these technologies, or concepts, makes it to a commercial product. There were four reviewers, who answered yes, with one adding the program is well managed and making excellent progress, there is a lot of good R&D projects within APEEM. One other reviewer who answered yes added there is a good focus on developing of fundamental understanding of the technical challenges and then focusing on developing the technology for targeted applications.

A reviewer stated that as an overview of the PEEM program, it was seen as directly related to the goal of making practical cars that can travel some distance on battery power available at a price comparable to current ICE-only models. Another reviewer said the sub-program is focused, well managed and effective. However, there are some repetitions of work (air-cooling) that need to be evaluated for usefulness. Projects need to address the cost issue more concretely.

4. Other comments:

A reviewer stated the focus on the reduction of cost may be addressed by having more projects that work with additional suppliers. The structure of USABC may provide a good template. Another reviewer said it was a very useful and informative review. Another reviewer commented there was a great job of working with industry (both OEM's and component suppliers) and university resources. Comments from another reviewer read while non-domestic vehicles were described and compared to FreedomCAR goals, there was no description or status of domestic vehicle makes. The variation in the funding for individual programs is significant (1-10x) but the presentations are essentially the same in depth. It seems that large programs (>$10M) should have more extensive review presentations. Also it seems that some of the reviews should be limited to 'government only' in order to assess the performance of the contractors. One reviewer noted that it was way too much information presented on each slide, and it was very hard to follow. Another reviewer stated this was a nice summary. The comments from the last reviewer suggest diversifying the program participation to include more university and small businesses in the program.

An Active Filter Approach to the Reduction of the DC Link Capacitor: Burak Ozpineci (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer referenced the importance of reducing the size of the DC link capacitor. Another observed that while the capacitor size will be reduced, overall cost may not decrease. A third reviewer noted that the project is aimed at improving the inverter design, and a fourth explained that the ultimate goals of the project are to reduce mass, volume, and power requirements versus the Toyota Camry standard. Yet another reviewer stated that in trying to help reduce the size of the DC link capacitor, the project seeks to come up with a more compact power converter that will accelerate the market penetration of HEVs, PHEVs, and EVs. A final reviewer commented that the project is a good approach to decreasing the size and weight of the system while simultaneously increasing the efficiency. This reviewer pointed out that the effort also will establish a baseline to determine the benefit of balancing between using a capacitor versus using power electronics that operate at a higher switch rate, yet he expressed concern over the cost of the active filter with respect to the DC link capacitor it is replacing. There are potential high temperature capacitors (up to 200°C) that could be developed but, according to this reviewer, the development efforts are limited due to their higher cost and lack of current commercial demand.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
In response to this question, one reviewer identified significant issues with additional switching losses imposed by additional switches, including the type of fuel economy impact that may result and the lack of clarity on whether the space-saving achieved through the smaller capacitor is taken up by additional circuitry and cooling needed to ensure long term reliability. Several reviewers pointed out that cost trade-offs are not analyzed, with one adding that power loss is very speculative. According to another reviewer, the investigator presents a robust approach in which the opportunity to reduce system power losses through both improved component hardware and improved control algorithms has been defined. Still another reviewer explained that the weaknesses have been well described by the authors, and that the approach, even with the promised improvements, will trade off the capability to operate at higher temperatures and a smaller capacitor for higher losses. The inverter efficiency is a key to the success of hybrid and fuel cell technology and cannot be lowered significantly.

One reviewer observed that the proposed use of active filters to reduce the size of the DC link is not a new idea; the key novelty is in the control sachem to help reduce the losses in the active filter. This reviewer opined that the following should be done: (1) undertake a high-level comparison of cost and reliability of the proposed system (with the active filter) versus the baseline case (with only the DC link capacitor) to determine whether the proposed system offers a net gain without significant cost and/or reliability penalties; (2) prepare a clear summary of how the proposed method compares to what already exists in the literature; (3) exercise more caution vis-à-vis the claims of improvement over the Camry, especially since the project is still at the simulation stage and, as it moves toward building prototypes, the expected benefits will start eroding; and (4) the improved APF might reduce some of the benefits of eventually migrating to SiC devices due to the lower switching frequency, but SiC devices still offer high temperature advantages.

One reviewer thinks it would help to establish, with respect to capacitance, temperature, current carrying capability, frequency, and failure mode, what capacitor is available now for the active filter. It appears at this time that a ceramic capacitor could be used to demonstrate the concept of the active filter approach; if this baseline is established, it would enable capacitor R&D efforts to design the device to the requirements.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer feels many questions are still left unanswered, and another believes there are still some significant challenges and risks that need to be retired. Even with the improved APF, a 500 microfarad capacitor is still relatively large, and the losses, albeit reduced (based on simulations), remain a key challenge. There is a need to move faster toward some hardware verification of the simulation results. Yet another reviewer observed that to date, the project has been a simulation exercise. Project completion is scheduled for September 2009, but only 50% has been completed thus far.

On the other hand, another reviewer thinks the program clearly is making good progress in the simulation and control algorithm tasks. This reviewer added that the schedule calls for hardware development of the 55 kW inverter in the summer of 2009, and he assumes there will be some sort of experimental validation of the simulation efforts. This individual expressed concern that this portion of the effort is somewhat compressed, but he acknowledged that the details of the relative importance of this task in the overall project plan were not discussed during the presentation. Still another reviewer believes that much progress has been made towards establishing an initial circuit design and simulation capability that identified the active filter's potential, and that good progress is being made towards developing an understanding of the variables that can be controlled to optimize the system, with a proper balance between capacitor size, switch rate, and efficiency. This reviewer expressed the view that it would be beneficial to show the amount of ripple current in the capacitor given the indication that it is lower when using the active filter, and he added that inasmuch as the capacitor size is decreased significantly, it would be of concern if there is a notable increase in current per volume (may necessitate a thicker electrode, which will limit the graceful failure of the capacitor). This reviewer also queried how this approach affects the transients and whether the reduced capacitor size has an effect.

One person pointed out that at the last review, the large amount of additional losses was identified. While a new control scheme has been proposed, the improvement in the loss has not been quantified.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Of the reviewers that commented, one remarked that it was not readily apparent from the presentation that a strong collaboration exists. A second noted that the presentation identified collaboration with the University of Tennessee, and that the university's tasks appear to be appropriate for its capabilities. A third reviewer stated that it might be a good idea to have an industrial partner to provide some insights about what actually has been built and tested, as well as some guidance about packaging and thermal management, which are critical to achieving the overall size reduction.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

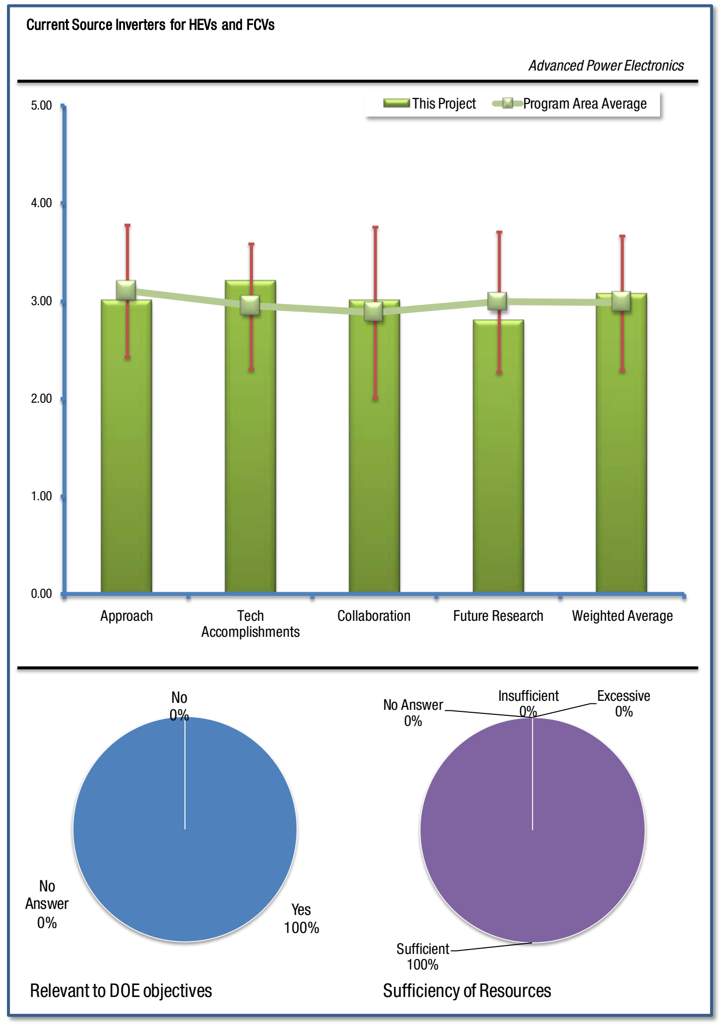
One reviewer noted that the project has no FY 2010 request, but added that the presentation clearly identified specific goals for future work. Another reviewer commented that the project's weaknesses have been identified. Still another stated that the amount of work proposed for FY 2009, including exploring new topologies and building and testing a prototype, seems to be very aggressive and there might be a need for re-scoping. In addition, in this reviewer's opinion, there is a need to move faster towards some hardware verification of the simulation results.

Still another reviewer opined that the project identified a good approach for investigating the advantages and limitations of the active filter as the size of the components and switch rate are modified. This reviewer added that it will help to construct the hardware and obtain real-time data to compare with the simulation. Finally, one reviewer believes there is a need to understand the progress made to date versus the original goals and gauge just how far the project has moved the needle.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers think the resources are sufficient.

Current Source Inverters for HEVs and FCVs: Gui-Jia Su (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Another reviewer observed that inverters are a significant contributor to the initial HEV system cost and impact fuel savings directly, through their own efficiency, as well as indirectly, through their effect on electric machine efficiency. The reviewer continued that this inverter technology provides clear advantages over the current technology, both in terms of initial system cost and operating cost (system efficiency). The inverter cost itself is reduced, and its higher temperature rating, if achieved, will eliminate the need for an extra cooling loop, further reducing the system cost.

Pointing out that EVs and PHEVs are important approaches to meeting DOE's petroleum reduction goals, another reviewer explained that the capacitor of the electric motor inverter is a significant portion of the cost and volume of the conventional VSI inverter, and the proposed CSI inverter approach reduces the capacitor needs. Consequently, this project may aid in meeting DOE cost and volume goals. Moreover, the reduced waveform distortion of VSI may improve motor lifetime.

According to another reviewer, the goal of demonstrating a current source inverter for EVs is important because the topology must displace well understood Voltage Source Converter topologies. Current source topologies are well matched to EV requirements due to the battery or fuel cell source and the natural boost properties for driving motors at high voltage to reduce I^2R losses and reduce motor size.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Responses to this question were mixed. One reviewer explained that the project has a logical breakdown and tackles one major problem at a time. Another praised the project's approach as very good and stated that the use of reverse blocking IGBTs will make a significant impact. This same reviewer added that the current approach of using IGBTs and series diodes custom modules is good, but noted that the series diode loss is not insignificant. He further added that several things were not adequately described, including open-circuit control and the use of normally on reverse blocking GaN switches. In addition, while the use of an interface circuit to allow regenerative battery charging and low output voltage appears to be a good idea, as was the case at the November 2008 kick-off meeting, no details were provided. To determine the feasibility of the approach, details should be made available.

A different reviewer raised concerns about the battery current waveform quality (i.e., ripple) in some operating conditions, and indicated that while these concerns have been expressed to the investigator, they have been answered only in part. This reviewer also said that the cost, losses, and complexity of the auxiliary circuit seem to have been understated, and that the availability of reverse blocking fast switching devices is a hurdle.

According to the third reviewer, the investigators have made progress in the prototype and testing, but the work does not explicitly demonstrate that a CSI is superior to a VSI. The prototype, though, does show why and how the high temperature operation can be reached from the systems perspective.

Another reviewer observed that high temperature inverter operation reduces the cost, volume, and weight of the inverter coolant system but requires high temperature components. High temperature, he added, is a challenge for the VSI capacitor because voltage is derated with temperature, although the reduced capacitor requirements associated with the CSI approach (2000 µf to 200 µF) mitigate this challenge. In addition, the CSI approach has no anti-parallel diode requirement but requires a reverse blocking switch. This same reviewer then pointed out that the reduced capacitor requirements of the CSI approach may be offset by increased output filter capacitance requirements; that the efficiency is only 97%, although a 3x voltage boost may help the efficiency of the motor; and that VSI fault response is well understood using switch desaturation protection by turn off, but CSI needs to turn on switches for short circuit condition - this needs to be tested.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer responded that the CSI charging detail is unclear. A second reviewer stated that the experimental results confirmed the simulation of design for the low temperature cooling phase. This reviewer added, though, that it would have been good to hear more about the projected cost and measured efficiency (series diode and IGBT vs. IGBT with a dual voltage blocking option), and that while the focus naturally was on the inverter, there seem to be efficiency advantages for the electric machine as well (e.g., voltage boost, possible harmonic reduction). On the latter point, he suggested possibly tying in a machine designer's view of how these advantages translate into initial and operating cost reduction for the electric machine.

According to another reviewer, the investigator met the milestones and the go/no go metrics. Good progress has been made, and he described the 97% efficiency as good. One person remarked that the investigator is making an effort to address the main hurdles, but that some lay outside the project's scope (i.e., availability of suitable power devices).

The final reviewer cited the following as the project's FY 2008 accomplishments: demonstrated prototype; lowered capacitance by 10x; low THD; and low volume. He then cited as an FY 2009 accomplishment the fabrication of the prototype for operation with a 105°C coolant. This reviewer added that reverse blocking IGBT is required, so the project worked with Powerex to obtain custom 1200V, 400 A modules. Noting that Fuji also has modules under development, this reviewer stated that the cost of the custom/niche reverse blocking IGBT approach merited discussion relative to conventional IGBTs used in the VSI approach. (This is not a technical challenge, but the lower volume of reverse blocking devices may increase the cost. Other high-volume applications do not need reverse blocking.)

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

According to one person, there was no indication of with whom the project is collaborating and the progress level. Another reviewer, however, commented that the project leveraged component manufacturers' expertise to address IGBT development barriers/opportunities, while a third stated that the project appears to be interfacing with the thermal control group. A fourth reviewer observed that the project is working with Powerex to develop custom reverse blocking IGBT modules. This reviewer noted, though, that the presentation did not discuss plans for testing the inverter with motor or vehicle integration issues, adding that these should be discussed in FY 2010 work.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

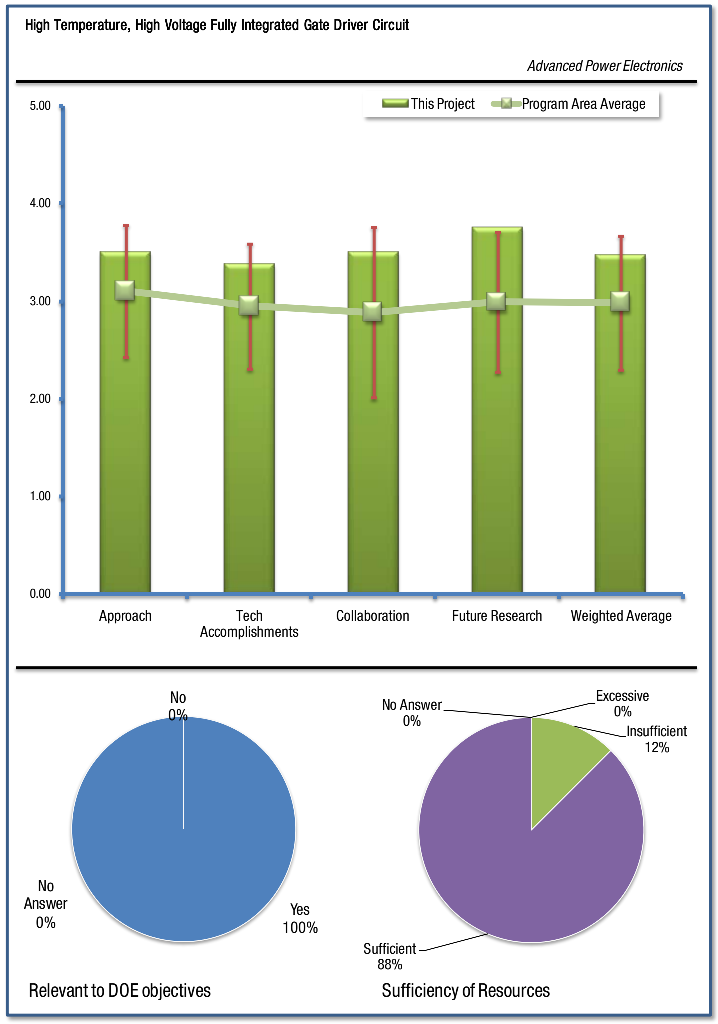
One reviewer described the proposed future research as very good, although he noted that many details remain to be divulged and he further observed that infusion of reverse-blocking IGBTs will be the key to reducing losses in series connected reverse blocking diodes. A second reviewer explained that the prototype build will show the results of the concept. Another reviewer stated that the series diode/IGBT approach can be used as an alternative to dual blocking IGBT. The project's strategy for dealing with the temperature limits of output capacitors is not clear; it seems merely to have shifted the temperature rating problem in current systems with a DC link capacitor.

A fourth reviewer stated the project is 08-2010. For the remainder of FY 2009, the goal is to complete the design and development of the 105°C version, which seems to be on track for completion. For FY 2010, the presentation proposed to test the 105°C system with the latest capacitor and switch components and study the applicability of the CSI approach for other vehicle applications. This, according to the reviewer, has merit and would provide a complete result for the project. It should include a critical evaluation of the realistic prospects of the CSI approach compared to VSI, including a comprehensive analysis of the pros and cons of both approaches. This reviewer noted that the presentation also discussed SiC and GaN for future, but the benefits of the CSI approach for normally off SiC are not as great as when normally on SiC was the only SiC option; CSI may lose some interest as SiC devices with normally off capability emerge.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers expressed the view that the resources are sufficient.

High Temperature, High Voltage Fully Integrated Gate Driver Circuit: Laura Marlino (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

According to one reviewer, because the ability to integrate the gate drive/control within or in close proximity to a power module is vital for highly integrated modules, this project plays a key role in enabling high temperature inverters in HEV and PHEV applications. The reduced cooling requirements associated with these products would enable greater market penetration of HEV and PHEVs, and a higher level of HEV and PHEV adoption by consumers will enable petroleum displacement and associated greenhouse gas reductions.

Another reviewer noted that it helps the SiC solution to have a driver that meets the same temperature requirement, while a third observed that integrated gate drive can also help cost reduction, and that specialty gate drives for new devices are essential and typically are not available on the market. A fourth reviewer posited that if high-temperature power modules are going to be used, then high-temperature gate drives probably are necessary to control them. Still another reviewer commented that high temperature device drivers will improve the performance and efficiency of electric traction and power electronics, which will decrease fuel usage.

One reviewer explained that the project's success would allow a single, to-be-well-characterized component that can drive traditional silicon or high temperature semiconductor switches (as known at present) without extensive qualification testing. When completed and debugged, this part would reduce design risk. This reviewer went on to state that the project supports petroleum replacement by reducing inverter design time, with that contribution assisting in the reduction of EVs' time to reach the market and improving inverter reliability in the field.

Yet another reviewer expressed the view that the development of a high temperature gate driver that can be used for controlling SiC and GaN switches supports the overall DOE objective of petroleum displacement in two ways. First, enabling the use of SiC and GaN switches supports the development of high voltage, high performance power electronics, which will reduce the weight of the power electronics through wire minimization and reduce the load on the battery, thereby improving the cost and reliability of multiple EV platforms. Second, enabling the gate driver to operate at high temperature permits its use with the desired 105°C coolant temperature that allows for minimization of cooling system weight and cost.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Responses to this query were generally positive. In one reviewer's opinion, the approach is solid and appears to be on track to overcome the technical barriers associated with high temperature drive circuits. Another reviewer, observing that the work is focused on a third generation driver with improved features, described the overall approach as excellent. This reviewer stated that it looks like it will operate up to 200°C, which is unheard of. The investigators are addressing all technical barriers and have excellent working partners. The biggest problem is finding devices to drive; there are not many SiC and GaN switches around.

According to another reviewer, the work has considered practical design aspects such as different voltage ranges, protection, on-board power supply, etc. It also is considering driving capability to suit different devices. The SOI approach allows high temperature environment operation. Design of custom IC is essential for cost reduction. A different reviewer stated that the technical approach is consistent with the larger issue of compatibility with practical commercialization considerations. The design is being implemented on an SOI foundry technology supported by a reputable commercial foundry. This is one of the most important factors to making the research relevant to the automotive industry, and the selection of Ben Blalock to deliver this is a wise choice.

One reviewer explained that the focus on the development of a high voltage, wide temperature range capable SOI gate drive chip places sharp emphasis on a key barrier to the development of a 105°C coolant EV, HEV, or PHEV. It addresses the barriers of reducing volume and weight, providing higher temperature tolerance and reducing cooling needs. The approach includes a number of important features directed at improving the reliability of the gate driver as well, including improved circuit topology and incorporating protection features. The selection of SOI is wise, as it provides more than enough high temperature capability (low leakage current, latch-up immunity) at a reasonable cost and proven reliability. In this reviewer's estimation, the only element lacking is some consideration of the ability of the packaging elements of the gate drive also to stand up to the temperature, including the issues of board and metallization, high temperature passive components, and high temperature solders.

A final reviewer cautioned that care should be exercised with the "one size fits all" concept. Sometimes those approaches *will* fit all, but not as neatly or as cleanly as would an application-specific design. This reviewer added that the silicon on insulator approach to enable high temperature operation is the key to the project's success.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Among the several positive comments, one reviewer praised the excellent project progress, adding that the device is very well designed and has been demonstrated to perform well even at temperatures (200°C) in excess of those needed for this application. The additional protection circuitry to turn the device off in the event of load short circuit, over temperature, and under voltage also is very impressive. In sum, all indications are that the program is well on the way to meeting its objectives.

Another reviewer described the progress to date as good. In this person's view, there is some risk associated with the loss of the SOI vendor, but this is likely to be manageable for the duration of the project, and if the project is successful it probably would not be a barrier to volume production. A third reviewer commented that the project has made significant progress in the design of this driver. The investigators are adding features such as desat and selectable gate resistance, which will be beneficial towards making a universal gate drive.

According to one person, while the progress is good, the design is not going to be ready for manufacturing for many years. A different reviewer noted with respect to the design issues that they can be addressed successfully. Yet another reviewer stated that some tests have been performed with existing gate drives, and observed that the group is getting familiar with the real life device operation. The boost-strap gate drive IC is under design. However, the circuit has V_{ss} tied to the power ground, and appears to be different from the tested waveforms that show +/- gate voltages.

This same reviewer added that while the gate drive speed is fast, device overshoot voltage is nearly doubled, and he suggested that the team address whether there is any tradeoff.

The final reviewer described as one of the strengths of the project the team's pursuit of a spiral design/development approach involving the planned increase in capabilities with successive iterations. Not having clearly defined specifications for capacitive drive and dV/dt capability, however, is an oversight that needs to be corrected. This could/should have been defined early in the program based on the known goal for the inverter, which drives the sizing of the IPM. Without this definition, it is not clear (by design) that the technical approach can meet the final requirement with margin. It is not easy for a reviewer to know for sure that there is not an inherent limitation that causes the project to fall short or to produce an unfeasible (from a cost perspective) final design, even if it works. While this reviewer does not think that will be the case, he believes at this point it remains a risk.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer praised the coordination between ORNL and the University of Tennessee (UT) as outstanding, adding that the seamless integration of the direction, evaluation, and testing work at ORNL with the IC design at UT has yielded outstanding program progress and success. Another reviewer described the collaboration with Ben Blalock at UT, and through him a commercial foundry, as one of the top strengths of the project. However, this same reviewer pinpointed as a project weakness the lack of early collaboration with the suppliers of the wide bandgap power semiconductors to better define the real specifications and requirements of the gate driver, although the person did acknowledge that the program manager identified this issue in her presentation as a priority for correction going forward.

Another reviewer commented that one of the collaborators seems to be good at IC level circuit design, and urged the team to work coherently to ensure that all functionalities are included. One person noted that the work has been done at ORNL and UT, and they are working with a chip manufacturer for prototypes.

A reviewer stated that IC manufacturers probably are working on this, too, and expressed the view that collaboration with more suppliers is needed. Finally, another reviewer believes it could be useful to solicit the opinions of additional inverter design experts, and that there really are only a few doing leading-edge research into topologies that minimize turn-on/turn-off stresses on switches. This person recognizes that some experts may not want to participate for intellectual property security reasons, but he added that as an outside reviewer, it is not possible for him to know just how much external solicitation has been done.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

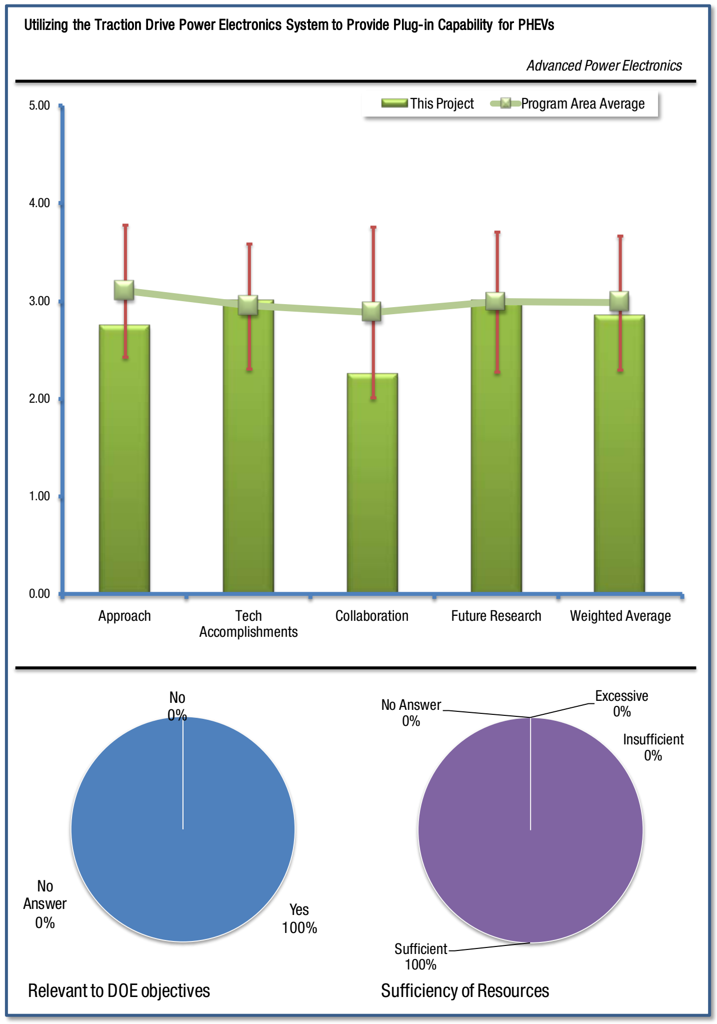
The responses to this query were generally positive. According to one, the plans appear to address the issues involved, and there is not a better way to proceed. Another reviewer remarked that the recognition and honest report by the program manager of one or two current weaknesses, including a commitment to rectify them, coupled with the spiral design approach that allows for incremental improvements (as opposed to a high risk one- or two-fab-cycle program that often is the case with government-sponsored research of this type), suggests that the prospects for successful development of an attractive technology are outstanding. This individual's sole recommendation would be to consider reserving additional financial resources for more fab cycles, and in this regard he noted that the commercial industry recognizes that this kind of development usually requires room for more fab cycles. A third reviewer thinks the proposed future research is tailored nicely to address the critical limitations identified, including a concern about the ability of the gate driver to handle the necessary output current levels for large power modules. Integration of the gate drive into an intelligent module is a forward-looking approach that should make the technology even more valuable. There is, though, a need for some packaging efforts, especially vis-à-vis the integration into an intelligent module.

One reviewer identified fabrication of the actual gate drive IC for testing as a very important step to proving the concept, and looks forward to seeing the results in the next meeting. Another commented that the future work builds on improvements over Gen 2 and is very focused on overcoming the known barriers. This reviewer believes, though, that some effort should be made to address cost because this technology does not appear to be low cost.

One person stated simply that progress in optimizing the design for manufacturing is a bit slow.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Seven of the reviewers think the resources are sufficient; one thinks they are insufficient.

Utilizing the Traction Drive Power Electronics System to Provide Plug-in Capability for PHEVs: Gui-Jia Su (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

All of the reviewers were positive about the project. One reviewer said the charger concept is very interesting, and that it can reduce the cost of the charger drastically. One said it is a clever idea to cut cost, another described low-cost fast charge implementations as very relevant, and a third indicated that reduced cost and size (volume) are important factors in realizing the long-term success of HEVs/PHEVs, adding that work in the area of high temperature compact inverters is important. According to the last reviewer, PE system optimization and the pursuit of enhanced traction drive performance characteristics increase the efficiency and performance of the hybrid electric drive system. Efficiency improvements of these subsystems enable a reduction in fuel used by the ICE electric generation system, and if projected charger efficiency performance of the proposed inverter modifications are realized, DOE objectives can be achieved.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer stated that the pros and cons of the idea are not listed and tackled fully. Another felt that the fundamental limits of the technical approach should have been stated up front and clearly. First, it is not clear that a battery which operates above and below the peak voltage of the ac line can be charged using this technology. To avoid unregulated forward bias of the inverter diodes, the battery voltage must be greater than the ac line peak voltage (what is the minimum delta voltage that this topology will work to?). Second, bus capacitance must be large to suppress the 60 Hz fundamental; if low ripple dc battery charging currents are preferred, the traction battery impedance apparently needs to be much higher than the capacitor impedance. Third, what is the range of measured motor leakage inductances and are there issues with the technology working with them? Fourth, what is the required switching frequency (it ties back to the leakage inductance question) and at what switching frequency was the test conducted? Fifth, this method does not isolate the battery from the chassis of the vehicle. NEC code requires that the vehicle be grounded during an ac line charge. Does the work examine the consequence of tying the high voltage battery to ground and does it examine the impact on the filtering (Y-caps) that are implemented throughout the vehicle electrical system? Sixth, this approach must not lose sight of the need to supply auxiliary load power (12V dc) for the purpose of operating the vehicle electronics. The reviewer went on to state that this appears to be a current sourced inverter topology, and that it would be useful to understand the operation in the “portable generator mode” where a low impedance voltage source is desired. He wondered whether the investigator is planning on using the vehicle for the ground in this mode.

The last reviewer commented that the modified traction drive inverter systems being investigated do not have major technology hurdles to overcome, but require validation of the novel topology and battery charging concept. If successful, this topology will evolve directly to support future PHEVs as well as initial HEVs and directly addresses system level obstacles of cost and PHEV suitability. He would like to have seen some of the control design aspects of the conceptual modified inverter circuit and a discussion of the possible effects of regenerative energy and peak power demand periods (primarily with regard to battery protection), as well as explicit consideration of thermal aspects of high rate charging on motor reliability and projected lifetimes.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Of the three reviewers who commented, one stated that the key concerns of ground fault current flow, real world motor zero sequence inductances (leakage inductance), and allowable THD and THD at specific frequencies need to be understood. This individual noted that he specified 3% THD for the DC to AC converter on his PHEV vehicle, not the investigator's specified goal of 10%. He added that the technology needs to address the range of voltages at which a battery operates, including the absolute worst case minimum voltage and maximum voltage.

The second reviewer believes progress is being made towards the project goal, although he stated that the authors need to demonstrate that the proposed topology is superior to another topology, otherwise it may not make sense to continue. They also need to look into the broader system approach for the temperature and high efficiency operations.

The third commenter indicated that prototype fabrication and characterization at both 120 and 240V charging sources provides good substantiation of the project performance of the modified traction drive inverter topology. Measured efficiency, PF, and distortion values were impressive, but this person would like to see a comparison with respect to the competing motor/generator technologies being considered (PM IM's SR, etc.).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer stated merely that inverter suppliers shall be collaborated. Another said that many of his already-stated concerns may have been addressed; otherwise, he suggests that separate efforts be kicked off to try to understand their impact. A third reviewer indicated that OEM collaboration on safety issues is a necessary but not sufficient condition for this criterion. This reviewer feels that closer collaboration with energy storage and PE partners could add significant value.

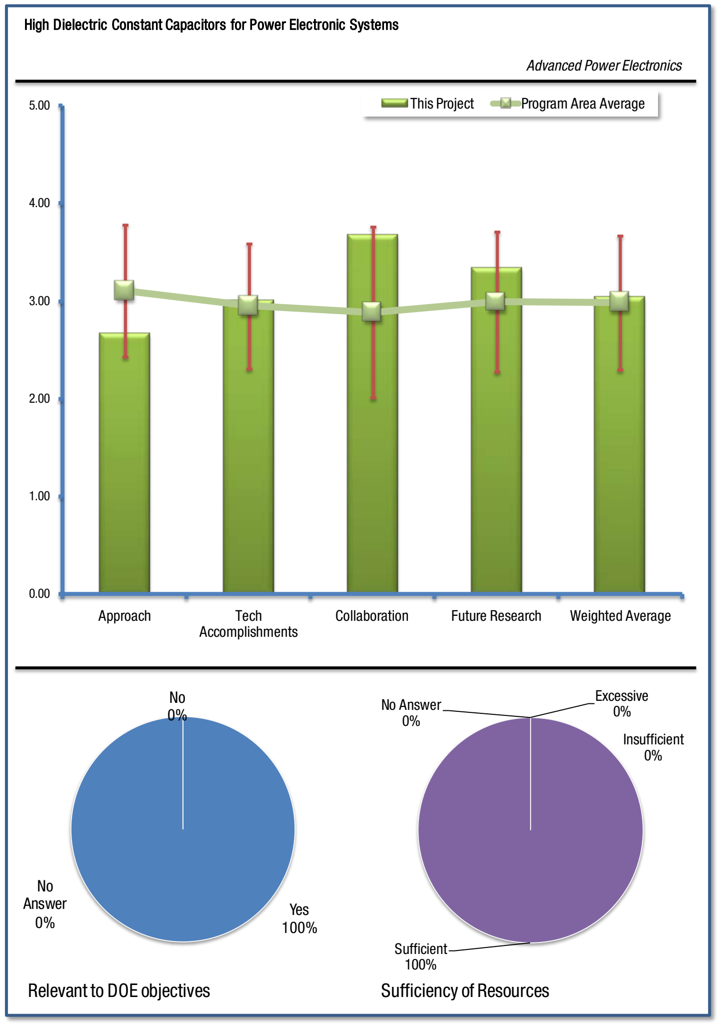
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer reiterated his response to the prior question, i.e., many of his already-stated concerns may have been addressed; otherwise, he suggests that separate efforts be kicked off to try to understand their impact. A second reviewer remarked that FY 2010 plans appear to address the reviewers' risk concerns regarding cooling and control implementation, but explicit consideration of machine type and energy storage considerations should be included to project possible failure mode activation of these components for high charging rates, regenerative/peak power conditions, and thermal conditions.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers believe the resources are sufficient.

High Dielectric Constant Capacitors for Power Electronic Systems: U. Balachandran (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer commented that capacitor size and temperature limitations are major barriers to low cost power electronics. Another believes that improving capacitors is an important factor in the reduction in size, cost, and capability to withstand automotive temperatures, although this reviewer is concerned about the ability to scale the technology up for large capacitance values. Similarly, the third reviewer stated that capacitors have been identified as a limiting component in a variety of power electronic applications, and that while the energy density appears to be state of the art, it remains to be demonstrated whether it can be scaled up beyond a stamp capacitor.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Only one reviewer responded to this prompt, remarking that the dielectric properties look to be promising, but it is unclear whether the project has been tailored to the requirements for power electronics. What is the voltage for the application and will this dielectric material suffice? It is unclear whether the nonlinear capacitance (drop from k=1000 to k=65) will affect the capability to reduce the ripple voltage at the targeted voltage levels. Due to the high breakdown strength, it may not. It would be beneficial to obtain feedback from a power systems engineer to identify whether this is a limitation. If so, there may be a need to focus on reducing the drop in capacitance as a function of voltage.

Furthermore, it may help to obtain breakdown data as a function of electrode area and film thickness so as to identify degree of limitation for scale up, which was identified for future work. Would it be beneficial to evaluate the voltage breakdown strength for the dielectric when deposited onto a flat surface such as a silicon wafer? That may reduce defects induced by the foil.

Finally, this person posed the following questions: have microscopy techniques been used to identify the source of defects? Are there pinholes present within the film? Have the grain size and boundaries been investigated, since it is suspected to have an influence on the voltage breakdown strength?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

In one reviewer's estimation, progress is slow but moving on. Another stated that the effort has completed a thorough evaluation of dielectric properties, but it is a major challenge to scale up a dielectric to manufacture a prototype capacitor. It would help to obtain feedback from a capacitor manufacturer to identify those limitations at an early stage. Moreover, the demonstration of the graceful failure was stated for a single layer, but it would help to see the characterization of the clearing site. Was the electrode or dielectric vaporized? It also would help to see the I vs. V or Capacitance vs. applied voltage plots to demonstrate the capability. There are techniques available to monitor the capacitance during a voltage breakdown test. Lastly, this reviewer explained that the TCC data look to be promising, but some of the other talks with respect to the applications indicated ambient temperatures up to 200°C or possible self-heating of the device due to large ripple currents. Will the temperature limit of 175°C for this material be sufficient or will its high DF value (8%) cause notable heat dissipation?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer thinks that collaboration with capacitor suppliers is needed. Another thinks the collaboration with Penn State will help verify the reported dielectric properties and enable a comparison with other high energy density dielectrics, and that it would be useful to identify a capacitor manufacturer so that the project can learn from previous scale-up efforts.

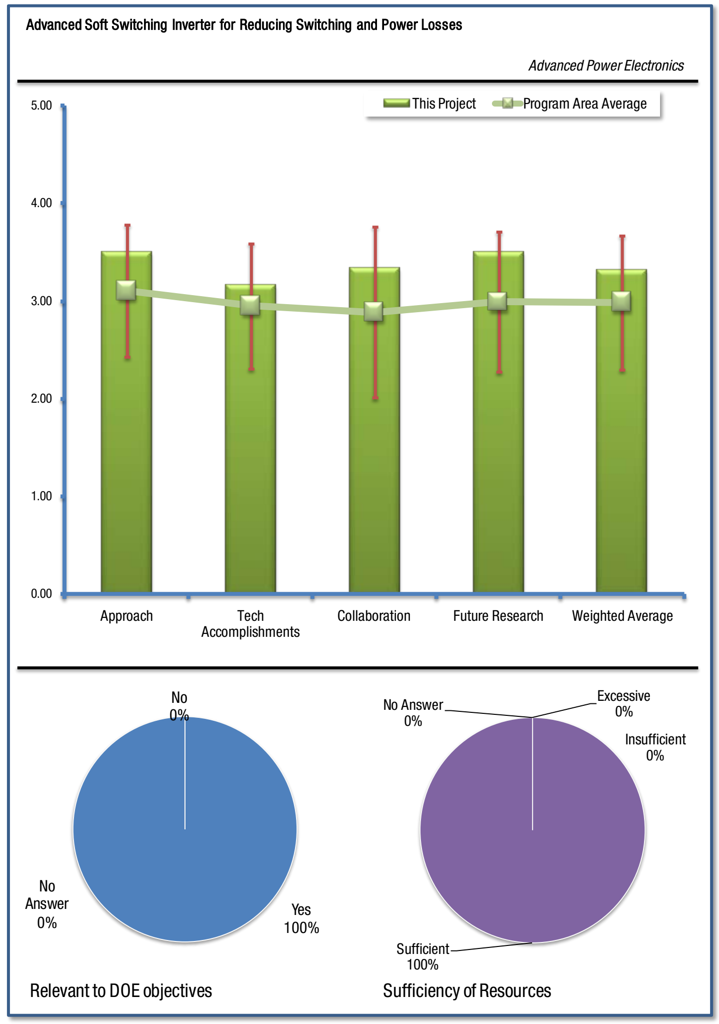
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The lone respondent asked about the solvent's identity and whether it is an issue for scale-up efforts. Referencing the stated goal of increasing the area and thickness of the active dielectric in the capacitor, he remarked that it was not clear how this will be pursued or investigated, and with respect to the graceful failure, he stated that a discussion of the current understanding of the mechanism and how it applies to these dielectric and electrode materials and their respective thickness would be helpful.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers believe the resources are sufficient.

Advanced Soft Switching Inverter for Reducing Switching and Power Losses: Jason Lai (Virginia Tech)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

According to one respondent, lower loss devices are a key to improved thermal design and smaller overall packaging that affects volume, mass, and cost. Another indicated that the project is directly relevant to the programmatic goals of reducing mass and volume while attaining compatibility with the 105°C coolant requirement. A third reviewer commented that it is a new approach to driving the output, helps EMC, and saves cost. A fourth reviewer observed that by using a power module with lower thermal resistance, silicon size can be reduced, and if the silicon is smaller, then the cost is lower.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer described the project as being sharply focused on demonstrating the lower losses and EMI improvements. Another said that the investigator is addressing both modeling and hardware development and has broken down the milestones to independently address prioritized technical barriers, and that the project team demonstrates a clear understanding of the relevant technical barriers and milestones. Furthermore, they clearly understand the state of the art equipment and potential/attainable improvements.

One person agreed that using an integrated AlSiC baseplate can reduce the total thermal resistance of the power module, but noted that it is very expensive. A fourth reviewer suggested verifying the temperature rise on the module using an IR camera, and pointed out that in one slide the investigator shows a Cu base plate pin fin for his low thermal resistance module, while in the next slide he shows an AlSiC pin fin base plate. Is there a preference? What is the projected thermal resistance at the end of life on the Cu vs. AlSiC base plate?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer feels there has been very good progress to date, while another indicated that the project appears to be on schedule and substantially meeting the presented technical milestones. This person commented that the work/results are very thorough and well presented, appear to be well researched and validated, and are directly related to the project goals. It is noteworthy, he added, that the results are not limited to simulation.

A different reviewer offered three specific comments. First, slide #9 only shows the temperature difference between the junction and the baseplate. The temperature difference between the baseplate and coolant was not covered. Since the coolant temperature is 105°C, the junction temperature will exceed 120°C. Second, the cold plate performance and temperature should be verified through actual measurement. Third, the soft-switching topology was not included in the slides. Based on the pictures on page 12, however, the power stage is bulky (with 6 inductors).

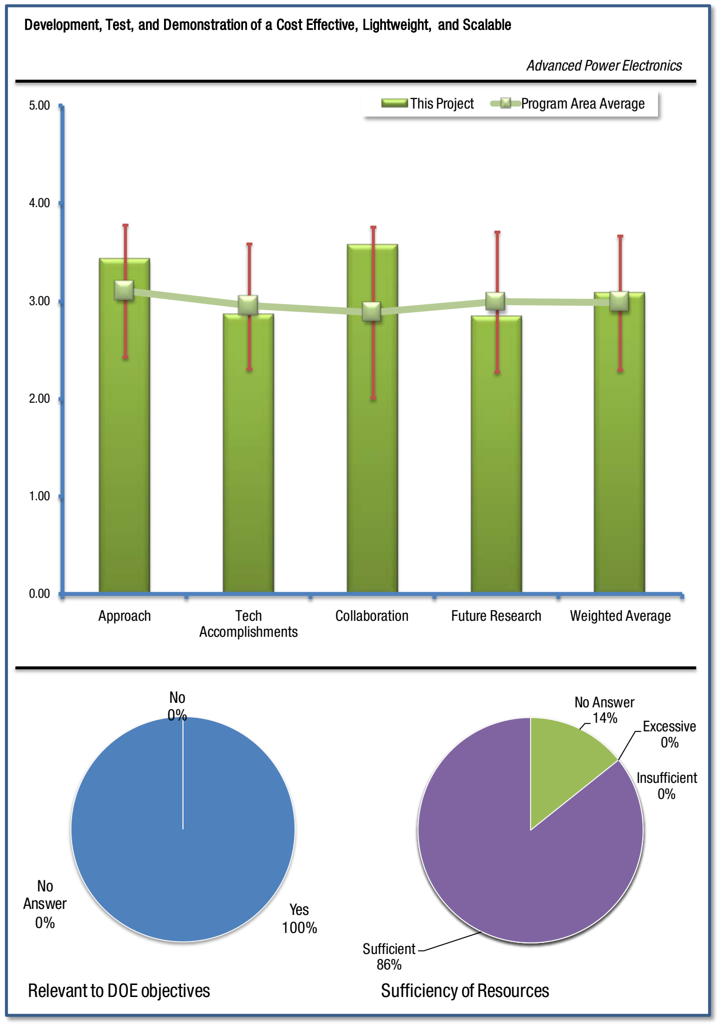
A fourth reviewer asked whether a relative cost comparison for the soft switching approach versus a hard switch approach can be provided. What is reduced or eliminated in one approach versus the other?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer liked the collaboration with industry (Azure Dynamics). Another remarked that the extent and close coordination of the technical partners is clear from the presentation materials, and said that the accomplishments and experimental results demonstrate a well-coordinated effort. A third noted that while there are a limited number of partners, all seems to be working together. Finally, one person thought that suppliers need to be engaged.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Three reviewers responded to this question, and all did so in a positive manner. One described the project as being well defined with a limited scope; seems very manageable. Another referred to it as a very focused project with an intent to verify on an EV to show lower losses and no EMI issues. This reviewer said he looks forward to understanding the integration of the additional gate circuitry and the manufacturability and cost analysis. The third respondent said the proposed future work is a logical extension of the previous efforts. The proposed tasks represent a full understanding of the existing results, and seem to offer a logical technical roadmap for realizing the greatest technical output from the program resources.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
All of the reviewers believe the resources are sufficient.

Development, Test, and Demonstration of a Cost Effective, Lightweight, and Scalable: Ralph Taylor (Delphi)



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Emphasizing that HEVs and PHEVs are important approaches to meeting DOE's petroleum reduction goals, one reviewer observed that the project consists of multiple coordinated technology development tasks of moderate to very high risk targeted at reducing the cost, volume, and mass of HEV and PHEV power converters. The individual tasks are integrated through modeling of the potential performance of each technology if they are successful. According to another reviewer, the project supports EV, HEV, and PHEV platforms with advances in inverter concepts using new capacitor materials, new semiconductors, new packaging concepts, and inverter topologies to improve weight, size, and cost of the vehicle power electronics. A third person commented that the work is aimed at more cost-effective hybrid propulsion systems. A fourth reviewer said this program is developing a comprehensive approach to high temperature inverters that, if successful, will enable greater market penetration of HEV and PHEV products. The greater fuel economies associated with these vehicles will enable petroleum displacement. Another reviewer similarly remarked that inverters represent the majority of the cost of current HEV powertrains, and therefore are one of the biggest determinants of widespread HEV market acceptance.

One person said this project is above just advanced development, and the outcome can go into production as soon as completed. The final reviewer stated that this work is aimed at reducing inverter cost thru advanced technology. Delphi is integrating several high-risk elements, including the advanced cap work with PLTZ and extruded film caps. The SiC work will be very challenging as well. The lowest risk will be the Viper package, which is still considered experimental by most OEMs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer referred to it as a well-designed project, with good use of alternative concept evaluation before deep-diving into detailed optimization, and also good use of dual-path contingency planning in such areas as film versus. film-on-foil capacitors and silicon versus SiC power semiconductors. Another reviewer said the team is well staffed with competent partners. A third thinks the multiple technology development tasks are well-coordinated through modeling, and the double-sided cooling, elimination of wire bonds, and integrated PCB approaches may result in power converters with a 10x reduction in mechanical part count and 2x size and 3x mass reductions. This same reviewer added that (1) the high heat transfer coefficient of the advanced heat sink task can reduce device temperature and help enable 105°C coolant, and (2) high temperature dielectric materials that can be made into films with good cost effectiveness provides the possibility of enabling an improved trade-off between cost and 105°C coolant operation. On the negative side, this person said the subtask of the Dow experimental investigation of SiC on Silicon claims to someday provide the same enhanced performance that recently has been demonstrated with other SiC materials but at a much lower cost; some in the SiC materials technical community think this subtask is ill-conceived and has no new innovation that would lead to success for this SiC on Silicon approach that has been unsuccessful in the past.

A reviewer thinks Delphi is really pushing the envelope of technology advancement. Integrating all these high-risk technologies is a real challenge, and this project will demonstrate how these will or will not work together. Most of these technologies are still a long way from commercialization, but the reviewer is glad to see that funding is available to do this work and believes that if the project is successful, it may lead to some exciting new power components.

One reviewer remarked that bottlenecks of going to a higher temperature module are being investigated. Yet another reviewer explained that the capacitor technology development approach at GE appears solid and the thermal modeling and packaging efforts are strong and well thought out. However, work on capacitors at Argonne is very speculative and possibly difficult to scale up to large capacitances. The work being performed at Dow Corning is extremely speculative and no data on this materials development effort has been presented for the last one and half years. In this person's view, Dow should present the status of their development effort in order to assess progress under this program.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Responses to this query were fairly mixed. On the favorable side, one reviewer noted promising developments, while another said overall progress has been excellent. The investigators are being hampered by the work in the area of dielectric on foil capacitors, but they are taking steps to improve the process and remove defects. Delphi has taken a multi-path approach to mitigate risk, and this looks to be wise since each path has significant risk. A third person referenced good progress on packaging and thermal management and high temperature film capacitors, but believes it is unclear how this approach to SiC semiconductors is different, i.e., what makes this project likely to succeed where others did not.

Another reviewer said good progress has been made in gaining an understanding of the process for capacitor materials, in developing large area capacitors, and in identifying materials for package and producing double-sided cooling packaging, etc. This same reviewer, however, thinks some tasks were not supported in the presentation material with sufficient metrics and evaluation data to monitor progress and determine the potential future impact of the developments. Additionally, 10 µm SiC on Silicon layers have been produced by CVD, but it appears that the SiC on Silicon material has not yet reached the quality necessary to demonstrate semiconductor electronic material properties. Future efforts, this person maintains, should have clear metrics assessing the progress of the material quality, and the team should be prepared to answer questions regarding the status of the material quality.

To another reviewer, actual accomplishments have been difficult to quantify due to vague milestones and metrics in this program, although there appears to be significant progress in identifying inverter topologies, packaging technologies, integration methods, and advanced cooling techniques.

On the decidedly negative side, one reviewer believes there is little evidence of the claimed progress.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

With one exception, all of the reviewers who responded spoke positively of the level of collaboration and coordination. According to one, the inverter is a complex, multi-disciplinary product, and Delphi has done a great job of breaking down the development task into manageable pieces and leveraging component suppliers and ORNL and

NREL resources. Another said the coordination with NREL in thermal modeling, Argonne NL in capacitor materials, and ORNL in system modeling makes excellent use of competence in these areas. A third reviewer stated that this is a very high-powered collaboration with top notch partners, all of whom appear to be well integrated and coordinated, while a fourth person said the advance development teams, component manufacturers, and module producer are working together. Still another reviewer observed that the research and development team is broad and includes NREL for thermal modeling and simulation. It appears the lead (Delphi) is coordinating with other efforts.

The lone non-positive commenter said the effort seems not to be as coordinated as promised.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The responses here were mixed. According to one reviewer, Delphi provided strategies for pushing past barriers and also contingency planning to mitigate risk. Another thinks the future work will build on the past success.

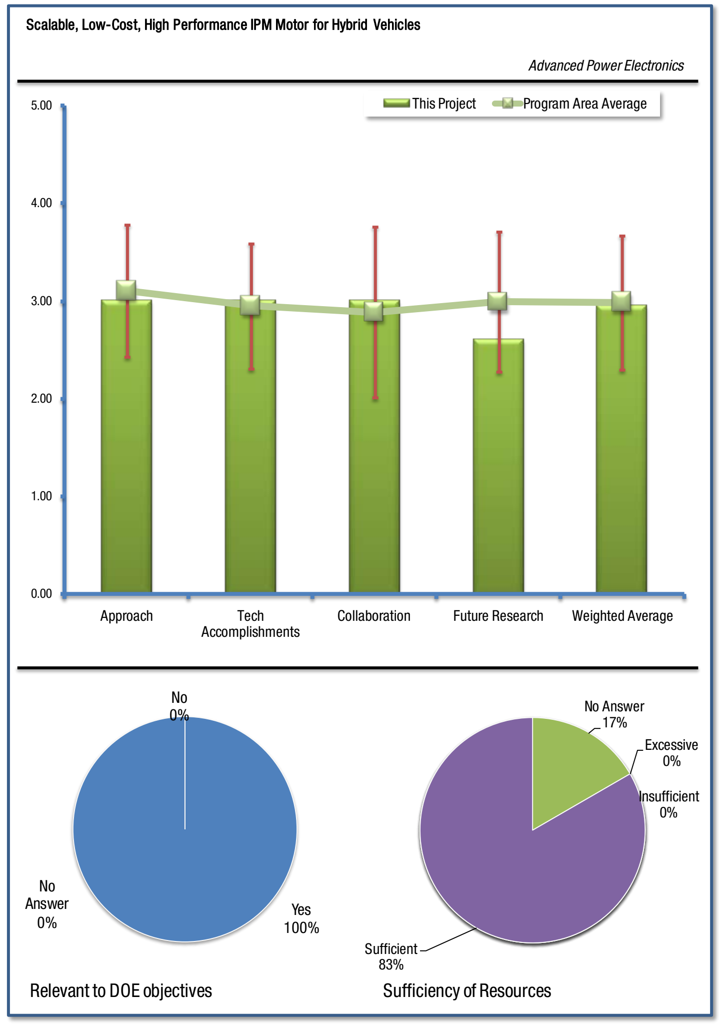
On the other hand, a reviewer commented that the description of future work provided in the presentation material was not detailed. This person expects to see a plan of how the project is being directed to address results of performance metric evaluations to meet program goals. Another characterized the proposed research as vague and not presented in detail. Future research should be broken down to include a timeline and milestones in detail.

Finally, a reviewer wondered how GM's purchase of the Delphi Kokomo plant is going to affect this work, and asked whether this project should continue under GM's overall system work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Six of the seven reviewers responded; all believe the resources are sufficient.

Scalable, Low-Cost, High Performance IPM Motor for Hybrid Vehicles: Ayman El-Refaie (General Electric Global)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

According to one reviewer, motor efficiency and thermal capability are very important to the goals, while another said a low cost PM motor is a key to drive system cost reduction. A third said the project is targeted at low cost drives for HEVs, and a fourth reviewer remarked that this work is aimed at developing a very high efficiency electric motor, which may be key to high efficiency EVs and hybrids. Still another reviewer indicated that high efficiency motors are needed to optimize the range of EVs for specific battery capacity. This also minimizes the thermal management requirements. Finally, one person said that an efficient, high-power density BLDC motor is essential enabling technology for PHEVs/HEVs/EVs, and that this project hopes to double the current SOA in power density.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer assessed the approach as effective. Another assessed it as a realistic evaluation of a very aggressive DOE target efficiency goal and RPM range over which that efficiency goal must be met, and noted a willingness to take on new basic magnetic materials research to assist in meeting those goals.

A third reviewer noted that the team is investigating the use of a high resistivity microstructured magnetic material/alloy for efficiency improvement. Some other design considerations such as end-turn length reduction and new rotor design were mentioned, but no details were given. Design tradeoff on eddy current and hysteresis losses projected 95% efficiency at 325 V dc. The number is encouraging, but needs test verification.

To one reviewer, the approach seems valid, but there is not enough information on the results to evaluate the progress. The authors should provide test results to the EETT for evaluation. In the view of another, the technical approach appears to boil down to a careful engineering effort to optimize the normal design trades to emphasize rotor speed while keeping losses under control to maintain or improve efficiency. A key aspect appears to be the high-resistivity soft magnetic material. Beyond that, the reviewer could not respond inasmuch as nearly all details were withheld from the presentation. For this reason, this reviewer rates the approach as good, and he agrees that a careful engineering effort, rather than a science experiment, is what you would expect from GE, where a commercializable outcome is expected and desired.

To yet another reviewer, the DOE requirements are very challenging to meet. The investigators have focused on meeting efficiency by reducing the bulk resistivity of the soft magnetic composite material and magnets. While this approach will yield low losses, it also yields lower magnetic saturation flux properties, which in turn lowers torque density and increases motor volume. This person has reservations about the initial approach meeting all of the requirements.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer thinks there has been a great effort in materials research and motor topologies, and that thus far the accomplishments are very good. The real measure, he added, will be when the actual motor is tested and reported upon. Another reviewer said that with the assets of GE and its partners, hardware has been built and results obtained such that it is likely that the goals will be met, or at least closely approached. This research, he continued, is an example of how well-orchestrated projects undertaken in well-run commercial operations can be. A third reviewer characterized the design tradeoff study and simulation as key achievements, noted that the team filed more than 12 invention disclosures, but added that the most important hardware prototype testing remains to be seen.

To one reviewer, the final phase one report is needed before a full thumbs-up on the project can be given. A different individual expressed a similar sentiment, stating that while the approach seems valid, there is not enough information on the results to evaluate the progress. Again, the authors should provide test results to the EETT for evaluation. Still another reviewer stressed that very few specific accomplishments were reported in the presentation due to proprietary considerations. The project's management therefore is asking for “trust.” Given that there are major technical risks associated with magnetic materials and other more mundane issues like copper losses at the high rotor speed that don't really get addressed until Phase II, this reviewer found himself unable to get excited beyond a score of “fair” at this juncture. He felt this was reinforced in the Q&A period, when the speaker acknowledged that “re-scoping” will be required to deal with deficiencies in the soft magnetic materials.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Responses were mixed. One reviewer rated it as a very accomplished technical team, another remarked that close ties appear to be in place between materials vendors and motor assemblers, and a third reviewer indicated that a fair collaboration between universities and industry is in place, adding as well that the next phase should include a motor manufacturer.

The remaining two respondents referenced GE’s heavy role. According to one, it appears that the major effort and achievement are done by the prime contractor. The first prototype due in March seems to be delayed, and the presentation did not indicate contributions from other team members. According to the other respondent, the project has three qualified collaborators, but during Q&A the speaker said that 80% of the project is being kept within GE.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Three reviewers provided responses. One responded that future research makes sense, adding that verification that the performance obtained is scalable will be important. Some barriers foreseen by this reviewer include process uniformity for magnetic materials to maintain magnetic characteristics and the high resistivity intended to reduce eddy current losses.

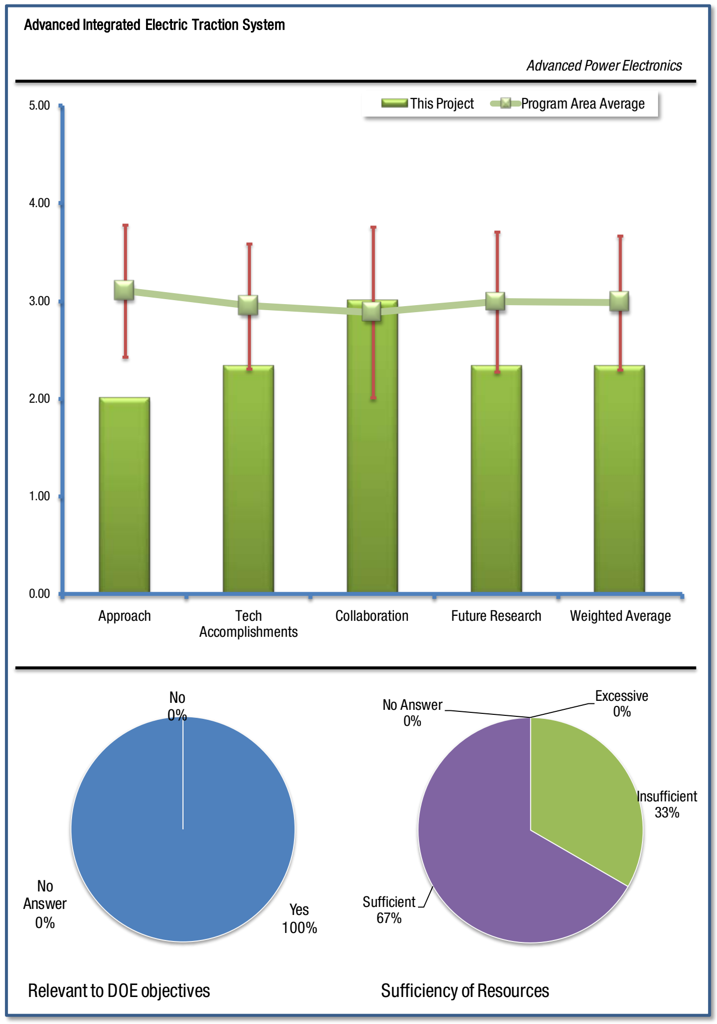
Another reviewer believes most of the real effort still lies ahead. Combined with the acknowledged need to re-scope even before Phase I is over, it looks like project management is getting its arms around what it will have to do to be successful, beginning with redefining success. The investigator emphasized that the original project goals were extremely aggressive, so some allowance for this risk should be given.

The third reviewer believes the current approach may not yield an optimal machine, and some redirection may be needed. There are still significant issues with the application of soft magnetic materials.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Five of the six reviewers provided responses; all believe the resources are sufficient.

Advanced Integrated Electric Traction System: Greg Smith (General Motors Corporation)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

According to one reviewer, the project supports the overall objective of petroleum displacement by contributing to the development of electric vehicles (HEVs, PHEVs, EVs, and FCVs) that meet the DOE 2015 targets. It does this by providing 65 kW of continuous power and 120 kW of peak power for 18 seconds at a reasonable cost, low weight, and small volume, and with the use of engine coolant at a nominal temperature of 105°C. Another responded that the project is within the scope of the Vehicle Technologies Program, while the remaining reviewer believes research can find better ways to design TS for HEVs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer questioned how details of the study will be shared with other OEMs or their suppliers. The second reviewer noted that the scheduling has sufficient program reviews and verification steps to ensure a good chance of first-time success. This reviewer described as good the design and testing process, and opined that the project depends quite a bit on suppliers for the solution of technical issues. For this reason, suppliers need to be chosen carefully for their specific technical expertise.

One reviewer explained that multiphase winding can deliver more torque than three-phase machines - this is common knowledge, so there is no need to understand it through extensive simulations. The cost and complexity of power electronics increases as the number of phases increases, and this reviewer does not see a feasible solution to that issue.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer said that considering the amount of funding, more should be accomplished, while another person said there has been little prototyping and experimental work.

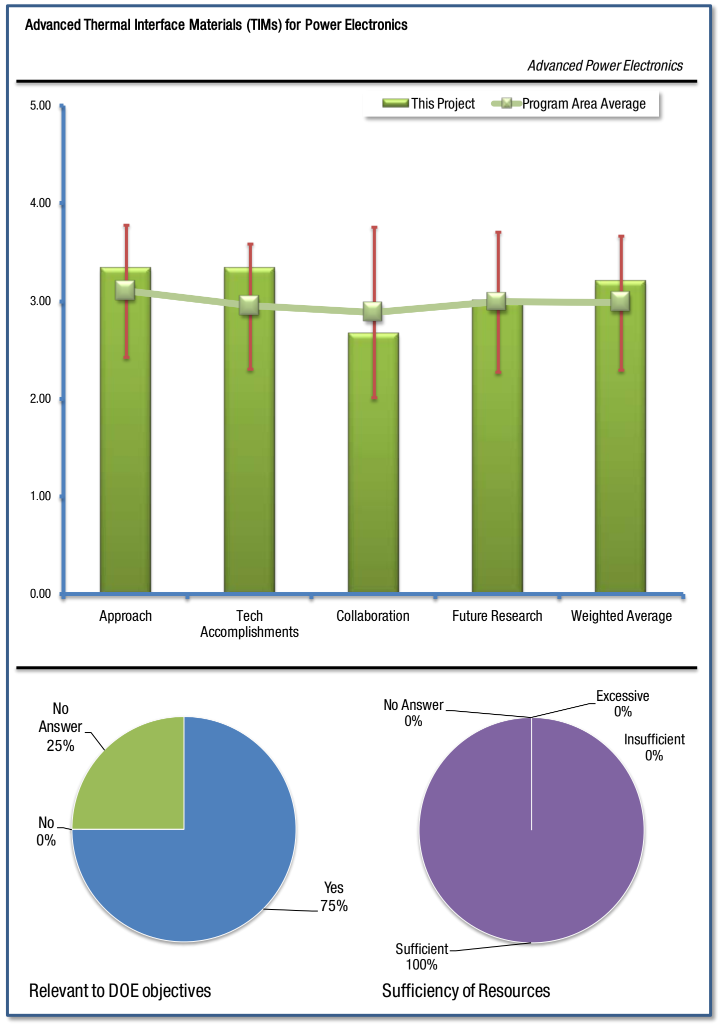
In the view of another, significant information has been acquired on customer requirements needed for program success, and good substantiation was provided for moving in the direction of a 5-phase instead of a 3-phase system. In addition, the reviewer mentioned excellent consideration of new technology to address high temperature packaging issues, including double-side soldered chips, new interconnection technology, use of high temperature PP capacitor, and improved board technology. More technical details on the packaging approaches suggested could be provided. Overall, this reviewer believes there is not enough information to assess the chance of success.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Two responses were provided. One complained that the detailed effort at collaboration was not spelled out clearly, while the other reviewer found very strong dependence on the supplier network, which seems well integrated with the program.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
To one reviewer, the plan focuses on past progress, and future research is focused on integration and demonstration of the technology in the prototype form. With the funding that has been spent, much more could have been accomplished; for example, this reviewer would have expected a motor system that has been tested and integrated in a GM HEV/PHEV.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Two of the reviewers think the resources are sufficient; one finds them insufficient.

Advanced Thermal Interface Materials (TIMs) for Power Electronics: Sreekant Narumanchi (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One person remarked that thermal interface materials can increase the performance and life of power electronic components, while another indicated that because TIM packaging materials represent the largest single component to the thermal impedance of a packaged electronic device, the junction temperature and therefore forward conduction losses can be reduced measurably by eliminating or reducing this significant contribution. Reduced junction temperatures mean reduced losses, higher efficiency, improved reliability, and reduced fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The one reviewer who responded stated that survey and analysis of available commercial and R&D TIM choices is a good benchmark or baseline metric. The modeling approach toward characterizing the physics of thermal transport at interfaces or on small dimensional scales should have been presented in terms of models or approaches being pursued. In addition, the data relating to CNT R_{th} overestimates the values actually achieved in laboratory experiments. Alternative approaches to bonded approaches are extensive and should be investigated beyond Ag nanopastes. Hopefully, the research is adequately focused on the reliability aspects of TIM material performance with respect to thermal cycling over the entire operational range of temperatures expected in platform. Static performance is not necessarily the primary consideration if R_{th} increases with cycle life, i.e., CTE matching or grading of bonded approaches.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The one respondent found that there has been good progress on the evaluation of existing TIM material options, and sees no reason why the modeling activity should not have proceeded in parallel. A true lack of physical understanding of interfacial heat transport exists and progress in addressing this issue could be significantly beneficial. The investigator should have conducted a more thorough analysis of bonded approach options and materials; the potential list is extensive and opportunities for innovation exist.

This reviewer also believes that the significant effort that has been expended on developing characterization capability, while to an extent necessary, may have been too extensive. Collaboration with numerous academic groups with existing characterization capability would have been a more effective use of resources.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

According to the lone commenter, there appears to be good coordination with module manufacturers and system integrators concerning the technology being developed and evaluated.

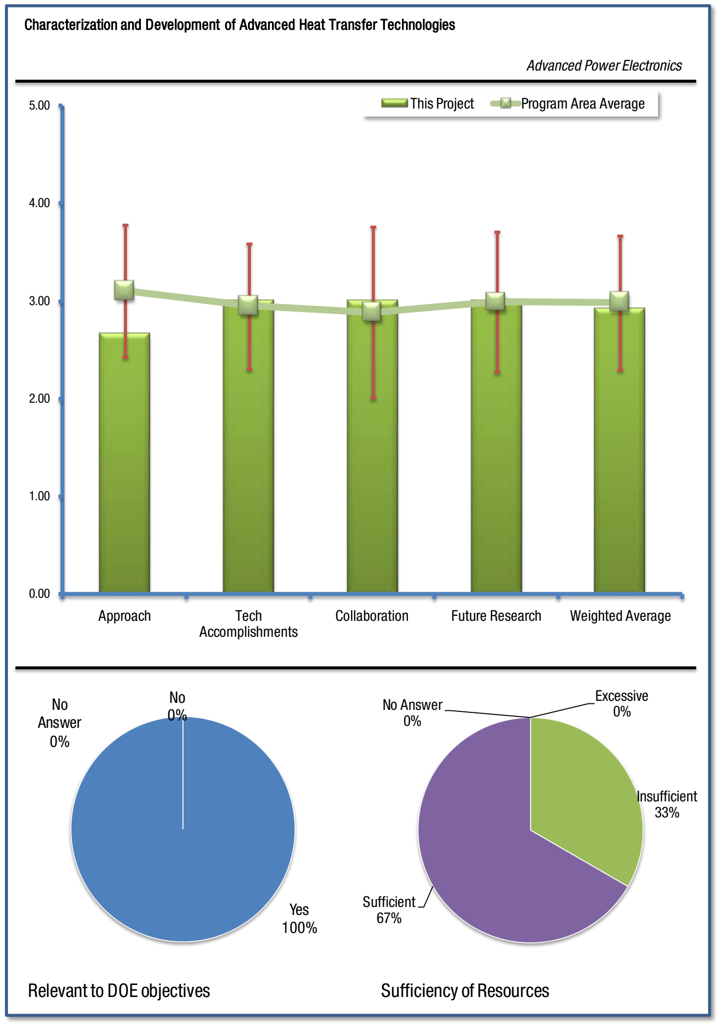
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

In the view of one reviewer, a new material or bonding process should be explored, while a second reviewer believes the future plan is consistent with the project goals.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers rate the resources as sufficient.

Characterization and Development of Advanced Heat Transfer Technologies: Kenneth Kelly (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
One reviewer replied that improved heat transfer is critical to reducing volume, another stated that the project will enable high power modules to operate at a higher coolant temperature, and the third indicated that the thermal system limits utilization of power devices, and this low utilization adds cost.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
According to one reviewer, questions of cost and reliability need to be addressed further as part of the approach. According to another, while the investigator addressed the need for automotive thermal solutions, the data supplied was at time 0. Can data be supplied that shows performance over the product's lifetime, and how can you show that erosion or contaminants do not degrade the system over time?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer referred to good technical work but sees the need for a greater focus on how the project will overcome key barriers like cost and reliability. Another believes the degrading or failure modes of impingement systems need to be addressed. How is low cost defined for the applications? Is that a piece cost analysis or a system analysis, and if the latter, what assumptions are made? What are adders and subtractors (especially for impingement, may need a pump, filter, material coatings, closed system; while the gain possibly may be less silicon area).

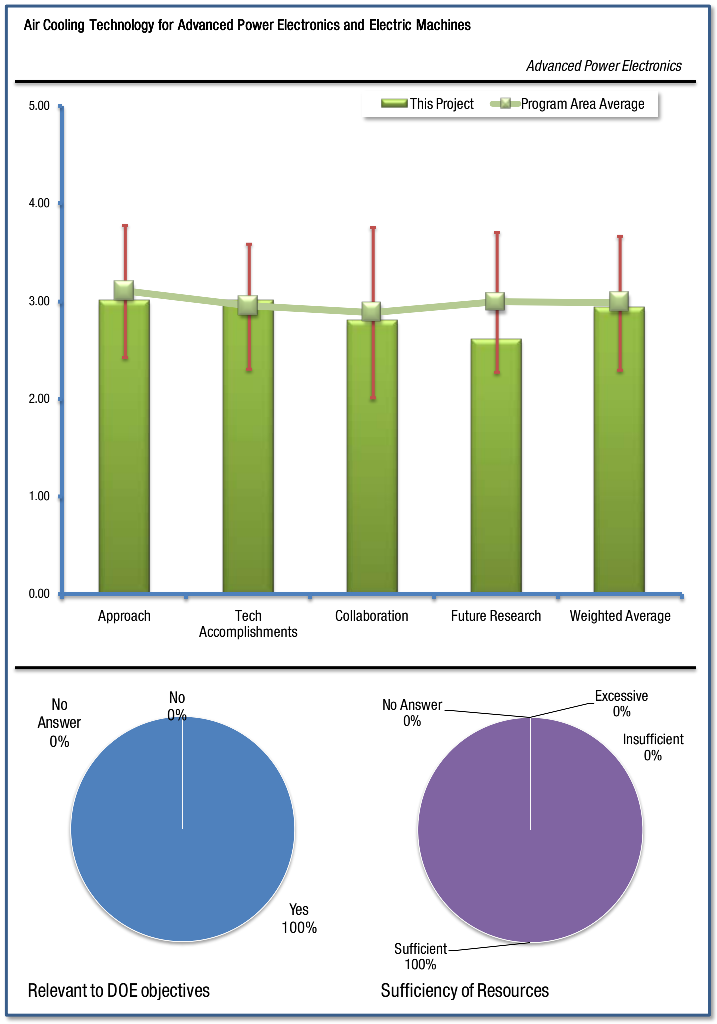
Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer found good cooperation with industry and open sharing of information, while another feels that collaboration with tier 1 suppliers would help greatly in addressing the cost and reliability issues. This reviewer also points out that work was done on the Semikron inverter, but no relative cost assessment has yet been performed.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One reviewer thinks the investigator needs to address the cost and reliability issues. Another thinks the future work on surface enhancements will be of interest, and wonders whether the investigator will look at the products from Wolverine Tube that are doing these surface enhancements commercially.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two of the reviewers rate the resources as sufficient; one finds them insufficient.

Air Cooling Technology for Advanced Power Electronics and Electric Machines: Desikan Bharathan (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

According to one reviewer, if air cooling could be used instead of liquid cooling in HEV and PHEV applications, the cost savings could be significant and would lead to greater market penetration and associated petroleum displacement. Another observed that such cooling can eliminate the need for a second cooling system, while a third reviewer stated that if successful, air cooling can enable higher power density and lower cost. Still another reviewer noted that air cooling is desirable in many power electronics cooling applications, and generally leads to simpler designs and low mass and power consumption. Describing HEVs and PHEVs as important approaches to meeting the petroleum reduction goals, the last reviewer noted that air is an important alternative to liquid cooling, providing lower weight and cost with a trade-off in higher volume and additional fan power requirement. Simplicity also is an advantage of this approach.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Among positive reviews, one person found the technical approach to be well conceived and executed. The technical barriers are clearly defined and understood by the investigators, and addressing them appears to be guiding the progress of the project. Another believes the project is dealing with the higher volume and parasitic power barriers that need to be addressed with air cooling of propulsion inverters. In this commenter's view, the use of CFD simulation to design air cooling alternative high performance air cooled heat exchangers is important and NREL has good capability. However, the project should include more close collaboration with inverter programs and should include a detailed plan of how the cooling system will be integrated with the inverter.

To a third reviewer, the approach is logical and systematic, and moving to experimental validation as quickly as possible is preferred. This reviewer recommends providing a clear comparison with liquid cooling so that one can better understand how the current project effort compares to the state-of-the-art, and specifically questions whether 30°C ambient air temperature is a realistic assumption. Ambient temperatures can go to much higher levels under the hood. This adds a lot of tubing and pipes in the system and will significantly increase the overall system weight compared to liquid cooling. This issue needs to be carefully examined.

One reviewer expressed a desire for a more detailed project plan so that one can know what the next tasks are and how resources are to be utilized. In the opinion of another, a stronger case needs to be made that the air cooling will be adequate for high power HEV and PHEV power electronic systems. The issues of parasitic power, air filtration, and noise suppression (if required) also need to be addressed aggressively. It is not obvious from the presentation and the results to date whether a solution that overcomes these challenges in a manner that could lead to a real world product can be identified.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to one reviewer, the project has developed an improved air flow heat removal approach, has validated the approach and design with hardware measurements, and has demonstrated good performance. Another thinks the investigator has made significant progress; the results attained suggest that programmatic goals may be met, and the innovative heat transfer surfaces designed by the project team suggest that significant performance improvements may be obtained with attendant reduced costs and system mass.

One reviewer found good progress, but believes a clear system comparison of air versus liquid cooling needs to be carefully performed. Another asked for an identification of the major breakthroughs and the next step.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer thinks there is good collaboration with external partners (DOE is providing funding solely), and another found that the investigator demonstrated collaboration with technical partners, and that the NREL project lead is coordinating interactions with the needs/requirements of industrial and government partners.

A reviewer believes the project should consider collaboration with one of the inverter teams to integrate cooling hardware with inverter hardware because issues related to vehicle integration, inverter integration, and integration with power electronic component packaging have not been addressed. One person observed that most DC/DC power converters use air cooling, and asked whether there is any collaboration with them.

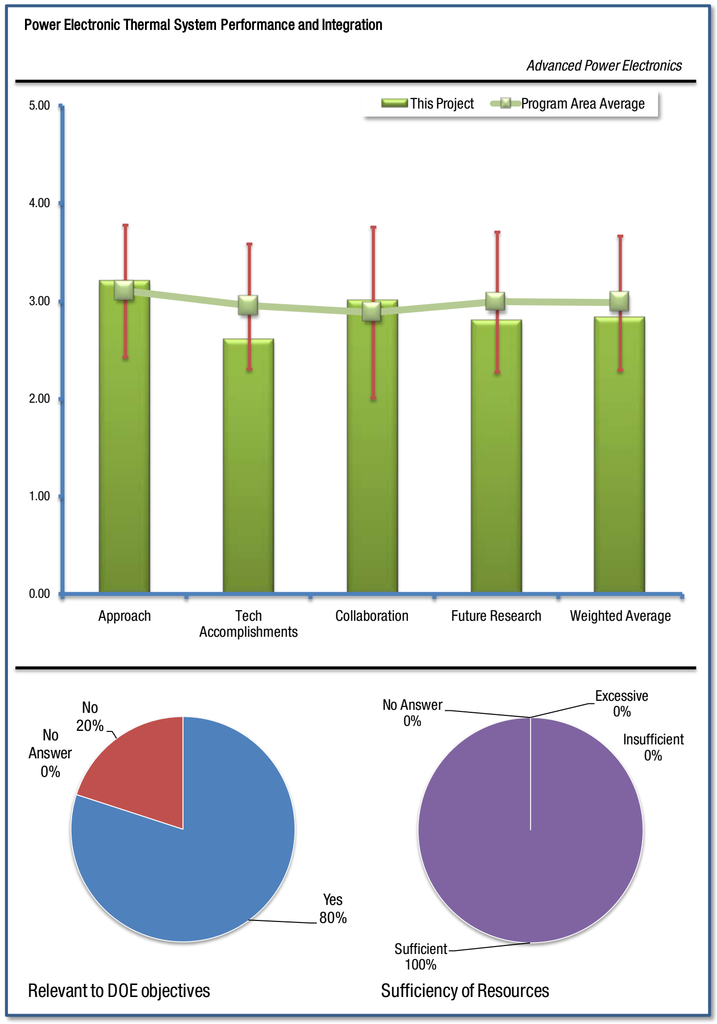
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

To one reviewer, the proposed future work will address the most pressing technical needs. These efforts are anticipated to yield the greatest technical and programmatic impact, i.e., DOE should realize the biggest bang for its buck. To another, the proposed future work spells out the key challenges without a specific proposal of how to address them. Finally, one reviewer thinks that the plan to "develop guidelines for performance estimation, cost, volume, weight, and other measures for industry" does not seem reasonable without having fully considered the integration with the inverter; similarly, the plan to "develop second iteration design and demonstrate air-cooling" does not define the reasons and goals for a second iteration.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers believe the resources are sufficient.

Power Electronic Thermal System Performance and Integration: Kevin Bennion (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

To one reviewer, finding the optimal package to dissipate heat in the most efficient way is critical. To another, the computational framework allows a comparison of various thermal management techniques at a system level for optimization/investigation of integration scenarios. A third reviewer maintains that thermal management strategies will have a significant impact on the size, cost, available power, and weight of EV power conversion and electric machines, and that a reduction of any of these factors will make practical EVs more palatable to the general public. One reviewer believes the work should be a subset of power electronics system development, not a standalone project that has very little linkage to a real system. It can be considered as analysis tool development, but it is too general to be a key DOE project under the advanced power electronics program.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer found that a comprehensive approach was presented for computational assessment of thermal management techniques that includes FEA 3D heat flow analysis coupled with fluid dynamics to realize realistic thermal models for comparison of proposed cooling designs. This reviewer observed that the main approach appears to be coupling of CAD and FEA packages along with code to perform parametric analysis for possible optimization of thermal management approaches. It is unclear, however, how this work is actually made useful to the vehicle industry where it is needed most. It also is unclear what level of throughput is possible to make this approach useful in an engineering scenario.

Another reviewer considered the characterization of temperature response to transient loading in the frequency domain to be an interesting idea, albeit one that takes a bit of work to grasp. As in, what is the temperature response to power input fluctuations converted to a spectrum; different heat removal techniques have a thermal transfer function that defines differences between strategies.

One reviewer noted that there are companies working on packaging thermal simulations and design enhancements, such as Mineware in Novi, Michigan. More collaboration with these companies is recommended to speed up the progress. A person pointed out that the thermal impedance was evaluated with different thermal management techniques and frequencies. It is unclear in terms of the impact to the actual system. Some real system examples need to be examined with real numbers, instead of the general curves shown in the presentation. The plan on analyzing the system level thermal performance covering the chassis, power devices, and capacitors is important, but again, some realistic numbers need to be included in the presentation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

In one reviewer's assessment, the technical accomplishments presented meet the program goals and also are progress toward the overall DOE goals. The key technical accomplishment of generating publicly available reports for engineers and vehicle makers to access appears to be extremely useful. Another reviewer specifically asked, what are the results of the analysis of Toyota dual surface cooling compared to Delphi's and current single side coolings? A reviewer observed that the accomplishment shown in the presentation did not address the specific system and is too general, while a different reviewer found that the detail presented is so granular, it is difficult to determine what is behind the presentation. The capacitor model would be interesting to compare to what others in the capacitor industry have come up with. Capacitor models are more complicated than one might initially think. Anisitropic thermal conductivity and dissipation as a function of axial location within the capacitor are just the tip of the iceberg if a simulation is to be representative of a real capacitor.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer found the cooperation with Delphi to be a plus, while another recommended more collaboration with companies working in this field. To a third reviewer, interaction with OEMs is the key area where this effort will have an impact, and it appears the performers are working with the vehicle makers to understand the design tradeoffs of the varying approaches to thermal management.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

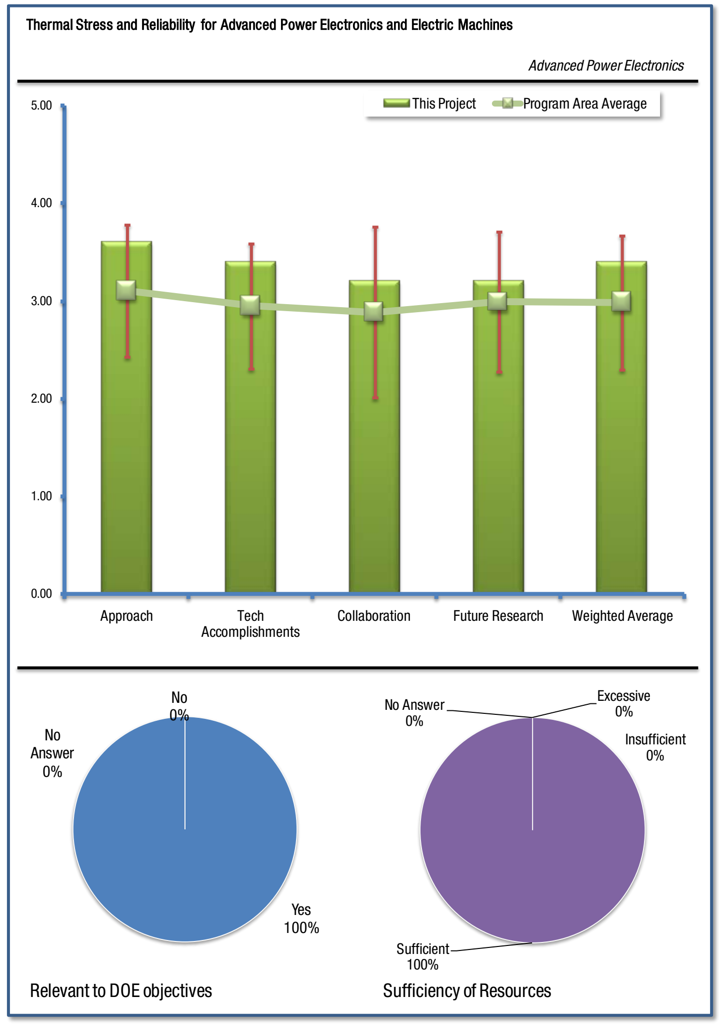
One reviewer sees the proposed future research as being consistent with the approach, primarily in the interaction with industry, to add relevance to the research program. Another key area is the investigation of uncertainty and variations that are difficult to analyze empirically. A reviewer believes the best future work would be to examine various thermal management strategies to determine an optimum "complete vehicle" solution direction that appears to best straddle the cost and performance goals. This reviewer adds that you cannot always get what you want when limited by wallet contents, but if you are careful you might get a good deal on something that is useful. In his estimation, this is what the US consumer is looking for in an EV.

Another reviewer wondered what the project deliverables are, what the thermal simulation tools are, and what the design guidelines are.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers rate the resources as sufficient.

Thermal Stress and Reliability for Advanced Power Electronics and Electric Machines: Michael O'Keefe (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
According to one reviewer, the reliability of power electronics components and life expectancy is important. The question is, how different is it from other power devices that have been out there for many years? For example, what tools were used by the industry to test for wire bond durability?

Another reviewer said this appears to be a solid system engineering study (with the "correct" answer not preselected), with adequate component detail for the conclusions not to be misleading or trivial.

A third reviewer stated that the project supports the overall DOE objective of petroleum displacement by overcoming the barriers to the adoption of low-cost, petroleum saving PEEM technology for a wide range of electric vehicles (PHEVs, HEVs, EVs, and FCVs). It does this through the enhancement and demonstration of the reliability of the PEEM technology via the development and use of CAE tools for design-for-reliability. These tools permit the cost-effective development of the technology by guiding R&D decisions, reducing deployment time, identifying barriers to meeting life/reliability goals, and increasing product robustness.

One reviewer said merely that the thermal issue is an essential part of the problem.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer stated that a prototype validation would be necessary for the study.

According to a reviewer, the work appears to be technically commensurate with the objectives. The scientific/engineering know-how and tools appear to be at least the minimum level of complexity (two dimensional FEA). Are three dimensions (or perhaps 2.5 dimensions) necessary to make a claim about "reliability" that doesn't lead to unexpected and nasty surprises? This reviewer realizes that "validation" is supposed to be the answer, but would say that in the absence of a commercially qualified experience, both calculations and empirical data can be misleading. Looking ahead with the best physics-based understanding of the problem is the best defense (e.g., how do you characterize solder?).

According to a different reviewer, the program focuses on making the PEEM technology more reliable using the latest physics-of-failure approaches to robust design and validation. These approaches focus on the development and use of cost-effective modeling and simulation to build reliability into the product upfront in the design cycle and validating that reliability in the final product to minimize testing cost. The application of this approach to three specific APEEM packages for which there is validation data focuses the program to a strong degree. The three packages chosen cover a range of thermal management and packaging approaches that have widespread application. Furthermore, the emphasis on wirebonds, die attach, and DBC attach issues hits the dominant failure mechanisms for power electronic modules.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer maintains that, in the absence of immediately available and reliable experimental data, excellent use of the literature was substituted to give a measure of interim confidence. Another stated that the team has made progress in setting up the models and simulation, and has an understanding of the fundamental issues and different possible configurations. A third reviewer believes excellent progress is being made toward program goals, with all the supporting information for the simulations being gathered and characterized in this year's work, including the definition of thermal boundary conditions, material properties, and fatigue properties of soldered and sintered interface. In addition, thermal modeling has been conducted. This will lead to the process of validating models versus test data and comparing life implications in next year's work.

One reviewer found that data are as expected, with one exception - where topology 3 took 10,696 cycles to failure and topology 2 took 11,982 cycles. Why? Was the failure due to direct spray on DBC?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer found good informal interaction with other national laboratories (ORNL), other government institutions, and academic institutions to gather reliability, modeling, and technology inputs. This reviewer also found good tech transfer of the results to industry. Nevertheless, it was not clear to him whether there are any formal partnerships with any of these institutions.

Another reviewer saw some interaction with ORNL and academia, although more is desired with industry (supplier involved in thermal solutions) and academia in the electric engineering field.

One individual did not see any collaboration with industry experts and chip makers. They should have the real-life experience and expertise on the reliability of these power devices.

A reviewer felt that collaboration was described in general terms. It might have been useful to describe the validation plans in greater detail, which also would highlight the value of collaboration and coordination in this project.

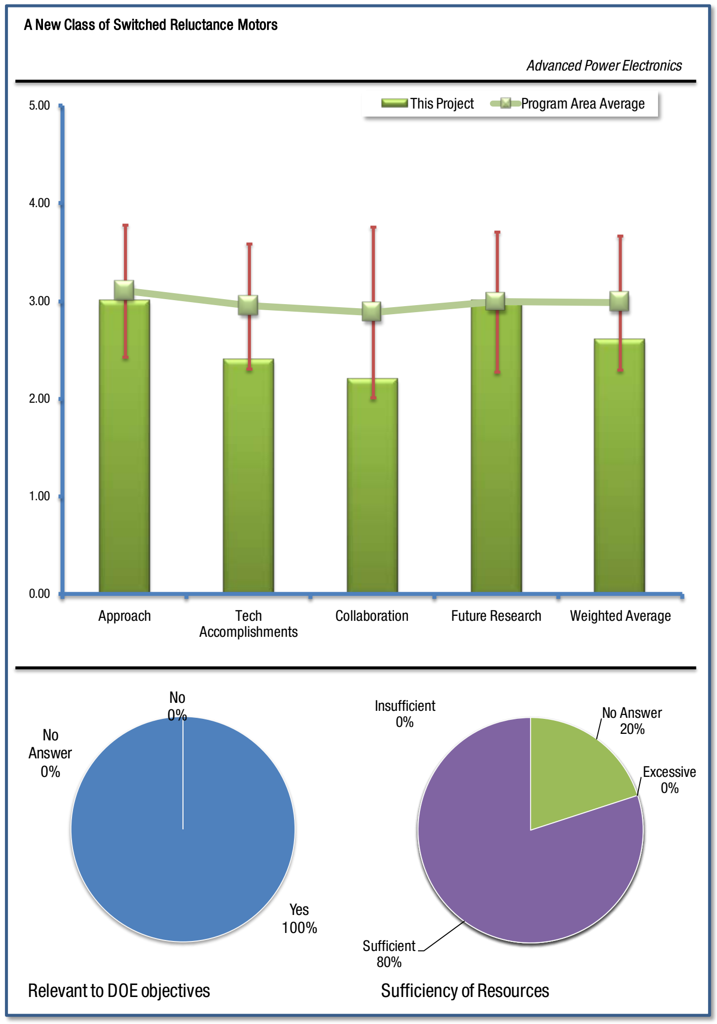
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Of the three respondents, one stated that the project looks very promising, although he did not see enough information about the empirical validation plan to feel fully comfortable with the going-forward plan. Another remarked that the next steps of validation and calibration of the modeling using test results, completing the comparison of the reliability of the different technologies, and an analysis of variability are all important and necessary tasks to complete this effort. The third respondent suggested that the investigator consider validation through experimentation, and involving real world systems from EE side so that the failure mechanism can be truly understood.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers think the resources are sufficient.

A New Class of Switched Reluctance Motors: Tim Burress (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer commented that a motor which does not use PM may be needed in the near future, and that cost is important, too. Another noted that the work may lead to a low cost motor by reducing the amount of permanent magnets. Still another said the project is targeted at developing affordable hybrid propulsion systems.

One person observed that this has the potential of being low cost, but that noise with SR motors must be addressed up front to determine viability. The final reviewer remarked that EM technology development and performance improvements focused on overall vehicle efficiency reduces fossil fuel requirements for fixed loads. The foci of this project on SRM flux leakage and torque ripple reductions both address efficiency improvements and thus classify this project as effecting petroleum displacement. The novel SRM being pursued has the potential to increase power density and thus weight, reducing fuel requirements.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer described the approach as well structured. Another said it is too early in the project for a real critical assessment, although he noted the approach looks good due to initial investigation and later downselect. A third reviewer believes the project addresses critical SRM issues dealing with complexity and cost (reducing # poles), flux leakage and mag material losses, and potentially cost. The program therefore is focused on the key SRM issues hindering pervasive adoption of this technology in a variety of platforms. It is a comprehensive and thorough investigation of novel SRM technologies that may yield significant benefits to motor size, weight, and cost.

Another reviewer wished he knew what the novelty of the design was so that he could make a better judgment. According to the remaining reviewer, the principal investigator claims to have solved many of the typical SRM issues. However, the little data presented from computer simulations shows an unacceptable torque ripple for vehicle applications. Although torque ripple is not included in the requirements, it is a significant concern because of its NVH implications. Unfortunately, SRM technology is notorious for its torque ripple, and this approach seems to emphasize that aspect even more.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to one reviewer, the modeling milestones appear to have identified several promising approaches to both the motor design as well as the control algorithm. He rates the project as very nice work.

To a different reviewer, the early results look promising, while to another, we are still waiting to find out what the actual approach is. In a similar vein, a reviewer believes it is too early to really tell. Yet another person said that at this early stage, there are only modest analytical results that indicate an improvement over conventional SRM. The principal investigator did not disclose the motor topology.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Comments were varied. One reviewer saw no collaboration with any manufacturer of industry expertise, and another said there has been no information sharing with OEMs due to ongoing patent work. A third indicated that most of the work is being done at ORNL, while a fourth remarked that while the UT connection is good, the project likely would benefit from coordination with a historical SRM manufacturer.

The final reviewer believes that for such an early stage, the collaboration level is appropriate.

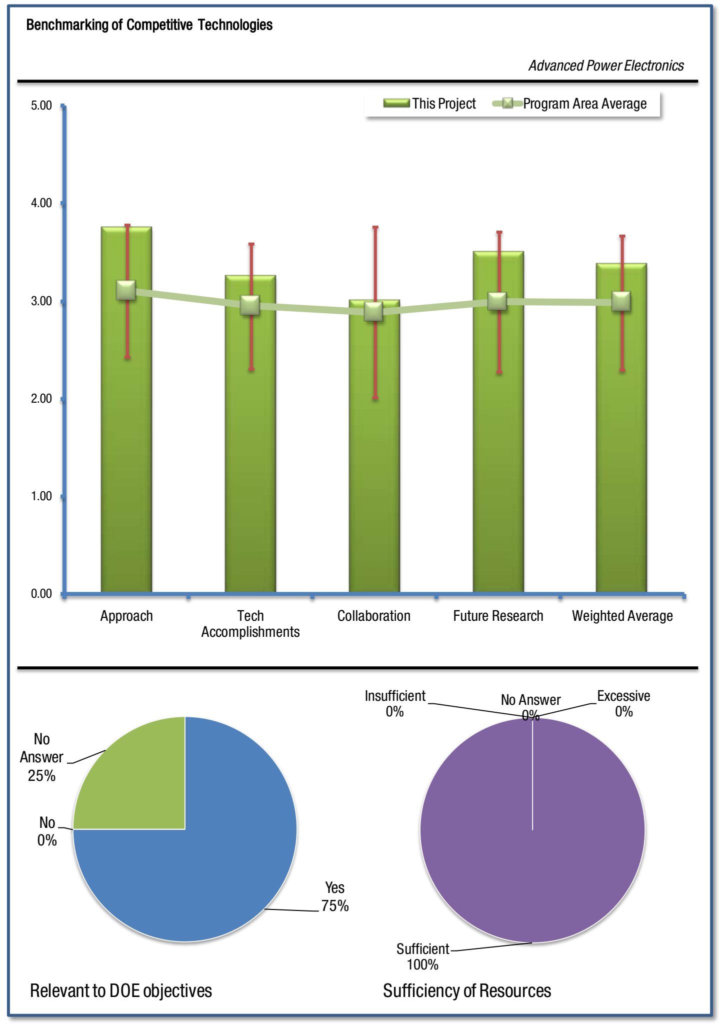
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Once again, the responses were mixed. On the positive side, a reviewer rated the project as very well organized and focused on the key issues. Another said the principal investigator understands the barriers and limitations of past switched reluctance designs and is trying to overcome these obstacles. A third reviewer thinks the plan is extremely vague and generic.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers think the resources are sufficient.

Benchmarking of Competitive Technologies: Tim Burress (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Two reviewers alluded to benchmarking's importance to understanding the state of the art, while another remarked that benchmarking would help us to understand where the competition is and learn their unique ways of design.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer explained that if there are technical barriers to the analysis, it is not clear what they are. He asked whether those test barriers can be presented. There may be some knowledge that has been gained that can be used by industry so it does not need to reinvent. This shared knowledge may help speed the time to market. Could this be a lessons learned database?

Another person said it is a clever method to run the competitive modules and gather functional data. High mile data is useful, too, for understanding life endurance.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer noted a good report on Toyota vehicles. To another, the analysis is well done, although several questions were raised, i.e., how can the work be more widely distributed, is any effort being made to understand and document the control algorithms used, and if Argonne is doing this work, can a link or contact be provided to get access to the information?

One reviewer said the results are not as fast as he would like, but considering the budget and resources, he is very satisfied. A different reviewer commented that a focus on quick turnaround will result in improved value.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Among the responses, one reviewer found a very good information exchange with OEMs with respect to EETT reviews. Another reviewer feels that increased collaboration with industry (USCAR) to identify critical data and procedures will bring more benefit.

A reviewer queried whether the results of others' benchmarking activities can be collected and attached as an appendix, and one reviewer asked why, if Argonne is doing the control strategy documentation, no reference is made in the presentation to their work?

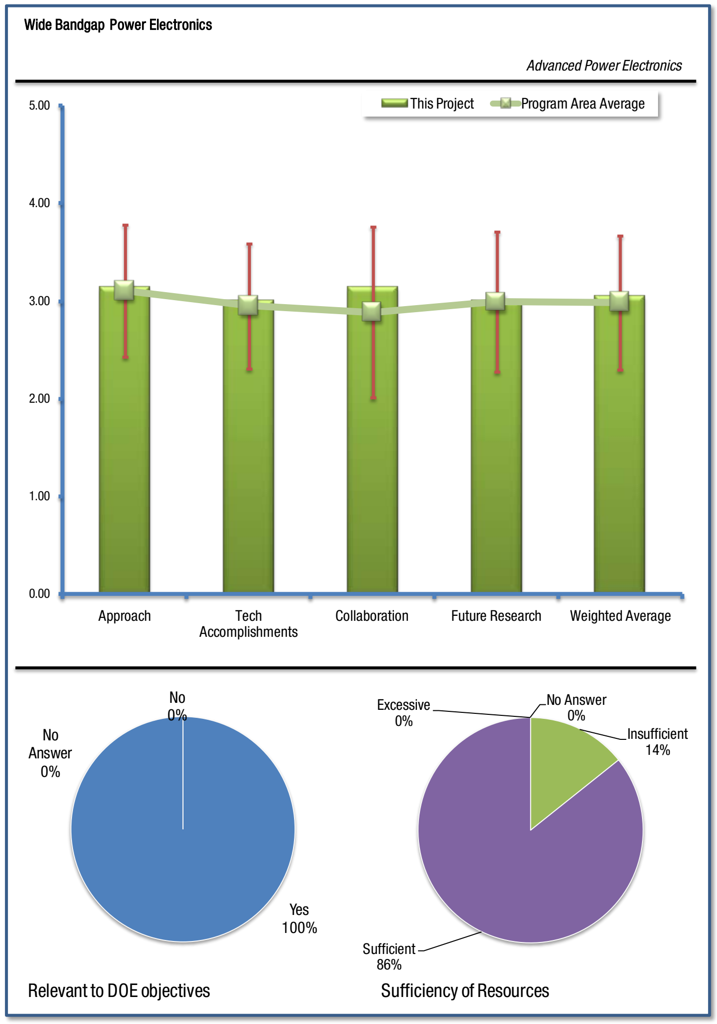
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer remarked that the work on surface enhancements will be of interest, while the other respondent queried that if the focus of future research is shifting to PHEVs, whether the benchmark vehicle should focus towards a BYD F3DM PHEV.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers think the resources are sufficient.

Wide Bandgap Power Electronics: Madhu Chinthavali (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

According to one reviewer, WBG devices are critical to lower loss, higher temperature operation that will enable smaller packaging, reduced mass, lower cost, and higher efficiency inverters. Another reviewer stated that such devices are a key promising technology for high efficiency power conversion technology.

A reviewer commented that an air cooled inverter is desired to eliminate the cooling loop, and if temperature operation is improved, then the inverter can be moved inside the transmission. Still another said that SiC devices have the potential of meeting the high power density and high coolant temperature targets, assuming the cost is going to go down in the future. Finally, a reviewer stated that wide bandgap power electronics are one avenue for reducing HEV system cost. This can be accomplished by eliminating liquid cooling and decreasing the overall size of the inverter.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

To one reviewer, the WBG device level testing is key and fully supported. However, it appears an “air-cooled inverter design” project has developed within this project, and the reviewer would rather see the two be separated so as not to dilute the focus on the WBG devices characterization efforts.

Another reviewer thinks the project is necessary to evaluate new devices, and that it seems like a logical approach to characterizing them and identifying system issues (e.g., gate drivers, control, etc.). A different reviewer found that the project has clearly defined goals and barriers to overcome, although the proposed air cooling system was not presented.

One individual, referencing the air cooled inverter, inquired as to how other components will be affected. He assumes with elimination of liquid coolant that more heat will be transferred into the rest of the module and increase the ambient temperature inside the module.

A reviewer raised the following four points: (1) testing more devices at a wide temperature range and various gate drive voltages will provide a valuable database in terms of understanding the issues and tradeoffs; (2) more work needs to be done at the system level and more specifically on the inverter design - so far, the focus has been on testing individual modules; (3) the issue of paralleling the devices still does not seem to be addressed; and (4) the air temperature specifications need to be well defined and compared against what practically can be available; there needs to be a number(s) equivalent to the 105°C number for liquid cooling.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer believes the project has made progress in the area of acquiring new prototype devices, but the extent of progress towards meeting thermal and power goals is difficult to assess at this time. Another remarked that there has been good progress, although an air cooled design has not been seen yet. A third reviewer indicated good progress, but added that comments on the approach need to be addressed and the issue of having suitable gate drives is dependent on another project. There should be strong coordination between both projects to make sure that the gate drivers will be available on time for testing the devices.

Still another reviewer thinks overall there has been good progress, but finds it hard to compare directly to the program objectives. The accomplishments to date are directionally correct, however.

In one reviewer's opinion, the assessment of devices should be performed more, for example, except for Ron, and switching power loss data, the temperature dependence of other parameters also are important, such as leakage current, blocking voltage, switching times (tr, tf) Capacitance C_{iss}, C_{res}, etc. The comparison of WBG devices and Si devices should be performed on power loss and thermal/temperature performance. Another issue that may be considered is the reliability of WBG devices, including the effects of poor interface structures, thermal cycling/power cycling, and short circuit capabilities; from a system point of view, what is the trade off device (die) and heat sink (cooler)?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer described the collaboration as outstanding for the device level but poor for the air-cooled inverter design portion of the project. Another commented that it seems almost all the work is being done at ORNL, and it was not clear what the role of the external partners was other than supplying the devices. A third reviewer was not clear on the University of Tennessee's contribution to the project, but found a good tie-in to component suppliers for an evaluation of SiC and GaN devices.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

In one commenter's estimation, the future goals appear to be reasonable. The goals will become more specific with future progress: complete thermal design and automated test facility. Another reviewer feels the plans are a logical extension of the work to date. This reviewer reported no significant barriers identified, except for the development of the wide bandgap materials themselves.

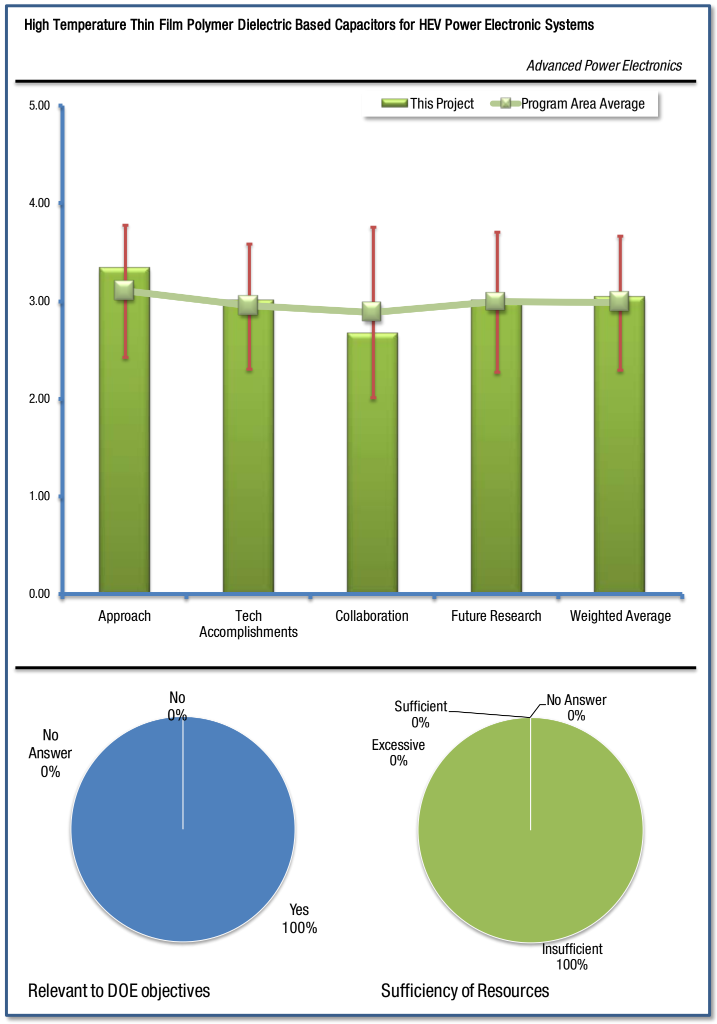
A reviewer reiterated that he would rather see the air-cooled inverter design project separated, as well as better collaboration with the tier 1 suppliers.

One person believes that testing more devices as well as finalizing the test facility and finalizing the inverter design all are steps in the right direction.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Six of the reviewers believe the resources are sufficient; one finds them insufficient.

High Temperature Thin Film Polymer Dielectric Based Capacitors for HEV Power Electronic Systems: Shawn Dirk (Sandia National Laboratory (SNL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer stated that high temperature DC capacitors are needed for the development of a high temperature inverter, and that size needs to be reduced, too. Another remarked that high temperature capacitors are considered to be a key technology for enabling the use of 105°C coolant for vehicle power electronics, simplifying and reducing the cost of PE thermal management. The third reviewer said the synthesis of high temperature polymer films with a high energy density is a cost-competitive approach to developing DC-link capacitors. The composition and structure of the polymer should be designed to utilize a low cost monomer, to enable a graceful failure, and to improve manufacturing quality of the films.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer thinks polymer on foil may be a good solution, but notes that the manufacturability seems to be very difficult. He inquires about the investigator's confidence that it can be manufactured with a decent yield.

The second reviewer maintains that the creation of high temperature polymer film suitable for use as a capacitor dielectric is an entirely worthy goal. Working with a capacitor manufacturer that also has some film manufacturing capability also is attractive. Some technical barriers to high temperature capacitors, however, were not mentioned, such as leakage (specified dielectric stress & temperature) and ability to self heal.

The third reviewer believes an excellent job has been done to identify the requirements for developing a polymer film for capacitor applications to include cost, graceful failure, and film processing capability. It also is beneficial to investigate both solvent casting and melt extrusion for film processing due to concerns with the cost and quality for each method. It may help to identify the advantages or disadvantages of these film processing methods with respect to the copolymer that has been developed. It also would help to discuss what needs to be overcome before scale-up with respect to each method.

The reviewer continued that developing the capability to design and synthesize a copolymer with desired properties is a notable achievement, but what is unique in this effort is that lab-scale film processing techniques have been developed. This approach enables the ability to design the polymer for scale-up to film manufacturing, which is a common barrier due to the high cost of the film processing equipment and amount of material required. Moreover, the inclusion of nanoparticles is a good approach to improve the dielectric properties of the polymer film.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to one reviewer, it is difficult to take a polymer candidate and create film that can be made into a capacitor. Such film must have few defects and be of uniform thickness. The suitability of a film for use in capacitors needs to be determined as early as possible in the development cycle to avoid work that may lead to an expensive dead end. Practical questions can be answered fairly early with small film quantities. Can it be metalized? Will it self heal at dielectric faults? What is the leakage current at constant dielectric stress and varying temperature? Some of these factors may be addressable early on small quantities of film that can be created in the lab. The reviewer believes the investigator as a chemist is doing good work, but would like him to be more understanding of what is needed for a real capacitor and thus be able to pursue more plausible polymer technologies looking for an ideal candidate as others are discarded when fatal flaws are found.

To a second reviewer, much progress has been made considering the amount of funding. It is a major challenge to develop a polymer dielectric for capacitor applications and an even greater challenge to scale it up for film manufacturing. The dielectric properties appear to be stable across the desired temperature range. It would help to obtain some DC or AC lifetime data for this dielectric material as a function of temperature. In addition, it would help to compare the dielectric properties to commercially available polymer films or even ceramic materials. Some information that would be good to see is the insulation resistance of the film as a function of temperature (required for DC link applications) and the voltage breakdown strength of the film.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer thinks there should be more information transferred regarding the dielectric requirements that are needed for capacitor manufacturers to produce practical and reliable capacitors; this reviewer was surprised at how little information apparently had been transferred to the investigator concerning exactly what was needed for such film to work, even to characterize the film that was made. The plot of Capacitance vs. applied voltage made no sense to this reviewer; it looked as though an instrumentation problem needed to be resolved.

Another reviewer found the collaboration with ECI to be significant because this company has the capability to evaluate the polymer film for scale-up. This company also has the capability to manufacture the film using both a prototype and an industrial scale system. In addition, they have state of the art equipment to metalize and wind the polymer into wound capacitors. If stacked capacitors are going to be pursued, it may be beneficial to look into the capabilities of capacitor manufacturers that focus on stacked devices (e.g. Paktron or Sigma Technologies).

It also may help to seek a collaboration to enhance the ability to characterize the dielectric properties under controlled environmental conditions.

The final reviewer asked who else within the industry is working on these types of capacitors, and whether there is any chance of collaborating with them.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

In one person's view, this was/is very low budget research. It may be that the available funds did not stimulate ECI to be more collaborative. The reviewer believes the budget stated for this project does not allow very much to be done, especially external to the research entity initiating an investigation like this. This, he maintains, is work that should be done and funded at an appropriate level. More information flow is definitely needed between the investigator and the capacitor manufacturer with whom he is working.

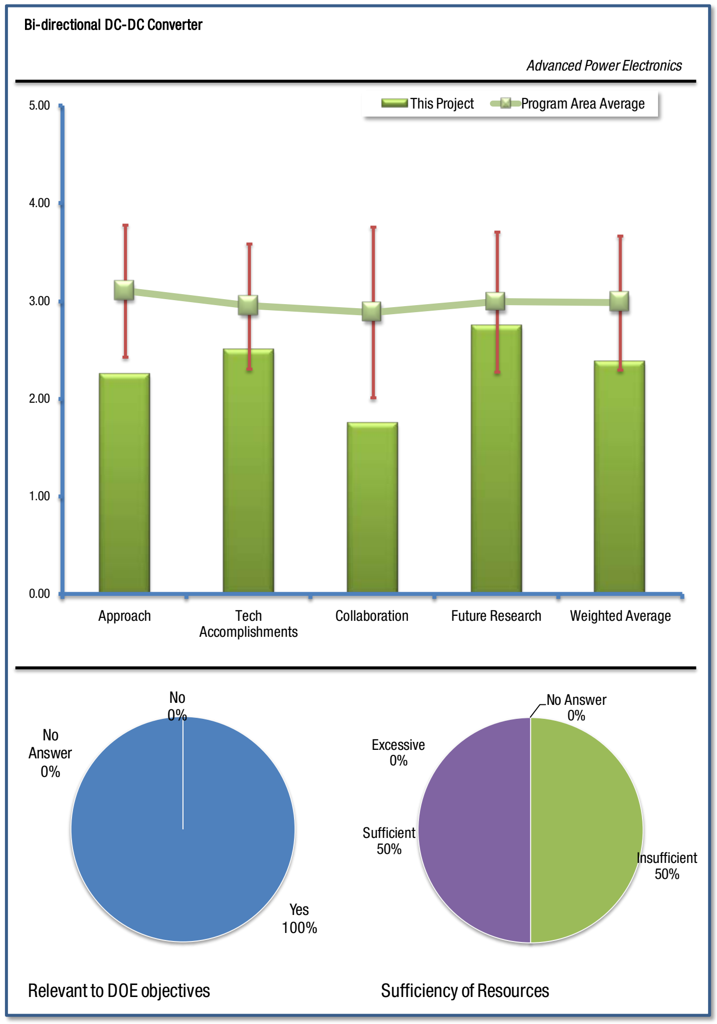
To another person, the incorporation of nanoparticles is an excellent approach to increase the energy density, but it also has been reported in the literature that it also can be utilized to improve the AC/DC breakdown strength, AC endurance, insulation resistance, and film processing capability. Functionalization of the nanoparticles is the right approach to obtain good dispersion within the polymer matrix. While there are many current efforts investigating polymer nanocomposites, this effort expands this field of research to investigate high temperature films. The collaboration with ECI is an excellent approach to investigate the film processing capability, which is essential since there is a current need to transfer information between polymer synthesis efforts and the film manufacturing efforts. The cross-linking of the film may improve the voltage breakdown strength or the Tg.

One reviewer asked how nanoparticle development is going to be handled, and whether it is a parallel development or whether the nanoparticle will only be investigated if the polymer does not work.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers believe the resources are insufficient.

Bi-directional DC-DC Converter: Abas Goodarzi (U.S. Hybrid) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer stated that a bidirectional dc-dc converter allows energy transfer between two energy sources and between energy source and load. It helps energy management and improves the system level efficiency, and with proper design, it also can help extend the operating life of the energy source. Another remarked that a bidirectional DC/DC converter is another “must have gizmo” in PHEV/HEV/EV systems. The application to the two-battery energy storage system is justified, but not new. A third reviewer commented that this project supports the overall DOE objective of petroleum displacement by providing a low cost, high reliability, high power density converter that can be used to improve battery life in multiple EV platforms. The converter also meets DOE’s 2015 goals of operation at 105°C inlet coolant and ambient temperatures.

For the final reviewer, conceptually the project sounds like a good idea, but he did not see any evidence showing how the cost and complexity of this system will pay for additional benefits. Nor did he see data showing the benefits.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer observed that Toyota uses the DC-DC boost converter to increase the voltage to around 500 volts; they just do not have a second high power density battery. How can 8 kW DC/DC be enough for full speed cruise?

According to a different reviewer, the technical approach, from a system perspective, is not new, and can be seen implemented in the L5 commercial product from Hymotion if one recognizes that the existing Prius NiMH battery is intended to play the role of the high-power-density battery. There appears to be an added element of novelty in the use of SiC normally on JFETs. Besides the fact that the initial design uses the wrong type of SiC switch for the topology used, it is not clear that any SiC switch is justified in that the cost/benefit ratio may not be favorable.

One reviewer thinks the approach should permit extended battery life and thus lower cost of HEVs along with improved EV-only range through the use of a dual battery system with a bi-directional DC-DC converter. This overcomes significant barriers to the acceptance of EVs. The approach to building or sourcing the actual converter, however, is not clear, as the focus appears to be on the vehicle system study.

One person offered three observations. First, multiphase circuit topology was mentioned, but the design was quite ordinary. The design did not adopt interleaving techniques, so the overall ripple current will be high. This requires an excessively high switching frequency to reduce the ripple. Otherwise, a large capacitor is needed to absorb it. The presentation indicates that 100 kHz is the planned switching frequency. This will result in poor efficiency. Second, the phase dropping concept for different load conditions is not new. The key is how to deal with dynamic changes, and this was not addressed in the presentation. Third, overall the presentation did not show any novelty or design improvement over the state of the art.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer would like to see more simulation test data to prove the concept's benefits.

To another reviewer, the presentation only showed vehicle level simulation results to justify the sizing of the dc-dc converter. This is not the core of the development, which should be the converter itself. In terms of sizing, different vehicles will have different requirements. The sizing issue should not be a major study as long as the converter can be scaled easily. In addition, the presentation did not really show any accomplishment. Key design elements such as inductor design for size and cost consideration, controller design that deals with dynamic load and operating mode changes, and semiconductor switch selection and packaging were not shown.

A reviewer remarked that aside from his lukewarm opinion of the project's relevance and technical approach, enthusiastic technical progress appears to be indicated from the presentation.

In another reviewer's opinion, significant vehicle system modeling has been completed for converter sizing along with a characterization of both Si and SiC converter component performance. This indicates that the barriers to the development of this technology will be overcome, although no prototyping or performance validation has been conducted.

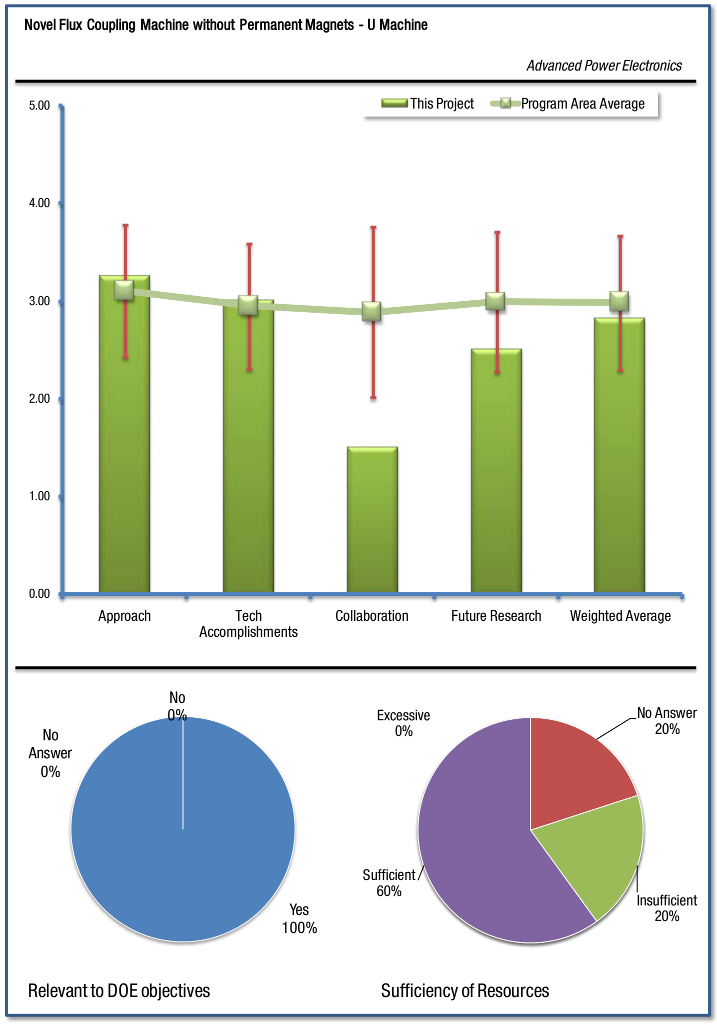
Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Generally speaking, the responses were not very positive. One reviewer could not see how the university is involved and what input it has. Another did not see much collaboration, save for some data scavenging from the battery vendor, while a third indicated that the presentation did not identify the individual contributions of the team members, adding that it is unclear which work is being done by which organization. The remaining reviewer said the project appears to be a collaboration between US Hybrid and the University of Illinois-Chicago, with no other partners. The roles of each of these two institutions are not clearly spelled out.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
In one's view, the project management seems to know what they need to do to complete the project. Since this is primarily a modestly complex engineering project, the going-forward research plan seems adequate. According to another reviewer, full performance validation of the production prototype high density power converter for efficiency at junction temperature, power density, specific power, and bandwidth are planned. These elements will demonstrate sufficient capability of the converter to show that it can be used to provide the advantages outlined in the vehicle system study of Phase I.

One respondent noted that while high switching frequency and high current loop bandwidth were mentioned, the issue of how to maintain high efficiency was not addressed. The 20-kHz current loop bandwidth was targeted, but the sensor conditioning and analog-to-digital bandwidth limitation and sample-and-hold delay were not addressed. How practical is this bandwidth and why is it necessary?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The responses were evenly split; two believe the resources are sufficient, and two believe they are insufficient.

Novel Flux Coupling Machine without Permanent Magnets - U Machine: John Hsu (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One person feels this work could lead to a low cost traction motor, which will improve the fuel economy of HEVs and could be applied to pure EVs. To another reviewer, advanced motor design and development that promises to increase constant power speed range and power factor can potentially reduce volume and weight at a minimum. By itself, this will reduce fuel consumption. Yet another reviewer stated merely that the project is consistent with DOE objectives, a fourth said it is targeted to low cost motors, and a fifth said it strives to eliminate PMs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer described the approach as a good start, and another said it is a very well organized and structured project with a focus on key novel magnet-free design with improvements over IPM performance and power density. The concept of using the stator frame to carry the exciter current is highly novel and appears to provide tangible benefit to the overall motor performance. If PM materials can be eliminated, there is potentially a measurable reduction in motor cost with regard to conventional PM machines.

One person remarked that the principal investigator has extensive machine design experience and understands the limitations of current electric motors. This design seeks to overcome the barriers of high magnet cost by removing them. The concept of a statically excited field would motor is not new, but this implementation is novel. Placing the excitation coil in the end bell helps reduce overall length. If the investigator can overcome some obstacles, it will provide effective field weakening and improved low speed torque.

Another reviewer said a nice investigation has been carried out, but there are still doubts about the feasibility of the proposed approach. The power density is questionable. The last reviewer said there is insufficient information to assess the approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer thinks the FEA results look promising, while another opined that although the analysis looks promising so far, there are still many cost and mechanical design issues ahead. This reviewer said he will be more confident when a working prototype is built and tested. Similarly, another reviewer noted that so far the work is on paper. Even though it has demonstrated some advantages, more work is needed to further demonstrate the technology.

A reviewer feels there is insufficient information to assess the accomplishments and progress. In another's view, thorough modeling results have reasonably mapped out the relevant design space for this novel design. This particular reviewer would like to have seen some thermal modeling data to accompany these results and benchmark the baseline design in terms of winding and flux path heat rejection.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer feels there is insufficient information to assess the collaboration with other institutions, while another believes there is no collaboration at this time. A third thinks this effort is internal to ORNL, and a fourth maintains that the work needs to be connected to industry, for three reasons: (1) industry can provide feedback on the technology and whether it is feasible (performance, manufacturability, etc.); (2) for eventual commercialization of the technology; and (3) to hasten the development process.

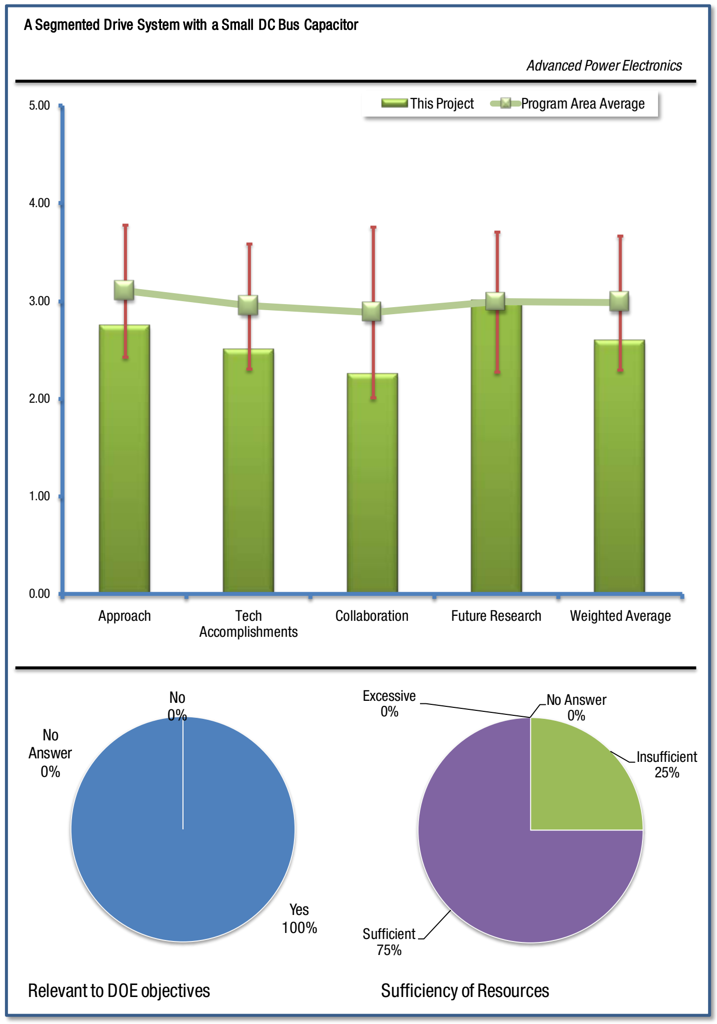
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer merely said it is hard to predict the outcome, another noted that the investigator plans to build hardware next year, and a third indicated that while the project may be able to overcome the barriers, a prototype is urgently needed to validate the claims. Another reviewer found a good plan to evaluate manufacturing cost, structural design, and torque issues.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Four reviewers responded; three think the resources are sufficient, and one finds them insufficient.

A Segmented Drive System with a Small DC Bus Capacitor: Gui-Jia Su (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer believes the project, if successful, will enable capacitor downsizing, while another thinks it could provide significant improvements in package volume and inverter cost. According to yet another, the project supports the overall objective because modifying the circuit topology to reduce the ripple current reduces the demand for the DC link capacitor, which will enable a lower weight and volume. This reviewer wonders, though, what the benefits are based on the cost, reliability, and complexity of the modified circuit topology.

To another reviewer, this is a new start and very little technical information is available. Information is under patent review. The presentation, however, suggests it is addressing the goals.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One person said he did not learn enough to know the concept, and another thinks there is insufficient information. According to the third respondent, the simulation data looked good but the circuit topology used in the simulation was not clear. It appeared that a higher switch rate was utilized, but it was unclear how this would affect the capacitor (e.g., parasitic inductance and DF).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer asserted a need to learn more and understand details of the work so as to be able to make judgments. A second reviewer said it is too early to tell, and a third simply reiterated his view that this is a new start. The fourth reviewer noted that due to a patent pending, not a lot of information was presented to gain an understanding of the approach taken. It would help to evaluate the efficiency and cost of the modified circuit topology versus that gained from decreasing the size of the capacitor. Also, what are the new requirements for the capacitor using this segmented drive system, and can current capacitor technology be utilized?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Only two responses were provided; one reviewer stated that collaborations were not indicated, and the other said that although it is very early, he would like to see some collaboration.

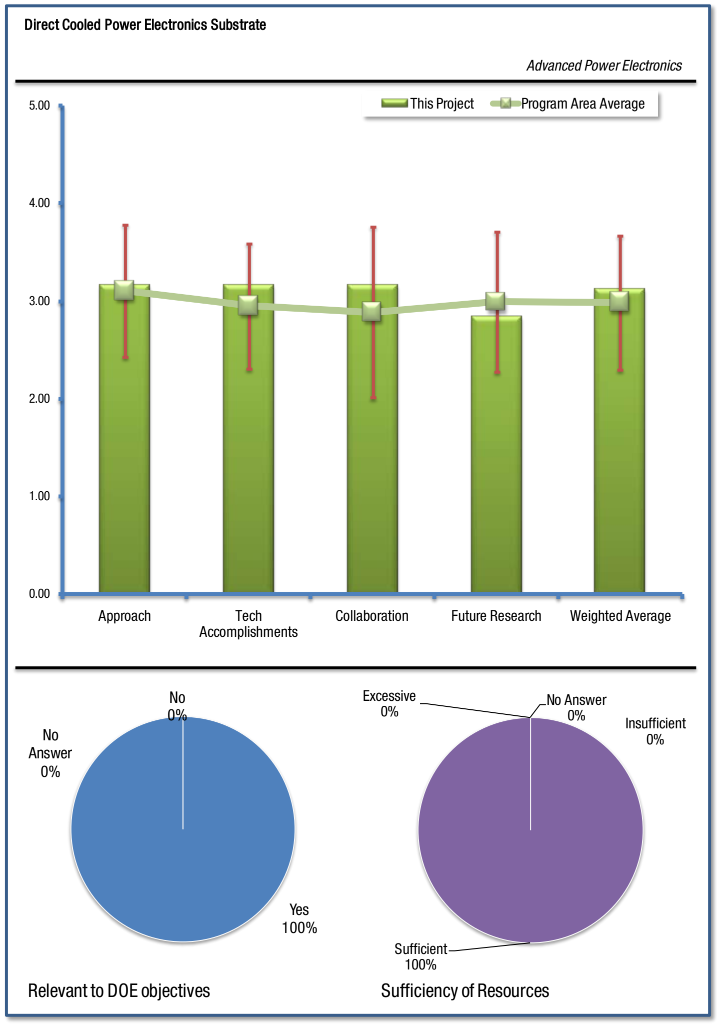
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The lone respondent said it will be beneficial to discuss the circuit topology in the future and to verify the simulation with the construction and testing of the hardware.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Three reviewers think the resources are sufficient; one believes they are insufficient.

Direct Cooled Power Electronics Substrate: Randy Wiles (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer stated that the project can enable a higher coolant temperature, another noted that the technology, if successful, will be an enabler for meeting the high temperature and power density targets for the power converter, while a third indicated that direct cooling can lead to smaller packaging, reduced mass, and higher power densities; with a proper level of integration, it also should support reduced cost.

To one reviewer, the ability to embed effective cooling channels into a Direct Bond Copper (DBC) substrate would be a great step towards reducing the thermal resistance between the power semiconductor devices and the coolant. Such a reduction could enable higher power ratings for a given inverter, or the direct use of 105°C coolant with silicon- based devices. Achieving one or both of these goals could significantly drop the price of existing HEV and PHEV solutions, which would enable petroleum displacement due to the higher levels of fuel economy associated with these vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer said he likes the focus. Another thinks the approach is well defined and clearly presented, and that the objective demonstrates an understanding of fundamental engineering and manufacturing (sealing) issues that are to be overcome. A third reviewer believes the proposed technical approach systematically is trying to address many of the challenges, although it is not clear who is going to build the whole inverter. More focus is needed at the system level.

One reviewer identified a key concern that may require some investigation -- the stability of these assemblies relative to thermal shock. This already is an issue with DBC substrates that use thick metal, and some analysis should be conducted to evaluate the reliability of this technology with respect to this issue.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One person found the simulation results to be promising. Another reported good technical progress, but noted the test results are the key to validating the project's merits. Similarly, a different reviewer indicated that the key phase will be to see how the test results match expectations. According to yet another, the technical accomplishments are significant and appropriate, the investigators have identified promising designs, and the technical accomplishments are experimentally validated.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Each of the three respondents gave a positive assessment. One stated that the collaborative efforts are clearly identified in the presentation. Another found that there is a lot of collaboration with external partners in terms of manufacturing the devices. The third commenter remarked that the only way to get better collaboration would be to include a Tier 1 supplier that understands the automotive environment better and could provide a better systems look.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer believes the future work is well reasoned, and that testing the hardware clearly is the greatest goal. Another thinks moving to the marketplace may require the involvement of other partners. To the final respondent, the proposed future work is logical and systematic. This reviewer suggests that the project team keep an eye on what other teams are doing (especially the Delphi project) and benchmark its progress versus other technologies.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All of the reviewers believe the resources are sufficient.

4. Advanced Combustion Engine Technologies

Introduction

The Advanced Combustion Engine R&D subprogram of the U.S. Department of Energy's Vehicle Technologies Program (VTP) is improving the fuel economy of passenger vehicles (cars and light trucks) and commercial vehicles (medium-duty and commercial trucks) by increasing the efficiency of the engines that power them. Work is done in collaboration with industry, national laboratories, and universities, as well as in conjunction with the FreedomCAR and Fuels Partnership for passenger vehicle applications and the 21st Century Truck Partnership for commercial vehicle applications. Research and development (R&D) efforts focus on improving engine efficiency while meeting future federal and state emissions regulations through a combination of: combustion technologies that minimize in-cylinder formation of emissions; aftertreatment technologies that further reduce exhaust emissions; and understanding fuel property impacts on combustion and emissions. Technologies that improve the overall engine performance are also pursued.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Heavy-Duty Low-Temperature and Diesel Combustion & Heavy-Duty Combustion Modeling	Mark Musculus (Sandia National Laboratory (SNL))	4-8	3.83	3.67	3.83	3.33	3.69
Light Duty Combustion Research: Advanced Light-Duty Combustion Experiments	Paul Miles (Sandia National Laboratory (SNL))	4-11	3.75	3.75	3.75	3.50	3.72
Sandia Optical Hydrogen-Fueled Engine	Sebastian Kaiser (Sandia National Laboratory (SNL))	4-13	3.33	3.33	3.17	2.83	3.25
HCCI and Stratified-Charge CI Engine Combustion Research	John Dec (Sandia National Laboratory (SNL))	4-15	3.75	3.88	3.63	3.50	3.77
Low-Temperature Diesel Combustion Cross-Cut Research	Lyle Pickett (Sandia National Laboratory (SNL))	4-18	3.50	3.50	3.50	3.17	3.46
Automotive HCCI Engine Research	Dick Steeper (Sandia National Laboratory (SNL))	4-20	3.60	3.60	3.80	3.60	3.63
Large Eddy Simulation (LES) Applied to LTC/Diesel/Hydrogen Engine Combustion Research	Joe Oefelein (Sandia National Laboratory (SNL))	4-22	3.29	2.86	3.29	3.29	3.07
Free-Piston Engine	Peter Van Blarigan (Sandia National Laboratory (SNL))	4-24	3.17	2.67	2.67	3.00	2.83
H2 Internal Combustion Engine Research Towards 45% Efficiency and Tier2-Bin5 Emissions	Thomas Wallner (Argonne National Laboratory (ANL))	4-26	3.00	3.14	3.43	3.43	3.18
Fuel Spray Research on Light-Duty Injection Systems	Christopher Powell (Argonne National Laboratory (ANL))	4-28	3.43	3.43	3.67	3.33	3.45
Visualization of In-Cylinder Combustion R&D	Steve Ciatti (Argonne National Laboratory (ANL))	4-30	3.14	2.71	3.29	2.86	2.91

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Modeling of High Efficiency Clean Combustion Engines	Salvador Aceves (Lawrence Livermore National Laboratory (LLNL))	4-32	3.50	3.57	3.50	3.00	3.47
Chemical Kinetic Research on HCCI & Diesel Fuels	William Pitz (Lawrence Livermore National Laboratory (LLNL))	4-34	3.80	3.80	3.75	3.75	3.79
KIVA Modeling to Support Diesel Combustion Research	David Carrington (Los Alamos National Laboratory (LANL))	4-36	3.40	3.20	3.00	3.20	3.23
Stretch Efficiency for Combustion Engines: Exploiting New Combustion Regimes	Stuart Daw (Oak Ridge National Laboratory (ORNL))	4-38	2.86	2.57	3.00	2.57	2.70
Achieving and Demonstrating Vehicle Technologies Engine Fuel Efficiency Milestones	Robert Wagner (Oak Ridge National Laboratory (ORNL))	4-40	3.22	3.33	3.33	3.63	3.34
High Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines	Robert Wagner (Oak Ridge National Laboratory (ORNL))	4-43	3.29	3.00	3.00	3.43	3.13
Ignition Control for HCCI	Dean Edwards (Oak Ridge National Laboratory (ORNL))	4-45	3.40	3.40	3.60	3.20	3.40
A University Consortium on Low Temperature Combustion (LTC) for High Efficiency, Ultra-Low Emission Engines	Dennis Assanis (University of Michigan)	4-47	3.71	3.57	3.86	3.14	3.59
CLEERS Coordination & Development of Catalyst Process Kinetic Data	Jae-Soon Choi (Oak Ridge National Laboratory (ORNL))	4-49	3.75	4.00	4.00	3.60	3.89
CLEERS Activities: Diesel Soot Filter Characterization & NOx Control Fundamentals	Darrell Herling (Pacific Northwest National Laboratory (PNNL))	4-51	3.00	3.00	3.00	3.00	3.00
Development of Advanced Diesel Particulate Filtration (DPF) Systems (ANL/Corning/Caterpillar CRADA)	Kyeong Lee (Argonne National Laboratory (ANL))	4-53	2.25	2.50	2.50	2.50	2.44
Diesel Soot Filter Characterization and Modeling for Advanced Substrates	Thomas Gallant (Pacific Northwest National Laboratory (PNNL))	4-55	3.50	2.75	3.00	3.33	3.04
Mechanisms of Sulfur Poisoning of NOx Adsorber (LNT) Materials	Charles Peden (Pacific Northwest National Laboratory (PNNL))	4-57	3.50	3.75	3.75	4.00	3.72
Deactivation Mechanisms of Base Metal/Zeolite Urea Selective Catalytic Reduction Materials	Charles Peden (Pacific Northwest National Laboratory (PNNL))	4-59	4.00	4.00	4.00	3.00	3.88
Investigation of Aging Mechanisms in Lean NOx Traps	Mark Crocker (University of Kentucky)	4-61	3.50	3.25	3.50	3.00	3.31
Kinetic and Performance Studies of the Regeneration Phase of Model Pt/Rh/Ba NOx Traps for Design and Optimization	Michael Harold (University of Houston)	4-63	3.67	3.67	3.33	3.33	3.58
Advanced Collaborative Emissions Study (ACES)	Dan Greenbaum (Health Effects Institute)	4-65	3.50	3.50	4.00	4.00	3.63
Real-World Studies of Ambient Ozone Formation as a Function of NOx Reductions: Summary and Implications for Air Quality Impacts	Doug Lawson (National Renewable Energy Laboratory (NREL))	4-68	3.60	3.80	3.60	3.00	3.63
Measurement and Characterization of Unregulated Emissions from Advanced Technologies	John Storey (Oak Ridge National Laboratory (ORNL))	4-70	4.00	3.67	3.67	3.50	3.73

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation and Controlling NOx from Multi-Mode Lean DI Engines	Jim Parks (Oak Ridge National Laboratory (ORNL))	4-72	3.33	3.67	3.33	3.00	3.46
Cummins/ORNL-FEERC CRADA: NOx Control & Measurement Technology for Heavy-Duty Diesel Engines	Bill Partridge (Oak Ridge National Laboratory (ORNL))	4-74	3.75	3.75	3.75	3.25	3.69
NOx Abatement Research and Development CRADA with Navistar Incorporated	Todd Toops (Oak Ridge National Laboratory (ORNL))	4-76	3.20	2.80	3.00	3.20	2.98
Light Duty Efficient Clean Combustion	Donald Stanton (Cummins Inc.)	4-78	3.60	3.80	3.00	3.80	3.65
High Efficiency Clean Combustion Engine Designs for Gasoline and Diesel Engines	Kenneth Patton (General Motors Corporation)	4-80	2.67	2.83	2.33	3.00	2.75
Advanced Boost System Development for Diesel HCCI/LTC Applications	Harold Sun (Ford Motor Company)	*4-83*	3.20	3.00	3.20	3.20	3.10
Low Temperature Combustion Demonstrator for High Efficiency Clean Combustion	Willy de Ojeda (Navistar International Corporation)	*4-85*	3.40	3.40	3.80	3.20	3.43
Development of Enabling Technologies for High Efficiency, Low Emissions Homogeneous Charge Compression Ignition (HCCI) Engines	Scott Fiveland (Caterpillar Inc.)	*4-87*	4.00	3.25	3.50	3.50	3.50
An Engine System Approach to Exhaust Waste Heat Recovery	Richard Kruiswyk (Caterpillar Inc.)	*4-89*	3.00	3.00	3.00	3.00	3.00
Enabling High Efficiency Clean Combustion	Donald Stanton (Cummins Inc.)	*4-91*	4.00	4.00	3.50	4.00	3.94
Exhaust Energy Recovery	Chris Nelson (Cummins Inc.)	*4-93*	3.00	3.25	2.25	3.00	3.03
Heavy Truck Engine Development & HECC	Houshun Zhang (Detroit Diesel)	*4-95*	2.25	1.75	3.50	2.50	2.19
Variable Compression Ratio Engine	Charles Mendler (Envera LLC)	*4-97*	2.80	2.40	2.60	2.60	2.55
On-Board Engine Exhaust Particulate Matter Sensor for HCCI and Conventional Diesel Engines	Matt Hall (University of Texas at Austin)	*4-99*	2.86	3.57	3.00	2.86	3.23
Develop Thermoelectric Technology for Automotive Waste Heat Recovery	Jihui Yang (General Motors Corporation)	*4-102*	3.25	2.75	2.75	2.75	2.88
Thermoelectric Conversion of Waste Heat to Electricity in an IC Engine Powered Vehicle	Harold Schock (Michigan State University)	*4-104*	3.17	3.17	3.33	2.67	3.13
Automotive Waste Heat Conversion to Power Program	John LaGrandeur (BSST LLC - Amerigon)	*4-106*	3.60	3.60	3.60	3.00	3.53
Improving Energy Efficiency by Developing Components for Distributed Cooling and Heating Based on Thermal Comfort Modeling	Ed Gundlach (General Motors Corporation)	*4-108*	3.00	2.33	3.00	3.00	2.67
Very High Fuel Economy, Heavy Duty, Narrow Speed Band Truck Engine Utilizing Biofuels and Hybrid Vehicle Technologies	Chun Tai (Volvo)	*4-110*	2.00	2.00	2.60	2.40	2.13
Benchmark Reaction Mechanisms and Kinetics for Lean NOx Traps	*Richard Larson (Sandia National Laboratory (SNL))*	*4-113*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Degradation Mechanisms of Urea Selective Catalytic Reduction Technology	*Charles Peden (Pacific Northwest National Laboratory (PNNL))*	*4-115*	*4.00*	*3.50*	*3.50*	*3.50*	*3.63*
Low-Temperature Hydrocarbon/CO Oxidation Catalysis in Support of HCCI Emission Control	*Ken Rappe (Pacific Northwest National Laboratory (PNNL))*	*4-116*	*3.00*	*2.50*	*3.00*	*2.50*	*2.69*
High Temperature Thermoelectric Materials	*Norbert Elsner (Hi-Z)*	*4-117*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
OVERALL AVERAGE FOR ADVANCED COMBUSTION			**3.32**	**3.24**	**3.31**	**3.16**	**3.26**

NOTE: Italics denote poster presentations.

Overview of DOE Advanced Combustion: Gurpreet Singh, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated that this presentation offered a good summary and overview. Another liked the format of the presentations with relevant information condensed onto a few slides, and felt the format made it very easy to find needed information. The other reviewers agreed that the sub-program area was adequately covered.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated that the plans are good, but help might be needed to understand more about the direction of future research; for example, is there any change in balance of basic versus applied research? Redirection of fuel cell versus IC versus battery etc? University versus Lab versus industrial funding split? Another welcomes expanding the research into lean gasoline/SI research. The other reviewers agreed that there were plans identified for addressing issues and challenges.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

A reviewer stated that this was very good, and the group at DOE has been instrumental in developing low emission, high efficiency IC engine technology while pushing important work at times when few thought it was important and that work is now relevant. The other three reviewers agreed that the Sub-program area appeared to be focused, well-managed and effective in addressing DOE VTP R&D needs.

4. Other comments:

A reviewer stated that more areas of the government should do such a good job of anticipating needs and providing the necessary underpinnings, along with having good people to work with and fine technology development. Another liked the format of this year's presentation and commended the fact that they didn't have to evaluate each presentation, having the presentations available for reference was invaluable and the PeerNet software worked very well. One other reviewer supports expanded effort in gasoline FE due to the projected increase in global diesel demand (HD mainly) relative to gasoline (CAFE, ethanol).

Overview of the Heavy Truck Engine and Enabling Technologies R&D: Roland Gravel, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

Two reviewers agreed the Sub-program was adequately covered and important issues and challenges identified, with one reviewer noting a good summary was presented of work being done and the reasons for the work. One reviewer also stated it would be helpful to see in addition to the previous year, progress presented in comparison over the entire duration of the Sub-program, e.g., over the last 3 years, 5 years, etc. as applicable.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

Two reviewers agreed that the plans were identified for addressing the relevant issues and challenges and with no major gaps in the project portfolio.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

Two reviewers stated that this Sub-program does appear to be focused and properly managed to address the DOE VTP needs.

4. Other comments:

A reviewer stated that it would be helpful for DOE to actually claim more public credit for success stories. The short term progress was charted very well, but the medium term progress seemed to be somewhat ignored and it would be beneficial to the program to track progress in the 3-5 year timeframe. Another reviewer believed some added emphasis was needed beyond DOE on the ambient air quality data and its implications for regulations. The same reviewer also said that high emitters should be studied more and identified. The last reviewer stated they were not able to comment on this presentation.

Overview of DOE Emission Control R&D: Ken Howden, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated that a lot of things were covered so fast that they didn't get time to catch them all, but did say that good progress was being made. Another reviewer said the directions and challenges were adequately presented in summary form; however they would encourage a better summary of progress and to touch on the highlights in more detail. This reviewer then went on to ask, what were the key two or three developments in the last year in each category? The rest of the reviewers agreed that the Sub-program area was adequately covered, with one stating the progress was clearly described and the majority of important issues and challenges properly summarized.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated that the plans are identified and there is a challenge to continue research versus industrial proprietary limitations. Another reviewer said hybridization/electrification of the vehicle presents interesting challenges and opportunities; for example, the battery can cover up much of the problem areas on the engine map – LT, HS, heavy transients, etc. The range extender engines essentially operate at a steady state and all of this has emissions implications that need to be explored further. They also said that there is much room for fundamental understanding and discovery and they sense there needs to be more effort here. There is too much emphasis on HCCI for diesel, that they were very supportive of these programs till this year. Emissions were limiting diesel engine penetration, however, in these modes FC goes up while emissions go down. This reviewer stated further that they encourage the DOE to consider pushing FC reduction technologies while letting after treatment handle the emissions. CO_2 will prove to be much more elusive as after treatment gets better and CO_2 regulations become tighter. Overall, this reviewer said the program otherwise seems complete with a good emphasis on LT conversion, modeling and cutting edge stuff. Another reviewer said they would welcome increased focus on sensors for control and OBD. The reviewer went on to ask, a lot of projects were focused on LNT, are any of them redundant or do they complement each other? One other reviewer stated they would like to add one item to the list of the future technology priorities, which hopefully can get included in the program portfolio: the pre-competitive, fundamental research in the area of catalysts and sensors, enabling efficient self-diagnostics of the aftertreatment system. They went on to say a full capable self-diagnosing system would go beyond meeting regulatory OBD requirements, also enabling more efficient operation of the system overall due to leaner margins, thus reducing fuel penalties (in engine or in aftertreatment) associated with meeting emissions. Furthermore, it would have a potential for reducing the system's lifecycle cost due to minimizing unnecessary replacement of aftertreatment elements, some of which are quite expensive. The last two reviewers said yes, there are plans identified for addressing issues and challenges.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

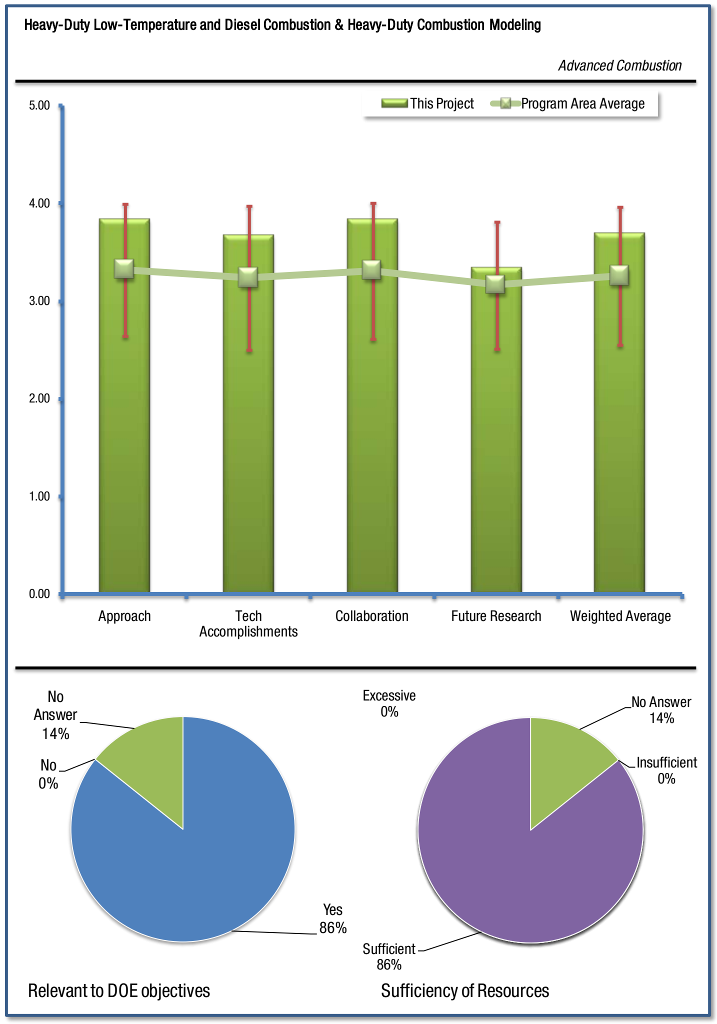
All of the reviewers who answered this question agreed that the Sub-program was well focused and well-managed. One reviewer went on to say the program managers are well connected to the work and do a good job of finding and directing opportunities. Another reviewer said inputs are solicited and taken into account; the programs seem flexible and ready to adjust. They also said there is enthusiasm and the program is developing superior talent and insight. One other reviewer commented that there was a well-defined channel for systematically collecting industry R&D gaps

(CLEERS), a good balance between different aftertreatment technologies in the portfolio, and remarkably coordinated, complementally efforts between various National Labs.

4. Other comments:

A reviewer stated that the program is quite comprehensive and they urge DOE to focus even more on cutting edge CO_2 reductions via heat recovery, new materials and methods for heat preservation (thermal barrier, coatings), bottoming cycles, and the effects of these on criteria emissions and control. This reviewer also said the Department should continue pushing the envelope on research and move even more in this direction, and the supply of fundamental information only comes from these programs, as private funding has pretty much dried up. Another reviewer liked the format of this year's presentation and commended the fact that they didn't have to evaluate each presentation, having the presentations available for reference was invaluable and the PeerNet software worked very well. One other reviewer mentioned they are not sure if DOE support is needed for after treatment device development since many of these technologies are becoming commercial. They also said that overall FE impacts are small and the incentive for improving diesel penetration in LD is diminished with shifts in global gasoline/diesel balance. The last reviewer who commented said they believe after treatment has major potential to be unlocked through further research, for enabling fuel economy improvements for the overall powertrain, and with proper research, these fuel economy gains can quite realistically go beyond incremental. The key improvements are likely to come from pushing NOx conversion efficiency to very high levels, comparable to those achieved today using three-way catalysts, which would allow us to drastically relax the emission constraints on the engine itself, wringing out its maximum fuel economy. There are a number of other areas which can aid in fuel economy improvements through better understanding of the after treatment systems, such as reduced aftertreatment-related fuel penalty. One last thing this reviewer said was even though the key types of aftertreatment systems have been successfully commercialized (LNT, SCR, DPF), the industry is essentially at the limit of what can be done empirically; further breakthroughs can only occur based on the improved understanding of the performance and aging behavior of the catalysts and sensors.

Heavy-Duty Low-Temperature and Diesel Combustion & Heavy-Duty Combustion Modeling: Mark Musculus (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that LTC has the potential to reduce fuel consumption, but perhaps more importantly reduce the requirement for complex and fuel inefficient emissions aftertreatment. Another reviewer noted the project addresses low temperature combustion fundamentals to spray interactions, soot, and UHC formation while one reviewer added it addresses low emission combustion system understanding needed for efficient engines. One reviewer commented this project targets enabling the use of LTC combustion in HD diesels toward meeting future emission standards. Such modes of combustion are critical for engine OEMs in producing future engines that meet emission standards while delivering acceptable thermal efficiency. Comments from another reviewer mentioned this project provides an understanding of in-cylinder LTC combustion, including sprays, mixing, emissions, and efficiency. This understanding is critical to designing practical LTC combustion systems that can deliver their full potential. Another reviewer added this project is structured to gain fundamental understandings of LTC combustion for heavy duty applications, specifically unburned HC and CO emissions. As these understandings are absolutely necessary to enable LTC architecture, the project does support the DOE objective clearly of petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the goal of extending the now accepted diesel combustion model (Dec et al.) to multiple injection LTC with high rates of EGR is a very worthy one. However, how much of what is seen in the present work is geometry-specific is not well understood. Obviously the interaction of the injection spray geometry and the piston-bowl is critical to understanding the soot formation problems, for example, but how are the geometries selected? For the optical engine, the geometries are fixed, but what about the modeling? In other words is there a feedback mechanism to allow the piston and injector geometries to be modified in the future based either upon experimental or modeling results or both? Another reviewer commented it's a nicely balanced experimental and modeling approach. One reviewer noted this work is needed for calibrating CFD simulations of diesel fuel sprays and combustion.

Comments from another reviewer mentioned this project is very focused on better understanding LTC combustion; it is understood that this type of combustion mode will be critical in future diesel engines that must meet very stringent emission standards. The only suggestion for improvement from a large scale viewpoint is to also try to assess thermal efficiency impact associated with various injection strategies. Another reviewer added the hardware used in the investigations is relevant. The focus is on relevant strategies using practical piston designs. The approach is to apply state of the art optical techniques to observe the combustion and emission formation process and feed that information into CFD models. It is difficult to improve this kind of an approach significantly. Comments from one reviewer stated this project is well designed. It is a balanced project that uses 1D models (1D CFD), optical techniques, and 3D CFD to help build the necessary building blocks required for LTC.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the development of a fully comprehensive predictive model for LTC at high rates of EGR and for multiple injections is a very important and required focus of work. The 'entrainment wave' phenomenon seems to be important, but how much of this is a consequence of normal, real injection characteristics (the end of liquid injection) and how much is a 'new' standalone phenomenon? The Wall temperature diagnostic looks to be a fortuitous discovery, but will it turn out to provide a high enough fidelity temperature measurement to be useful? Will it be optical engine specific? (glass versus metal conductivities, for example). Another reviewer added there was nicely presented results on entrainment wave measurements and soot formation work for short and long injections. One reviewer mentioned they liked the entrainment wave model. How does different in-cylinder air motion affect this wave? The collaboration with KIVA models is good stuff. This is where a long term benefit to industry is helpful. The reviewer thinks there is a lot of stuff in A/F, swirl, bmep, and EGR that have large effects on this that need investigation. Overall, they are skeptical that this LTC is relevant for Heavy Duty. The project should be showing results for 1000 to 1800 kPa BMEP at low NO_x levels. This is real heavy duty territory. What about fuel economy? Comments from another reviewer noted this project is starting to produce useful qualitative information for engine OEMs on how to more intelligently choose main-pilot injection strategies in LTC combustion mode. Much work is still required in the future to better quantify the impact of injector geometry, combustion chamber design, and the timing of events on reducing soot while hopefully keeping NOx in an acceptable concentration range. Another reviewer commented the accomplishments identified fuel lean mixing after the end of injection as a cause for HC emissions. At the same time entrainment wave rapidly oxidizes soot near the injector. The study is revealing how post-injection interacts with soot left over from main injection and can reduce soot at some conditions. Going forward, multiple injection strategies such as these to reduce emissions and PM in-cylinder are going to be the key if LTC is going to be successful. This reviewer went on to say that smaller bowls allow hot combustion gases to interact with unburnt regions and oxidize them. Such understanding will permit the intelligent design of optimum piston bowls. These measurements are being used to create new CFD Models which are being used to fill-in holes where experiments have gaps. Observations of one reviewer noted that significant technical progress has been made. The entrainment wave analytics provide a working hypothesis as to where a dominant source of UHCs are coming from. The hypothesis looks to be validated through the use of experimental optical techniques and 3D CFD. In addition, it provided clear evidence as to the benefits of split injections in a LTC environment. Lastly, it provided strong evidence that the cause of UHC were linked to overly lean regions and not overly rich. It would be interesting to know whether this would general statement would hold up with different combustion geometries.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Four reviewers stated that there is a good collaboration with UW and industry for the budget allocated. One reviewer also went on to say Cummins and GM using entrainment wave phenomena in their R&D programs. Going forward, more benefits of understanding the "Entrainment Wave" should be advertised so that more users and designers of LTC combustion systems will be encouraged to make use of the EW's benefits. Another reviewer added the collaboration and coordination is excellent and this project has outstanding collaboration with the ERC KIVA group toward better understanding LTC combustion around a narrow operating condition window. Additionally, there is good collaboration with Cummins Inc. Comments from another reviewer noted the presentation highlighted effective collaboration with KIVA developers, industrial partners, etc.

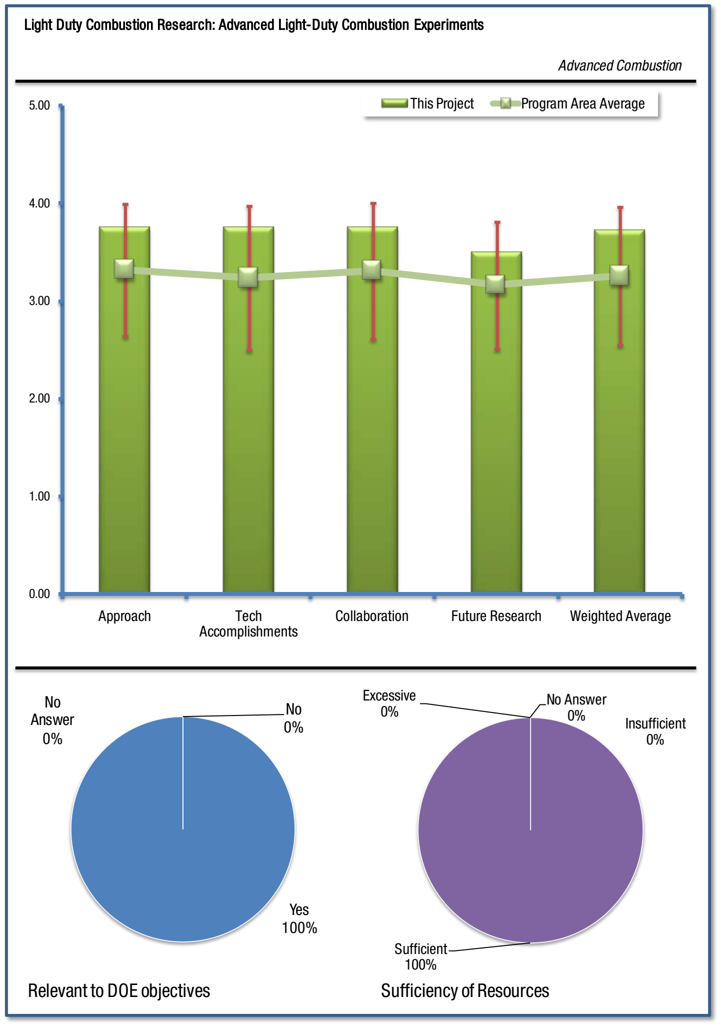
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated what about transient LTC behavior - or mode switching? The questions of relevance include will it be feasible to use the same hardware for both modes of combustion? Consider these issues or tell us that they do not matter. Another reviewer commented that wall temp diagnostics were mentioned, but not clear what future approach will be. Interactions observed with additional bowl and spray geometries would be beneficial. One reviewer noted the HD needs high BMEP and good fuel economy. They think this work is more light duty. Can we crank up the BMEP? Comments from another reviewer mentioned they recognize that there is still an abundance of experimental work in the future to improve the community's understanding of LTC combustion. Ultimately, this project must eventually result in the development of 'engineering' models or 'rules of thumb' for more intelligently choosing fuel injection strategies for LTC combustion. It would be useful to see more engineering modeling activities during the next year or two to address any ultimate goal of aiding engine OEMs in developing future LTC combustion strategies. Another reviewer added the future plans outlined in this presentation are exactly in line with the recommendations of the reviewer. The focus on various multiple injections schemes, understanding the EW's role during these multiple injection events and the interaction of post injection with main injection soot should be the focus. Observations from one reviewer stated the future program looks promising but they are left a bit unclear as to what the goals are. What exactly is meant by "a conceptual diesel model extended to LTC"?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated there was no indication of how many people are supported or the total amount of personnel time spent through the year. Another reviewer noted it was difficult to judge based on presentation. What is impeding the rate of research? One reviewer added this project has a very, very fair budget toward addressing the goals of this research. In the future it would be useful to know how the budget is split between hours (labor cost), materials, maintenance, etc in order to assess the sufficiency of funding level.

Light Duty Combustion Research: Advanced Light-Duty Combustion Experiments: Paul Miles (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is excellent work to develop understanding of complex processes in diesel engines. Another reviewer added the project reduced UHC and CO support both improved efficiency and reduced aftertreatment cost. One reviewer noted the project addresses issues and barriers for light-duty LTC combustion. This project aims to improve load range, minimize CO and HC emissions and cost. Comments from another reviewer mentioned this project focuses on low temperature combustion for light duty vehicular applications. Specifically, the objective aims to look at the sources of combustion inefficiencies (CO and UHC) emissions. Therefore, this project does support the overall DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the combination of optical, metal engine and detailed modeling is very strong. The efforts are well integrated. Another reviewer noted the approach needs to be careful research isn't engine geometry specific and can be translated to other designs. Long term goals should include plans to address this. One reviewer commented the approach is well thought out, coordinating the strengths of several institutions by focusing on near identical engine hardware. Engine matches metal engine at the University of Wisconsin. Combustion and emissions between the two engines are well matched. Comments from another reviewer mentioned it’s a strong approach which uses the optical engine at SNL and couples it with simulations done at UW.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is a good pace or research with significant progress this year. Another reviewer mentioned that clearance volume HC and CO, and near-injector HC sources identified earlier. But measurements do not show CO formation in bowl as the CFD did. Extended diagnostics were conducted to probe this source, with PIV to visualize liquid. The effort to locate this source within the bowl is commended, and should be pursued. One reviewer noted there was a strong improvement in optical measurements relative to 2007-2008 timeframe. The improvements largely stemmed from being able to get optical measurements in areas away from the squish where CFD analysis showed significant sources of UHC and CO.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is excellent collaboration through the MOU with other labs, academia, and industry. These results are going directly to people who are doing real engine design. Another reviewer commented that a good agreement is being obtained by the University of Wisconsin modeling effort. But we still do not see CO and UC source within the bowl. This discrepancy is very perplexing and should be pursued until the mystery is solved.

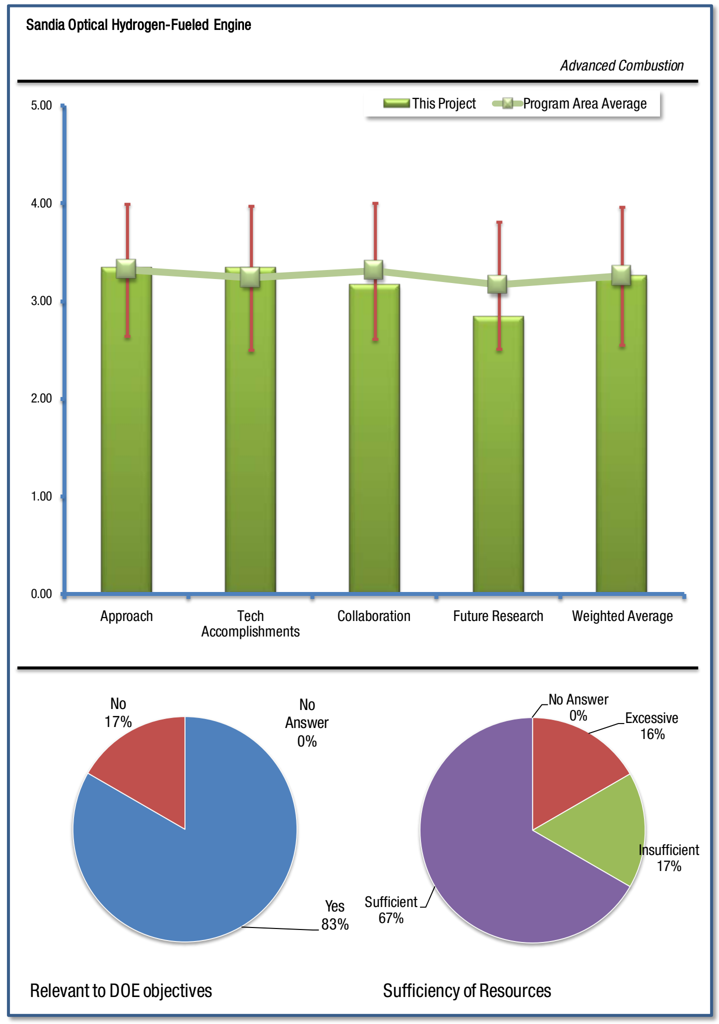
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the data should continue to be provided to refine models. Also, the planned work with close-spaced multiple late injections should be given high priority.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources for the project are about right.

Sandia Optical Hydrogen-Fueled Engine: Sebastian Kaiser (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the DOE should continue to investigate hydrogen as a fuel in ICEs, even though the use of fuel cells for mobile applications is being de-emphasized. An investigation like this is important to allow us to keep up with the feasibility of hydrogen use in engines. Another reviewer noted that H2ICE can be superior to fuel cells depending on the vehicle configuration. They can be a high value approach to sustainable, near zero emission transportation; depending on the source of the hydrogen. One reviewer commented the focus is on hydrogen which is a fuel that can potentially replace petroleum. Comments from another reviewer mentioned yes, if one assumes the hydrogen does not come from petroleum, otherwise, they are afraid this is a dead end. Another reviewer added the research is important for developing hydrogen combustion systems. The H2ICE fills a key niche prior to large scale adoption of fuel cell technology. Acceptance of H2ICE still depends on infrastructure on and on-board storage as key roadblocks. A remark from one reviewer questions the use of hydrogen being able to ever meet the DOE objectives of petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project aims at providing general insights into hydrogen injection and combustion. Engine geometries may be the key and yet it is tough to vary this in a comprehensive fashion in a project like this. Another reviewer added it's a good approach to using optical engine to obtaining better understanding of what takes place in hydrogen engine. One reviewer mentioned this is a good job of measurement and of using a tracer to make the PLIF work. Provides a reasonable insight into the combustion chamber and allows for calibrating a CFD model. Comments from another reviewer noted the project needs to insure results are generally applicable and not focused on one combustion system design (piston geometry and flow field due to intake port geometry for example).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated this is good progress but the project needs to be more integrated with simulation before the results can be used for engine design. The results were interesting on jet collapse using the 13 nozzle injector. Another reviewer noted the project developed good solutions to the problem of being able to more accurately view hydrogen stratification under different injection conditions. One reviewer commented they would like to see much more simulation. In-cylinder CFD could provide a lot of the same insight at lower cost. Now that the project has done this, the reviewer would expect to see a lot of work with simulation to optimize the setup over the speed and load map and look at different combustion shapes and nozzle geometries. One reviewer asked, what are the targets you are aiming for fuel air mixing? What is needed for good overall efficiency and maintain low NOx? What are the maximum equivalence ratios in the chamber?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a good collaboration with ANL and Ford. What about HD direct injection of hydrogen like Westport does? Another reviewer added there is a good collaboration with several automakers. One reviewer mentioned at least the project has a partner in Ford, but they could see this will be difficult to get partners due to the lack of fuel source.

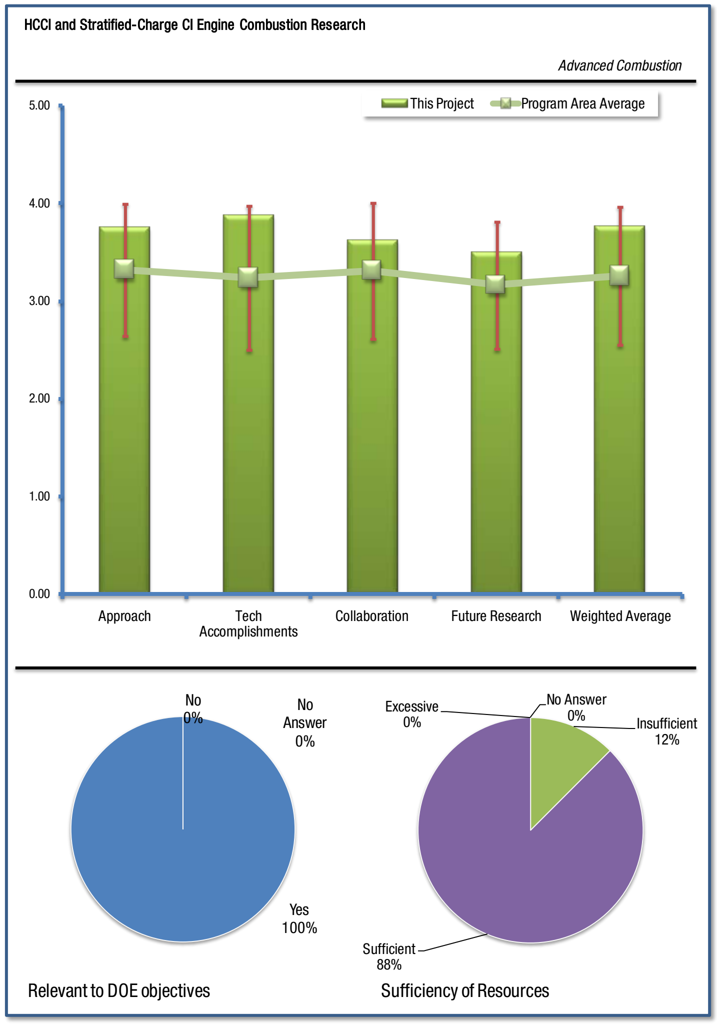
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated it is clear that this hydrogen imaging work is starting to track diesel injection strategies. Has the project considered the full range of state of the art injection diagnostics that are now being pursued for diesel work? Can the PI elucidate where hydrogen injection and diesel injection differ and where they are the same? Another reviewer commented the proposed work pan is good with extension of work to multi-injection strategies. One reviewer added they are not sure where this is going.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that compared to fuel cell funding, this promising area receives very low funding. If a breakthrough in hydrogen storage/infrastructure occurs, effective and affordable utilization paths such as H2ICE need to be ready. Another reviewer mentioned that the resources seem sufficient. One reviewer noted that they are spending plenty on a fuel with no source and no distribution system. Comments from another reviewer question the use of hydrogen being able to ever meet the DOE objectives of petroleum displacement. Therefore, they believe that this funding is excessive.

HCCI and Stratified-Charge CI Engine Combustion Research: John Dec (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that HCCI is an important fuel efficiency and low emissions strategy. The use of ethanol in HCCI is an important, novel new step in non-conventional combustion. Another reviewer added that this is great work that really extends the understanding of HCCI combustion. One reviewer mentioned this project addresses low emissions need, fuel economy, and alt fuels. Comments from another reviewer noted this research compliments the overall portfolio of LTC projects at SNL. Boosted HCCI fits nicely with downsizing/boosting being embraced by some OEMs. Ethanol HCCI is also appropriate. Observations by another reviewer stated this project is relevant from the viewpoint of possibly enable the use of non-standard combustion modes for meeting future emission standards while pushing engine load higher; good alternative project to counter work on DI diesel combustion R&D in LTC, HCCI, PCCI, and other alternative diesel modes. Another reviewer commented this addresses LTC barriers, like extending operating range to higher loads, CO and HC emissions at low loads and an understanding of in-cylinder mixing and combustion processes. The project is now including gasoline and ethanol fuels. This project also addresses the most relevant issues pertaining to LTC gasoline combustion for light-duty application, which has significant potential for reducing light-duty petroleum consumption. One reviewer noted this provides fundamental research towards enabling HCCI combustion. HCCI combustion still looks to achieve high thermal efficiencies at ultra low emissions. As thermal efficiencies are starting to look more promising than they have in the past, this does support the DOE objectives of petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that extending HCCI to much higher BMEP levels is an important application for the commercial success of this combustion mode in the future. Another reviewer noted the thermal stratification work seems to be a primary focus, while other aspects of HCCI haven't been investigated. Perhaps there should be a more balanced approach for the future? One reviewer commented the combination of optical, metal engines and modeling is very strong. Comments from another reviewer mentioned this is a good method for addressing the BMEP limitations of HCCI. They would like to see more modeling with this, both 1D cycle simulation and 3D CFD. Another reviewer added the project needs to address NVH of the boosted HCCI. Is ringing intensity a standard metric for NVH? Observations from one reviewer stated this experimental effort is very good. The only suggestion is to establish practical load limits for HCCI gasoline engines under real world intake charge temperature limitations. For example it is not practical to expect charge air temperature to approach ambient conditions in the real world application - this research has established such a theoretical limit based on ignition control under high load conditions. One reviewer talked about the use of a metal engine as well as an optical engine simultaneously is an excellent approach to understanding the in cylinder combustion processes. The metal engine serves as a platform that generated detailed issues for practical and relevant combustion phenomenon. These issues can then be probed in detail with the optical engine. Comments from another reviewer said one of the major technical barriers for HCCI operation is the extension of the load range. This work is clearly laying the groundwork as the load range has been extended to IMEP values that, to their knowledge, have not been previously demonstrated. This is fantastic work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there were good results on very high load using gasoline. Ethanol results are also very interesting and potentially important. One reviewer added the thermal stratification work is very interesting and helps clarify HCCI ignition while another reviewer said "good work on getting some high loads out of HCCI." Another reviewer commented they would like to see some cycle simulation work to go with this to show what is really needed from the air system to support this operation with high EGR and high boost. This could provide some good brake thermal efficiency estimates. Comments from another reviewer mentioned that there is good progress to date on establishing load limits on gasoline HCCI, in assessing ethanol versus gasoline combustion variances, and in exploring thermal stratification effects on combustion control. Observations from another reviewer noted thermal stratification is one key to increasing the high-load limit of HCCI, it allows lower pressure rise rate. Retarding injection timing further reduces pressure rise rate, so does EGR. Understanding how thermal stratification (TS) evolves has been advanced. TS develops as cold pockets, which are then transported into the central region as we progress towards TDC. TS increases as we progress towards TDC. Intake boost results: Run out of injection retard and reduction of intake temperature. They have determined that addition of EGR can result in further increases in load. The load levels achieved are impressive. Another reviewer stated it is great progress. Showed significant increases in load capability for gasoline based HCCI combustion (up to 16 bar IMEP).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a good collaboration and dissemination of information. Another reviewer mentioned this is a major part of the MOU collaboration. There is a solid transfer of knowledge to the industry and other researchers. One reviewer asked, are we working on being able to CFD simulation of this? The reviewer didn't see anything on this. This may require modeling the iron to get correct wall temperatures? Comments from another reviewer noted there is excellent collaboration with industry and another national lab. Possibly including UW-ERC in the future might be worthwhile in the kinetics development area. Another reviewer added appropriate and sufficient collaboration with relevant combustion modeling efforts at national labs, and consultation with OEMs and working groups is taking place.

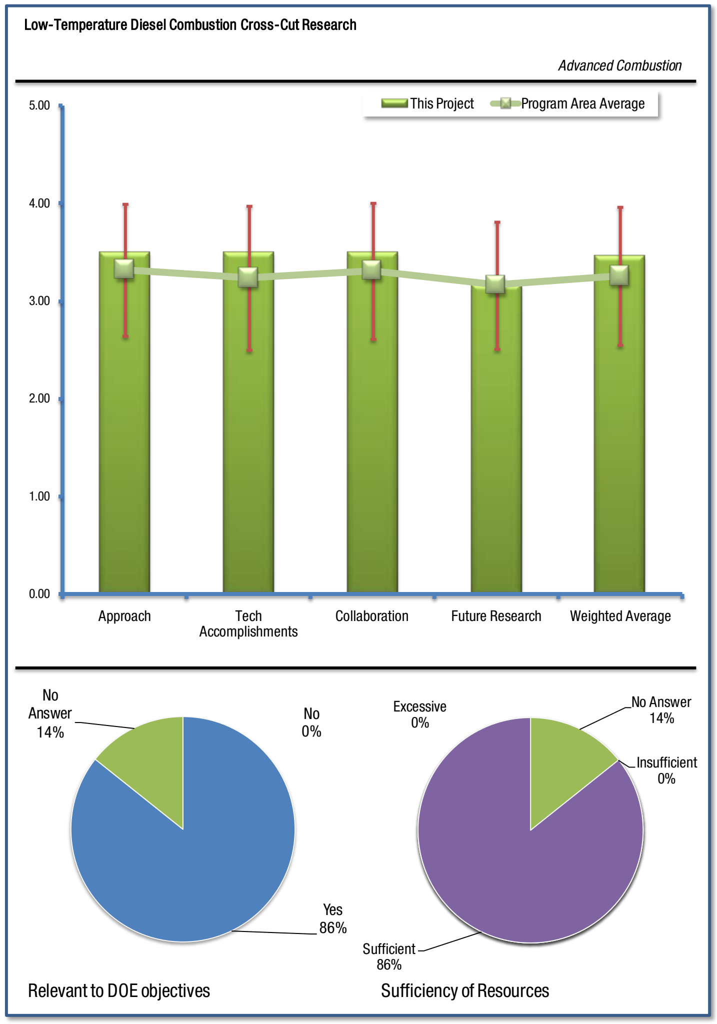
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated a good future pathway has been established. Another reviewer noted generally, the proposed research is very good. The only suggestion is to limit the high load HCCI excursions to practical intake temperatures during some part of this study, otherwise an opportunity will be lost to provide engine OEMs with practical boost limiting operating conditions. One reviewer mentioned the future work listed is all very relevant and critical. All aspects of this program should be continued.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that more funding would be useful, but managing the research effort gets tricky. Another reviewer noted the resources for the project are about right. One reviewer commented it is a well funded project. It would be nice to see the budget breakdown by labor, materials, maintenance, etc. Comments from another reviewer mentioned this program is making wonderful strides in extending the load range capability of HCCI. This is particularly important for engine applications that operate at high load for majority of their duty cycle.

Low-Temperature Diesel Combustion Cross-Cut Research: Lyle Pickett (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the project is working on complex injection spray dynamics and visualization important for modeling and simulation efforts, which in turn will lead to better engine designs for high efficiency, low emissions engines. One reviewer added the project addresses key fundamentals on mixing / atomization of Diesel combustion while another reviewer said the project is understanding injection and mixing is the key to understanding combustion. Another reviewer noted this project works on better understanding spray targeting under LTC conditions is relevant because it aids engine OEMs in developing injection strategies that must address any potential liquid-wall impingement effects that could lead to UHC and PM formation issues. Comments from another reviewer mentioned this work provides fundamental understanding of injector and spray effects on engine combustion and emissions. Another reviewer stated this work is fundamental to enabling low temperature combustion and avoiding the problems of liquid fuel impingement on liner surfaces.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this is a good approach to a complex situation - rendered complex by virtue of the large number of potential variables that can be varied while another reviewer said the presentation wasn't clear on what results were from optical engine and which from a combustion vessel. Another reviewer commented this is a good method of measuring liquid and vapor and putting the two together. They like how the project shows the variability of shot to shot. This is something that is often overlooked due to the lack of models being able to measure this. One reviewer added that one limitation to the experimental approach is lack of real world engine geometry that may impact the vapor head of the jet. Nevertheless, this constant volume bomb work is important for better understanding the transient behavior of the liquid jet regime and applying such knowledge to engine OEMs toward such combustion system development activities under LTC-like conditions. Comments from another reviewer mentioned the approach is to mimic engine temperature and pressure conditions in a constant volume chamber. While engine flows are not reproduced, the fundamental and quantitative understanding in a controlled environment is invaluable. The understanding not only directly impacts engine design but also aids in the development of engine combustion models via the Engine Combustion network. Observations from one reviewer noted the scope of project effort has strong focus on establishing the fundamentals of liquid length penetration and how it depends on in cylinder conditions and fuel properties. The reviewer sees this as fundamental to facilitating designs that allow early injections without causing liquid fuel impingement problems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there were good experimental results. Another reviewer added that there was impressive liquid/vapor during spray imaging. More background on technique would be nice in the presentation. One reviewer noted the project is showing the limiting factors that need to be understood to design a LTC combustion chamber. This is useful for designing a successful system, or for showing how it can't be done. Comments from another reviewer noted the generation of experimental transient liquid length data and the development of the steady-state time of liquid length scaling are significant accomplishments. It would be useful is these accomplishments were expanded to include the impact of the injection profile with time (effect of injector actuation) and also the latter steady-state liquid length scaling was explored using CFD under well known experimental conditions. Another reviewer stated the accomplishments help understanding liquid impingement on walls, especially at early injection conditions; advanced injection timing causes increased penetration. Studied effect of fuel type on penetration; exercised Siebers model for understanding. Existing spray models can be improved with this data.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the concept of the ECN and the uniform injector (Spray A) show that this group is attuned to close collaboration and coordination. The use of this project's results by others shows the importance of this work. Another reviewer noted the engine combustion network is a powerful database. Further examples on how information is applied would be useful. One reviewer commented that ECN is an excellent concept while another reviewer added this work is well published and advertised. Comments from another reviewer mentioned it looks like the future will include more collaboration with Universities and other labs. This list did not include the UW-ERC KIVA group - possibly it would be valuable to collaborate with this group given their extensive experience with various diesel engines.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

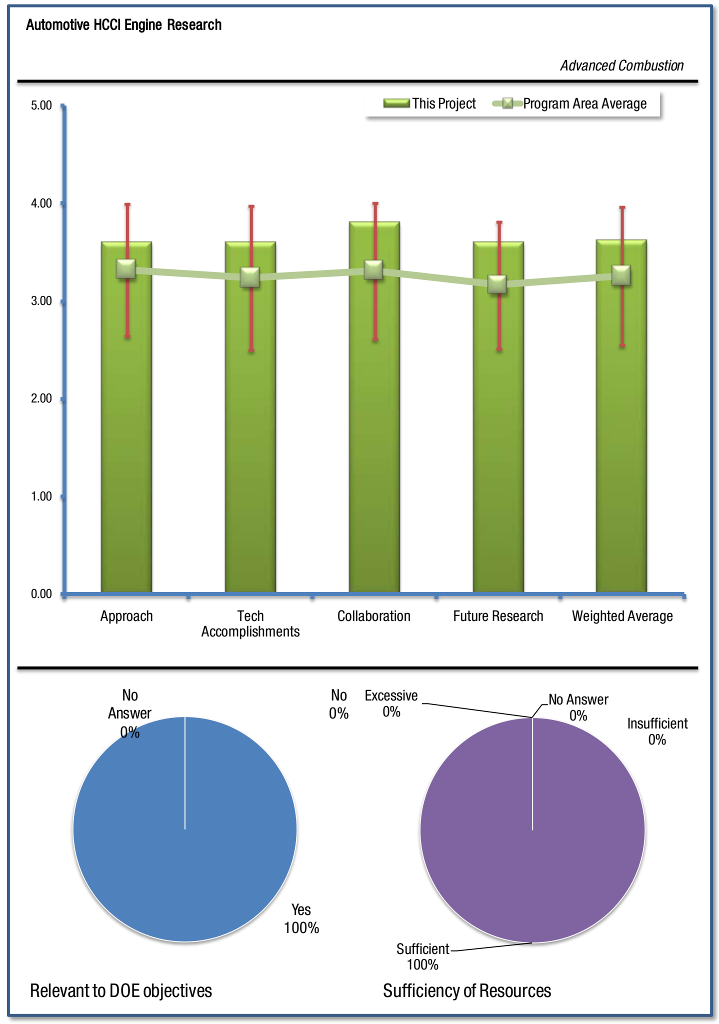
A reviewer stated the project needs to keep up the momentum. Another reviewer mentioned that some effort towards a user friendly engineering tool to make use of these findings would be beneficial.

One reviewer added this work is aimed at LTC, which is highly suspect as a long term solution for high BMEP engines. This means the challenge may be to have a combustion system that can run in a LTC mode and as a conventional high BMEP mode. Comments from another reviewer noted that overall, the proposed research is logical. It would be helpful to provide more validation of the proposed steady-state liquid length scaling as a function of parameters such as transient injection profile and injector nozzle geometry (internal geometry changes; k-factor, and internal hydro grinding).

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that more is always better when it comes to funding, but this is a good use of available funding. Another reviewer noted it’s hard to access without further information. One reviewer mentioned the funding is very fair for this project. It would be helpful in the future if funding was broken down by labor cost, material cost, maintenance, etc.

Automotive HCCI Engine Research: Dick Steeper (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the extension of HCCI combustion regime(s) to light-duty applications is important and should be pursued. Another reviewer asked what is HCCI benefit once an engine has been highly downsized and the window of HCCI operation is limited? One reviewer mentioned this project improves basic understanding of LTC for gasoline-based LD applications while another reviewer added the research dovetails well with overall portfolio of research being conducted on HCCI by SNL and others. Comments from another reviewer noted this project provides fundamental understanding of LTC combustion for light-duty application.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the focus is good, but it's not clear if this is aimed at diagnostics or modeling or experimental results (presumably a combination of all three). Another reviewer noted the simultaneous temp / composition diagnostics work seems very promising. What has limited the use of this technique on other applications? One reviewer commented this is a good solid approach. Comments from another reviewer mentioned the approach has been to use a metal engine and an optical engine to study the effects of thermal stratification and equivalence ratio stratification on the LTC process. Results are used directly for engine development as well as model improvement.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is good progress on a number of fronts. Another reviewer commented this was a nice presentation of split vs. main injection comparison. The affects of adding tracer on heat release, experimental and Chemkin are very useful. One reviewer added the project and accomplishments are making nice progress. Comments from another reviewer noted a comprehensive study of HCCI combustion utilizing negative valve overlap strategy has been undertaken. Various aspects of NVO HCCI fuel, heat release and phasing effects are beginning to be understood.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two reviewers stated there looks to be good collaboration and integration with industry and others. Three other reviewers noted the collaboration with Stanford/LLNL/ UWM is very good.

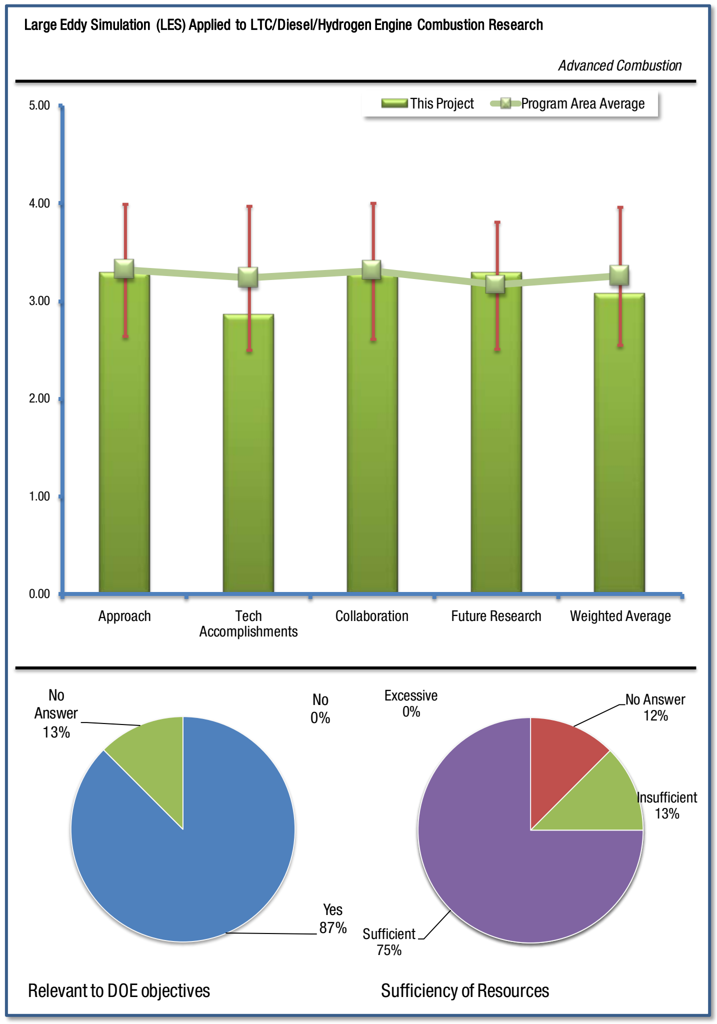
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the use of CO diagnostics seems promising - the motivation for using CO rather than other tracer's needs to be better quantified (other than a component/product usually found in combustion). Another reviewer asked is there any plan to address sensitivities to real world factors such as varying humidity, fuel composition, temperature etc? One reviewer mentioned it is good work and they look forward to the results. Comments from another reviewer noted that more experiments are planned to complete the understanding of NVO combustion on the main HCCI combustion.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer suggests accelerating work on transient combustion effects in mode transitions. Side vs. Central differences on mixing during NVO may be interesting. If hardware upgrades are hindering this work, then perhaps additional funding may be helpful?

Large Eddy Simulation (LES) Applied to LTC/Diesel/Hydrogen Engine Combustion Research: Joe Oefelein (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is a long term project with high potential payback. This kind of work can only be done in the national lab environment - and needs to be done. One reviewer noted the fundamental research is useful to confirm / dismiss theories based on experimental observations while another reviewer added LES may be an important tool for the future for the modeling of future engines. Another reviewer commented this is the kind of really fundamental work that industry can't do. Only the government can apply this level of resource. Comments from another reviewer mentioned it is relevant, but at this point the connection is weak due to the development nature of this computational tool. Ultimately, the hope is that this tool in the future will be used to study fluid mechanics and eventually combustion in engines such that future engine design efforts by engine OEMs will reap the benefits. This tool is years away from being useful as an engineering tool. Observations from one reviewer stated this project aims to develop multi scale models of various relevant engine combustion modes, including LTC, diesel and hydrogen. Another reviewer commented yes, this program can lead to fundamental physics understanding that cannot be gained through other computational approaches or even experimentally.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the integration of this form of highly complex modeling and experimental results is a useful approach. One reviewer commented that validation on H2ICE is useful, work towards application on hydrocarbon fuels while another reviewer added this is good work on an important problem. Another reviewer mentioned they like what the project is doing. We could never do this in industry. They would like to see diesel fuel instead of hydrogen. Comments from another reviewer noted the PI is doing his best to validate the fluid mechanics models and turbulence in particular. This effort definitely needs much more experimental validation and should include more collaboration with other sources who can provide data and/or perform necessary experiments. Observations from another reviewer commented the High Performance Computing capability of this project for numerical applications is unmatched. Another reviewer stated a strong case was made for why these simulations are needed and why the problem is so challenging. However, it is not clear how the high computational resources are intended to be used. Are there specific combustion modes that will be investigated? Hydrogen was mentioned as an early case study but wonder if that is a wise choice. Is there a roadmap? The presenter did acknowledge that this is the early stage and not so results oriented yet. This reviewer went on to say that more thought needs to be given as to how results will be validated. Although LES provides much more statistical information, the high level macroscopic variables should be compared first (average swirl, near wall velocities, etc.).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated they need to see more results - journal publications are good, but do we have access to actual animations of in-cylinder flow and injection characteristics? Another reviewer asked what specific understanding has resulted from this work that could not be obtained experimentally? More examples of validation cases would be useful. One reviewer noted interesting results; need to keep going to find how well it really matches the experiments and how predictive it is. Comments from another reviewer mentioned there were lots of neat pictures and look similar to the data. It seems as if the presenter is almost overwhelmed by all the data. The reviewer thinks this is one of the main challenges of LES. Once it is run, what does the reviewer do with all this? They think a methodology on how to post process all the data would be helpful to everyone. Observations from another reviewer noted it is difficult to assess the progress because the validation has been minimal to date. The reviewer recognizes that this effort is important toward providing engine OEMS with another diesel engine design tool and thus provides a fair rating but anticipates much progress within the next couple years. Another reviewer stated that good progress has been made in modeling hydrogen injection processes.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated good collaboration - but it would be useful to have more input from industry, particularly as this is the sort of work that industry would like to do, but simply cannot. Another reviewer noted the project is good at trying to model some hydrogen data, but they think more useful stuff is with diesel injections at very high pressures (300 MPa). This would be something to work towards. One reviewer asked why not have a CFD industry partner in this? Comments from another reviewer mentioned this project has shown very little collaboration with sources that could provide data or experimental services to support this effort. Is it possible to collaborate with UW-ERC, UMich, or others towards this end? Three reviewers agreed there were collaborations with other National Labs, along with Universities and other DOE offices. One of the reviewers also added there was a useful validation on H2ICE.

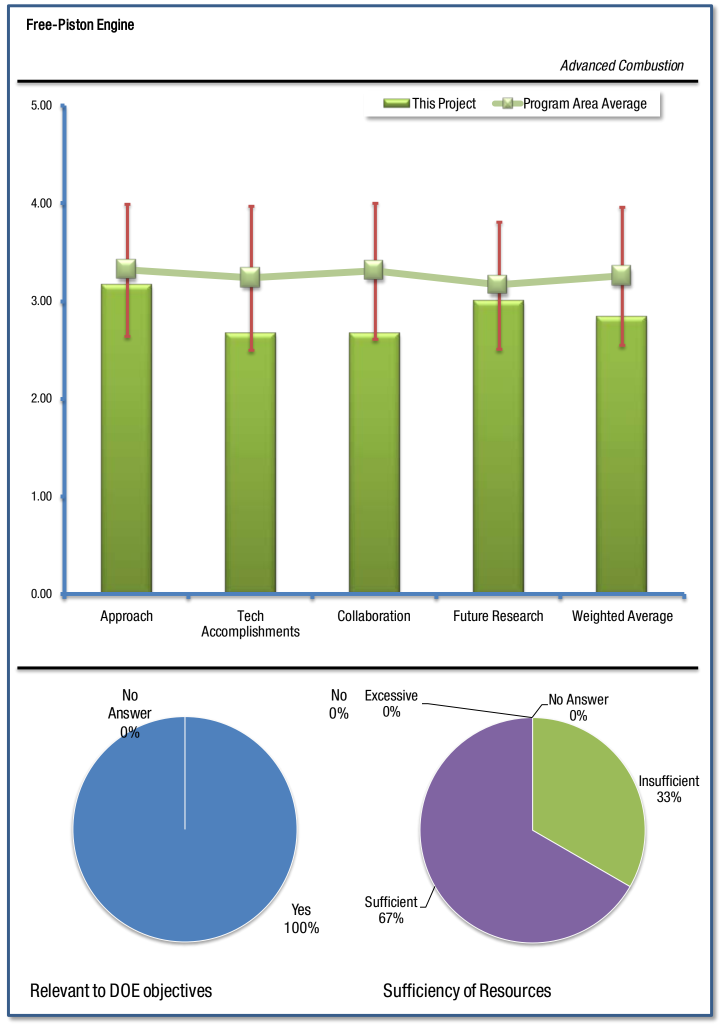
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated there was good future progression shown. Extension to HCCI is important, but is the hydrogen work really a priority, especially as this work is really only scratching the surface of diesel and HCCI simulation. Another reviewer commented direct injection process work planned for gasoline. One reviewer mentioned there is a good approach. The presenter seems a bit fuzzy on how they will quantify the benefits and quality of results. Work is needed on how to compare simulations to experiments and what constitutes "good enough". Comments from another reviewer noted they think this is important key work looking toward the future and is some of the most difficult work being done while one other reviewer would like to see more other toward validation with other labs and universities. Observations from another reviewer added the rate of progress to model liquid fuel sprays and HCCI mixing and combustion in engines should be accelerated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that more is always better particularly when Cray hours are concerned. More output would be useful. Another reviewer added that assuming access to appropriate computational resources exists in the future. One reviewer noted this might be an area where more investment is needed. Comments from another reviewer mentioned this project has a very fair amount of funding - it would be helpful to see a cost breakdown including labor cost, materials, test and evaluation, etc.

Free-Piston Engine: Peter Van Blarigan (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is a high risk, long pay-off project, but it should be pursued by DOE (if DOE didn't fund it, who would?) The potential efficiency of this engine makes it worth pursuing. Another reviewer mentioned this project is about hydrogen alternate fuel. One reviewer commented the focus is on engine design that could potentially be more efficient than conventional ICE's. Also potential for variety of fuels, including non-petroleum derived. Comments from another reviewer noted if implemented it supports overall DOE objectives. Understanding more of how the OEM partner, GM, values the project would be helpful. Observations from another reviewer added has the potential of very high efficiency via high compression ratio and constant volume combustion; has multi-fuel capability; employs LTC combustion and so has the potential for low NOx; also low cost. They are expecting 56% indicated thermal efficiency and a 50% brake thermal efficiency. Another reviewer stated this program provides an interesting approach to enabling HCCI combustion and is also looking to break the thermal efficiency barrier of 50%. Therefore, this does support the overall objective of petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this is a long and slow progress. The approach seems to be ad-hoc on a year to year basis, probably as a result of the limited and erratic funding. One reviewer noted there is too much on power electronics side, without addressing high CR hydrogen in a low-cost prove-out rig for heat transfer effects etc. while another reviewer said the proposed approach of building and testing a research prototype one of these engines is good. Another reviewer commented it is understood the research is proof of principle but the key barriers with a practical implementation need to be understood for research which has been conducted for this period of time. Comments from another reviewer mentioned there is a need to understand the overall efficiency to allow it to be compared to other ICEs. Another reviewer stated the approach is to design and build a free-piston engine alternator that can demonstrate the high efficiency claims. Observations from another reviewer added the approach seems reasonable. However, in looking at the historical timeline, it appears that the program has moved around quite a bit with the most recent change being to an opposed piston design. This design can offer some benefits although it may be more complicated to realize in principle. The reviewer would have preferred to have seen this demonstrated without the opposed piston first, in addition, expect that this concept also has value for non HCCI type combustion events. Would be nice to understand why those have not taken off. This reviewer agrees that HCCI is interesting because of the variable compression ratio capability. It was not clear exactly how the variable compression ratio would be used across the load schedule.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there were good accomplishments for the budget expended. Another reviewer noted to get it running. One reviewer added the progress seems to have been good on design and construction of the engine setup. The key will be to continue progress with experiments. Comments from another reviewer mentioned there is reasonable progress but need to see testing. Two reviewers agreed the progress has been slow with one of them adding need to establish proof of principle and key implementation barriers and then make a go/no go decision. The other reviewer who said the progress was slow also stated perhaps funding should be increased and more resources put on the project, especially the experimental part. The important thing is to demonstrate the potential for high efficiency just for the engine first. Has that been experimentally demonstrated in the last 14 years? On the other hand, is piston synchronization going to be the Achilles heel for this concept? Is the ability to achieve and maintain the desired compression ratio going to be the main problem? These are serious questions but it seems like progress towards answering any one of these questions has been slow.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated better collaboration with others would be preferable, although the limitations of the budget and the scarcity of interest from outside interest would explain this. Another reviewer commented LANL, GM, UM, and Stanford were listed as partners, although not clear what roles each play and extent of collaboration. One reviewer mentioned the collaboration is unclear. Appears that there are industrial partners interested but didn't seem as integrated as other DOE programs under review.

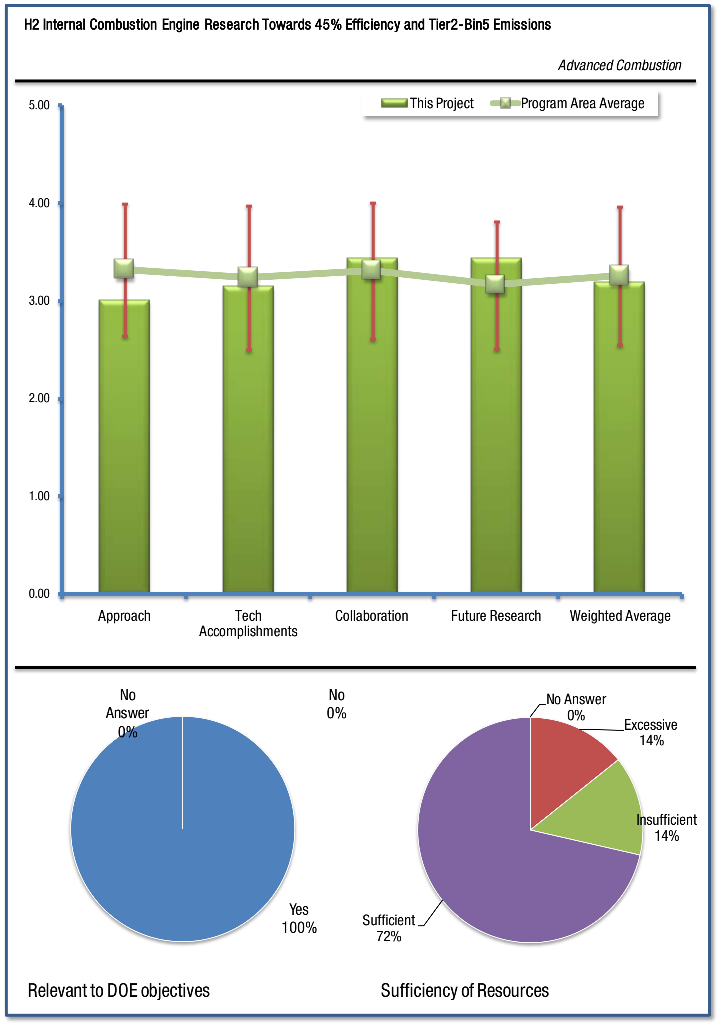
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future work is claiming that a wide range of conventional and alternative fuels will be tested in the next period is probably premature, noting the history of this project. Another reviewer added the key will be results from initial proof-of-concept experiments. One reviewer noted the future plans look ambitious and speak to testing all sorts of different fuels. Good to be forward looking but it appears that there is an enormous amount of learning that needs to take place with a single fuel first.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the funding for this project has never been enough to do much more than keep it on life-support. Another reviewer commented there is no evidence that resources are not appropriate. One reviewer added it seems like more funds to accelerate the experimental part of the program is needed. Comments from another reviewer mentioned recognizing that this is a different engine architecture with high risk; it is possible that increased funds to help get experimentation underway may provide benefit.

H_2 Internal Combustion Engine Research Towards 45% Efficiency and Tier2-Bin5 Emissions: Thomas Wallner (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated hydrogen as a fuel in light-duty and heavy-duty engines is a worthwhile approach. Another reviewer added H2ICE can offer a clean, sustainable path to efficient transportation. While shown to be comparable efficiency to fuel cells, H2ICE has only a tiny fraction of the development budget. One reviewer noted the project has some relevance if hydrogen should go anywhere while another reviewer said yes, if you have a hydrogen source that is not derived from petroleum. Comments from another reviewer mentioned H2ICE fills niche prior to widespread roll out of fuel cell technology. This dovetails well with the other H2ICE project (Kaiser). Another reviewer stated it has potential for high efficiency. No carbon combustion is involved. Observations by another reviewer commented it is their opinion that hydrogen research with regard to internal combustion engines will not lead to the DOE objective of petroleum displacement. There are currently too many barriers (production, storage, distribution, etc). This program does provide fundamental learning but without line of sight to hydrogen based transportation system; this reviewer doesn't see this work as supporting the DOE objectives of petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project is well-defined and responsive to modifications suggested in previous years. Another reviewer added the approach with one hole injector allows fundamental mixing/timing investigations. One reviewer mentioned the approach is developing diagnostics. Comments from another reviewer noted it seems like they threw together some hardware and found it doesn't work so well. Maybe we should do some CFD analysis first! Maybe we do some cycle simulation analysis to show how we are going to get to 45% efficiency. The reviewer would like to see a good analysis done first. Observations from another reviewer suggested having more detail on whether the project will estimate the emissions vs. goal of T2B5. Is T2B5 still appropriate for ongoing work? Another reviewer stated the approach is sound, involving integrated optical engine work, CFD, and injector design work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is very good progress. The incorporation of EGR and water injection is promising technologies. The efficiency improvements shown do not corroborate the 45% thermal efficiency claim. One reviewer added there is good work balance of efficiency vs. emissions tradeoff while another reviewer said good progress, but still missing many variables. Another reviewer asked what is the optimized bore/stroke ratio? What analysis supports this and how much gain is there? If we were going to do EGR, we should have modeled the effect and then designed a system and ran it. Comments from another reviewer mentioned the work seems like it could progress faster. Did they have to spend time investigating injection angle values where they know the engine would run poorly? Also, some perspective needs to be given to the program. What is the target efficiency for the program? How do they know whether they are doing good or bad? Would not any conclusions for NOx reduction have to be made at constant thermal efficiency? How are the test points chosen? E.g., how is the 1000 RPM, 6 bar IMEP point relevant? More focus should be on answering the key question of whether a Hydrogen ICE has a chance as a competitor to the gasoline or diesel ICE.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that collaboration with Sandia, BMW and Ford seems to be at an appropriate level for a project such as this. Another reviewer noted the Sandia collaboration is promising, encouraged to continue. One reviewer added there is a close relation with industrial and research partners while another reviewer commented that continued collaboration with OEM is valuable. Comments from another reviewer mentioned some collaboration with Ford and BMW in the future. Will there be any collaboration with anyone else? This seems like a project for Ford. Another reviewer stated the collaboration is adequate.

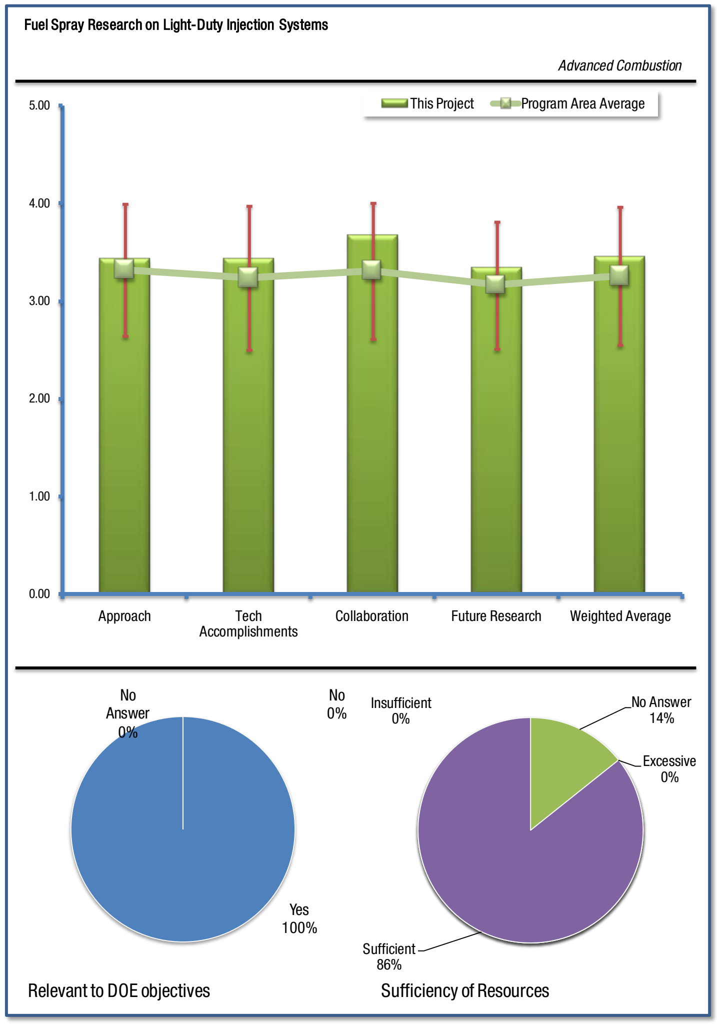
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the use of next generation piezo injectors and EGR are a good addition to this project. Another reviewer commented there is a logical continuation of the program. One reviewer added the project is showing EGR is needed. But is it a really a mixing problem. The reviewers understanding is that hydrogen can burn lean enough to not create NOx. Comments from another reviewer noted an assessment of the engine's efficiency and engine-out NOx at a couple of common points should be made relative to a relevant gasoline or diesel engine benchmark.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that compared to fuel cell research, H2ICE is nearer term and with similar costs to gasoline conventional engines. With additional funding, H2ICE may further improve such injector challenges and overall efficiency.

Fuel Spray Research on Light-Duty Injection Systems: Christopher Powell (Argonne National Laboratory (ANL))



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the quantitative measurement and diagnosis of sprays is an important task that has widespread relevance to SI and CI combustion using a wide range of fuels. Argonne has a unique capability in this respect. Another reviewer mentioned additional spray measurement technique lends to knowledge base. Mixing and atomization of diesel sprays have been shown to be the key to efficiency and emissions behavior. Spray modeling advances are needed. One reviewer added the focus on making low temperature combustion is more practical while another reviewer said all DI engines are dependent in injector spray; this needs solid understanding. Comments from another reviewer noted this can lead us to a better understanding of how to make better fuel injectors which will lead to better engines. Observations from another reviewer commented the project provides basic understanding of fuel spray behavior. This understanding should help improve models of sprays and the design of advanced combustion concepts.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated there is good focus on experimental studies of sprays. These studies are of great interest to the modelers and this is a unique capability that deserves to be supported. One reviewer noted impressive results of injector needle and spray behavior while another reviewer added the approach of using x-rays to study the spray seems reasonable. Another reviewer commented nice use of very special equipment for a practical set of experiments. There isn't any other way to see this stuff. Comments from another reviewer mentioned a good technical approach to measure needle motion and fuel sprays and it has yielded good results. Observations from another reviewer said X-ray imaging to produce time based resolution is unique to this project. Project needs to continue to tie research to engine performance (or performance deficiencies). Another reviewer stated X-ray imaging is a unique diagnostic that most conventional diagnostics cannot match. It provides a true nature of dense sprays.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated there has been good progress over the years, with a good plan laid out. Another reviewer asked what is the significance of a wider spray from the 3 hole nozzle versus the 5 hole nozzle in engine operation? One reviewer mentioned there are very interesting results showing irregular, nonsymmetrical oscillatory motions of actual needles. There is also good work in linking that to observed spray patterns. Comments from another reviewer noted

this is some of the best visualizations of needle motion and fuel spray visualization they have seen. Another reviewer added the following: Effect of L/D, 3-d distribution and needle lift visualization.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is good collaboration - these are very important studies for calibrating spray dynamics for high resolution CFD work. Another reviewer noted it's good to collaborate with Bosch and Delphi. One reviewer added some collaboration mentioned with ERC and Sandia. The PI also mentioned getting injectors and nozzles from Bosch and Delphi - not clear if these are collaborations or just donation of equipment from those companies. Comments from one reviewer mentioned there is close work with industry and other researchers while another reviewer said its good tie in to fuel manufacturers who can benefit from this. Another reviewer stated to continue collaborations with injector suppliers and combustion research to isolate important injector design factors.

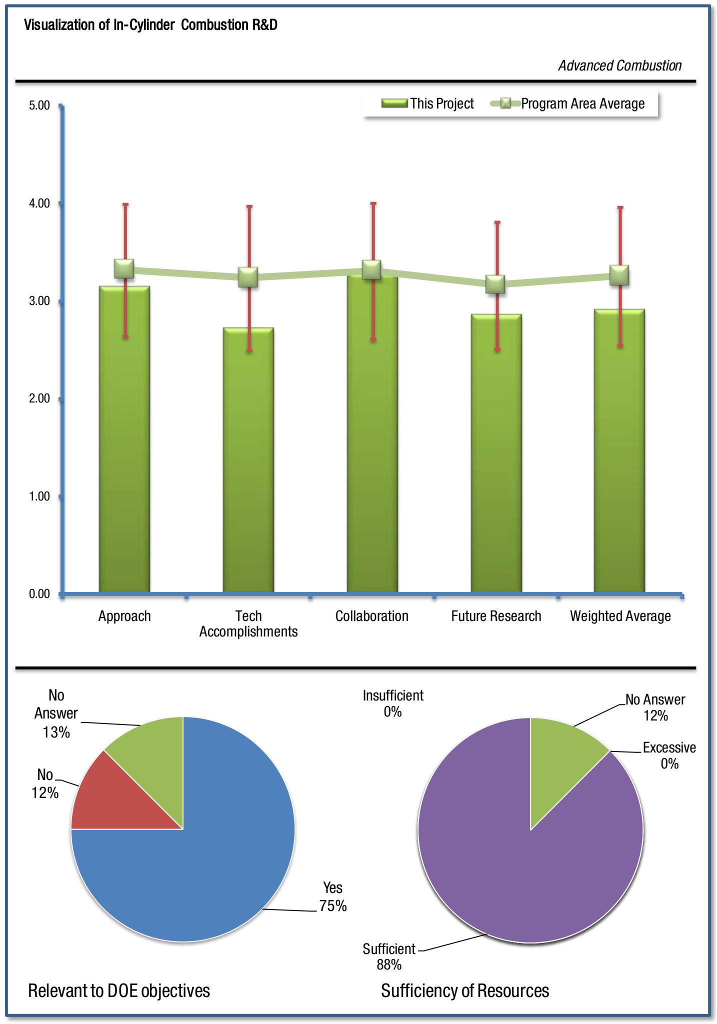
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated there are realistic plans for future work. Another reviewer commented strengthening ties to engine experiments should occur as a high priority. One reviewer mentioned the plans seem to support and built on recent progress. New dedicated experimental station should enable even faster progress.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this is a good use of funds allowed. Cost sharing (effectively) from BES, this is encouraging to see. Another reviewer added it was nice to hear that greater facility access has been arranged. How will increased time be used most effectively? One reviewer noted there was no indication that resources are insufficient or excessive.

Visualization of In-Cylinder Combustion R&D: Steve Ciatti (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the in-cylinder visualization in LTC is an important adjunct to the spray visualization studies and modeling studies. Another reviewer added that low temp combustion offers fuel economy and emissions benefits. One reviewer mentioned that HCCI combustion is relevant. Comments from another reviewer asked this improves fuel economy how? The project is still using petroleum fuels. Lower CR leads to lower economy. Observations from another reviewer noted this project is relevant - it should help establish high load operating limits on LTC combustion based on critical fuel properties (cetane number and volatility). The current state of the project is in the experimental set-up phase and future results will be relevant. This is a good project. Another reviewer stated this project aims to add understanding to control of LTC.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project is very responsive to previous comments and reviewer input. Another reviewer commented nice engine controller layout. Realistic constraints on combustion NVH should be incorporated into plans. Expand more on endoscopic plans. One reviewer added they don't see that much new. The endoscope is quite limited compared to optical engines so they would not expect new observations. It may be useful for investigations where optical engines are not available. Comments from another reviewer mentioned it appears to be just a large mapping exercise to see if we can calibrate an engine to run in this BMEP range by giving ourselves a lot of knobs to turn to try and optimize stratification. Be clearer on how the endoscope will give information that will feed back into the engine operation. Observations from another reviewer noted this project is at the state of commissioning the experimental set-up and the proposed approach is excellent covering wide ignition range fuels with various volatility ranges. Another reviewer stated the approach is good. However, can an endoscope provide enough information to aid in understanding the LTC combustion process well enough to better control it? One other reviewer said the mechanism to control LTC is an area that still needs fundamental research. Looking at low cetane/low octane "crossover" type fuel is an interesting concept to study. Not sure if power density in the 5 to 10 bar BMEP is attainable.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is good progress in getting engine and engine control up and running. Now there is a good open avenue ahead for future progress. Two reviewers agreed the project is still just starting, with one adding that substantial findings are expected during 2009. One reviewer noted the project is doing an excellent job of putting an engine test together and getting all the hardware and test equipment to come together. The reviewer is not sure what the efficiency goals are? What does the CFD prediction say about the lower compression ratios? Comments from another reviewer added this appears to be a relatively new project and the experimental set-up should be commissioned very soon. Accomplishments and results are not available yet. Observations from another reviewer mentioned faster progress will have to be made in the next period if significant contributions are going to be made before the project ends in 2010. Another reviewer stated progress on setting up test engine appears to be significant. Progress appears to have been dependent on getting a new post doc student on site.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two reviewers stated there is a good collaboration with OEMs, injection system suppliers, universities, fuels providers and National Labs. Another reviewer added the project should continue ERC communication. One reviewer commented the project seems to be plugged in to other activities. Comments from another reviewer noted if they can use measurements to calibrate some CFD models and then use the models to improve the engine, then they have something. Observations from another reviewer mentioned the collaboration seem adequate among the partners. Another reviewer stated the use of low cetane/high volatility FACE diesel fuels will be possible.

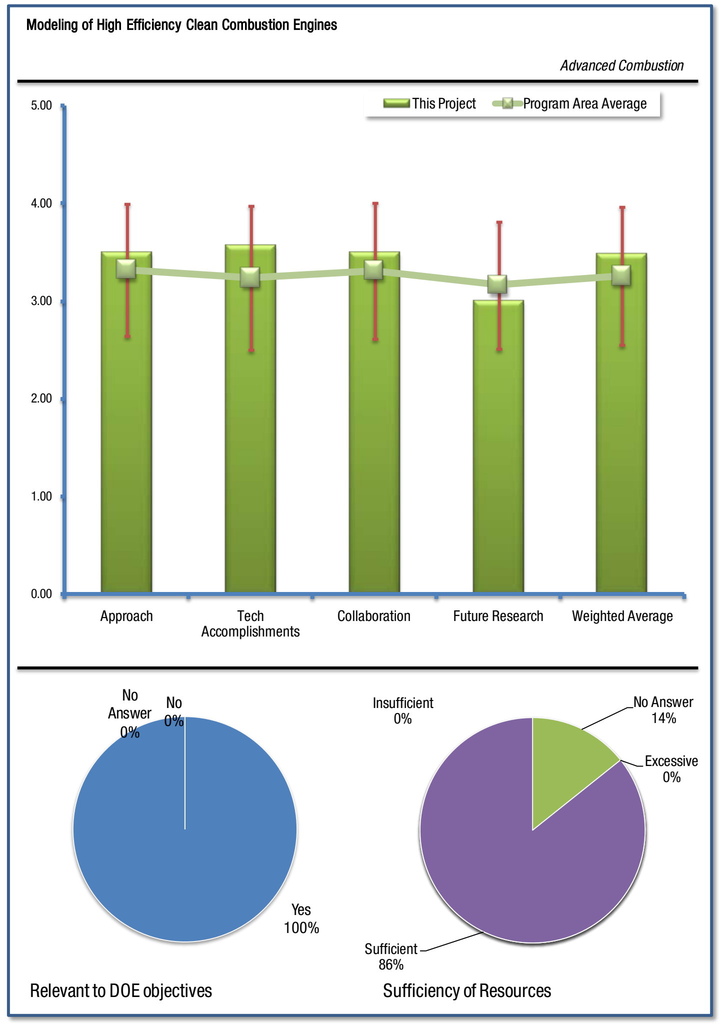
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future path seems well thought-out, even if the plans for the future seem somewhat 'spur of the moment'. They expect good things from this project - if only because it is a truly one-of-a-kind project. Another reviewer noted they don't expect much of anything new from this. The approach seems fuzzy and undefined, more of "let’s go see what we see". The reviewer thinks the endoscope will turn out to be quite limited. One reviewer mentioned the experimental set-up will be commissioned soon and the proposed research plan is good for now and will be expanded in the future based on output during the next fiscal year. Comments from another reviewer added there is one problem with this project is that it overlaps with similar projects at Sandia, Oakridge, U. of Michigan Consortium and perhaps others. It has also started fairly recently (last year). The reviewer doesn’t clearly know how this project is going to be distinct from these others. What is it going to contribute to the control of LTC combustion that the others are not already doing so? Also, this project should pay close attention to what has already been done at these other institutions so unnecessary duplication does not take place. Observations from one reviewer commented that research into a low cost fuel that may simply be a heavy straight run naphtha off a crude unit would be of interest to the oil industry.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the work seems to match the budget. Another reviewer added there should be a large enough budget to execute this effort assuming the PI doesn't run into any more major hardware issues.

Modeling of High Efficiency Clean Combustion Engines: Salvador Aceves (Lawrence Livermore National Laboratory (LLNL))



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the development of computational tools for future engines and new combustion regimes is an important area for DOE's involvement. One reviewer noted there are clean, efficient engine analysis tools while another reviewer said the numerical modeling work should enable the design or cleaner, more efficient engines. Comments from another reviewer mentioned this project should provide a possible simplified combustion analysis tool for engine researchers working on direct injection, near homogeneous combustion strategies for both gasoline and diesel engines. Another reviewer commented this project provides the modeling support necessary for the all the experiments being conducted in the other labs. Modeling such as this is the vehicle that retains the integrated learning and intelligence.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated it's a good, broad-fronted approach to collaboration in engine modeling is a worthy area for DOE to sponsor. Another reviewer mentioned the approach of finding ways to significantly reduce computational time is very valuable. One reviewer commented improving accuracy at higher intake pressures supports downsizing boosting approaches. Comments from another reviewer noted this project has been predominately focused on developing simulation tools for HCCI type combustion mode researchers. The only concern with this approach is lack of experimental validation. The reviewer realizes the major objective is model development, but validation will be critical if such tools are to be useful for engine OEMs. Observations from another reviewer added CHEMKIN; come up with a faster algorithm to generate and solve the Jacobian.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated a wide range of tools under development for computational modeling - the 'democratization' of high fidelity engine modeling is useful for most researchers. Another reviewer commented there has been excellent progress in reducing computation time by 1-2+ orders of magnitude. Also very good success in applying the models to the unstable combustion results obtained at ORNL as EGR was increased. The project also made improvements to kinetics model for combustion of a surrogate fuel and to the KIVA models. One reviewer noted reducing computational time to enable detailed multi-zone kinetics on a desktop is a significant accomplishment. Modeling of the transition will be very helpful in developing LTC control systems and calibration. Comments from another reviewer noted this project has continued to improve upon the required computational time for solving the governing equations associated with multi-zone, homogeneous type combustion. Excellent work reducing the computational requirements down to a PC level processor. Observations from another reviewer added the accomplishments successfully modeled ORNL data on transition between SI and HCCI combustion modes along with the Sandia HCCI engine (Steeper). Another reviewer asked what are the accomplishments and progress toward optimizing kinetic simulations of HCCI operation?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there are a wide range of collaborations with universities, OEMs, and others. Another reviewer noted very good extent of collaborations with researchers at other national labs and universities. There are fewer collaborations (one) with industrial companies. One reviewer commented to continue interaction with ORNL engine research. Comments from another reviewer added there is a great collaboration with other labs and various Universities. It would be useful if industry was involved in order to help validate the developed models versus taking on this process after the fact.

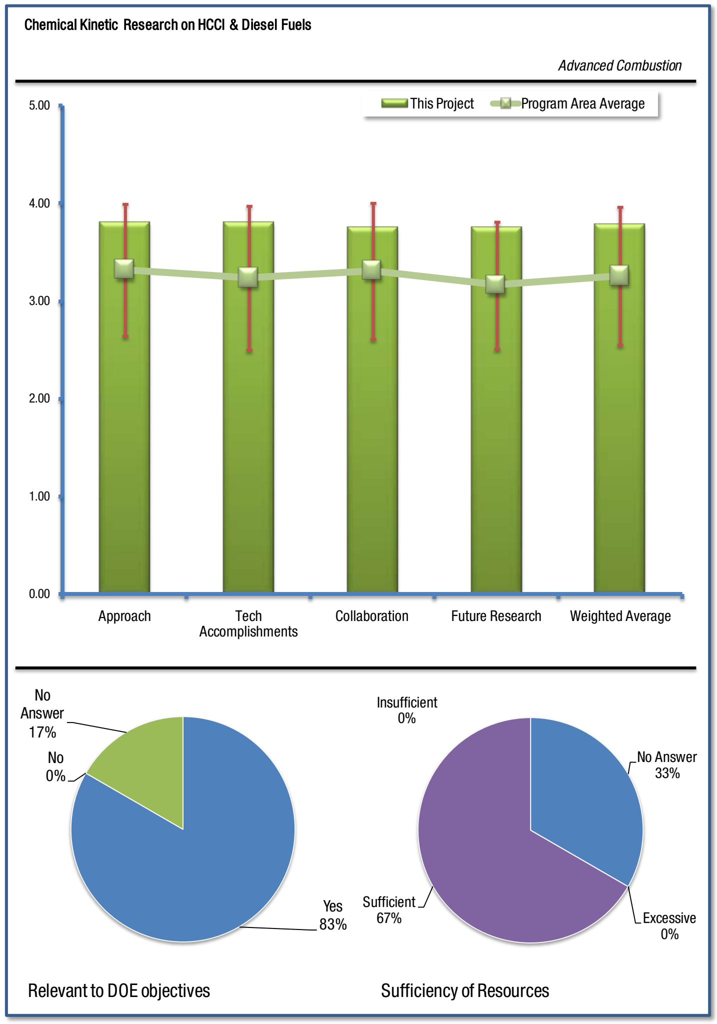
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future plans look somewhat thin and sketchy but appropriate under the circumstances, they suppose, noting that the idea behind this work is to be responsive to outside users. Another reviewer added the goal of enabling CHEMKIN and KIVA type models on PC's instead of supercomputers is a very desirable one. One reviewer noted the future research needs more detail. Comments from another reviewer mentioned overall, commercialization of the various codes is great. It would be nice to see more validation with industry and an associated iterative process to improve/modify each combustion system model. It wasn't clear if this project will be engaged in such an iterative process in the near future.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this project has a fairly lavish budget by present-day funding standards. Another reviewer commented this project seems to have a very good funding profile - it is difficult to assess if funding is excessive without studying the cost breakdown, i.e. labor, subcontracts, etc.

Chemical Kinetic Research on HCCI & Diesel Fuels: William Pitz (Lawrence Livermore National Laboratory (LLNL))



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the development of chemical kinetic models (both fully comprehensive and reduced order models) is very important to extend the use and reach of computational engine models that include chemical reaction modeling. Another reviewer noted there is a strong relevance especially for HCCI/PCCI work. One reviewer added this project is the same as the previous presentation. Comments from another reviewer mentioned this project improves our basic understanding of fuels.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this looks like a systematic approach to model the major components (or surrogates thereof) of diesel and gasoline fuel. Another reviewer added this is the right approach to extending and improving combustion models. One reviewer commented the PI has a good plan and have laid out a nice order of fuels to model. Comments from another reviewer noted that looking at a wide variety of fuels that have the potential of displacing petroleum based fuels. This project is developing models for each of these.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there were a wide range of technical accomplishments on this project, which broadens the reach of this type of modeling. Another reviewer mentioned nice progress on molecules of interest. One reviewer noted we now finally have models for typical automotive fuels. Comments from another reviewer added that work on surrogates for diesel fuel is a significant accomplishment. This is a good start on biodiesel.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a good collaboration and coordination with users and experimentalists. This is to be commended. Another reviewer noted there is a good model of government sponsored research supporting academic and industrial needs.

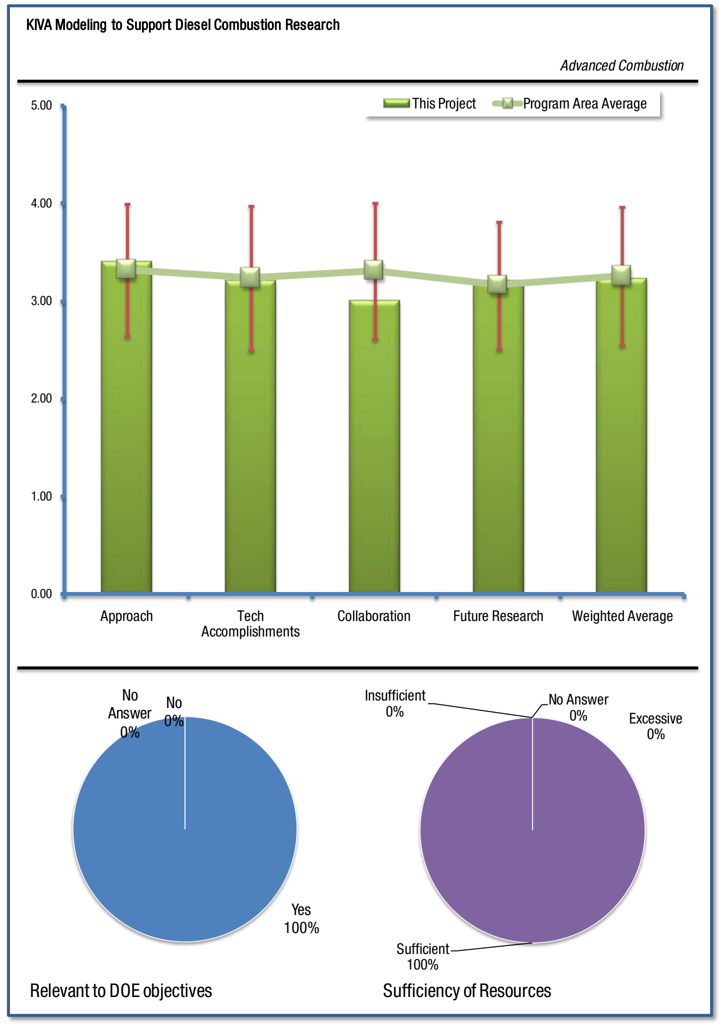
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future plans seem systematic in establishing priorities for studying the next set of fuel components. Is there not more interest in creating reduced order kinetic models amongst the end-users? Another reviewer commented to keep closing the loop holes.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

None of the reviewers commented on this question.

KIVA Modeling to Support Diesel Combustion Research: David Carrington (Los Alamos National Laboratory (LANL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that KIVA has become an industry standard, and so needs to be maintained and updated. Another reviewer noted that good modeling is the key to improving engine efficiency. One reviewer commented the project supports the objective indirectly by enabling improved understanding of combustion. Comments from another reviewer mentioned this project is relevant at some level - it is aimed at developing KIVA-IV for use in modeling IC engines. It is unclear at this point what level of anticipated improvement in engine design is possible in comparison to KIVA-III. Observations from another reviewer added KIVA has been the primary model that industry and others have used. A continuous improvement of all aspects of the model must continue to keep up with the latest needs of modelers, improvements in numerical algorithms and computer speed and memory, and changes in the needs and direction of the end users.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the selection of problems to choose to investigate seems confusing (heat transfer in solids?). Another reviewer commented it is clear what the plans are to improve KIVA and goes well with engine research. One reviewer mentioned that cut cell meshing technology is a very important technology for IC engine simulations. A commercial code called Converge already has such capabilities. How does this approach compare? Comments from another reviewer added that overall the approach is very good, but it would be nice to include more experimental validation. Perhaps collaboration with UW-ERC or some other engine test/evaluation lab could provide experimental data to assist with such validation. It will be critical that the PIs iterate on improving the thermal boundary layer equations and wall-film modeling solution resolution if this tool will more accurately assess heat transfer in comparison to KIVA-III. Observations from one reviewer added there was a good understanding of the needs of KIVA users is evident.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated it's not clear what transient 1D thermal conduction in a slab has to do with KIVA, or any other in-cylinder engine modeling. Heat transfer at the wall or to the wall is obviously important, but don't engine model developers have better things to do with their time and efforts? Another reviewer noted the cut cell and the h-p methods will be great improvements. One reviewer commented there is fair progress in modifying KIVA-III to accommodate the new grid generation approach and also other sub models such as wall film and boundary layer thickness. Much work still needs to be done to validate these sub models; the current mesh size is insufficient for predicting both predicting heat transfer and liquid film. Comments from another reviewer added that good progress is being made.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated that collaboration exists but why were those particular partners chosen? Another reviewer added that partnering with Iowa State to test model vs. experimentation is good. Continue to pursue experimental validation of model improvements. One reviewer mentioned it seems like UW-ERC or some other lab could collaborate with the PIs to help with validation. To date, validation appears to be minimized. It is unclear at what level Iowa State has validated boundary layer and wall film models, along with any general overall combustion system behavior (combustion characteristics such as heat release, exhaust temp. etc.) validation for a single or multi-cylinder engine. Comments from another reviewer noted that necessary links to other national labs, universities and industrial users are evident.

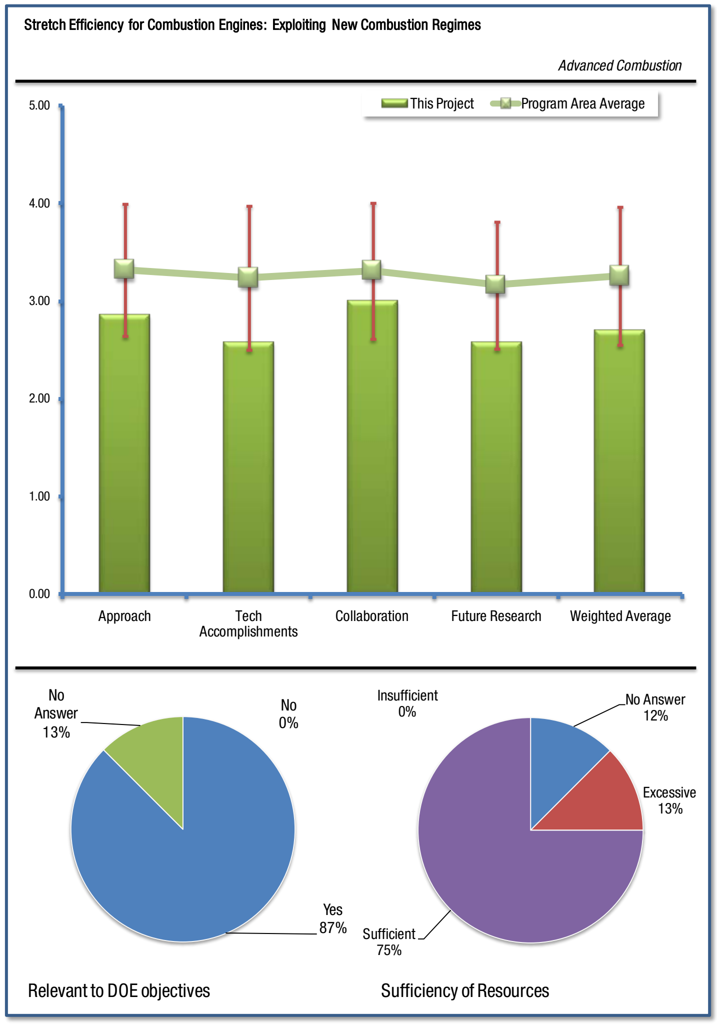
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future research is not well motivated at all. Another reviewer commented there are good plans for improvements to KIVA. They like the ideas to try and put this into the hands of combustion and development engineers. This is where the potential for this code can really show.
One reviewer added the future work doesn't include enough engine level validation. The PI should really pursue sources that can provide engine measurements for validation.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this project is well funded to support these modeling/software development activities.

Stretch Efficiency for Combustion Engines: Exploiting New Combustion Regimes: Stuart Daw (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is a highly speculative area of research that is worth pursuing. Another reviewer added the project is understanding and potentially reducing combustion irreversibilities: more research is required. One reviewer commented the project works on the basics of energy use efficiency. Can we reduce large irreversibility losses? Comments from another reviewer mentioned the program is looking to identify fundamentally new combustion concepts to improve thermal efficiency. There is a clear alignment with DOE goals. Observations from one reviewer added the project improved efficiencies while another reviewer said the fundamental understanding of limits to fuel economy improvement is the key to long term progress. One other reviewer stated that stretching the range of HECC and HCCI engines to achieve maximum energy efficiency is a key enabler to reducing fuel consumption and thus oil demand.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is ad-hoc. By this time a more detailed fundamental paper study should have uncovered some promising theoretical approaches to the use of thermochemical recuperation, or just thermal recuperation. We need to move beyond a naive discussion of energy, availability and energy losses - these concepts we know, in the intellectual sense, but how do they apply to real engine design? This is the part that is not clear. Another reviewer commented the efforts towards constant volume combustion are applauded. One reviewer added the modeling and lab experiments seem very appropriate while another reviewer said a relatively simple experiment is the key to testing theory. Comments from another reviewer asked, what led to the 50% reduction in combustion loss goal? Do you have some sort of modeling work that identifies this as achievable? How do you model combustion irreversibility? Observations from one reviewer noted the approach would test HC with less branching than iso-octane. Work does appear to strive for a holistic approach to reducing the destruction of available energy. But, the concepts still appear to raise more questions than they do answer. For example, concern from audience regarding charge air heating raised doubt as to how this concept could lead to a net benefit. Another reviewer stated that clarifying theoretical thermodynamic ICE efficiency limits is a difficult task. Reducing the combustion irreversibility losses by half appear to be a stretch goal and may be difficult to prove.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the progress is slow - perhaps a reflection of the budget and the changes in scope in previous years. Another reviewer mentioned the building hardware - they look forward to the test results. One reviewer commented the accomplishments showed no real combustion modeling. It showed some pressure curves from the constant volume device, but the reviewer wasn't sure what the results on combustion efficiency were. Comments from another reviewer noted there was good progress in the experimental set up. Observations from one reviewer added the accomplishments are unclear at this point. Would prefer to see a fundamental architecture that is trying to be worked and identifying what are the critical accomplishments that would have to occur on the component level to reach system level success. For example, presenter cited that the combustion of syngas resulted in less destruction of chemical availability. However, the production of syngas and the availability destruction may challenge this approach. Another reviewer stated the progress appears to be slow, but if the RAPTR experiment was easy to do, it would have been done recently. Having to change reactor design mid-way through experiment is unfortunate.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated a collaboration with un-named 'not for profit institutions' does not inspire great confidence. Why are they insisting on being un-named? Another reviewer noted that having additional catalysts and/or partners may accelerate the progress. One reviewer mentioned the involvement of several industrial concerns.

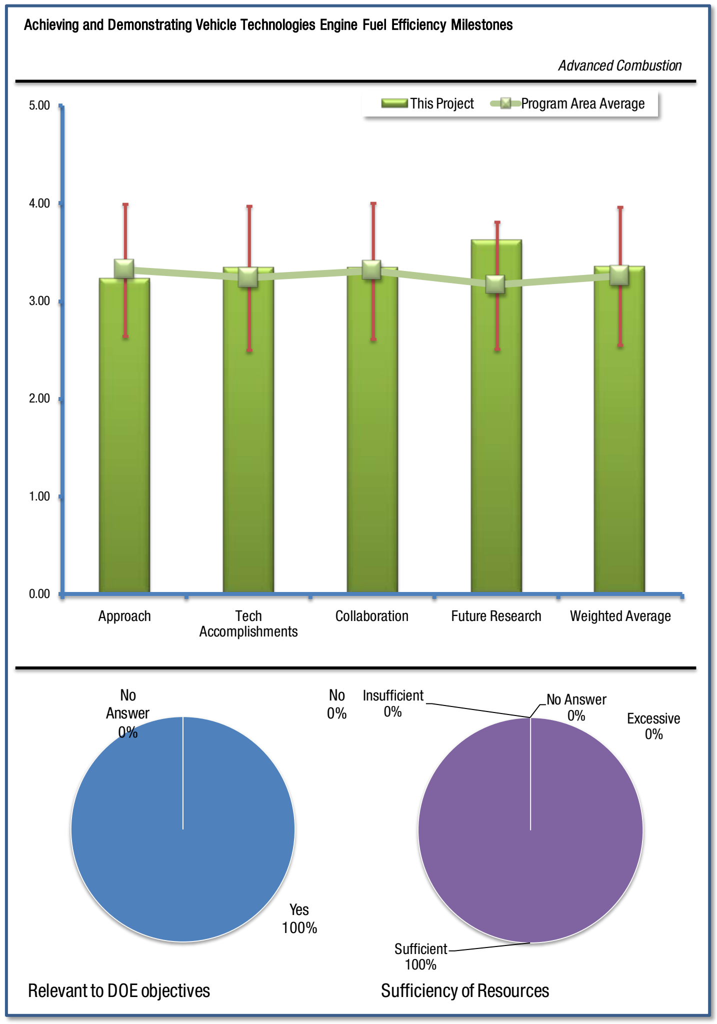
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future seems murky. Also a casual observer is left with the impression that work just seems to be done immediately prior to the annual review. Another reviewer commented the potential applications of the learning are rather fuzzy; perhaps this is inevitable since you don't know what you will learn until you learn it. One reviewer added they don't see a path toward a useful engine here. They expected to see a modeling effort or calculations that predict what we are going to do. Comments from another reviewer mentioned the key will be relating experimental results to engine design. Observations from one reviewer noted that steam reforming of wet ethanol, to save on LCA energy costs since it doesn't have to be dried for fuel use, is an interesting concept. Would there be an issue with water causing corrosion in the combustion chamber during cold start?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this project just seems to limp along with minimal funding and effort. Another reviewer added they have no vision at all where this is going.

Achieving and Demonstrating Vehicle Technologies Engine Fuel Efficiency Milestones: Robert Wagner (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 9 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that reduction of light-duty engine fuel consumption through waste heat recovery and systems integration is a useful endeavor. Another reviewer noted that while peak efficiency engine operating region can be far from drive cycle regions, it is still important to track engine progress. One reviewer commented this project supports better fuel economy while another reviewer said this is the only project devoted demonstrating DOE Vehicle Technologies efficiency & emissions objectives of 45% peak BTE. Comments from another reviewer mentioned yes, this project focuses on incremental improvements in peak engine thermal efficiency and part-load efficiency at a key operating point, and also appears will include this year and next year any engine generated maps for projecting vehicle miles per gallon improvements based on assumed vehicle characteristics. Observations from one reviewer added that making use of heat losses is the key to improving efficiency. This project would have a much bigger impact if applied to LD gasoline. Another reviewer stated this may be the only program that demonstrates engine efficiency improvements and system level efficiency gains. This is because practical engine and after treatment hardware are being used. Emissions compliance is assured while the efficiency gains are demonstrated. The numbers generated by this work is the metric used to gage progress of much of the DOE work on advanced combustion concepts. One other reviewer commented that waste heat recovery systems, although demonstrated and promising, still are lacking fundamental knowledge in how to implement for various load cycles and transient operation. Until that occurs, these devices will not be embraced fully by OEMs. As such, they believe supporting this effort is a very wise choice and has a clear alignment with DOE goals.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the integration of waste heat recovery in the form of an ORC is a useful approach. The use of thermal 'capacitance' or storage would seem to be an important part of a system like this. The availability of waste heat-derived energy is typically not well matched to high power requirements due to thermal lags. Another reviewer commented this is a good study of where the energy is going and where gains can be found. One reviewer mentioned the project may have reached the point of diminishing returns (from a value standpoint). It is more important than ever that the systems implications of turbo compounding or Rankine cycles are evaluated for their overall benefits. Comments from another reviewer noted this is a very good real world systematic approach toward exploring incremental gains in engine peak thermal efficiency by taking advantage of possible electrification accessory gains, exhaust energy recovery gains, friction gains, and fuel property gains. This project has a very good integrated engine system approach. Observations from one reviewer added the use of relatively simple concepts is a good first step while another reviewer said improving peak load efficiency is the key for hybrid applications. Another reviewer stated that the focus is on identify and demonstrating promising technologies for efficiency improvement, with minimal development. This focus on proof of principle is appropriate, divided between engine, after treatment, loss recovery and controls. Biggest potential gain is in recovery exhaust waste heat and coolant waste heat recovery, and more effort is beginning to be expended in this area. One reviewer commented that there is a lot of work ongoing. Turbo compounding concept is an interesting idea and further investigation seems warranted.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the progress seems lower than anticipated given the budget and funding history while another reviewer said there is nice availability scoping for BTE opportunities. One reviewer added there is good progress so far. The challenging part is now ahead. They like the approaches with turbo compounding and the Rankine cycle. Another reviewer noted they think a look at a smaller engine combined with a hybrid system, would change some of the technical approaches. They also think an analysis of which path would give better overall efficiency would be worth the effort. Comments from another reviewer mentioned it's good to see vehicle level models being developed and used. This project could end up spending a lot of time on the details of the Rankine cycle and turbo compounding component design for best efficiency on test engine. Observations from one reviewer commented this project is addressing a real world perspective on recovery energy from the engine system. The information produced from this project including limits of exhaust and EGR energy recovery, friction gains, and coolant pump gains is valuable as benchmark information. One reviewer said they recommend application of heat recovery techniques to light-duty gasoline since potential for recovery is larger. Another reviewer stated that demonstration of peak thermal efficiency is on target. Work on reducing emissions at the part load point with minimal efficiency loss is progressing well. Individual component efficiency contributions to the overall efficiency gain have been quantified. Models of hardware used for exhaust waste heat recovery systems have been built. This step is very important to understand the system-level efficiency potential of waste heat recovery concepts.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer asked how was the collaborating suppliers chosen, or are they merely whoever came along and showed interest in this project? Are they collaborators or paid suppliers? Another reviewer mentioned try to formally align with key supplier to develop energy recovery devices. One reviewer commented there is a good working relationship with GM while another reviewer said they are making good use of components from other groups. Comments from another reviewer added the PI has made the critical collaborative links with the engine OEM and Cummins Inc. for exploring Rankine Cycle WER; this project appears to be well integrated with other DOE programs. Observations from one reviewer noted appropriate consulting with Cummins on the organic Rankine cycle and with Woodward on turbo compounding is occurring. Also regular consultation occurs with industry OEMs, DOE working groups and the ACEC tech team. Another reviewer stated the program appears to be doing a good job of sharing information informally rather than through structured collaborations.

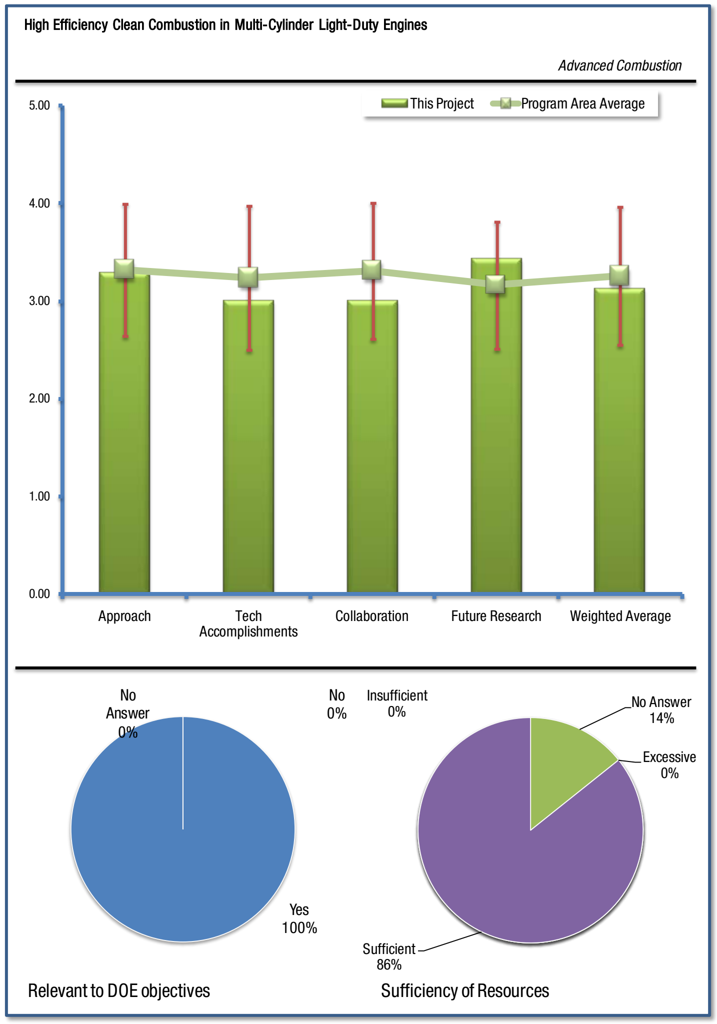
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future efficiency plans look good. What sort of an efficiency gain can be made through running the engine at a more efficient operating point rather than increasing the complexity of the engine? What about hybridization (either series or parallel) of a lower efficiency engine rather than a massive increase in engine complexity? Another reviewer added they recommend detailed study around EGR with various boost devices. Low vs. mid vs. high pressure EGR can affect matching and efficiencies greatly. An effort to repeat key operating points/configurations, or present data if it exists would be beneficial as the project looks for small efficiency deltas over time. One reviewer noted excellent integrated engine system and vehicle level path forward toward addressing potential fuel economy gains. The reviewer is looking forward to hearing the results next year. Comments from another reviewer mentioned the work needs to be completed on incorporating the organic Rankine cycle concept, and start developing the turbo compounding concept. It is critical that every effort is expended to arrive at the practical potential of these waste heat recovery concepts without losing focus.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that funding is commensurate with the overall analysis and experimental activities associated with the PI's path forward.

High Efficiency Clean Combustion in Multi-Cylinder Light-Duty Engines: Robert Wagner (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that combustion optimization in multi-cylinder light-duty engine operation is an important research area. Another reviewer added this is an investigation if issues are around LTC - many questions, this is addressing useful ideas. One reviewer mentioned that better efficiency means less oil usage while another reviewer said that taking HECC to the systems/multi-cylinder level is important. Comments from another reviewer noted there is some benefit in improving light-duty diesel emissions/efficiency. Much larger improvement possible by improving LD gasoline due to projected future increase in diesel demand (HD+air) vs. gasoline (CAFE, ethanol) in base case.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach seems piece-meal, a bit of this and a bit of that. How much of this work is a poor reproduction of work that is normally done at the OEMs in the course of their own development? Another reviewer mentioned the approach is generally good. In some respects it seems like you are going after "today's question" as opposed to having a cohesive long-term research plan. Having said all of that, you have an outline of multiple programs that seem well coordinated.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer asked to what extent is this project merely chasing the level of sophistication at the OEMs, and not catching up? This is particularly important for engine control. Too many of the results were 'from some time ago' and a mixture of old and new (MB and GM) engine results. One reviewer stated to note very clear how this differs from other ORNL Doe projects using 1.9 L GM diesel while another reviewer said a lot of high quality data is being generated. Another reviewer noted they would like to see a clearer picture of what you call PCCI and how does this compare to what SNL is doing for HCCI and stratified HCCI. They would hope that SNL would have something to contribute here. Good to see some KIVA modeling. Comments from another reviewer mentioned they were glad to see PSAT analysis. The reviewer would like to see the reduction in after treatment penalty due to the lower engine out emissions. Is the increased HC and CO significant? Observations from one reviewer commented that adding O_2 fraction as a third dimension to the typical map showing thermal effects on emissions is an interesting way to show how high dilution can minimize soot while staying away from the NOx production zone. It would be interesting to see other LTC methodologies on this 3D map.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaboration seems to be unfocused and not systematic. Another reviewer commented that aligning with piston or injector vendor may allow further progress. Current roadmap seems to overlap with what was already understood by OEM on production engine. One reviewer mentioned the project is well matched with Tech Team needs and wants, but not a specific hands-on partner(s). Comments from another reviewer noted it would be great if the project could show something incorporated from SNL on HCCI onto the engine and showed a performance benefit from it. Maybe this should be a goal for SNL or UW to convince the PI they have something to benefit the project. The project is trying to meet emissions and improve fuel economy. The reviewer sees the improved fuel economy as a weakness of SNL and UW. Observations from one reviewer added they are looking forward to future comparison of results from the various labs using the GM 1.9L test stand using common fuels. Closer collaboration is encouraged.

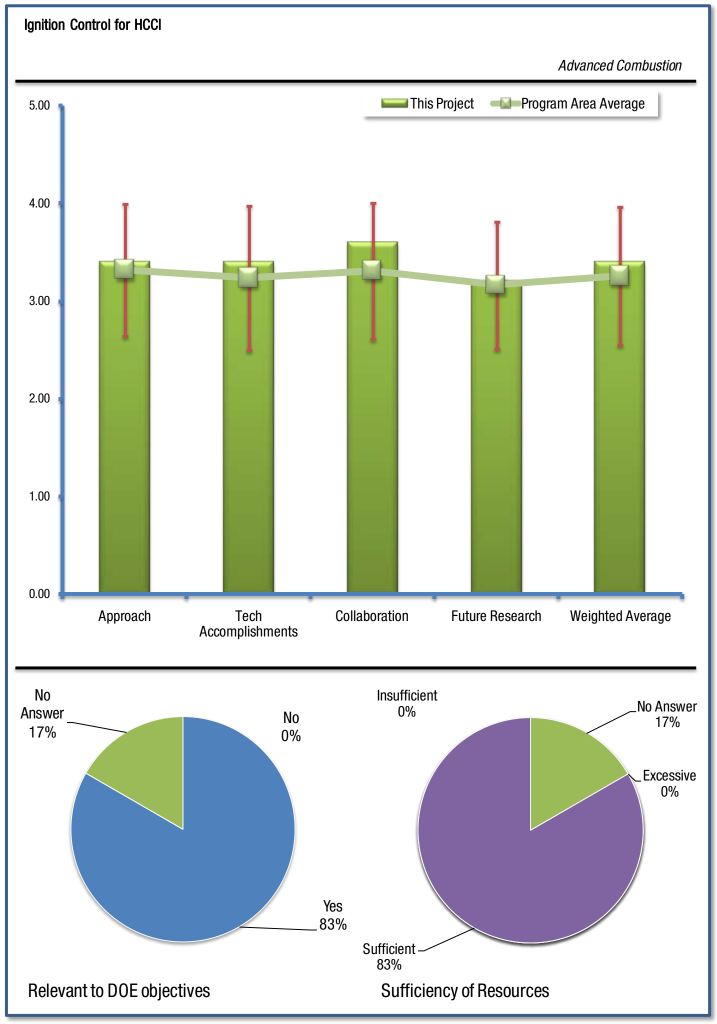
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated there seems to be a everything but the kitchen sink approach - what are the priorities? Is this project any more than just a voyage of discovery for ORNL at the tax-payers' expense? If so, the results should be better presented and packaged. Another reviewer added there are good plans for transient analysis. Suggest investigating interactions with hybrid strategies. One reviewer noted the transient and systems integration issues are excellent next steps while another reviewer said that overall FE improvement vs. conventional combustion unclear. Comments from another reviewer asked can you develop a more cohesive research plan to clarify how this fits with other work, what basic things needs to be understood and what experiments will get there?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated there are nice facilities are in place and it is nice to see them used for this work.

Ignition Control for HCCI: Dean Edwards (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that research into methods of mode transition control for LD HCCI engines is important. Another reviewer added that automotive HCCI address efficiency and emissions areas. One reviewer commented that extending load range of multi-mode operation is directionally correct for maximizing HCCI fuel economy. Also directionally correct for a downsizing and boosting approach. Comments from another reviewer noted the project is improving light-load gasoline fuel economy.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is sound. Another reviewer commented there is a good understanding of challenges of extending HCCI region (NVH, stability etc). One reviewer added engine control is the key to improving HCCI operating range while another reviewer said spark assist is a niche application, but looks to be critical to expand the operating range of gasoline HCCI operation. Comments from one reviewer noted since there is a danger that the results will be very engine specific, one of the outputs of this research should be a method to develop this on other engines.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that one of the major issues with LD HCCI is the transition into and out of true HCCI mode(s) of combustion. To what extent is GT-Power, which is intrinsically a steady-state tuned engine modeling suite, useful for transient or dynamic operation? Another reviewer noted there is a nice investigation of cylinder cross talk. One reviewer commented that multiple injection/multiple ignition may be a useful path forward to control the HCCI instability issues and smoothing transitions between combustion modes.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two reviewers stated the path to potential commercialization and substantial interaction with Delphi seems sound.

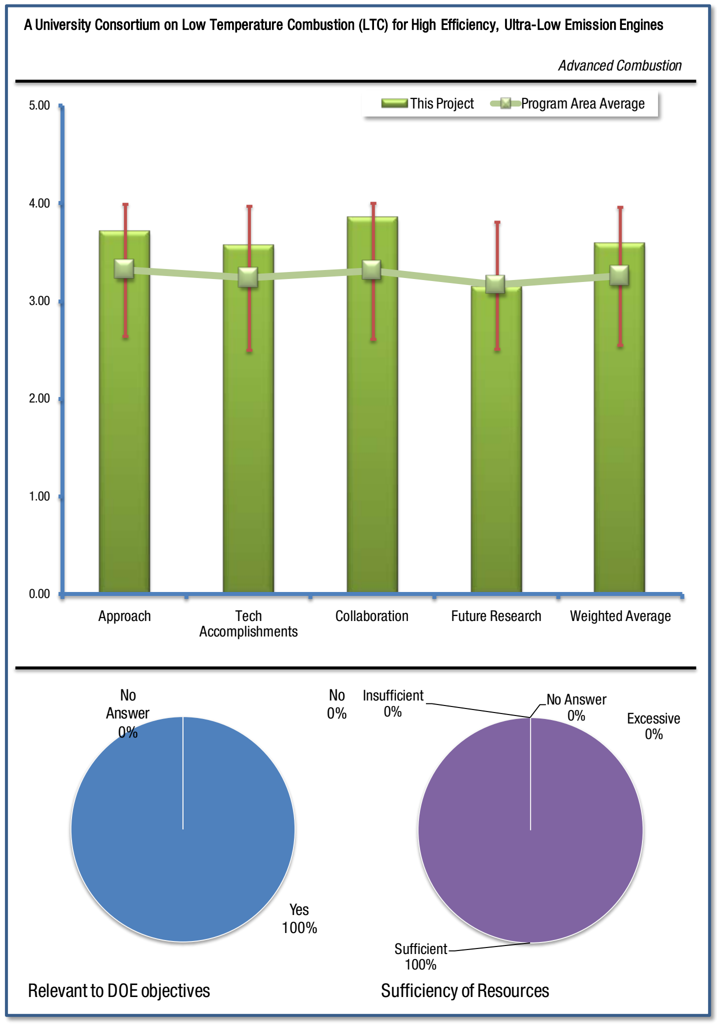
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the use of VVA via the Sturman mechanism is an important improvement in capability that adds an additional level of control input that will be extremely useful in future engine control and operation. Another reviewer commented the turbo DI may shrink HCCI region in drive cycle. Future investigation of HCCI with GTDI may be useful. One reviewer added the timeline will be challenging to finish phase 3 by end of 2009.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the budget seems suitable for this project. Another reviewer noted HCCI control complexity could easily require far more resources, to fully understand.

A University Consortium on Low Temperature Combustion (LTC) for High Efficiency, Ultra-Low Emission Engines: Dennis Assanis (University of Michigan)



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this program is a very comprehensive approach to addressing the relevant issues involved with LTC. Established and renowned researchers in five universities led by the University of Michigan are engaged in understanding the complex issues involved. The breadth and depth of activities is impressive. Another reviewer commented yes, it is a nice engine system effort focused on enabling new more homogeneous combustion schemes at light to medium load conditions with is important for enabling such combustion schemes in future, smaller, and hopefully more efficient automotive engines. One reviewer noted that improved light-duty LTC is an important potential method for fuel consumption reduction while another reviewer said it is Important to increase gasoline HCCI operating region. Comments from another reviewer mentioned the HCCI region extension is the key to the adoption of this technology. Once highly downsized, the useful HCCI region becomes much smaller.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated there is a good multi-front approach to a complex set of problems. Another reviewer noted this is a very good approach aimed at understanding all initial and boundary conditions influencing the load operational range of more homogeneous combustion approaches through modeling, simulation, and experimentation. One reviewer mentioned that load range extension, mixed mode combustion, system level evaluations are all appropriate while another reviewer said there is good focus on fundamentals to overcome barriers. Comments from another reviewer added that each of the elements of the comprehensive program is very appropriate. These include the very important task of extending the high and low load limits of HCCI. This is required to fully realize the potential of HCCI. Wall effects and heat transfer continue to be understood further. Spark assist has been included which will be important for the control of HCCI in practical applications. A comprehensive modeling effort to support and understand the experiments continues.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is a solid set of accomplishments - difficult to summarize in a forum like this. The publication record speaks for itself, they suppose. Another reviewer commented it was difficult to tell from the presentation how much of the overall project accomplishments were done in the past Fiscal Year. One reviewer noted this project is producing a significant amount of information concerning load limits of homogeneous type combustion mode for light duty engines. The output research to investment ratio appears to be very high. Comments from another reviewer mentioned that a new area now investigated is the effect of intake boosting. This is an important area considering that industry is moving towards downsized and boosted engines. The current high-load HCCI region has been mapped out; misfire and ringing-index limits have been identified in this region. The low-load limit has also been reduced. In this region the need to lower equivalence ratios to tradeoff reformation and exothermicity has been identified. This reviewer went on to say continue to understand combustion chamber deposits on wall heat transfer. Now spark assisted HCCI has been visualized in an optical engine. This fills a critical gap in the diagnostics to understand spark-assisted HCCI. KIVA and DNS models continue to be developed to understand experiments. Understanding ignition properties of biofuels and blends is beginning which will be important going forward as the industry seeks to use more biofuel. One reviewer added that 8% rebreathing and 11% recompression improvements to HCCI operating range appear reasonable.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a good united front. However are 'discussions' with OEMs good enough to qualify as 'collaboration'? Another reviewer asked for spark assisted HCCI, has there been collaboration with Edwards at ORNL? One reviewer added includes multi-university and industry involvement/oversight. Only suggestion is to leverage HCCI work underway at UW-ERC through some type of collaboration. Comments from another reviewer noted the coordination and sharing of information among the university partners and with industry continues to be good via the AEC and MOU. LANL modeling expertise is being exercised appropriately to understand ignition of biofuels.

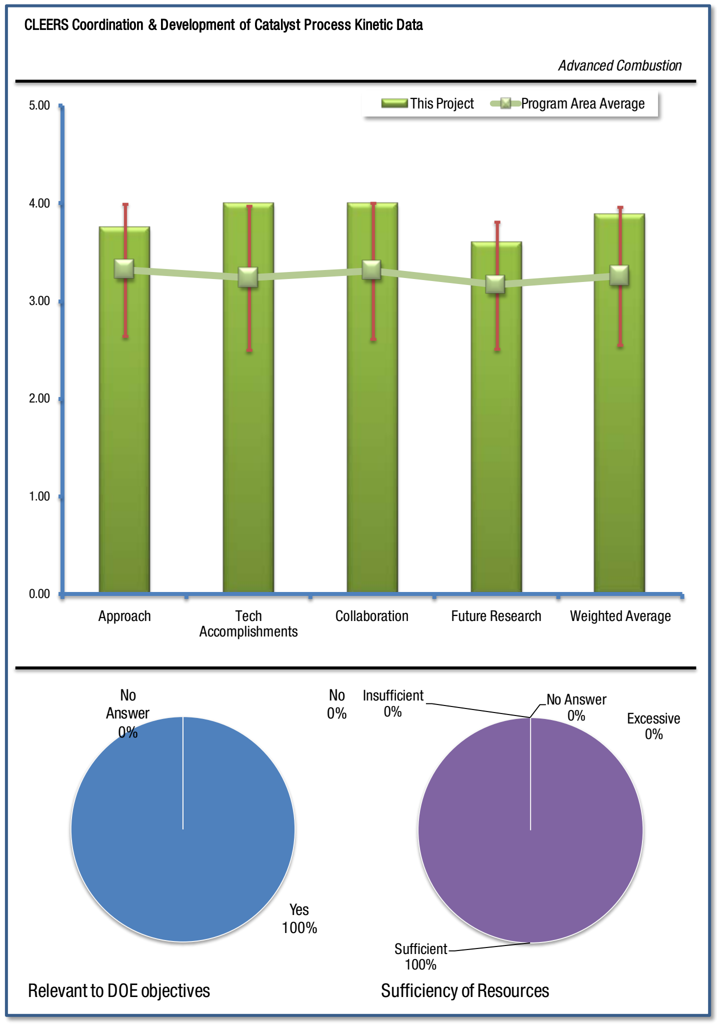
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated as engines are downsized, the LTC operating zones shrink accordingly, and the FTP speed and load regimes move higher up the engine operating envelope. In the limit, does this render LTC operation an unnecessarily complex and difficult combustion regime to use? In other words, can we get the same or similar benefits from hybridization and transmission improvements? Another reviewer noted that overall; the short term direction is good. The presenter mentioned experimental exploration of valve timing for extending homogeneous combustion operating range using a multi-cylinder engine with the Sturman VVT, but didn't include that bullet in the attached presentation material. Does the PI plan to perform such experiments this year? One reviewer mentioned there is very good potential for achieving significant fuel economy gains. Comments from another reviewer added that continuing to push the high load limit of LTC is appropriate. Equivalence ratio stratification and cooled external EGR should be considered to control the combustion process as the intake boost and load is increased. Spark-assisted HCCI should be given more focus, since this may prove to be a necessary control lever for transient control of the combustion process.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it looks like an efficient use of funding. Another reviewer added this project seems to have barely a sufficient amount of funding for covering the multi-university effort. It might be worthwhile increasing the funding by $100k or so.

CLEERS Coordination & Development of Catalyst Process Kinetic Data: Jae-Soon Choi (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated both of the technologies studied here allow the implementation of lean burn systems. Lean burn systems are inherently more fuel efficient as long as the fuel economy penalty for using them is not excessive. The workshops have been extraordinarily successful in that it brings the unique technologists together. These projects are quite well focused for the mission. Another reviewer commented this project is very relevant. CLEERS is incredibly useful in coordinating and communicating in the catalyst community. The catalyst research is also quite useful. One reviewer noted that overall fuel economy benefit relatively small due to small impact of after treatment and small light-duty diesel penetration. Comments from another reviewer mentioned that CLEERS activities overall support the fuel efficiency objectives by enabling development of more capable aftertreatment systems, allowing the engine to be tuned with more emphasis on fuel efficiency. In particular, CLEERS plays two important roles: 1) providing a channel for systematically tracking R&D needs and gaps in the area of after treatment and 2) providing funding for coordinated, targeted experimental and modeling work to address the key gaps.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated these presentations tend to cover a lot of ground. The CLEERS workshop and focus groups deserve a 4. The HC poisoning deserves a 3 because no clear path to model implementation is shown. Specifically should this data be able to be implemented as an inhibition term or will it have to be a full kinetic model? The sulfation of the LNT deserves a 4 as it is addressing some critical needs. The calcium doped work is interesting. The ammonia formation work from LNT's is very interesting, but is not well justified. The reviewer believes that there is a similarity between the ammonia formation mechanism in three-way catalysts and LNT's. They do not see that issue addressed in this work. Another reviewer mentioned CLEERS does a fine job of identifying research needs and accomplishments and communicating these to affected groups. One reviewer commented the approach has improved fundamental understanding of sulfur poisoning. Comments from another reviewer noted the ORNL/FEERC part of the CLEERS work, reported in this specific presentation, appears to be well-planned and employs proper experimental tools to fill in the critical gaps in the LNT and SCR technologies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated all of the projects are technically superior. Another reviewer added nice progress in understanding these complex systems. The use of a commercial catalyst that can be fully analyzed is a key capability. One reviewer noted there is an excellent job coordinating CLEERS projects relating to experimental work and modeling work. Comments from another reviewer mentioned the combination of spatially-resolved catalyst studies, targeted in-situ studies and quantitative performance/poisoning studies allows the ORNL/FEERC team to produce useful, high-impact knowledge.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the interaction between labs like PNNL and SNL are very good. The communication of results to the industrial partners is excellent. Another reviewer commented that CLEERS is fundamentally a collaborative effort. One reviewer added excellent job collecting input and disseminating the results through CLEERS.

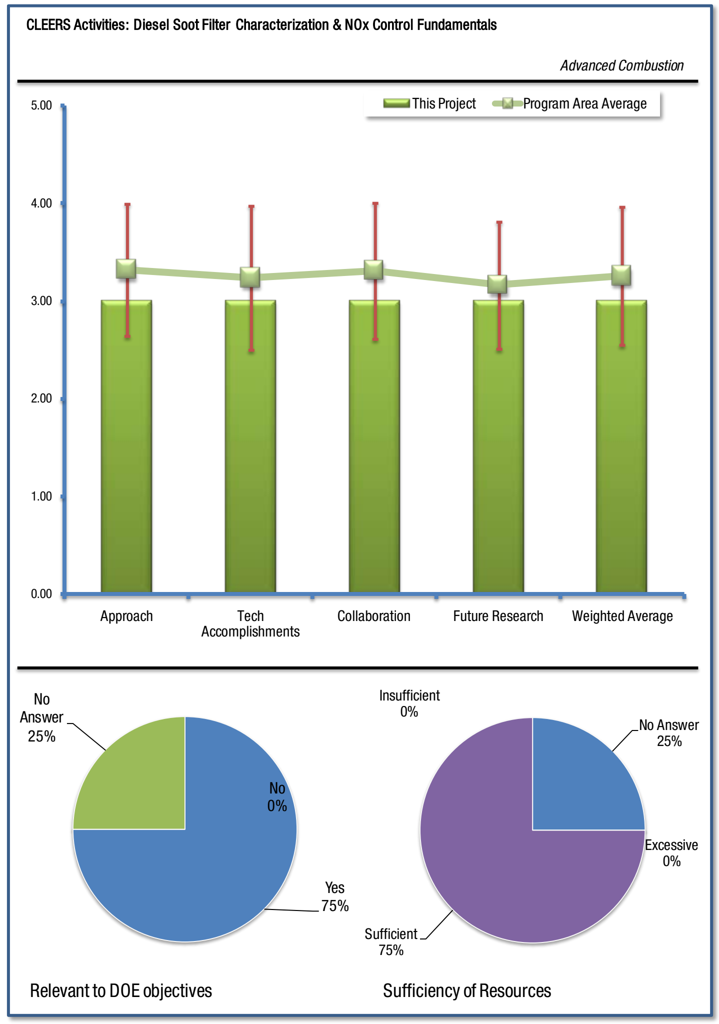
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the CLEERS organization future plans are great. HC poisoning of ammonia SCR is okay. Where and when is it going to be put into a model? LNT sulfur poisoning is on a solid path. There is ammonia production from LNT's. Where are the applications and what is the value? The reviewer believes the value is very high, but they do not see that called out in the work. They would very much like a clearer definition of application and how the research is going to impact that. Another reviewer noted there were nice plans and they were well presented. One reviewer commented the pursued issues are relevant to the practical application of the technology, and at the same time scientifically challenging.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the organization for CLEERS is properly staffed. HC poisoning needs more modeling support. Interaction between SNL and ORNL on LNT modeling is excellent and sufficient. Utilization of analysis equipment for sulfur poisoning for LNT's is exactly where the national labs should be. Is there an overlap between this work, the work at PNNL and the work at the University of Houston?

CLEERS Activities: Diesel Soot Filter Characterization & NOx Control Fundamentals: Darrell Herling (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated both of the projects discussed in this presentation allow the greater market penetration of lean burn engines, specifically diesel. These projects address the emission requirements for implementing these technologies. Another reviewer commented excellent fundamental support of other DOE programs. DOE funding on these types of fundamental studies are critical to long term energy reduction. Very important building blocks to technology development and understanding in a broad range of emissions issues. One reviewer mentioned CLEERS activities overall support the fuel efficiency objectives by enabling development of more capable aftertreatment systems, allowing the engine to be tuned with more emphasis on fuel efficiency. In particular, CLEERS plays two important roles: 1) providing a channel for systematically tracking R&D needs and gaps in the area of after treatment and 2) providing funding for coordinated, targeted experimental and modeling work to address the key gaps.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated SCR measurements and modeling are a good combination. Two major "nits": 1. No detail on the accuracy and completeness of the model; and 2. Which Fe zeolite is in use? Commercial or synthesized separately? They do have an issue with the comparison of the model to the measurements. The temperature measurements for the inlet gas and the brick are not clearly delineated. The concentration predictions will be very dependent on the brick temperature. The front edge concentrating discrepancies are most likely due to a wrong temperature for either the inlet gas or the bed temperature. If the temperature measurements are made using a "slow (thick)' thermocouple, then the temperature measurements are very spread out and do not reflect sharper temperature gradients that may be occurring in the front edge of the monolith. This reviewer went on to ask does this model solve the energy equation or is it simply using the measured temperature profile? If the temperature measurements are using a "slow (thick)” thermocouple, then they are very spread out and inconsistent with the temperature profiles the concentrations are responding to. DPF work has consistently addressed important filtration aspects. DPF studies are difficult and this work provides a clear description of important aspects of the filtration process. Another reviewer noted they sense the team is not completely up-to-date on ammonia nitrate formation or DPF regeneration. TU Milano (Tranconi), Paul Scherer Institute (Kroecher), and Waseda University (Daicho) have investigated this for several years. Try not to duplicate efforts, but you are addressing the modeling gap. On DPF regeneration, new catalyst understanding is emerging on direct oxidation of soot at the soot-catalyst interface. This will become more important than through NO_2. However, the modeling, again, is missing and a critical building block. Focus on new methods. Use your imagination for breakthroughs. The tomography representation of DPF porosity is an excellent example.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated SCR modeling and comparison with experiments is good work. It is not necessarily ahead of the industry. There are other papers out there that have done similar work. The presentation does not show the special accomplishments. Another reviewer commented the DPF studies are, they believe, very new work and interesting accomplishments. One reviewer mentioned the models are coming up to speed and hypotheses in place to address gaps.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a decent communication of results. More direct collaboration would be better. Another reviewer added no sense of collaboration in presentation. Seems the project needs to work closer with the experimental groups at ORNL and ANL for model substantiation. The reviewer thinks they might be wrong. One reviewer noted great job collecting input and disseminating results through CLEERS.

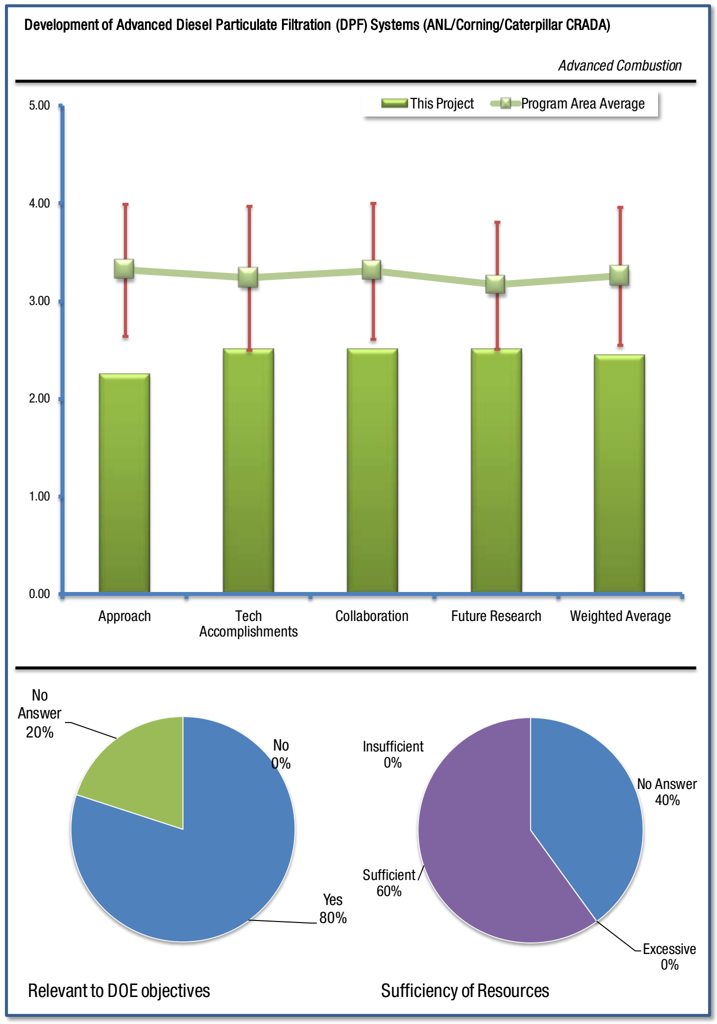
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated to keep the models flexible as things are changing quickly. You don't want the projects understanding to be obsolete when it is finished. New catalyst families (acidic zirconia, Ce-based soot catalysts) are promising and emerging. Another reviewer noted the future work includes surveys.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that leveraging the National Lab instrumental resources has always been a major strength of these projects.

Development of Advanced Diesel Particulate Filtration (DPF) Systems (ANL/Corning/Caterpillar CRADA): Kyeong Lee (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that DPF is a necessary technology for diesel vehicles. Another reviewer noted that meeting 2010 PM standards is critical to introducing light-duty diesel engines. This project addresses the issues involved with diesel particulate filters. One reviewer commented that a better understanding of DPF operation should enable reduction in its fuel penalty.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer asked, has the work of others been reviewed? What are the innovations here? Another reviewer mentioned this is a good approach but fairly similar to other efforts. One reviewer added experimental observations are made of the soot filtration process. Further experimental analysis of the particulate mass and heat release is conducted. Information is used to form models of the filtration process. Particularly, the ANL Advanced Photon Source is used to X-ray image the soot cake and ash particle structure along the membrane channel. Emphasis is also on back pressure characterization and regeneration characterization to reduce the fuel penalty. Approach is primarily experimental with some modeling support. Comments from another reviewer noted good capabilities and great partners, but the approach is unclear. What specific questions about DPF operation are being addressed? This appears to be a broad, generic survey of various aspects of DPF operation, from soot deposition to soot oxidation, rather than a focused technical effort.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there seems to be a question on the accuracy of the heat of combustion data -- and thus, on the methods used to estimate it. Another reviewer commented that measurements of pressure drop as a function of flow rate and surface area for various membranes have been completed. Cordierite membranes are looking promising. Thermogravimetric experiments to measure soot oxidation rate have been completed. Significant amount of metal components were found in the ash. The heat release of the soot deposits has been measured. The above measurements are used to differentiate various samples of particulate materials. The soluble organic compounds in the PM provide better ignition performance for regeneration. The specific heat of diesel soot as a function of temperature has been measured. Numerical modeling of the membrane channels has been completed. All of these measurements is impressive progress. One reviewer noted each individual piece of work did not go beyond what is known or intuitive to the technology practitioners: The micro-imaging illustrated soot deposition on the DPF wall, but did not yield any new findings or point how specifically the work will lead to anything new; Backpressure studies did not appear novel; Soot oxidation studies were rudimentary. The heat of combustion part of it was at best unclear, as pointed out by several reviewers in the follow-up discussion. What is the significance of ash loading being 7%? That is not a fundamental characteristic of soot; the amount of ash may vary widely depending on the deposition mode, oil consumption rate, etc.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the project is more of a work for others than an original R&D project. Another reviewer mentioned that although partners were listed there was no indication what the partners did other than Caterpillar providing an engine for testing. One reviewer added that an appropriate partnership with Corning, Caterpillar, and University of Wisconsin exists that leverages their unique strengths. Comments from another reviewer noted there is a very impressive list of partners, but not clear how their expertise was leveraged.

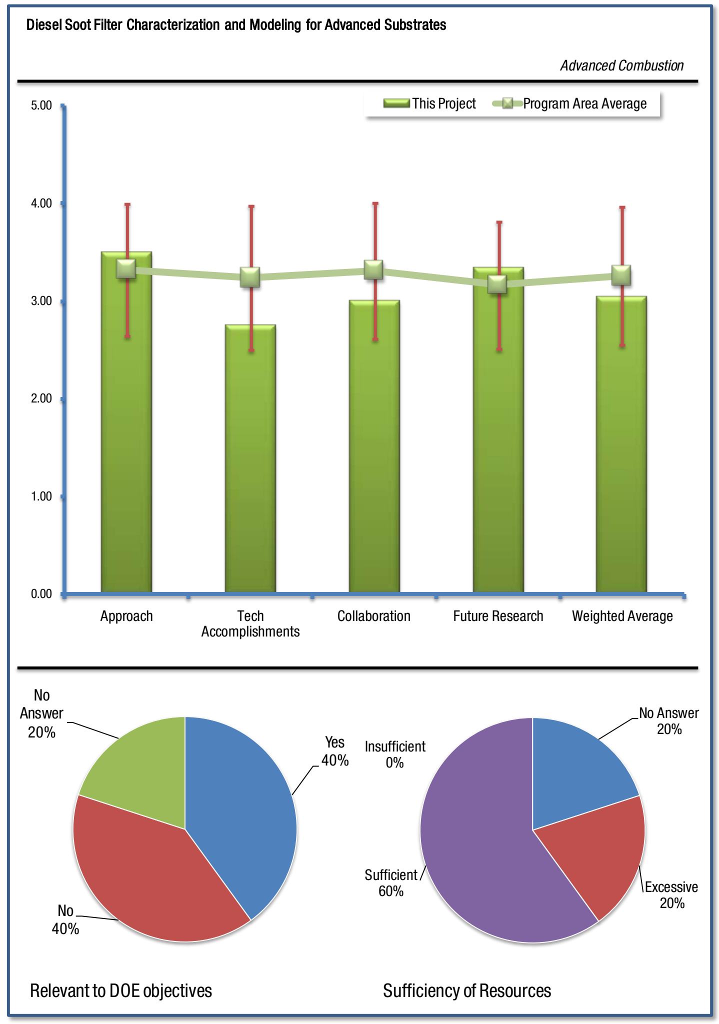
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer asked, what core competency does the Lab impart on the project? Another reviewer noted perhaps there is too much overlap with other DPF work. One reviewer commented the project will measure PM filtration efficiencies; evaluate effect of catalytic coatings. The project will do the above experiments as a function of engine conditions. They will also make measurements of the morphology of partially oxidized soot and ash particles. These are appropriate next steps.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this is hard to evaluate. How much is spent on "brick and mortar" and how much is on the core research?

Diesel Soot Filter Characterization and Modeling for Advanced Substrates: Thomas Gallant (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated they don't see that this technology will displace cordierite. So what is the value to jumping into a two-way after treatment system? This continues to feel like a way for Dow to leverage development costs and reduce risk. So far no tangible evidence has been shown to indicate that this will get to the marketplace. Another reviewer noted that de-NOx is tied to fuel consumption via the fuel consumption vs. NOx relationship. DPF enables diesel engines. However, the limited scope of the project gives results that mostly appear pertinent only to a specific type of filter that is not widely used. The results appear too parochial to the ACM as to not be universal. The ACM is not in production and seems niche. If DOE does CRADA work, it should be universally applicable to products or approaches that are widely used. This one seems more like publicly funded contract research for Dow.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated it seems like this approach is climbing further out on a very thin branch. Another reviewer added the approach seems based on sound approaches - literature review, simulation, experimentation. One reviewer commented the areas of focus closely aligned to address barriers identified from CLEERS project concerning wash coats and substrates.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is no evidence that this technology is getting any marketplace acceptance. Another reviewer commented the accomplishments addressed Dow's issues from various angles. Multi-faceted approach covered the relevant areas. Another reviewer commented the results shown seem modest versus the time and expenditures. Perhaps much effort was spent on developing the models for the new materials. NO_2 cycling results are impressive and interesting. One reviewer noted it is difficult to figure how significant the progress was over the past year. This is the last year of CRADA. The reviewer would guess that if the outside partner decides to move forward with production of ACM substrates, the technical accomplishments here are outstanding.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated they are obviously working very closely with Dow. Another reviewer noted the end users collaboration beyond CLEERS is not obvious. One reviewer added there seems to be good collaboration between industry and PNNL. They like the fundamental nature of the work. Comments from another reviewer mentioned there is a partnering with CLEERS with a report planned. What about SAE or other publication?

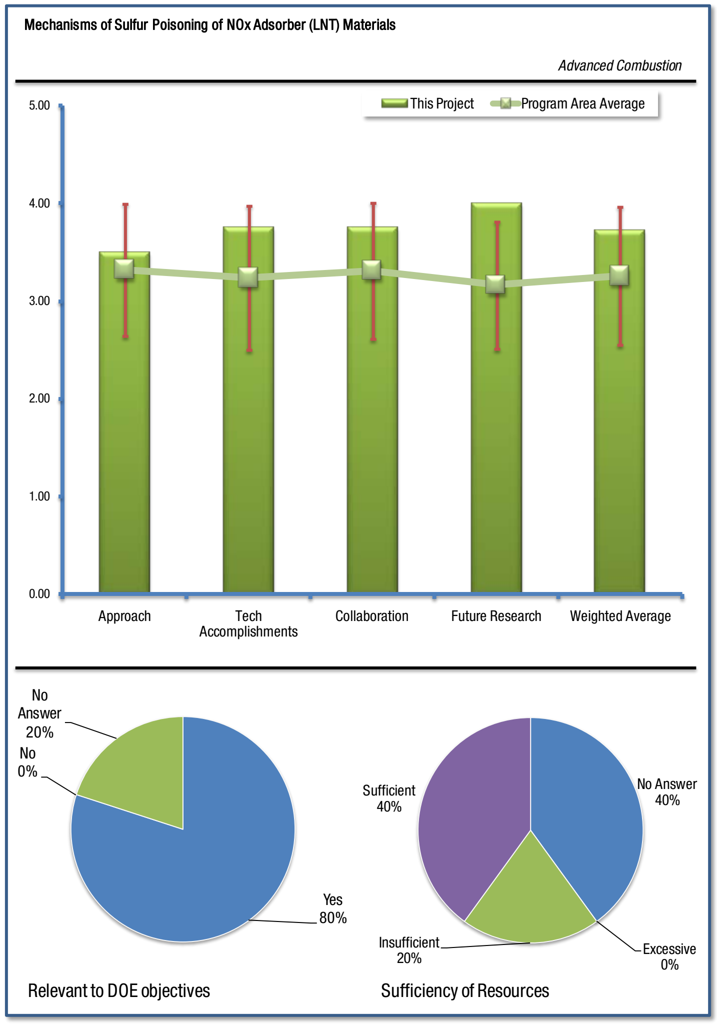
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Two reviewers stated it is time for this project to be completed. September '09 should be the end. Another reviewer added wrap up will provide more insights into wall flow vs. flow-through catalysis. Some work has been demonstrated by others, but much more insight is needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated they have never seen much future for this project.

Mechanisms of Sulfur Poisoning of NOx Adsorber (LNT) Materials: Charles Peden (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that absolutely this program was a contributor to LNT commercialization and thus to U.S. dieselization. Another reviewer noted deNOx function is directly tied to fuel consumption impacts via the fuel consumption vs. NOx relationship; LNTs are a viable technology for light-duty, medium-duty, and non-road. This project is addressing the fundamental understanding of LNT deficiencies and durability. It is also an excellent example of government and industry cooperation yielding useful results. One reviewer mentioned sulfur in the U.S. fuel is now a barrier to lean combustion technologies. Understanding sulfur poisoning and desulfation methods is critical to removing this barrier and thus enabling high efficiency lean combustion technologies to become feasible.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this was a rare opportunity for National Lab tools to be applied to realistic commercial catalysts. PNNL has done great work and because they have honored proprietary issues I think they open the door for other companies to be willing to do such work. Another reviewer commented the cooperation between industry and PNNL is obvious. The testing is fundamental yet reality grounded in its objectives. Testing methods are defendable; the results are useful and add to the fundamental understanding within the industry. One reviewer noted focus in on understanding poisoning mechanisms first before suggesting changes in catalyst formulation and sulfur regeneration algorithms. Wide array of state of the art techniques for catalyst characterization and testing at PNNL are brought to bear on the problem.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is a great fundamental learning. This work has helped us greatly, even though the reviewer is sure we only know part of what was found. This is a great example of high power government labs helping industry build better products. Another reviewer added there are multi-faceted results on Pt utilization, LNT desulfation, BaO/Al_2O_3 reactions, etc. They suspect there is a multitude of results and learning's not captured in the published information, thus delivering "proprietary" knowledge to the partners. This is needed to continue industry involvement. Learning's here added to the knowledge base on LNTs and will result in improved performance. One reviewer commented that most significant deactivation mechanism identified thus far is the sintering of precious metal and thus a loss of activity. Ceria is able to help reduce overall deactivation by inhibiting precious metal sintering. Most of the sintering occurs fairly early and so does the loss on NOx conversion. Incorporating Ceria into the catalyst formulation reduces the amount of platinum sintering. A testing protocol to separate effects of sulfur and high temperature has been developed. Also desulfation behavior is a strong function of the amount of Barium loading. The positive and negative aspects of water in the desulfation process have been identified. Real world samples from the 2007 Dodge Ram Heavy duty pickup truck have been analyzed.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there were good Ford & Cummins interactions. Another reviewer mentioned there was a close relation with catalyst supplier and OEM means the learning goes right into products. The industry people could not have done this without the Lab. One reviewer added collaboration is obvious. There was catalyst understanding from industry with fundamental measurement and theoretical aspects provided by the scientists. This is an excellent example of synergy. Comments from another reviewer noted collaboration is limited to Johnson Matthey via Caterpillar because of the CRADA between them. However, because of this understandably some of the information is not available to other interested OEMs and suppliers.

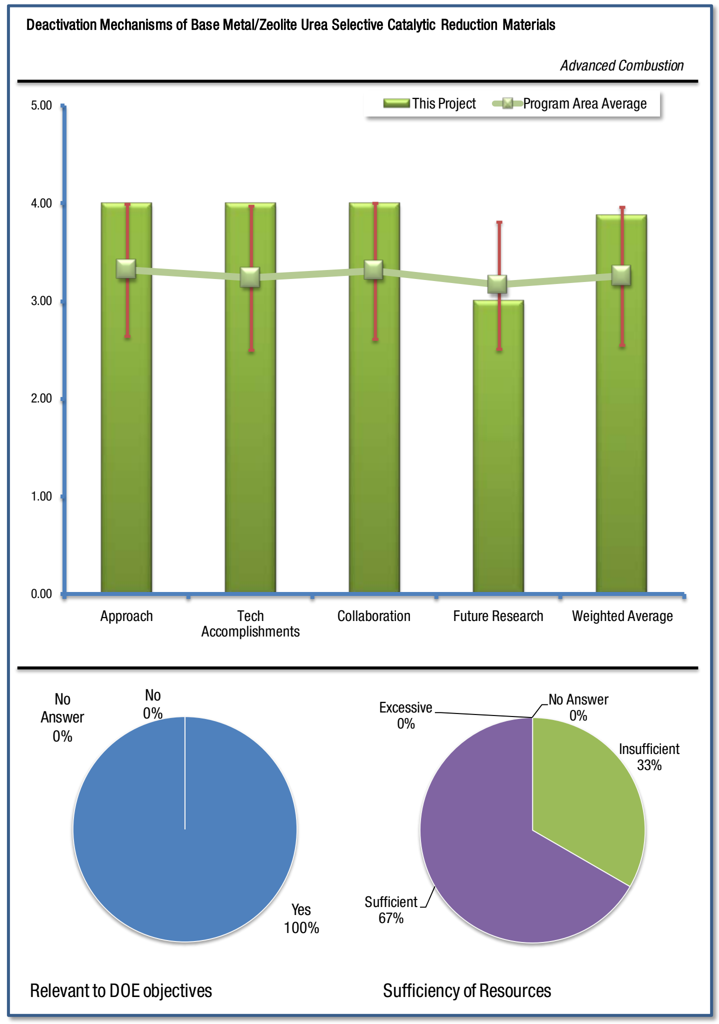
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated this is not applicable as the project is completed. Another reviewer added they hope the follow up on CRADA will get going. One reviewer commented there are very good future suggestions in regards to HT LNT formulations. They would advocate looking at speciation upon desorption/regeneration, especially as it pertains to ammonia generation, N_2O. Need fundamental understanding on HT LNT functionality and limitations. Comments from another reviewer mentioned that CRADA is done. Pending signing of a renewal, extending LNT performance to higher temperatures is planned. This is very appropriate, especially as the knowledge can be applied to lean gasoline engine combustion where temperatures are much higher.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this is not applicable as the project is completed. Another reviewer mentioned the works was done, presumably on time. One reviewer noted CRADA has expired. New proposal has been made and should be renewed. Also, a CRADA aimed at addressing the sulfur issues for lean gasoline engine technologies should be considered.

Deactivation Mechanisms of Base Metal/Zeolite Urea Selective Catalytic Reduction Materials: Charles Peden (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is a very clear indication of the effect of the DOC preceding an SCR on sulfur poisoning. The SO_3 aging effect is a very important piece of information. Another reviewer noted that pushing SCR NOx conversions to higher levels will enable re-running engines for higher fuel efficiency.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this was very sharply focused and easy to understand. Another reviewer mentioned the fundamental understanding of the deactivation mechanisms of the SCR catalyst is essential. PNNL is utilizing their core competency to push the SOA envelope. One reviewer added the CRADA is focused on several key fundamental challenge areas for the SCR technology, such as urea-related deposits, deactivation of zeolite-based SCR catalysts, and sulfur poisoning/regeneration of the SCR catalyst.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated slides 15 and 19 show the SO_3 effect and show the recovery from it. This is very good and important information. Another reviewer added the amount and impact of work is impressive. For example, the findings related to Cu agglomeration de-coupled from the zeolite dealumination when SCR catalyst degrades, are novel. Similarly, the information about the large difference in the impact of SO_2 vs. SO_3 on SCR catalyst is new and relevant.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Three reviewers all said there was coordination with Ford and PNNL. One also said it's hard to image a better collaboration.

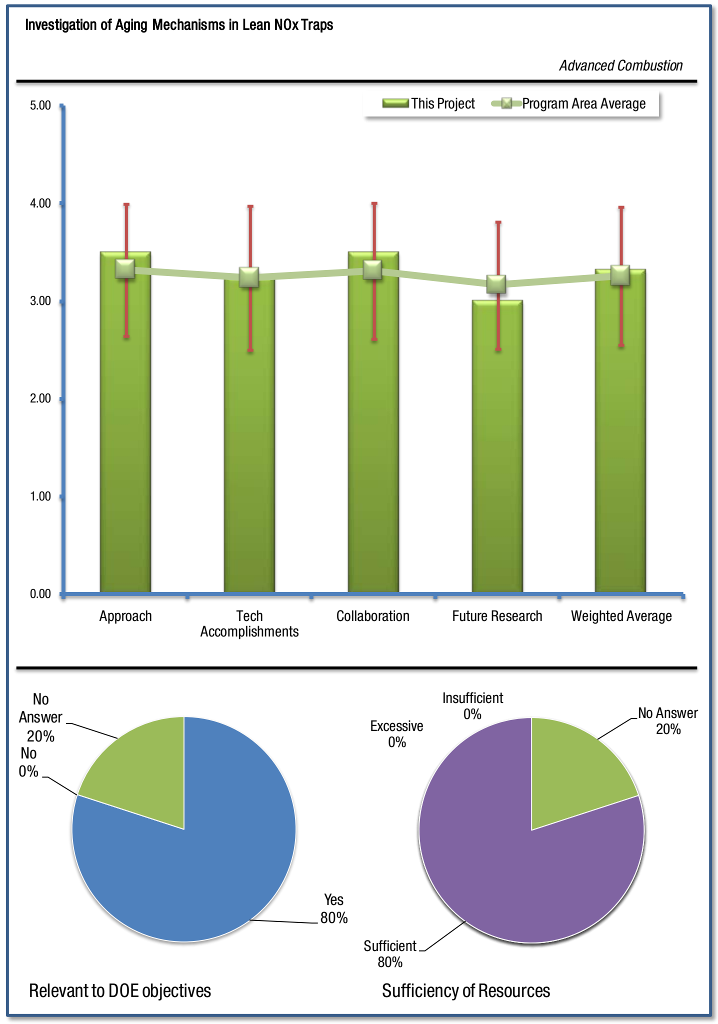
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would like to see the correlated aging approach. It seems as if Ford is going to keep that in house. That is disappointing since it would be helpful to the entire community and they are not convinced that it is a competitive edge for Ford.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated nice orchestration of PNNL and Ford resources to get a quick and useful result. Another reviewer added the project funding is lacking the planned level.

Investigation of Aging Mechanisms in Lean NOx Traps: Mark Crocker (University of Kentucky)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is useful work on LNT for diesel and gas engine use. Another reviewer noted deNOx is related directly to fuel consumption; project pointed to deNOx efficiency. One reviewer mentioned LNT catalysts are the key to introducing lean combustion technologies. Specifically sulfur poisoning, durability and cost (precious metal loading) are the issues. This project addresses these critical areas.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated meaningful model catalysts allow detailed study of aging effects. Another reviewer commented solid approach but perhaps too heavy on experimentation, as one would see in an industrial lab, with little heavy analytical methods characteristic of and unique to National Laboratories. They would prefer to see an iterative approach where experimentation is supplemented in parallel with detailed analyses to develop and prove hypotheses, which can then be used to design better experiments. One reviewer noted the approach is highly experimental in nature. Approach is to characterize various samples (with and without ceria) by subjecting them to various feed gases and an aging cycle, measuring NOx conversion performance and examining substrates with mass spectral techniques. Comments from another reviewer mentioned the sample matrix for this study was planned very systematically, to address several key questions about the impact of the typical LNT constituents, on its performance. The experimental conditions were judiciously chosen, a particular challenge for LNT studies.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated nice data; it seems that good conclusions and theories are coming along. Another reviewer added the results are interesting but generally are consistent with other studies. The new work will come from high tech analytical evaluations. For example, you results on ceria storage of sulfur are interesting and new, to the reviewer's knowledge. This came from unique instrumental analyses. One reviewer mentioned with ceria wash coats the reduction in NOx conversion efficiency was significantly reduced. Ceria acts as sulfur sink protecting the Barium NOx storage phase. Halving the loading of Rhodium did not affect performance. Significant sintering of the Platinum occurs without Ceria. Significant durability performance has been achieved with Ceria based wash coats. It is good to see that the results of this program are in agreement with the work at PNNL. Comments from another reviewer noted interesting findings, e.g. the impact of OSC component on the selectivity towards NH_3 vs. N_2 selectivity on the aged catalysts.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a good relation with Ford, ORNL. Another reviewer mentioned the exchange between state-of-art catalyst and OEM aging and inputs are invaluable. However, they urge more fundamental study. One reviewer noted appropriate coordination among the CRADA partners (Ford, Umicore, and ORNL) exists.

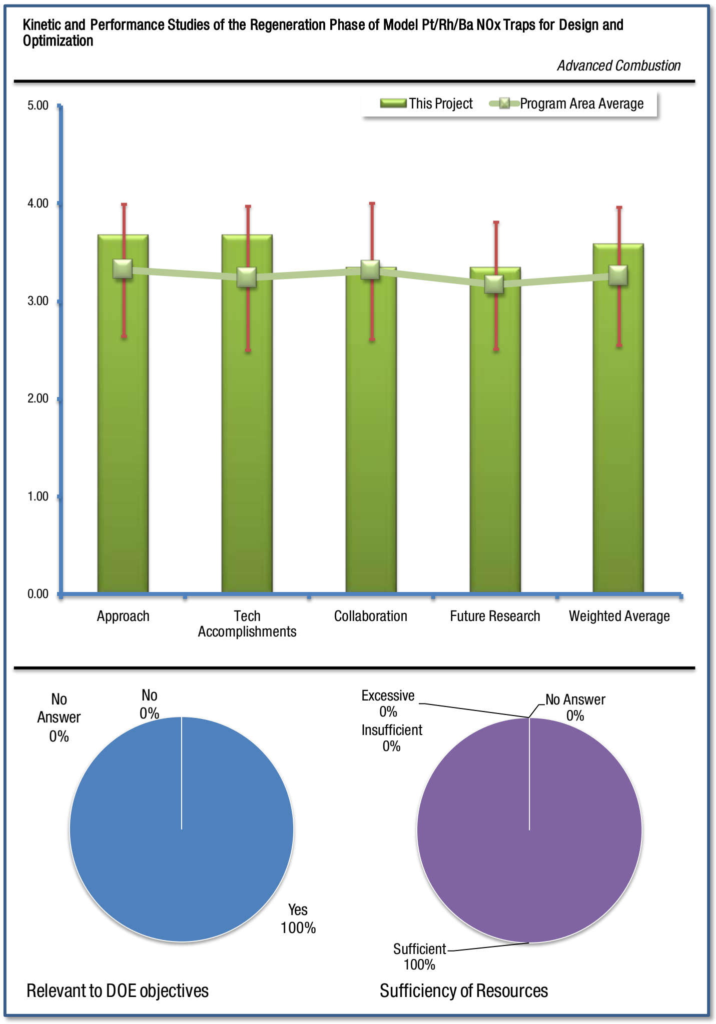
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Three reviewers stated the program is nearing its end in September 2009 with one reviewer adding, the remaining plans seem appropriate and useful. Another reviewer added finish up on analytical testing while one other reviewer said work remaining is modeling work to capture the experimental observations.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No reviewers commented on this question.

Kinetic and Performance Studies of the Regeneration Phase of Model Pt/Rh/Ba NOx Traps for Design and Optimization: Michael Harold (University of Houston)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated detailed mechanism for LNT activity is necessary for implementation and more significantly for the control strategy for that device. LNTs maybe a technology that is used in lean gasoline, diesel and highly diluted gasoline technologies. The reviewer does question whether there is not a lot of DOE resources applied to LNT projects. Another reviewer mentioned this project has good relevance. One reviewer commented high-efficiency NOx traps allow engines to be tuned for higher fuel efficiency. Also, better understanding of the details of LNT operation, especially regeneration, should lead to reduction in fuel penalty associated with the LNT regenerations.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated a technical barrier of an LNT model is just a bit diffuse; however, the work clearly addresses exactly that problem and has provided insights. The integration of experiment and modeling is very well done. The reviewer is however, very disturbed that the model can be multi-valued. They cannot see justification for that. In addition it would be very helpful if the experiments which were used to develop the model were defined. And then, separately, if the model could be compared with validation experiments which were not used in the model development. With this many parameters, one could conceivably fit an "elephant". Another reviewer added TAP reactor and range of catalysts is very good. No one else seems to be doing these isotope studies. One reviewer mentioned excellent combination of experimental tools and methodologies (bench reactor studies, TAP, isotopic labeling), focused on some of the most challenging fundamental LNT questions, such as relative reactivity of NH_3 and H_2 as NOx reductants, etc.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the isotope results are quite interesting. Another reviewer noted there is good progress and interesting results. One reviewer added Dr. Harold's group's results from this program provide unique insights into the chemistry of LNT regeneration.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the presentation indicates collaboration with Ford; however, there was little evidence of it in the presentation. Another reviewer commented there are good connections in academia and industry.

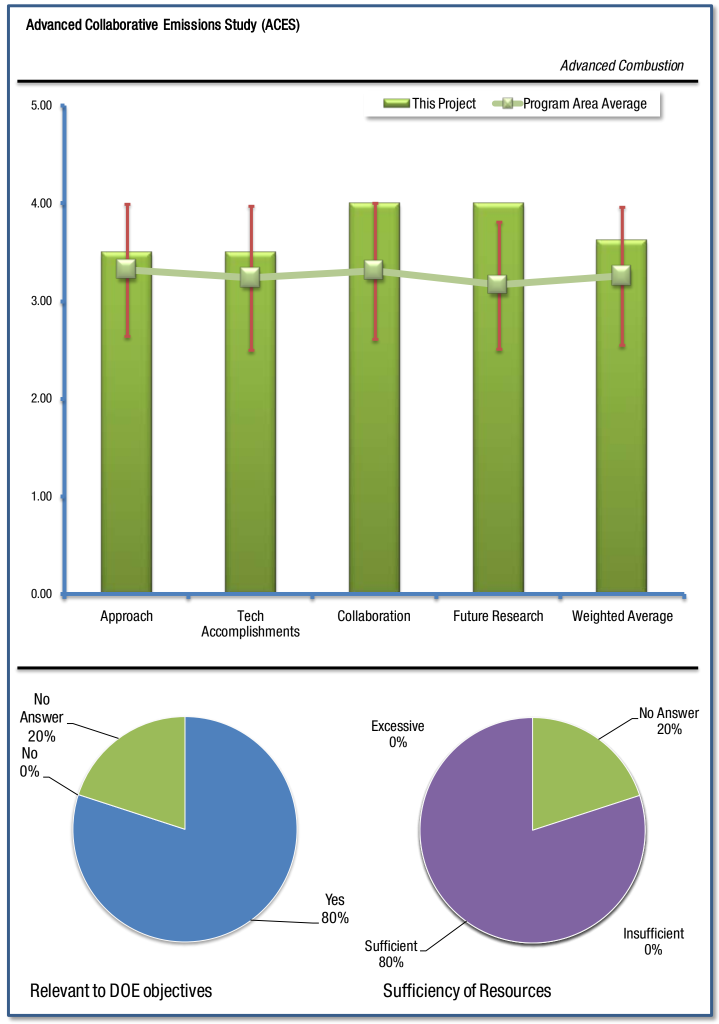
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would like to see some model validation comparison with experiments. The future work is pretty weak on transient experiments. Another reviewer mentioned the project is reaching an end, they hope it will be continued.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are sufficient if it gets extended.

Advanced Collaborative Emissions Study (ACES): Dan Greenbaum (Health Effects Institute)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that although study of health effects does not directly contribute to petroleum displacement, it is crucial to understand potential health impacts of new fuels and how they differ from those of existing fuels so that effort is not wasted on development of new fuels or technologies that would later face an unanticipated roadblock. Another reviewer mentioned diesel engines are 30-40% more fuel efficient than gasoline engines. As the US moves to the new diesel technologies in some applications, it will be important to ensure that there are unintended adverse health consequences related to exposures to new technology diesel exhaust. The ACES program describes by Mr. Greenbaum will address this issue. One reviewer commented much of the work will have to be done to find better catalysts so that as emission standards are tightened fuel economy does not suffer. Health effects of vehicles with different emissions are unknown. There is a concern that ultra fine soot particles may do more serious harm in the lungs during regeneration. Comments from another reviewer noted new fuel reduction technologies in general should be tested for any unintended impacts on health. This project fulfills this role for heavy-duty diesel engines. Would light-duty diesels be different? Market penetration so far probably doesn't warrant testing.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach is very straightforward and logical. Measure the emissions. See what happens if rats breathe them. They hope that the future work will include some information on dose vs. response for the exhaust (time series?). Also, it would be useful to know if it is specific individual components of the exhaust that are bad actors, or if the combination makes the impact worse than the sum of the individual components' impacts. This might be more useful and more elegant. Another reviewer commented there has been extensive planning of this study by a host of stakeholders, including DOE, EPA, CARB, engine manufacturers, and the petroleum industry. There have been a number of technical barriers that have been and are being addressed to measure the components of diesel engine exhaust and to ensure a consistent 2+ year exposure of animals to new technology diesel exhaust in a chronic bioassay. One reviewer noted the use of multiple engines, multiple test cycles and independent research organizations ensures that the approach is thorough. Comments from another reviewer mentioned it was a well planned out for such a complex (800 species) test. Stakeholder input was well utilized.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer was particularly interested in the reduction of as-yet unregulated emissions. This allows us to avoid possible surprises if EPA decides to regulate these compounds. Another reviewer added for various reasons, there have been significant delays in getting the study started and making progress is exposing animals to the new technology diesel exhaust in a chronic bioassay. Some of the delays have been related to technical issues that needed to be addressed. Others related to the long process of developing consensus on issues among the host of sponsors of the study. HEI is doing a reasonable job of "herding cats" on this project in making sure that most of the sponsors on the path forward. Having an excellent expert "oversight committee" has been a great help moving things forward. One reviewer commented the timing of the phases of the project is just about on track. The delay in phase three is not critical and much of it will be made up throughout the project. The results of phase one that was presented show how thorough and detailed the testing has been so far. The report coming out of this phase will be very important in determining future emission regulations. Comments from another reviewer noted interesting results so far. What will the 2010 engines bring?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated this project has a strong and reputable set of partners and advisors for both the emissions and health effects work. Another reviewer commented there has been a large amount of collaboration and coordination with other institutions on this study. Experts in the areas of engine emissions characterization and particle and diesel emissions toxicology have been brought together to design and oversee this study. In addition to setting up emissions characterization study at Southwest Research Institute, HEI has also been involved with designing and setting up the animal inhalation study at Lovelace Respiratory Research Institute. This is a very time consuming and complicated process. In addition to these core studies, HEI has coordinated with other academic researchers to assess other health-related endpoints as part of the ACES study. On the negative side, periodically, there is some frustration among the sponsoring engine manufacturer that they are being left out of the decision making process regarding how this project goes forward. This issue is being addressed by HEI. One reviewer noted the mix of engine manufacturers, regulators, independent laboratories and national labs makes for a well balanced team. Preliminary data suggests that 2010 engines may not meet specifications. The reviewer finds it encouraging that discussions are underway with all stakeholders about best way forward. Comments from another reviewer mentioned many of the industry stakeholders are engaged either directly or through industry organizations.

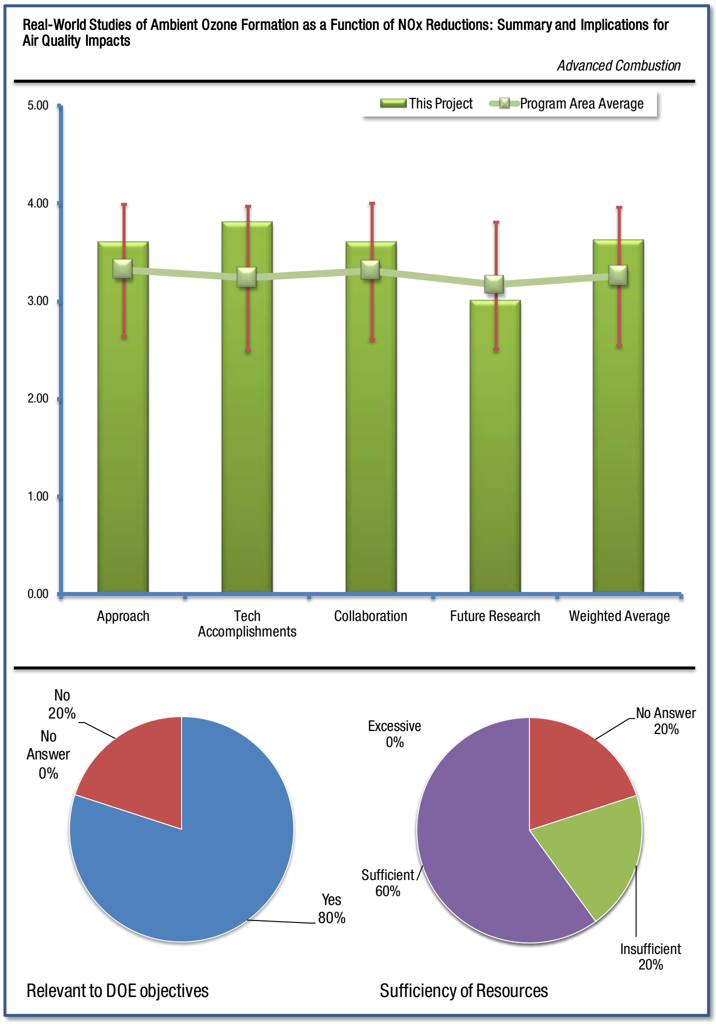
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated it is especially important to carry the exposure tests down to low exposure levels to insure that there are no important residual impacts at these levels. It would be useful to demonstrate if engines have gotten so clean that they do not need to be regulated even more stringently. They suggest also measuring emissions for biodiesels. Another reviewer added there has been excellent planning of the ACES study, with significant discussion at decision points so that logical paths forward were developed. HEI has done a great job of bringing together all the stakeholders at these decision points and developing a consensus on how to move forward. One reviewer commented the hardware and equipment for testing the health effects on animals is in place and exposure testing will start soon. Comments from another reviewer asked, were the all unregulated emissions (XAD sampled) above the minimum detection limits with the DOC/DPF used by 2007 engines? If not, would it be worthwhile to investigate improvements to this method?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this project seems to be adequately funded. There do not seem to be major areas that have been left out due to lack of funds. Another reviewer noted it is essential that DOE continues to provide their commitment to funding a portion of the ACES project. This is especially important during the current economic downturn, which is having a very adverse financial impact on some of the sponsoring companies. This study is absolutely critical to assessing the potential adverse health effects after a major change in diesel engine technology. Without this study, our society may suffer unintended adverse health consequences that would not be known until potential health effects are observed in humans many years in the future. One reviewer mentioned this is very important work that was well presented while another reviewer said great combination of government and industry contribution.

Real-World Studies of Ambient Ozone Formation as a Function of NOx Reductions: Summary and Implications for Air Quality Impacts: Doug Lawson (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated although this work does not directly reduce fuel use, emission studies enable continued use of diesel fuel, which is more efficient than gasoline. It is important to recognize connections of transportation technologies to real-world impacts. It is also important to understand how tighter air quality regulations impact fuel economy. Another reviewer added continuing to reduce NOx emissions from engines results in lowered fuel economy. Dr. Lawson's studies are showing that lowering ambient NOx levels in most regions of the US does not lower ozone, but in many cases increases it. Therefore, there is no reason to further lower NOx emissions from vehicles or power plants. One reviewer commented this project supports that we are wasting fuel to control NOx. Comments from another reviewer noted NOx reduction to meet future emission the fuel economy of heavy duty trucks may be reduced with current catalyst technology and engine design. This study correlates ozone formation with NOx reductions and may change our way of thinking about additional NOx reductions. Background data was shown that ozone levels have not changed in years based on California data trends. One reviewer asked, is this focused on reducing petroleum consumption by removing emission controls? Is this appropriate?

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the weekend/weekday comparison is excellent because it enables the team to see the impacts of changes in relative concentrations of the pollutants over a short time. It also allows inference of correlations. Another reviewer commented in the initial phases of Dr. Lawson's studies, he observed the weekend ozone effects in Denver and Los Angeles. Some argued that these effects were peculiar to only these areas of the country. So, Dr. Lawson extended his studies to the other metropolitan areas of the US and found the same effects. His challenge now is to convince government policy leaders of the importance of his findings and the change air quality standard for NOx ambient levels and emissions accordingly. One reviewer noted lots of good data that speaks for itself. There appears to be a non-technical barrier here and that is getting the word out. Comments from another reviewer mentioned the researchers brought on board regulatory bodies as partners so that the regulators could get first hand data on the effects of NOx and ozone. Wise move! One reviewer asked, what should be done to reduce ozone? This may be a good future focus. If emission controls is not effective, what would be effective?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated this is another criterion that is not very applicable to this project. The team is making excellent progress towards its goals of understanding the dynamics of ozone formation. The reviewer's only criticism is the failure to bring the results to the attention of the regulators who seem to have the misconception that it is always better to reduce air concentrations of any pollutant as far as you can, no matter what the cost. It is not a technical goal, but visibility of this work is crucial. Another reviewer mentioned Dr. Lawson has made excellent progress towards the objective of showing that further lowering of NOx levels in the US will not result in lowering ozone levels, but in fact will increase ozone in many areas of the country. He has been able to address every criticism of his studies. For instance, it was argued that downwind of high-NOx areas, there would be an increase in ozone formation. Dr. Lawson did a number of ozone measurement studies downwind of high-NOx areas and showed that the weekend effect applied there as well. One reviewer mentioned monitoring ozone data at 540 sites in 23 states outside if California is a significant accomplishment in itself. The data supports what the California trend lines have shown and that is that there is no weekend reduction in ozone levels on weekends when heavy duty track travel is reduced. The publication of nine peer reviewed papers by the Health Impacts Program is a great way to get the message out. One presumes these are published in technical journals. There should also be a version for the press and news outlets to reach a larger audience. Comments from another reviewer noted the broadening of data sources is good.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated if CARB is really a partner, they suggest trying to make them understand that reducing NOx may mean increasing ozone, and vice versa. Another reviewer added Dr. Lawson has done an excellent job collaborating with the Desert Research Institute, other academic research laboratories, and regulatory agencies, including the US EPA and the California Air Resources Board. One reviewer asked, how can you coordinate with the EPA? With policy makers? It sounds like you have invited them to the party, but they are showing up. Comments from another reviewer mentioned partnering with the regulators is a good move. Observations from one reviewer noted government biased collaborators, otherwise a good collection of collaborators.

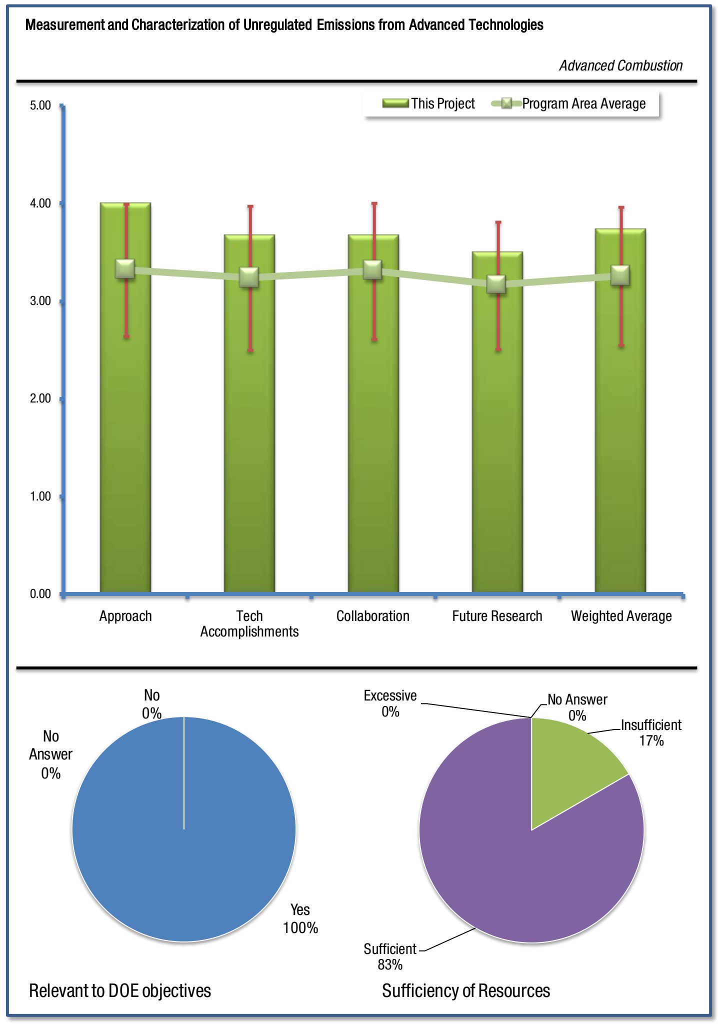
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated hard to tell from slides, but additional measurements and comparisons along the same lines would be very useful. Another reviewer commented Dr. Lawson has done an excellent job over the years of addressing criticisms of his findings, especially by policy makers, who want to continue to reduce NOx levels. His future research will continue to examine the weekend effect in other regions of the U.S.--perhaps he needs to look at other regions of the world, such and India and China, where NOx levels are very high. One reviewer mentioned ultimately, this work is to guide policy making to get the right things done. They are not sure they see a plan here to do this. Comments from another reviewer noted the next four years of on-road measurement activity will gather more valuable data. Observations from one reviewer said no discussion of future research. Again, what should be done to reduce ozone?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the team seems to be doing good work with allocated funding. Another reviewer noted funding for this project needs to be continued, so that the issues raised continue to be presented to air quality policy makers in the US. Much of the funding needs to go towards educating the regulatory agencies on the implications of Dr. Lawson's findings. One reviewer commented the overview page did state that this is one of multiple projects co-funded over several years but the FY09 budget of $80,000 will not fund even one full time grad student.

Measurement and Characterization of Unregulated Emissions from Advanced Technologies: John Storey (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated that although study of emissions does not directly contribute to petroleum displacement, it is crucial to understand potential impacts of new fuels and how they differ from those of existing fuels so that effort is not wasted on development of new fuels or technologies that would later face an unanticipated roadblock. Another reviewer noted advanced engine technologies can reduce air toxics emissions and improve fuel economy (e.g. hybrids). It is important to measure emissions of not only regulated compounds, such as particulate matter and NOx, but also unregulated emissions, because the latter have as great or greater potential health effects. As the U.S. moves to cleaner and more energy efficient vehicles, it is essential that the levels of potentially toxic compounds in the emissions be assessed so that there are no unintended health consequences of the new technologies. One reviewer commented all emission control is done to reduce risks to health. It is essential to be sure new technologies don't create new concerns but in fact help reduce health risks. Comments from another reviewer mentioned the use of petroleum and renewable fuels blends does dramatically reduce petroleum use. The greater the ratio of renewable fuels the higher the displacement. The project did not pick winners or losers in what the source of the renewable fuel was. This is good since there are many opinions on that issue. Observations from one reviewer added the project addresses the 'no harm' clause and petroleum displacement (ethanol, diesel) well.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the work directly addresses potential emission problems that could impede introduction of alternative fuels. Who knows what the EPA will decide to regulate? Another reviewer commented Dr. Storey's research is sharply focused on understanding emissions from new engine technologies. He has been very proactive and innovative on the conduct of these studies. One reviewer mentioned nice job of analytics, and good work to find reasonable test engines. Comments from another reviewer noted the use of multiple blends ratios with two different manufacturer's vehicle of different vintage and mileage gave an interesting perspective on the effect on the tailpipe emissions. It was not mentioned if the vehicles were specifically flex fuel or not. This test would be interesting on non-flex fuel vehicles. The work on the diesels and particulate matter showed some interesting results. Another reviewer asked, is there anything to be gained from better sampling methods? Repeat measurements? Many of these species are very low and the measurements are highly variable.

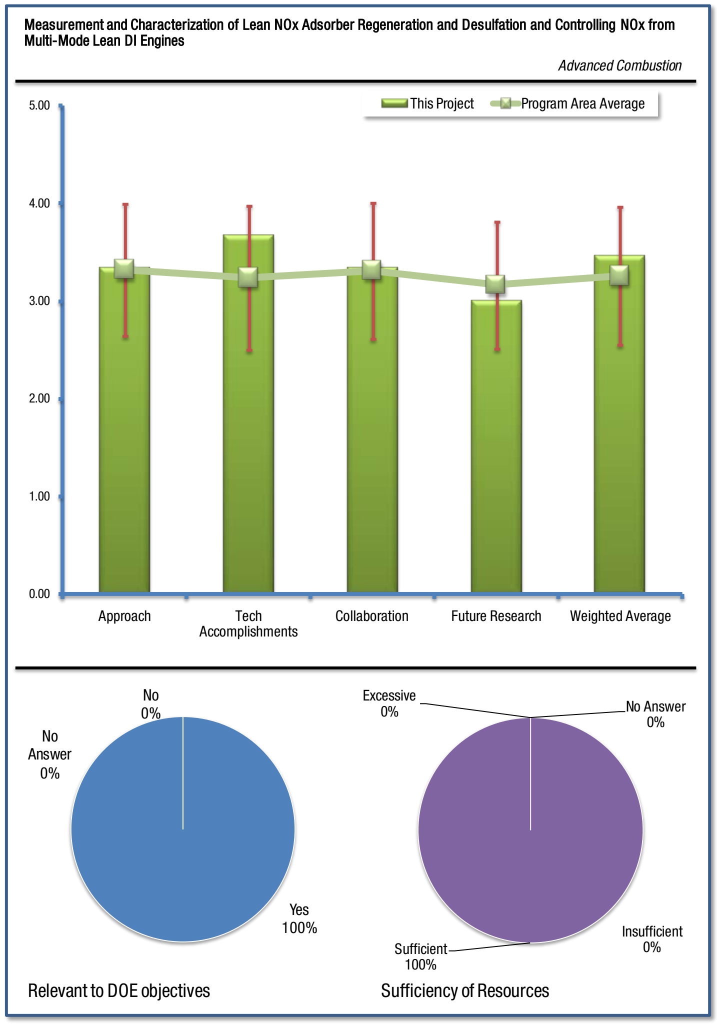
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated important new results have been obtained. It is particularly interesting to see how emissions vary for a given fuel combusted differently. Another reviewer noted Dr. Storey has made excellent progress in determining urea decomposition products. This is very important for assessing the potential adverse health impacts of implementing the SCR/urea technology in 2010 to reduce NOx emissions from on-road vehicles in the US. Dr. Storey has also made excellent progress in implementing technologies to measure MSATs. One reviewer added the data shared shows good progress with the project. The particulate separator sure is a novel device.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the team includes experts from several excellent institutions working together. Another reviewer added Dr. Storey is collaborating with a number of government and academic research laboratories. These collaborations have been well-coordinated. Dr. Storey's research needs to be published in the peer-reviewed literature--this will have a greater impact on driving the implementation of new engine technologies and advanced fuels. One reviewer commented active participation with CRC and similar groups. Comments from another reviewer mentioned they were pleased to see university participation along with regulatory agencies and national laboratories. This is a good mix for a fair and accurate research project. Observations from one reviewer noted a good range of collaborators. Is there any collaboration interest in industry for the project?

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated analysis of additional alt fuels and combustion technologies is appropriate if these are expected to see important contributors to future fuel supply. Work on SCR emissions is important. EPA regulations have been known to have their own impacts. Another reviewer commented Dr. Story's future focus on looking at MSATs from the use of ethanol blended fuels is extremely important. These renewable fuels will be important in addressing climate change going forward, but it is important to determine whether there will be unintended consequences of use of the new fuels in terms of increased emissions of MSATs. Dr. Storey needs to also focus on the potential release of unregulated air toxics from the SCR/urea technology, which is being implemented by most truck manufacturers starting in 2010. It is very important to assess whether this new technology will have the unintended consequences of increasing air toxic emissions. Again, Dr. Storey and his collaborators need to be more active in getting his results into the peer-reviewed literature. One reviewer noted the plans presented are right on target for what needs to be done yet. It would be interesting to determine the effects on engine durability and performance on non-flex fuel vehicles running on blended fuels over extended operating times.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer stated the team seems to be able to do excellent work with the funding allocated. Another reviewer added funding levels should be increased, since there are so many different new engine technologies and fuels being proposed for the future, and emissions of these new technologies need to be assessed. Dr. Storey needs to be provided the time and resources to write papers for publication in the peer-reviewed literature. One reviewer mentioned this is a large project but with combined funding from DOE and EPA it is about right.

Measurement and Characterization of Lean NOx Adsorber Regeneration and Desulfation and Controlling NOx from Multi-Mode Lean DI Engines: Jim Parks (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this is a critical understanding of deNOx function, which is related to fuel consumption. Another reviewer added this program addresses the after treatment issues of lean and LTC combustion technologies and therefore is critically relevant. One reviewer commented enabling broader market penetration of more fuel efficient, diesel engines.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this is an excellent engineering approach - set up the devices, put together an operation strategy, run the tests and analyze the results. It is missing the scientific approach that might be expected more from a National Laboratory: develop hypotheses, run experiments, adjust, and run again to gain system or fundamental understanding. We need more fundamental understand of LNT+DPF systems and LNT+SCR systems. Interaction, composition effects, feed gas effects, etc. Another reviewer noted the focus is on reducing fuel penalty during regeneration of catalyst. The approach provides a link between and system level performance. The approach also provides a platform for multimode engine operation and its effects on various after treatment philosophies. Approach is to supply data to CLEERS, universities and other national labs as feedback. One reviewer mentioned this is a much focused effort, clearly leveraging major learning from the previous years of this project, including rich engine calibration for optimal LNT efficiency; NH_3 formation and evolution across LNT, etc.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated characterization of the DPF+LNT and LNT+SCR systems is advancing. These data, added to other data from the literature is adding to the knowledge base. It is good to get this into the public domain. Much information is coming from this program, but more exploration into cause and effect would be more useful. Another reviewer commented the lower fuel penalty to regenerate DPFs for HECC combustion has been demonstrated. Lower desoot frequency also results in less time at high temperature for the catalysts. HECC combustion also results in lower back pressure rise rate. Work has also progressed to characterize ammonia formation and utilization in an LNT-SCR hybrid system. Ammonia generated during rich regeneration of LNT. SCR after the LNT cleans up NOx that breaks through the LNT. Challenge is to produce sufficient ammonia across the LNT. One reviewer added the results for a sequential LNT-SCR system are very interesting, especially the complementary comparison of NOx conversion and fuel efficiency.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the evidence of collaboration is apparent, but could be better. Did you get the best LNT formulation for NH_3 generation? Why wasn't OSC used on the DPF? Are you using a post injection strategy optimized for NH_3? Are you using the best analytical or modeling tools to delve into the fundamentals? Another reviewer noted good relationships exist between catalyst suppliers, CLEERS and other national labs.

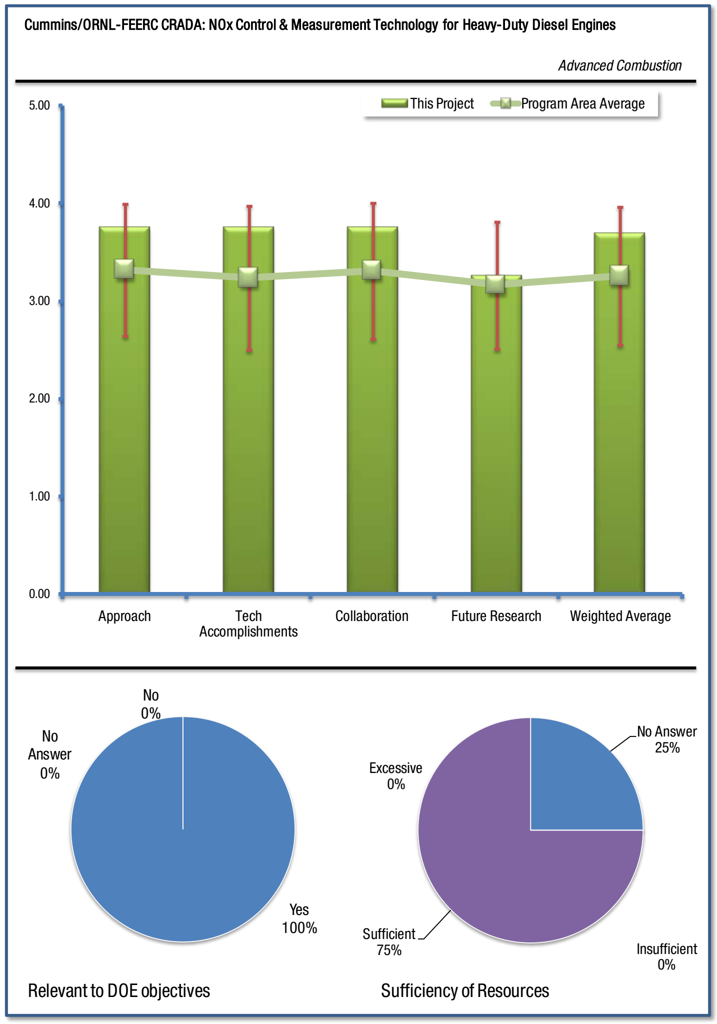
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they would prefer to see more fundamental analyses and system optimization on LDD before proceeding to gasoline. Lean burn gasoline is not in the cards for the US due to high sulfur levels. However, perhaps this study will show a pathway which could be interesting. Make sure the project explores these sulfur effects. The data will be useful for evaluating sulfur reductions in gasoline. Another reviewer added one of the barriers to introducing lean combustion technology is the cost of LNT-based after treatment system due to the high cost of precious metals. Future plans should include a focus on trying to reduce PGM loading on the LNT in order to reduce cost. Ways of shifting a larger burden of NOx reduction to the SCR should be investigated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it seems that for an engineering study like this, the staffing is adequate. However, they would like to see more fundamental resources (modeling, analytical) added to really add to the base knowledge.

Cummins/ORNL-FEERC CRADA: NOx Control & Measurement Technology for Heavy-Duty Diesel Engines: Bill Partridge (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated both topics support the overall DOE objectives of petroleum displacement. Another reviewer noted excellent connection with needs. One reviewer added instruments will help to calibrate engines better and faster to operate in a more efficient mode. Comments from another reviewer mentioned this program addresses the state of art in after treatment of lean combustion emissions and has already proven itself by impacting commercial product.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?
Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated typically the work on this project has provided the instrumental development and support for a range of DOE initiatives. As such it has been very successful. The direction of the project has adjusted in a continuous fashion to support the other projects in the EERE DOE portfolio. Another reviewer commented nice application of scientific analyses to engine development problems. One reviewer mentioned very good results from your new measurement techniques. Comments from another reviewer noted the approach is well balanced utilizing the strengths of ORNL to develop and demonstrate diagnostics to gain system insights, and strengths of Cummins to apply these diagnostics to develop engines. CRADA has some benefits for the broader community through regular interaction in the various DOE workshops.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the instrumental accomplishments have been outstanding. The SpaciMS has moved into the expected research technology. The optical backscatter probe shows great promise. The negative about this work is that it is typically support work and often has no specific identity of its own. Since the researchers have been very successful working with other groups this is not a significant negative. Another reviewer added very nice work with solid results. One reviewer commented very good measurements. They think real final progress would be to put these instruments into the hands of engine makers. That is another barrier to be overcome. Good works on helping us understand SCR performance. Comments from another reviewer mentioned Fuel-in-Oil (FIO) diagnostic development has been completed and transfer of that technology to Cummins has been completed. The accomplishments also have developed a fast cycle-to-cycle and cylinder-to-cylinder diagnostic for PM measurements. The benefit of this sensor is its simplicity and ease of use. Both the above probes should be considered for commercialization. By sensing the Water Gas Shift Reaction, a tool is being developed to diagnose the NOx storage and sulfation levels of a catalyst. This will be useful for OBD II diagnostics. Progress has been made on understanding sulfation and ammonia production characteristics.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the instrumentation is willingly and enthusiastically shared. It would be hard for them to believe that collaboration could be any better handled. Another reviewer mentioned there is a close relation between industry partner and Lab. As an outsider, it is obvious this has been very valuable. One reviewer added they would think a partnership with an instrumentation company would be helpful. The reviewer knows there are other optical pm measurement devices on the market. How does yours compare? Comments from another reviewer noted this is a CRADA between ORNL and Cummins and collaboration is excellent.

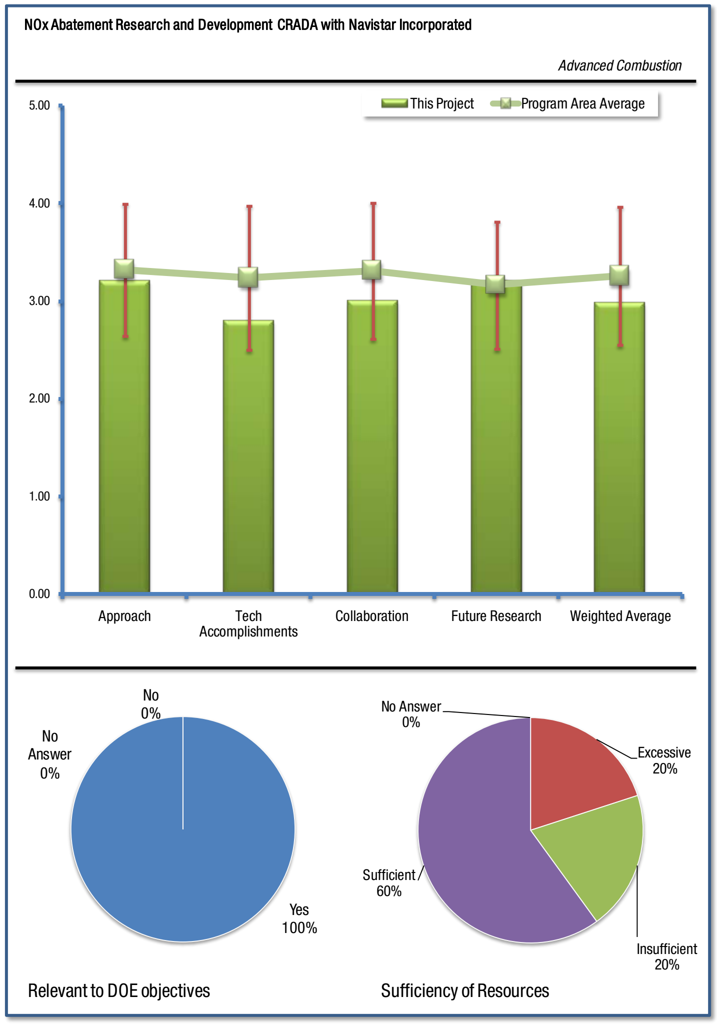
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated as long as the close collaborations are continued, the future work is well selected. If the collaborations are not actively pursued, then they do not feel there is cohesiveness to the future plans. Another reviewer noted seeing the development work completed on the optical backscatter probe and the sensing of the WGSR to monitor sulfation will be very valuable. Similarly, understanding sulfation effects on ammonia formation is also the key to developing low cost SCR hybrid after treatment systems.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the National Laboratory unique and complete instrumental availability is very well leveraged. Another reviewer commented it sounds like the CRADA should be extended.

NOx Abatement Research and Development CRADA with Navistar Incorporated: Todd Toops (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated SCR after treatment technology is presently the front runner for significant implementation for after treatment of lean burn engine technologies. LNT after treatment technologies will be used on at least part of the implementation of lean burn engine technologies. The high cost of the precious metals is a concern for significant penetration of this technology. This work addresses both of those applications. Another reviewer noted the project feeds into deNOx and fuel consumption relationship; may enable better medium-duty and light-duty diesels. One reviewer commented the project is using SCR systems most efficiently lead to better fuel efficiency. Comments from another reviewer mentioned the project is supporting broader penetration of fuel-efficient, diesel engines.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the evaluation of the CLEERS proposed SCR protocol is a major need in order to provide an industry wide implementation of this technology. Having an independent and well instrumented laboratory provide that baseline evaluation is of great value. The reviewer continues to be concerned that the step changes in concentrations must be well characterized and need to minimized as much as possible diffusional spreading in those step changes. The authors need to provide more detail on that portion of the protocol. Another reviewer commented the approach towards SCR understanding seems satisfactory. There is a need for understanding on NH_3 storage, oxidation, and deNOx effects vs. operating parameters. One reviewer mentioned they are not sure what technical barriers are being overcome here. Comments from another reviewer noted collecting transient data and evaluating sensors for closed loop control are critical research areas. Observations from one reviewer added the experimental approach on the ORNL side is solid and clear, however on the side of the industrial partner; the requested work appears to be filling gaps in their basic lab capabilities, rather than addressing some major fundamental technology challenges.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the experimental results are very good. They are a bit disappointed that there is limited physical "explanation" for the experimental observations. There is not too much unexpected in the experimental observations. Much of that information is expected. The authors need to go a bit beyond the simple observations. Another reviewer added the results incrementally add to the state of knowledge. Data will be useful for modeling and CLEERS inputs. Good build-up to fundamental understanding of SCR reactant interactions; much of the data, however, is available in the literature. One reviewer commented there were good, methodologically thorough results.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated good reporting. There is very little information shown from any partner. Are they just being pulled along? The reviewer would sure like to see a few Navistar and MTU slides showing some of their work. Another reviewer noted the plan seems reasonable with the University of Michigan and Navistar, but little evidence of collaboration on this segment of the investigation. One reviewer mentioned it seems like a good deal for Navistar. Every engine maker is out there working on this in cooperation with their SCR catalyst supplier. Why would the government help Navistar with this? Comments from another reviewer added MTU modeling capabilities is an excellent recent addition to the program.

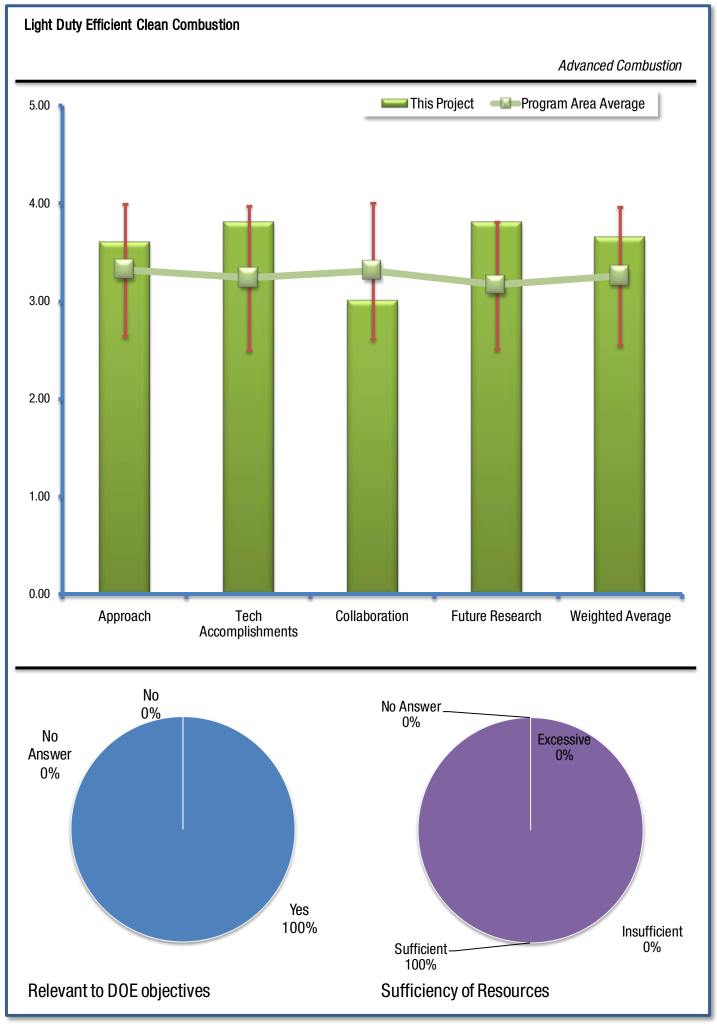
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future work seems to be okay. Not much specific detail, just business as usual. Another reviewer added space velocity SCR impacts will round out study. Much is in the literature on the topic, so try to fill in the gaps. Filling out the options with a DOC + DPF study will be interesting. New information that is needed is the effect of alt combustion strategy on DPF regeneration. It looks like this will be accomplished.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated no modeling results shown. They thought that was a part of this project. Another reviewer noted they don't see justification for this. 2010 engines are coming out with this. How is this advanced work?

Light Duty Efficient Clean Combustion: Donald Stanton (Cummins Inc.)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated it directly impacts automotive market fuel efficiency while maintaining low emissions signature. Another reviewer noted the proposed work intends to evaluate a combination of technologies for efficiency improvement in diesel engines. Moreover the final mix has the possibility to be used across a slew of engine ranges. One reviewer added it is hard to be more relevant than an engine manufacturer trying to improve fuel economy and emissions. Comments from another reviewer mentioned this is one of the more important and impressive programs within the DOE ACE portfolio. Fuel efficiency reductions improve year on year with potential for real engine-based reductions of 10+% while maintaining very low emissions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this is a very comprehensive approach that addresses just about every challenge in this area, such as combustion system technology integration (boosting, EGR, injection, etc.). However, only in this year have they considered integration of after treatment technology. Another reviewer commented they would have liked issues such as cost-effectiveness, transient response (especially with two stage turbo charging) addressed in addition to packaging issues. Else, there is a possibility for this to remain as a lab curiosity. One reviewer mentioned the approach is starting from sound models and moving toward full engine tasting is the right approach, which is nicely done. Comments from another reviewer noted a very impressive balance of hardware evaluation, modeling, measurement, strategy. There is also an impressive focus on barriers and objectives - efficiency, emissions, commercialization potential. Observations from one reviewer added minimizing the noise at intermediate loads is a good area of research; minimizing air entrainment for better flame propagation sounds like a big enabler for achieving bin 5 with in cylinder combustion control.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there was excellent progress on the combustion system and integrating simulation with experiment to achieve practical BMEP levels (6-8 bar) while achieving a slight increase in efficiency while getting close to Tier II Bin V. Another reviewer added excellent! Exhibit a willingness to change course should the opted path not work prove less attractive. However, considering the exploratory nature of some of the elements of this work, very little is reported in open literature. This reviewer would encourage a few SAE publications, for posterity. One reviewer noted very good progress and outstanding results. Comments from another reviewer mentioned impressive year-on-year advancements. There is a huge amount of data and progress.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated it is not clear at all what Chrysler is contributing, but that may be more an effect of the financial state of Chrysler than any fault on Cummins part. Also not very clear what contribution BP is making, although BP involvement is a plus. Another reviewer mentioned collaboration with neither Chrysler nor BP nor the DOE seems apparent. It looks as if the DOE is funding contract work at Cummins. This might be appropriate to get the necessary information into the public domain. One reviewer commented they would have liked some collaborative efforts (to the extent possible) with national labs and universities. Comments from another reviewer added this builds on long history of Cummins involvement in research and modeling. It shows the benefits of long term research.

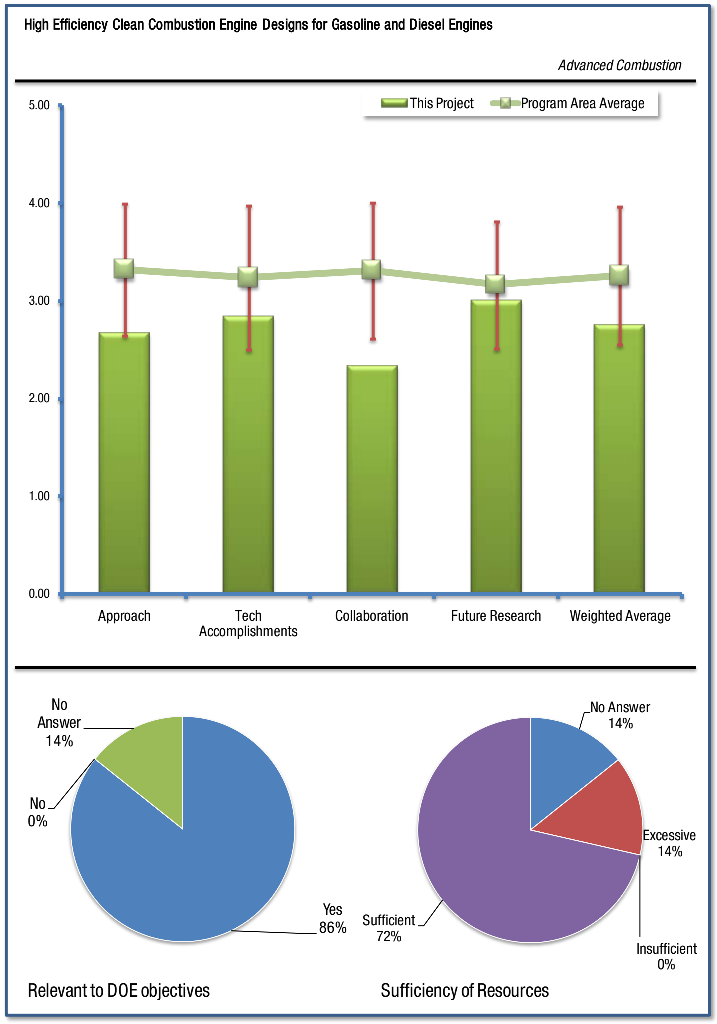
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated alternate pathways have not only been identified, in some cases they have been implemented; such as NOx after treatment integration. It probably should have been included from the beginning, but it seems to be working well at this time. Another reviewer noted the project is moving toward the product very nicely. One reviewer added the future directions are solid and they can hardly wait.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it appears that the resources match well with the project and the accomplishments/goals. Another reviewer mentioned they are very surprised at the high return on the dollar.

High Efficiency Clean Combustion Engine Designs for Gasoline and Diesel Engines: Kenneth Patton (General Motors Corporation)



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this project does indeed, on some level, address improvement in fuel efficiency. Another reviewer commented there is good relevance to GM engine design planning. One reviewer added that improvements in gasoline and diesel HCCI engine operation meets DOE goals of reducing fuel consumption and reducing emissions. Comments from another reviewer mentioned the HCCI work shows at least 6% fuel efficiency up to a 20% fuel efficiency. The PI did not describe or evaluate the VVT technology on a standard SI or CI combustion system. Observations from one reviewer noted the project addresses emissions and efficiency objectives which are in direct support of reduced petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this project appears to be an opportunity to test several different VVA strategies, whether they have applicability to LTC or not. This is not to say that LTC does not benefit from VVA, but more conventional combustion systems also benefit from VVA and this presentation did not address that characteristic. In addition, it was entirely unclear why there were different VVA partners for each program, and the presenter did not provide a technical answer as to why the VVA partners were different. The efficiency gains appear to be very modest with a very limited operating envelope for the gasoline HCCI strategy - leading to the question as to whether the gasoline HCCI system is even remotely worth the effort. Another reviewer noted there are a large number of technologies included. It seems there is risk of diffusing the effort. One reviewer commented enhancing the transition between HCCI and SI modes was emphasized as an important part of the work, but very few details of how this has been enhanced were given. How is the FFVVA being used to achieve this? For internal EGR: if you can't measure the rate of EGR, how will you quantify the variability between cylinders when you go to the multi-cylinder? What is being done to remove this barrier of quantifying the internal EGR rate? If internal EGR can only be used at light loads, how can it be used to control NOx emissions at higher loads where it is needed more? Comments from another reviewer mentioned there was no comparison to standard combustion system improvements with this technology. VVA technology was chosen for the projects not because of technological advantages but because of working relationships. In some respects this looks like an attempt at evaluating VVA technology and not low temperature combustion. Observations from one reviewer added the approach of using VVA technology with controls to understand potential of more production viable systems makes sense. Both gasoline and diesel approaches are reasonable. More information on emissions plan/integration with combustion would have been interesting. Another reviewer stated incorporation of FFVVA to improve operating range of gasoline HCCI is an interesting approach and may lead to this new technology to become acceptable in a wide range of commercial applications.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated if this program has received $6.5 million over 5 years and they are just getting to the point of spinning a multi-cylinder engine (not operating, spinning) with the respective VVA systems: that seems like fairly slow progress. The reviewer can appreciate how difficult it is to actually implement these systems, but that seems to be a significant amount of time/money for the apparent progress. Another reviewer added there was good progress on several items but it is not so clear you have a real direction forward. The project is working on many systems and many concepts. The project also needs to have a plan to down select and move forward with a system concept. It is not clear how well you have used models to focus the research needs. One reviewer mentioned the spin rig testing of VVA work was good. No progress on mode switching was reported. "Lack of cylinder pressure sensor" was cited as a remaining obstacle for doing closed loop feedback. The reviewer assumes this comment is based on some cost criteria. Cylinder pressure sensors are certainly available on a test or proof of concept basis. Can the multi-cylinder demo meet Tier 2 Bin 5 without aftertreatment? If not, why not? Just making the statement that "This program will have an impact on future GM production engine designs" is like saying "trust me." The reviewer thinks GM owes a better explanation to DOE (i.e. tax payers) of what the impact will be, and should this be shared with other U.S. companies. The accomplishments to date from the beginning of this project seem to be disappointing with the level of funding that has been received to date. It is understood that the progress from last year was small due to the low amount of funding received in FY09. Comments from another reviewer noted progress towards their milestones were good. Fuel efficiency gains were impressive also. Progress seems on-track. Several specific comments were provided by this reviewer:

- Slide 6 - What is the reference for efficiency/emissions improvements? It would help to understand the significance of improvements. Also would be nice to have numbers on axes but understand the sensitivity.
- Gasoline and diesel activities use different suppliers for VVA systems. The reviewer is curious as to why. Perhaps gasoline and diesel teams have different histories with VVA suppliers.
- Gasoline portion did not talk much about transition to more realistic VVA system for production. The reviewer would be interested in the anticipated path. The diesel portion did address this.
- For diesel portion, exhaust re-breathing was approach of choice. The reviewer realizes heat loss will be less with exhaust as compared to intake re-breathing, but is it still not an issue?
- For both activities, more quantitative information on goals/objectives would be useful. Focus seems more on tools development. The reviewer does realize the tools are necessary to get to the efficiency/emissions improvements and development is a long, hard process.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated GM certainly has a good track record of working with suppliers and it appears that they are starting to see the fruits of these collaborations in hardware at this time. However, aside from supplier interaction, it doesn't even appear that there is internal communication between the gasoline and diesel HCCI projects being funded here, much less effective communication or interaction with other organizations. Another reviewer noted many suppliers seem to indicate some indecision and perhaps limit how closely the supplier is willing to work with you. One reviewer commented the response to last year's reviewer comments was disappointing in regard to the technology transfer. It doesn't appear that GM "gets it" in terms of how to work with academia. This project is ideal for working with a university, but the tech transfer would most likely be from a university to GM. The responses indicate that transfer of research understanding occurs only from GM....a rather presumptuous statement that "GM knows it all" and wouldn't learn anything from another partner. Comments from another reviewer mentioned there were no outside institutions used. They only worked with their suppliers. This is not a fair way to judge OEM's. OEM's cannot collaborate extensively on new technologies for fear of losing their economic advantage. Observations from one reviewer added this is a GM/DOE partnership with good use of resources and collaboration with others.

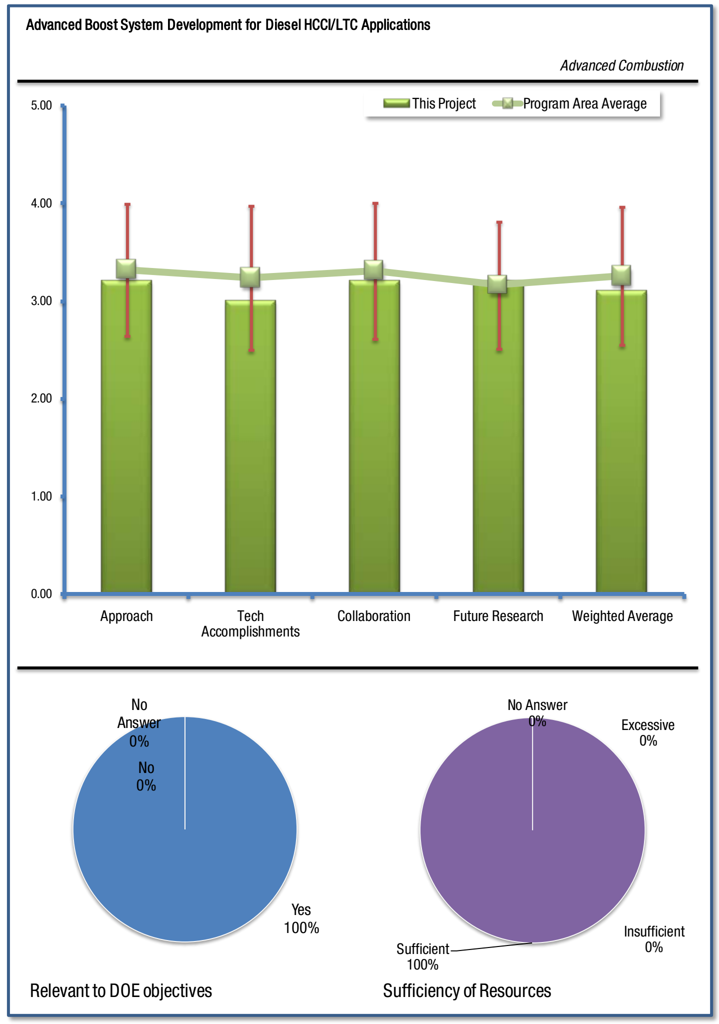
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated it doesn't appear that this project is focused upon advanced combustion, but rather VVA technology. Not much in terms of alternative pathways for LTC seem to be accounted for if any of these VVA systems do not function as advertised; and there is little engine/vehicle operation evidence that was shown to provide confidence that these VVA technologies will be significant enablers for LTC. Another reviewer commented the plan to move forward seems fuzzy. Will you continue both gasoline and diesel? Will you select a system concept to move forward? One reviewer mentioned that completion of multi-cylinder VVA systems will be important to finish up this program. Comments from another reviewer added the project is in its final stages. There is no proposed future research. Observations from one reviewer noted the path forward seems good. They would like to see more detail on where the gasoline program is going in terms of production viable VVA. Plans seem well thought out and reasonable.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated at least to this point, the resources committed by DOE over the timeframe of this entire project do not seem to match well with the progress or the stated DOE goals. Another reviewer noted nice project, nice progress, and good example of successful industry/DOE partnership.

Advanced Boost System Development for Diesel HCCI/LTC Applications: Harold Sun (Ford Motor Company)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated combustion air handling systems and heat recovery are tools to increase fuel efficiency; these characteristics are significantly different in LTC operation and this project reflects that. Another reviewer noted this project has the potential to provide a high efficiency turbocharger that can be an enabler for HCCI technology in diesel engines. One reviewer commented that turbo-machinery is extremely important driver to enabling LTC and other approaches to improved efficiency and emissions. This project addresses this. Comments from another reviewer mentioned advanced diesels have the opportunity to displace petroleum. The speaker indicated that turbo manufacturers were unable or unwilling to explore the range of operation of interest to improve compressor efficiency at low mass flows.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated there is a good mix of simulation and experimental work in this project to guide the development of this turbocharger. Integration with the engine combustion system people at Ford is critical to insuring the success of this project. Another reviewer commented the technical barriers were adequately addressed on the technology down selected. A discussion about the technologies considered and details about the down select process need to be documented somewhere. Nevertheless, a unique combination of modeling and rigorous testing (14 iterations) holds the promise of a deployable technology. One reviewer mentioned turbo-machinery is extremely important but the connection to improved efficiency and emissions was never tied into the advances in turbo-machinery. The reviewer does realize that this is perhaps proprietary. Some insight would have been helpful. Comments from another reviewer noted it seems like a good approach and progress was made. This reviewer suggested that slide shows "major turbo manufacturer" under partners, even if the company does not wish to be named at this time.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated this project has made significant progress toward the goals of developing a high pressure ratio/low mass flow turbo for LTC engine application. Developing these simulation design tools will be very helpful for future engine development, since high EGR rates are likely to be utilized in any future combustion system, conventional or LTC. Another reviewer noted good progress exhibited through bench-scale testing. One reviewer added nice progress toward improved turbo-machinery. Nice modeling and overall progress. Supplier partnering is good and necessary. Comments from another reviewer mentioned good progress has been made, including modeling and fabrication of prototype parts.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Two reviewers stated the collaboration with the turbo company appears to exist, although not "officially" for technicality reasons concerning the contract. One of the reviewers went on to say partnering with a university for the simulation work is a great choice. It was less clear the role of the consulting company. Another reviewer added the Ford team willingly works with others. Also, their willingness to publish part of the work in SAE publications is commendable. One reviewer commented the collaboration is great, working with supplier and DOE collaboration important to enabling improved turbo-machinery for LTC.

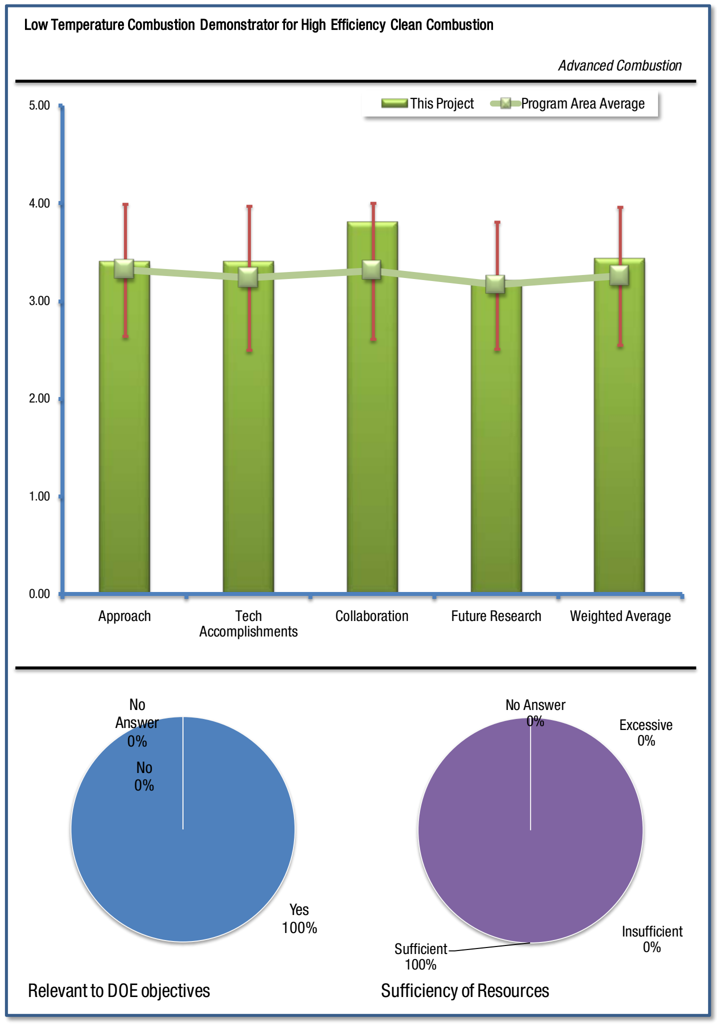
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated this project appears to have the barriers well-identified and the current progress has both identified and helped to overcome additional barriers that have been overcome. They would expect to see more specific information regarding the engine/s of choice for this turbocharger at the next review, with the required speeds/loads and air mass flows and pressure ratios identified. Another reviewer mentioned the future bench-scale testing needs to address low-flow areas as well. This is important considering use of high EGR rates. One reviewer noted they are anxious to better understand potential improvements and integration with engine. It is not clear what will actually be demonstrated on engine. 3-5% is a good target.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated this project appears to be applying the correct amount of resources to accomplish the project goals. Another reviewer noted the resources are adequate in every respect.

Low Temperature Combustion Demonstrator for High Efficiency Clean Combustion: Willy de Ojeda (Navistar International Corporation)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated nice efficiency improvement at emission requirements. Another reviewer added the increase in BMEP of LTC is one of the major barriers needed to make the combustion this combustion regime viable. One reviewer commented efficiency gains are demonstrated in this project. Fuel economy was demonstrated while meeting the NOx target of 0.2 g/bhp-hr. Comments from another reviewer mentioned expanding LTC operating envelop and efficiency while lowering NOx contributes toward program goals. Observations from one reviewer noted yes, nice demonstration as well as strategy development.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated nice application of models followed by hardware design and test. Another reviewer mentioned from the presentation, they couldn't get a feel for the diesel fuel impacts being studied. It was indicated that a range of cetane number fuels were made available, but have they been explored? One reviewer asked how the ROI model is incorporated into the combustion model. Is it a new sub-model within the CFD code, or a separate stand alone model? Who is doing this part of the work? Comments from another reviewer noted the work was good but they have not quite achieved their goals. They are within 5% of their BSFC goal while maintaining low NOx emissions. Observations from one reviewer added good control strategy and good use of existing models and technology to predict performance. Another reviewer stated the PI had a good plan that was well thought out and explained in presentation. Progress and results reflect this good plan.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the increase in BMEP to 16.5 bar is indeed a significant accomplishment. The claim on fuel economy improvement is a little confusing...5% over 13 mode cycles vs. 1.2% with PCCI at low emissions. Are these compared to the same base, or is the 1.2% an additional improvement over the 13 mode data? The reviewer looks forward to the additional improvements you will achieve with the VVA. Another reviewer commented LTC fuel economy potential was demonstrated with respect to current product over the 13 Mode cycle with 0.2 g NOx/bhp-hr. Improvements of 5% were obtained at some of the 13 Modes. One reviewer added utilization of sensors and reduction in response time for controllers represents significant accomplishment that enables control. VVA reduction of sooting very good and there is ROI model contribution. Comments from another reviewer noted nice progress with a few comments:

- Slide 8 -- Increasing fuel injection pressure showed improvements in ISFC. If you take into account the energy necessary for higher pressures, is efficiency improvement still significant? In other words, what does this look like with BSFC?
- Slide 9 -- EGR distribution biased to cylinders 1 and 2. What about air mass distribution and overall impact on equivalence ratio in each cylinder? Where does EGR transfer line originate in exhaust? Does this affect boundary conditions of each cylinder differently?
- Slide 10 -- Nice work with ECU capability.
- Slide 11 -- Nice injection control with nice illustration of benefit to soot reduction.
- Is VVA system production viable? It wasn't clear.
- Fuel economy improvement is modest. The reviewer would have expected higher. They do understand the project is also meeting emissions.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated it seems well integrated with several suppliers. Two reviewers mentioned there is a good mixture of partners for this program. One reviewer noted the OEM had nine collaborative partners including universities. Comments from another reviewer added there is DOE/Navistar collaboration with relevant supplier.

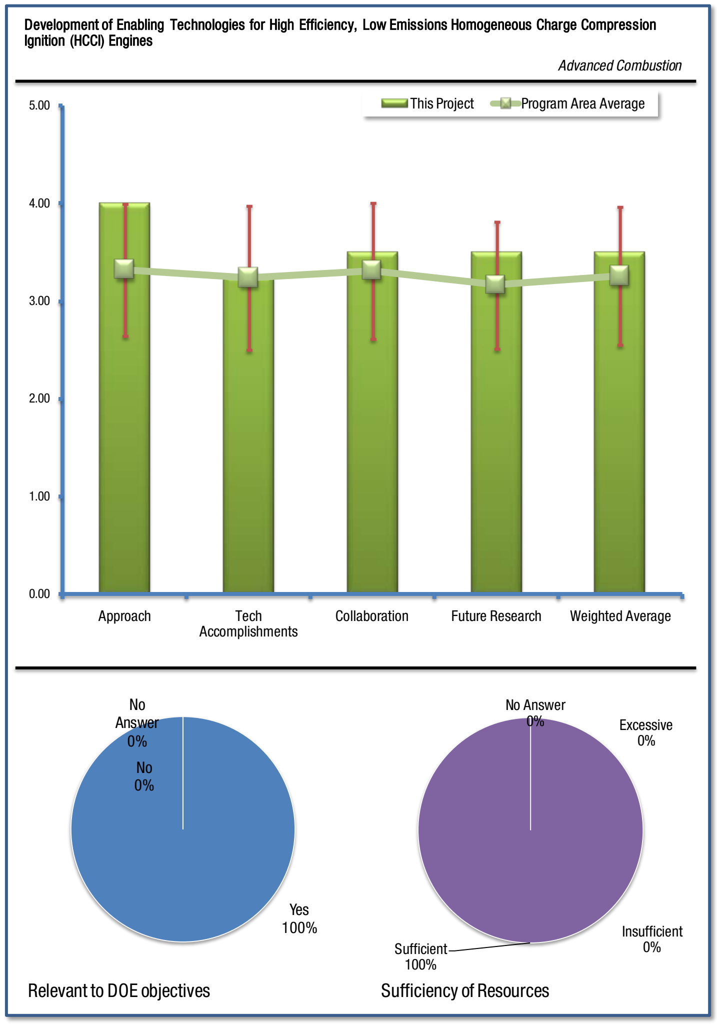
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the program is ending; looks like this technology will go toward production. Another reviewer commented the VVA work will be interesting to see and the program will be wrapping up this year. One reviewer added the proposed future research is to go after the remaining fuel economy benefits that were proposed. This may be aggressive but not out of line with what can be done with the time they have left. Comments from another reviewer mentioned there is minimal work to be done while the initial work on transients is promising. Observations from one reviewer noted the project is nearly complete with objectives to be met, which is rare.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated good use of resources to achieve targets. Another reviewer noted overall, a very nice demonstration. Efficiency improvements seem modest even with meeting emissions targets. Nice development of controls, hardware, strategies, etc.

Development of Enabling Technologies for High Efficiency, Low Emissions Homogeneous Charge Compression Ignition (HCCI) Engines: Scott Fiveland (Caterpillar Inc.)



Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated implementing LTC into a production engine will increase fuel efficiency and reduce fuel consumption. Another reviewer noted the project is very relevant; important work to couple research into product designs. One reviewer commented the project attacks HCCI issues effectively.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the approach to clear the barriers to LTC implementation is well described. Cat and their partners are addressing each major hurdle and look to be on the way to success. Another reviewer mentioned the approach seems to be very good, although such a short presentation has to gloss over many steps. The reviewer assumes the intermediate steps were done properly. One reviewer added there were clear goals for LTC and systems approach. Recognized gaps and developed effective strategies to address. Consideration of fuel effects adds significant value. Tank to wheels approach effective. Good blend of fundamental and applied.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the progress thus far has been excellent. There is actual engine data that supports the technology goals, with multi-cylinder engine data forthcoming. Another reviewer noted it is hard to judge; there seem to be a great number of excellent detail results but a short presentation can't detail them. It seems system decisions are coming. One reviewer commented good findings on single and multiple cylinder engines. There were significant findings on fuel effects.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated that collaboration with partners like Sandia, ERC, and others appears to be well-coordinated and integrated. Each partner brings specialized expertise to the project. Another reviewer added good team and very good utilization of strengths of partners.

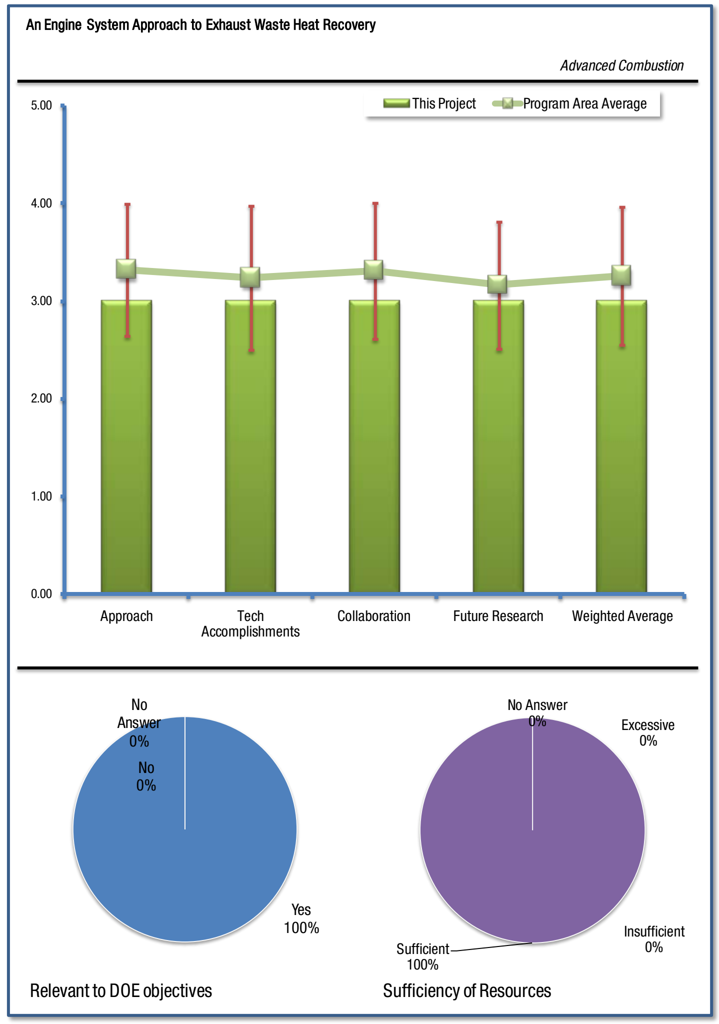
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the critical barriers have been identified with a clear plan to overcome these barriers. Another reviewer mentioned the future work is moving research to production effectively. One reviewer noted good plans to build off existing developments to move toward controlling transition between PCCI and conventional operation.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the staff and equipment/facility resources appear to be well matched with the expected progress and work plan. Another reviewer noted this is not enough time to give a coherent review of such a large project. One reviewer commented Cat and its partners are well equipped to carry out this work.

An Engine System Approach to Exhaust Waste Heat Recovery: Richard Kruiswyk (Caterpillar Inc.)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the project could lead to the development of potential waste heat recovery technologies and thereby lead to higher efficiency power plant. Another reviewer commented these are the next steps in improving energy efficiency. One reviewer mentioned yes, a 10% improvement thermal efficiency would meet the DOE objectives. Comments from another reviewer noted the project is working towards a demonstration of 8 to 8.5% BTE improvements using turbo compounding.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach followed constitutes a revisit of previous technologies and an attempt to marginally improve them. A clear cut approach with an initial system evaluation and down select for an improvement path is advisable. Also, recommend sharing/ publishing the results of the configurations being evaluated. This could lead to model development for future system analysis. Another reviewer added there is a good analytical base. One reviewer noted this is a good systems approach, and appears to be very comprehensive in nature. Caution is advised on the decision making based on cost. This is obviously an issue that is highly dependent on the current cost of oil/fuel in terms of what a customer would pay for fuel savings. Decisions made based on today's operating costs may not be appropriate when performing research like this for future implementation. The reviewer would hate to see novel approaches discarded on this basis. Comments from another reviewer mentioned the approach is well focused on areas where realistic gains can be achieved.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the progress on individual efforts is excellent. However, identifying a clear-cut pathway for implementation on an engine along with improved combustion technologies -PCCI, LTC, etc. - or aftertreatment is missing. As a result, issues such as cost effectiveness, packaging, reliability, etc. remain unaddressed. Another reviewer mentioned a lot of good detail work on component optimization. One reviewer commented Caterpillar has demonstrated 8 to 8.5% of the 10% goal with a path for the 10% solution. The solution is application dependent. It would be good to extend this approach to a LTC operation for comparison to see if the economies are comparable. Comments from another reviewer noted the project is well behind schedule for a 4 year project.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated in the work that was presented, the contribution of Oak Ridge National Laboratory was not clear. Another reviewer commented outside partners mostly related to turbo manufacturing or related companies. Is there a place in the program for a university or National Lab participation, perhaps in the heat transfer area? One reviewer added the OEM had four turbo related manufacturers and no universities or national labs.

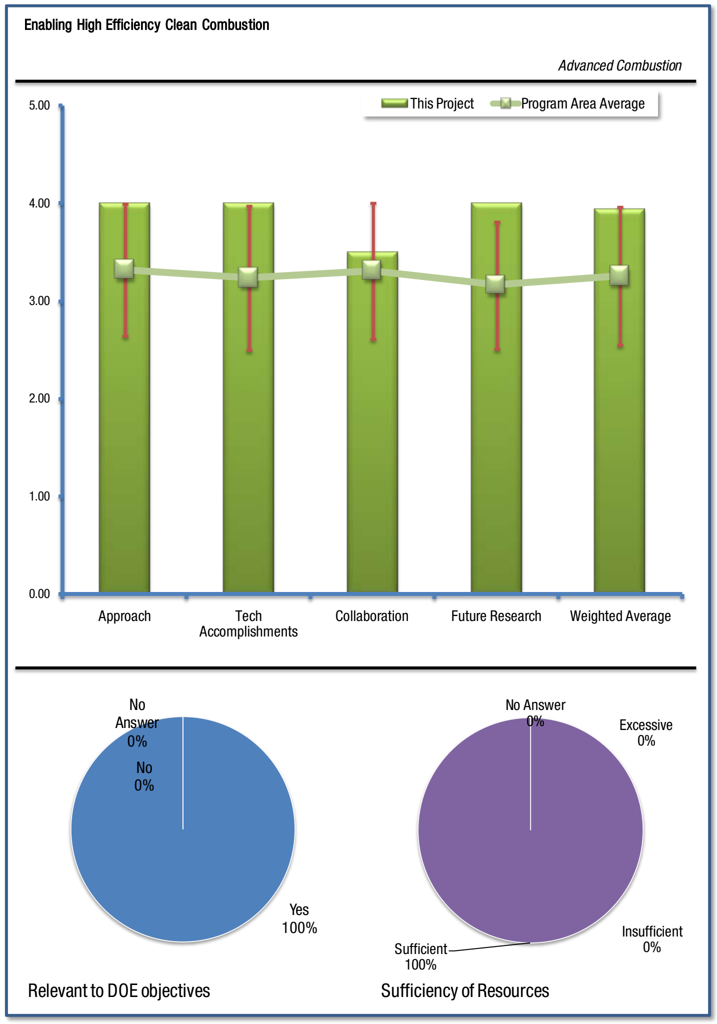
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated some of the configurations propose to be evaluated "Under future work" were previously evaluated and presented by caterpillar as early as 2002. The need to revisit them again needs to be justified. Another reviewer noted it will be interesting to see the system design and performance, and especially how it works for various customers and drive cycles. One reviewer commented the plans look reasonable and on target to achieve the stated goals. Comments from another reviewer mentioned the future research is focused on areas of greatest benefit.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it appears to be a well funded project, with good results being achieved for the investment.

Enabling High Efficiency Clean Combustion: Donald Stanton (Cummins Inc.)



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the project has a direct effect on product - how relevant can you get? Another reviewer commented excellent demonstration of efficiency improvements as well as technology path to more improvement. Also mention of transferring technology to product.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated there is excellent focus, with well organized thoughtful approach. Another reviewer noted nice, comprehensive approach. The barrier and potential solution slide is a nice addition to help us understand the issues and potential solutions. This is obviously a well thought out plan which is confirmed by steady progress.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated very good efficiency results in realistic engines. Another reviewer mentioned nice progress. More detail would be interesting but understand time issues and Cummins policy limits amount of information you can share. Slide 15 really demonstrates the progress. The reviewer is also very impressed on how the project is using similar technologies for two engine classes. A challenge Cummins met head on with success further increasing value of the research to the country. More detail on lifted flame approach would have been interesting. The reviewer needs to check the literature to see if Cummins has published any of this in detail. The reviewer knows others are working on this but appears Cummins is probably ahead of the game.

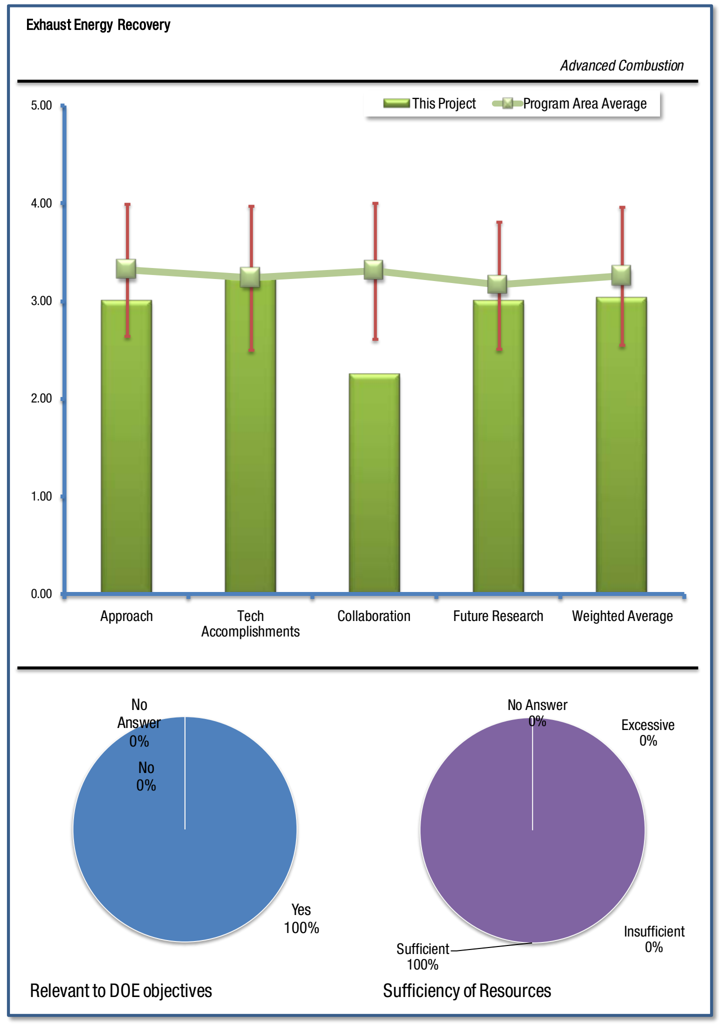
Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the collaboration seems primarily in-house but that is appropriate. Another reviewer commented nice collaboration across the board including industry, academia, and national laboratories. Also, the good transfer to marketplace helps demonstrate the value of government collaboration to reducing fuel consumption.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the project has a good plan for the future work. Another reviewer noted the future work makes sense based on current progress. The future work was well described in program schedules. This reviewer would like to have seen the presenter go through these slides but realize there simply is not time in 20 minutes.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated "great job." They wish they had something more constructive to add but the reviewer thinks Cummins has done a top job in defining the barriers, presenting possible solutions, and then enabling the solution which make the most sense.

Exhaust Energy Recovery: Chris Nelson (Cummins Inc.)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that waste heat recovery is an effective technology to improve fuel efficiency. Another reviewer mentioned the project develops a nicely integrated system using an organic Rankine cycle and EGR for waste heat recovery leading to efficiency improvement up to 10%. Further accommodates after treatment and is applicable and usable on a variety of engines. One reviewer commented the project directly addresses efficiency improvement while another reviewer said yes, a 10% improvement thermal efficiency would meet the DOE objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the simulation work and experimental work to date have shown the technology barriers and have made reasonable progress to overcome the barriers. The change mid-stream on the part of Cummins to pursue SCR catalysis, compared to their previous position, has hampered the progress of this project to some degree. Along the same lines, it would have been better to see a little more coordination between the WHR project and the Heavy Duty LTC project so that they were not operating in a vacuum from one another. Another reviewer noted the approach exhibits a clear pathway to success by addressing the associated issues adequately. One reviewer added the project needs to sort out emission levels and system effects, otherwise the approach excellent. Comments from another reviewer mentioned the approach has been good and comprehensive up to this point in the project; however, it would be prudent to focus more on the LTC concepts being promoted for low emissions / improved fuel economy to see how effective the approach is with lower temperature exhaust (lower quality heat). The reviewer is glad to see the approach is being modified to account for the use of SCR after treatment. Are effects of DPF being considered too?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated this project has displayed reasonable progress toward an effective strategy to improve thermal efficiency by waste heat recovery. The opportunity to improve BTE by 10 percentage points seems feasible with the current accomplishments and plan. Another reviewer added projected significant waste heat recoveries through simulations, which were later validated through engine testing. Though the decision by Cummins halfway through the program to use SCR after treatment reduces the overall effectiveness, it is worth a try to establish the full potential of the proposed technology. However, would like estimates for penalties incurred in cost, weight and durability. Two reviewers mentioned good results with one adding this is an interesting concept.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there are no other listed partners in this work, aside from a slight collaboration with a turbocharger company. Three reviewers added most of the collaboration appears to be within Cummins with one reviewer adding they recommend publishing some of the results, or the overall implication for record and posterity. Another reviewer mentioned the collaboration is mainly in-house but that is appropriate here. One reviewer noted it would seem that other outside institutions could lend assistance with the Rankine cycle optimization.

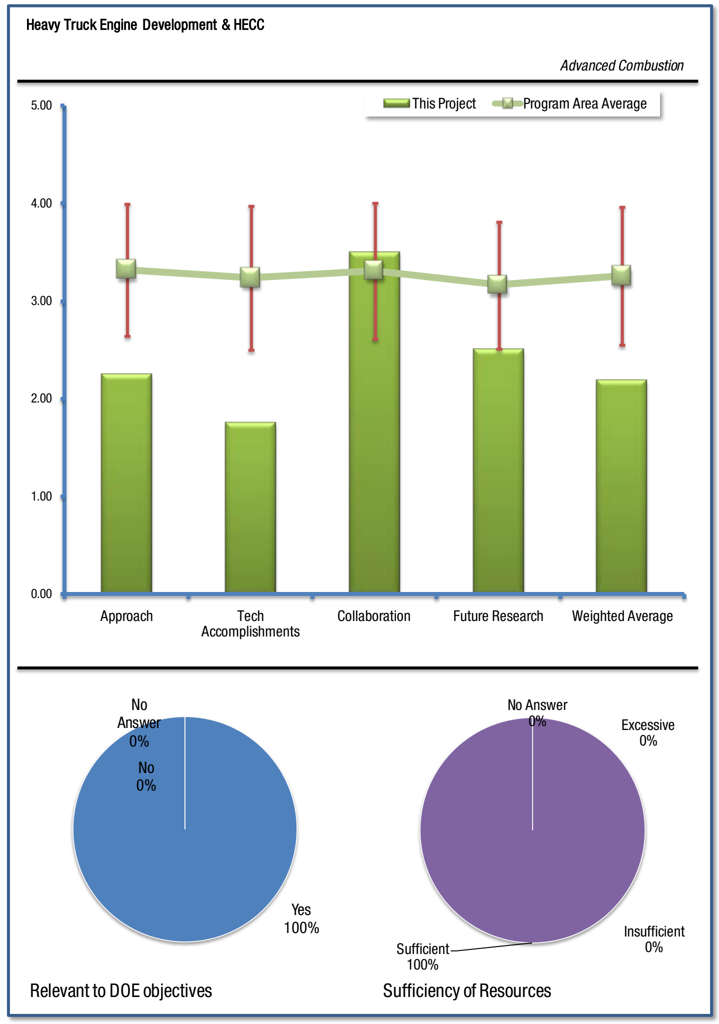
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the plans to integrate this work with the LTC project are a good step - although LTC may provide further challenges to the goal of a 10 percentage point improvement in BTE. Less waste heat that is available to recover will reduce the opportunity for WHR. Another reviewer commented the projected efficiency gains for each of the potential improvements of heat recovery (viewgraphs 18 - 26) are somewhat reasonable. However, they might not be additive as projected in viewgraph 26. The project gain of 11.7% might be a stretch. One reviewer added to keep going and look at other potential applications and drive cycles. Comments from another reviewer mentioned there is LTC and after treatment incorporation into the future testing plans.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that especially since this project did not appear to be funded in FY 09, the progress displayed as admirable and the overall project appears to be an excellent value for the research dollar.

Heavy Truck Engine Development & HECC: Houshun Zhang (Detroit Diesel)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the project has direct relevance to the overall DOE objective. Another reviewer added the goals of this project are to reduce fuel consumption while improving HCCI combustion. One reviewer mentioned there is a clear tie to increased fuel economy and reduced emissions. Comments from another reviewer noted the project addresses DOE goals of efficiency and emissions compliance, but concerns about cost-effectiveness due to complexities of approach.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach seems fragmented. Is this an injector program or an engine system program or a control system program? The various elements are all interesting but the approach seems disjointed. Another reviewer noted the project has been spinning its wheels for three years with the dual injector system which by their own admission they believe probably won't work. The reviewer doesn't believe that they will overcome the technical barriers by the end of the fiscal year and their project to get this system to work. There has been no real progress on the engine work side of this project except for the next generation controller. More than the controller is needed to enable this to go into production. One reviewer commented not clear on the set of technologies being applied to increasing efficiency/reducing emissions. Are new technologies being developed or is investigator optimizing use of "off the shelf" parts? Can one use multiple injection events to get performance approaching performance from two injectors? Is the increased performance from two injectors/cylinder worth the money and effort required to implement? Approach appears to be more piecemeal as opposed to systems-level approach. Comments from another reviewer mentioned the approach has positive and negative aspects. Positive aspects include use of multiple technologies to achieve the goal. Also, use of control system to tie all technologies together and support of modeling results is good. Negative aspect is concern of the complexity of the fuel injector technologies. Specifically, plan for dual injector experiments will use a lot of resources that may be better spent on accelerating the development of the MVCO injector. This reviewer went on to say the high risk of MVCO injector is reasonable, but need to keep resources focused on that aspect to maximize possibility of high reward. Another approach comment considering feedback control...would be nice to see limitations of speed of feedback. And, what other parameters besides SOI can be used for optimal control (mass fraction burned, peak heat release, etc.)?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the results shown are disappointing. The injectors don't seem to have worked (although not time to give up). Perhaps the presentation did not explain the controls well enough. Will you really use two injectors in one engine for anything other than a theoretical research test? Another reviewer commented the progress is poor. The same comments that were applied to last year's peer review can be applied to this year's presentation. While work has occurred, it does not appear that any progress towards the goals of this project has been made. A suggestion for the presenter is to show Gantt charts with relative dates and goals. Saying "Status: On Schedule" is not informative and does not let us know what has happened over the past year. One reviewer mentioned there was some efficiency increase, but approach doesn't appear to deliver exceptional fuel economy benefit while simultaneously reducing NOx and soot. NGC results are promising. Comments from another reviewer noted the progress on individual aspects of approach has been good, but overall system demonstration on engine is weak. The team needs to have more engine experimental data to validate approach.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is some collaboration with injector suppliers, but not obvious there is real work as opposed to buying some parts from them. Another reviewer mentioned the project involved an OEM, parts manufacturers, National Labs and universities. It is a shame that the project isn't showing any progress. One reviewer commented good list of collaborators, but not clear that partners are involved beyond supplying parts. The reviewer would like to see more evidence of real collaborative effort. Comments from another reviewer added the collaboration is good. In particular, project has good collaboration with many suppliers.

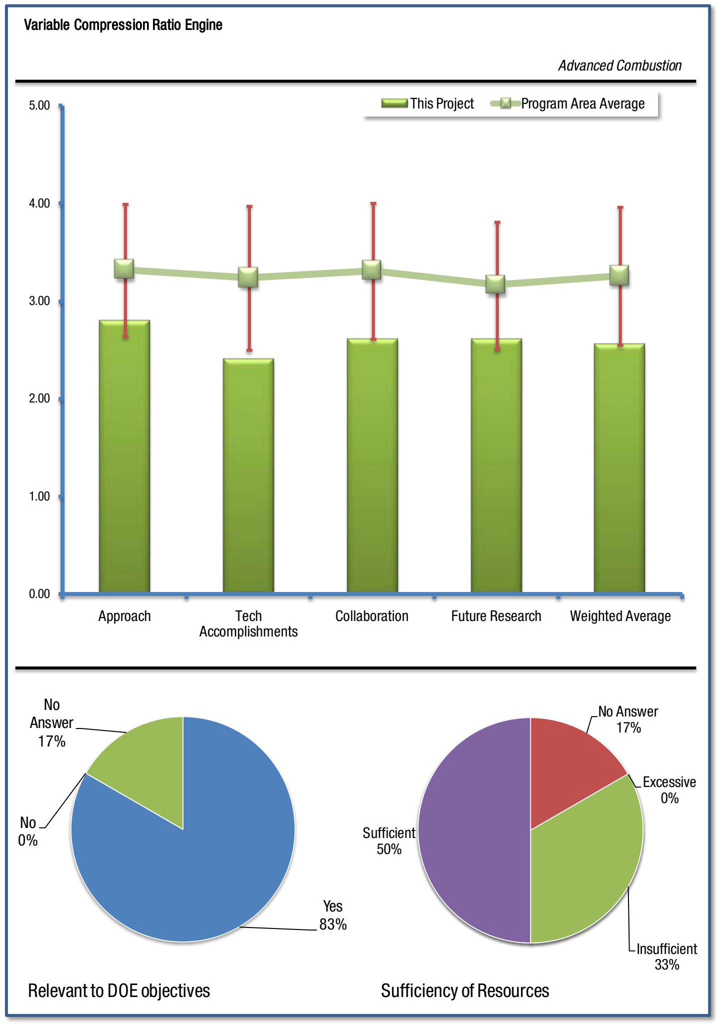
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the future work is disjointed. Some focus is needed to select some concepts and make some progress on it. Another reviewer noted it appears that this project has run into barriers that it has no ability to solve. There were no long term plans proposed since this was the last year of the project. One reviewer mentioned the proposed research plan is generally good, but problems exist with the plans for duel injector approach. The reviewer would rather see extensive resources/effort on addressing this complicated work spent on other project tasks.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

None of the reviewers commented on this question.

Variable Compression Ratio Engine: Charles Mendler (Envera LLC)



Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated VCR is a technology that can improve efficiency and reduce fuel consumption. Another reviewer commented variable compression ratio has high value if it can be managed and reliable. One reviewer mentioned the concept to develop a variable compression ratio mechanism could enable mixed mode engine operation. This could enable the use of high efficiency combustion modes, especially under low-load operation. Overall the technology that is being pursued offers higher fuel economy. Comments from one reviewer noted the project is moderately relevant; this was not really well explained while another reviewer said variable compression ratio is another parameter to be tuned for better efficiency.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated it appears that the project has taken a decent approach to using simulation and modeling to identify barriers and hurdles early so that overall cost and development time are minimized. However, there are many things that can only be learned by building hardware and there is no hardware built for the current configuration. Another reviewer noted the concept seems viable, but certainly needs testing in latest configuration. These kinds of systems often have major problems with wear, fretting, and durability. One reviewer commented the contractor has previously developed this concept and has made marginal improvements under the present funding. Evaluation of the full potential of the present concept - on a working engine with tests performed spread over a typical engine operation is recommended. Also, from the presentation, design targets for the time response of the actuator were not clear, nor were the achievements. Comments from another reviewer mentioned the mechanism design seems well done but they did not present a convincing rationale why you would want this if it works. Observations from one reviewer added the focus has been on the mechanical design to get an improved working prototype. The PI seems to have a good handle on the importance of a rigid and manufacturing assembly.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated there has been progress in the design changes - specifically the hydraulic pressure requirements to actuate the VCR mechanism. Again, the progress has all been on computer screens, not in any hardware. There are likely significant issues to be addressed in the one year left on the contract before a working prototype of this new design is functioning. Another reviewer commented good progress on concept but little on development and testing. The project will need engine testing both for reliability and performance. One reviewer mentioned that just stating "project completed" without providing any proof or evidence leads us to place less confidence in the claims.

Comments from another reviewer noted it was an interesting design. Observations from one reviewer added that getting a design with a lower pressure requirement looks to be a good idea and avoids the need for the higher pressure hydraulic source. Good FEA analysis to give confidence in the design. Another reviewer stated it looks like the project has a good lab engine that can be used to explore the benefits of VCR. The reviewer was not clear from this presentation exactly what those benefits are, though for HCCI operation, they could see this as helpful to maintain stable operation.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there are no collaborators by design, since this is a proprietary technology. One reviewer noted the collaboration was adequate while another reviewer said the PI mentions conversations with various OEMs, but no real customer seems to be lined up or participating in the work. Another reviewer mentioned there was good manufacturing input from the auto companies. The reviewer likes that PI is in discussions with them and are striving to make a manufacturable design.

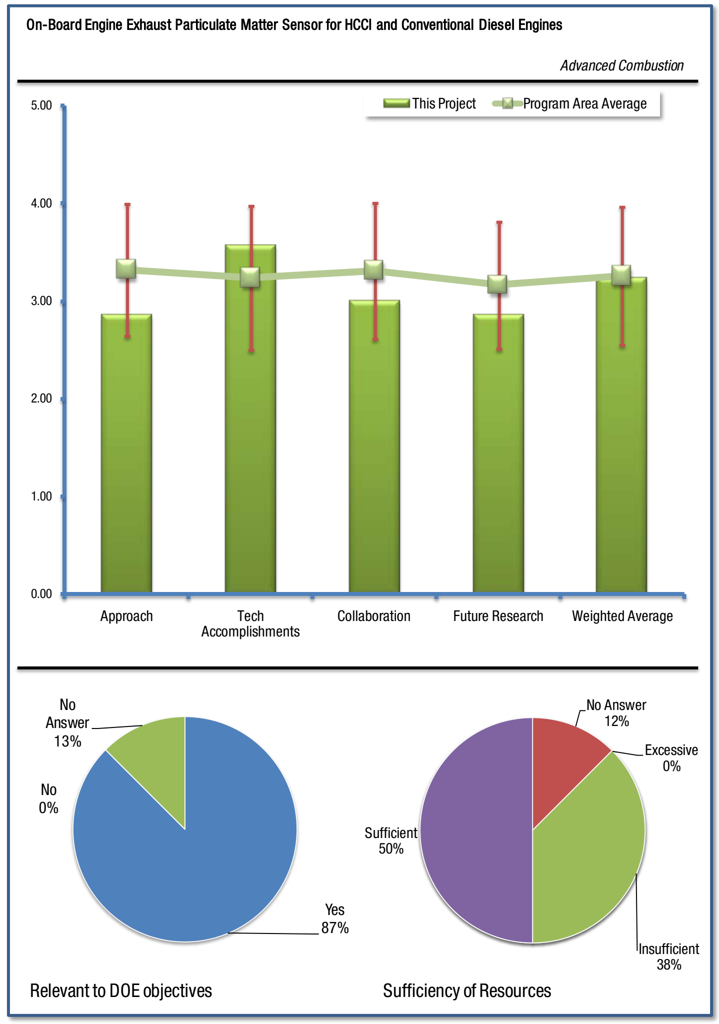
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the progress on the actuator appears to be reasonably good, but it is very unclear what the benefit to VCR in a gasoline engine downsizing program might be. The efficiency gains are very nebulous, since the intent is to have very high CR but throttle the engine heavily for medium load output. It needs to be shown much more clearly that there are efficiency gains to be had in this approach, since the cost and manufacturing issues are likely to be high compared to current technology. It would be critical to display that the engine has significant benefit to run highly throttled at high CR, versus mostly open throttle at lower CR. Another reviewer noted the plan is in place. The project should be targeted more on SI engine rather than diesel for initial application. One reviewer mentioned the engine testing will be interesting but they did not hear a plan to really run tests or come to an evaluation of the concept.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated if the goal of the project is to validate the actuation mechanism; the resources appear to be sufficient. However, the case needs to be made much more clearly that this VCR approach is worth doing in the first place. Another reviewer commented the project probably will require much more effort to demonstrate conclusively. One reviewer noted there is no apparent plan to test it once it has been built.

On-Board Engine Exhaust Particulate Matter Sensor for HCCI and Conventional Diesel Engines: Matt Hall (University of Texas at Austin)



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the device could be quite useful in managing DPF regeneration, OBD, and HCCI control if successful. Another reviewer added the pursued work is very relevant to ensure smooth operation of advanced diesel engines that offer high efficiency and low emissions. The PM sensor that is being developed can enable the use of advanced closed-loop controls in addition to engine component failure detection. One reviewer commented a good Pm sensor in front of the DPF can help minimize the fuel usage for DPF regeneration, by avoiding unnecessary regenerations while another reviewer said PM sensors allow auto manufacturers to use PM filters more effectively. Comments from another reviewer mentioned the PM sensor provides a potential enabling technology for aftertreatment (DPF) failure detection, and possibly for closed loop feedback for HCCI type combustion. Observations from one reviewer noted it is extremely relevant and important to enable advanced emission controls which will lead to more optimal regeneration strategies, OBD, and ultimately more efficient engines. Another reviewer stated the PM sensor has been a highly desired diagnostic in this program for years. Closed loop control of the advanced diesel could hinge on exhaust sensing to best balance NOx, PM, and fuel consumption. Sensor sensitive and cheap enough for OBD such as downstream of the DPF would be desirable as well. Relevance of a sensor is high; however focus of this project could be improved.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project does not appear to have clear and measurable targets- accuracy, durability, sensitivity, response time, temperature range, etc. Without this, it is not possible to design an appropriate evaluation program or to judge progress. Another reviewer noted the approach followed is novel - it encompasses simplicity with the needed performance. The reviewer would have liked to have seen a performance comparison with established instrumentation in addition to light extinction. One reviewer mentioned the need for the Cummins engine data was highlighted in the presentation. Hopefully, this will provide answers to many of the questions of calibration, sensitivity, and compatibility with various sensor locations. Comments from another reviewer added they would suggest modifying the project plan to have Cummins help answer some of the calibration questions. They have the instruments needed to correlate the sensor output to particle number & size, as well as mass. This information will be critical to making the go/no go decisions for various applications of the sensor. The reviewer would have rated the approach outstanding if the PM measurements were made with a CVS/dilution tunnel. They are afraid that PM mass may be lost in the sampling system. The reviewer believes a lot of PM's would have condensed on the walls of the sample bags. Observations from one reviewer commented that more information is necessary on sensor sensitivity to exhaust temperature and pressure. The presenter showed velocity sensitivity. What is the impact of that in a real world environment? Does it change with temperature and pressure? If the pressure is sensitive that would be an issue upstream from DPF. Another reviewer stated early experiments with vehicle perhaps not best route but understand necessity while waiting for Cummins engine. The reviewer would like to see more data to support comment that sensor output is linearly related to soot density. That was not clear from soot data or the opacity measurements. One reviewer said the approach is okay but sensing before and after the DPF seems very challenging with the same sensor. The innovation of the sensing approach appears fine. The test and development that has followed seems somewhat meandering and overly ambitious. Blaming the partner (Cummins) for lack of an engine for testing is a bit unprofessional (several shots at Cummins for their tardiness). A more appropriate statement would be to simply state that Cummins had some internal issues that delayed delivery of the engine. As one reviewer pointed out, if testing the sensor downstream of a DPF was an important milestone, there are numerous diesel vehicles equipped with DPFs are available in the marketplace that could be rented to test the sensor downstream of a DPF.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that despite lack of clear targets, the work is very promising. This should drive strengthening the approach rather than stopping it. Another reviewer added that within the limited budget, the researchers have made excellent progress. One reviewer commented the results to date look very good. They would like to see a correlation of engine-out PM in g/kWhr to PM concentration in mg/m^3. This would help the reviewer understand if the PI is getting low enough in measurement. Comments from another reviewer mentioned the level of accomplishment in this program is impressive with the very modest funding level. However, the reviewer does believe there is a significant amount of work left to be done to make the sensor commercialization ready to hand off to your partner Ceramatec or someone else. Observations from one reviewer noted the have followed the progress of this project while at USCAR. UTA has come a long way with little budget, nicely done. Another reviewer stated more information on sensitivity and linearity would be helpful to better understand actual status of sensor. Also as one reviewer commented, a set of specifications and well defined intended use is necessary. If only interested in DPF failure, requirements would be "softer" than necessary for cylinder-to-cylinder balancing or HCCI feedback control. Vehicle vs. engine tests showed considerable difference in sensor sensitivity. This reviewer does not believe 204 vs. 350 mg/m^3 V to be "close". Why such a large difference? Was there an error in measurement method, i.e., vehicle versus steady state engine? One reviewer said the progress appears modest, but is okay considering the budget. The project could have tested sensor downstream of a DPF by renting or borrowing a late model diesel vehicle.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated stronger links with the engine company should be established to clarify targets and improve development process. Another reviewer commented their teaming with Cummins and an instrument developer is commendable. Recommend working with a national lab that already has the needed instrumentation for performance evaluation of the sensor. One reviewer mentioned a good partnership with Ceramatec and Cummins make a well diversified team. Since the engine data seems to be behind schedule, perhaps Cummins could do some engine testing or durability testing to help catch up and finish this project on schedule? Comments from one reviewer noted they have followed this project through USCAR and it does have several collaborators. They are not sure how serious Cummins Engine is but the collaboration with the other partners is good. Observations from one reviewer added the collaboration plans is good. The project has included a commercialization company and an engine company. Unfortunately the engine company is not as responsive as one would hope, but appreciate challenges engine companies are facing in current market. Another reviewer stated a Cummins engine was donated, but is Cummins really involved other than supplying the engine? Collaboration with the sensor company is good if the technology is to be commercialized.

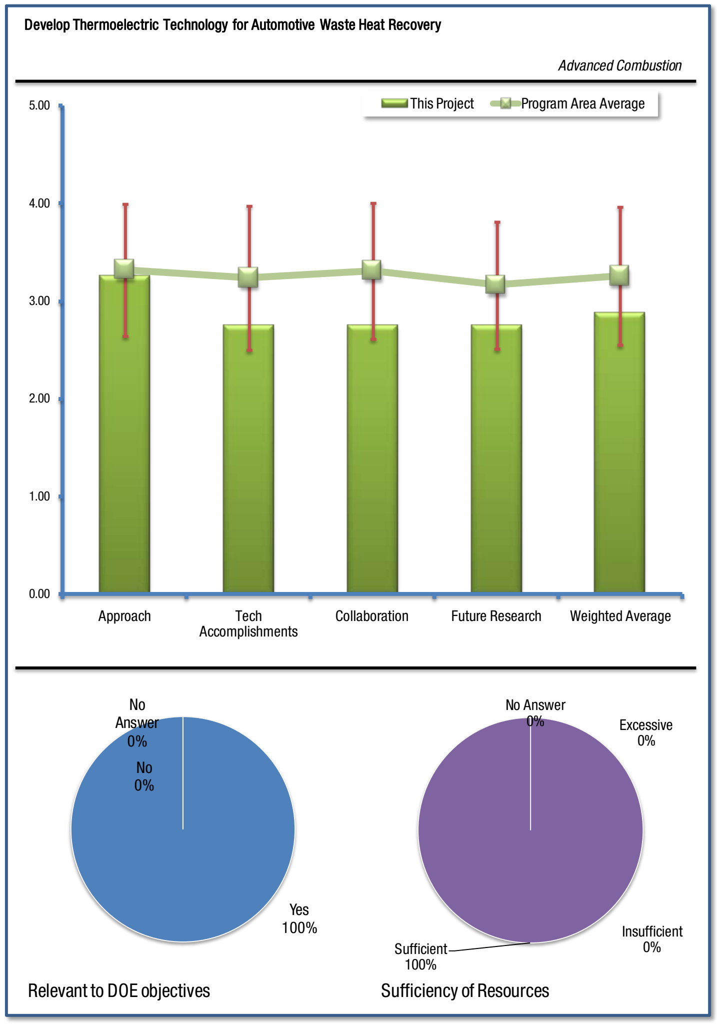
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated that better planning is needed. Another reviewer noted it is a well known fact that the charge on PM emissions varies with engine load and speed. It might be worth to conduct two sets of tests: one with charge neutralization prior to use with the sensor, the other without neutralization. One reviewer commented they think this sensor belongs in front of the DPF and then it can be used to prevent DPF failure and plugging. Comments from another reviewer mentioned the future work appears to be right on target to address open issues that remain to be resolved. The reviewer somehow doubts that they can be completed by the end of this year. The PI should request an extension of this program, as it could be valuable in particular for DPF failure detection, as you indicated. Observations from one reviewer added there is still a lot of work to be done in a short time. Another reviewer stated the project appears to be on path this year but really need to make sure final iteration is well defined to meet a specific purpose. One reviewer said UT should better define goals of the project. After Q&A, the speaker finally settled on the OBD application of the sensor being the main thrust, but also mentioned HCCI control, upstream of DPF sensing, etc. If OBD is the primary objective, then a post-DPF test should have had higher priority. Multiple applications have different requirements. Again, the innovation here is good and interesting and may show promise, but the research could be better focused.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that more resources are needed to do the proper job. If it is promising, maybe added funding could be found from a sensor company or engine manufacturer. Another reviewer mentioned it looks like some more work to be done, but this might be the potential manufacturer's responsibility. The funding level needs to be increased and extended for another year to achieve the desired outcome of this project. One reviewer mentioned the project has good resources. Delays in Cummins dynamometer engine is outside of the control of presenter. While vehicle tests are probably not perfect for calibration, it is good to proceed with that method so program does not stall while waiting for a dyno engine. The resources appear fairly moderate. However, this reviewer does not recommend a large increase in funding for UT. The sensor manufacturer probably has enough at this point to take the sensor to commercialization. Perhaps a neutral third party assessment of an advanced prototype would be appropriate here.

Develop Thermoelectric Technology for Automotive Waste Heat Recovery: Jihui Yang (General Motors Corporation)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the objective is to obtain a 10% improvement in fuel economy without increasing emissions. Another reviewer added these waste heat recovery programs in general are a great example of government sponsored research. One reviewer commented the modeling indicates that they will improve fuel efficiency by 5% in large SUV. However, there are a number of assumptions that went into that model that have yet to be verified. Also, the goal of the program is a 10% efficiency gain. Comments from another reviewer noted this project supports the overall DOE objectives of petroleum displacement since the TEG converts waste heat from exhaust gas to electrical power, thus the engine will be more efficient resulting in less fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated a systems-level approach has been taken. This will ensure a high probability of successfully overcoming barriers and achieving success. It would have been helpful to learn exactly what barriers were encountered. Another reviewer commented there is a good combination of modeling and hardware testing. One reviewer noted the approach is valid. However, they are heavily dependent on the success of their high temperature material. ZT claims are just for n-type and at material level. At this point in the program they should be measuring module level ZT. Are they really seeing 850°C at the hot side of material? Skutterudite stability at high temperature is a known issue and is not addressed (as it is in MSU program). Comments from another reviewer mentioned the project is well thought out and all the barriers are addressed adequately.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated a systems approach is critical to advance this technology. Such an approach appears to have been taken, but one would expect a clearer identification of the barriers to evolve by exercising the model that was discussed. For example, it is well known that increases in ZT will increase the efficiency of the thermoelectric device, but at a decreasing rate. Therefore, at some point further increases in ZT are no longer cost-effective and would begin to adversely affect the stated performance metric of dollars-per-Watt. Because a systems level model is presumably in place, it would be very important to know what ZT value corresponds to the maximum dollar-per-Watt metric (it is not a ZT of infinity). Another reviewer mentioned the project seems to be coming up short of the 10% goal. Can 10% be achieved? If so what is the path to reach this level? One reviewer added it seems they have made little progress over the last year. At last year's review, they extensively discussed their new test facility, but didn't show any data from it. All of new data was based on simulations. They still haven't finalized thermal system design. Most of the materials are still legacy. Comments from another reviewer noted significant technical accomplishments have been demonstrated toward DOE goals.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated they did not see evidence of strong collaboration with other institutions, although collaboration among the various topics (materials, thermal control, and electrical control) appears to be good. Another reviewer added there is a good mix of government labs, universities. Are there other companies that could pick up GE's role? Are there other suppliers that could commercialize the product if it is worthy? One reviewer noted there is very little discussion of work going on at other institutions and how it is integrated. GE pulled out and was responsible for much of thermal system design and experimental verification. There was no discussion of the role of ORNL, BNL, USF. Comments from another reviewer mentioned they would strongly recommend that the TE material properties needed to be verified by NIST before commercialization.

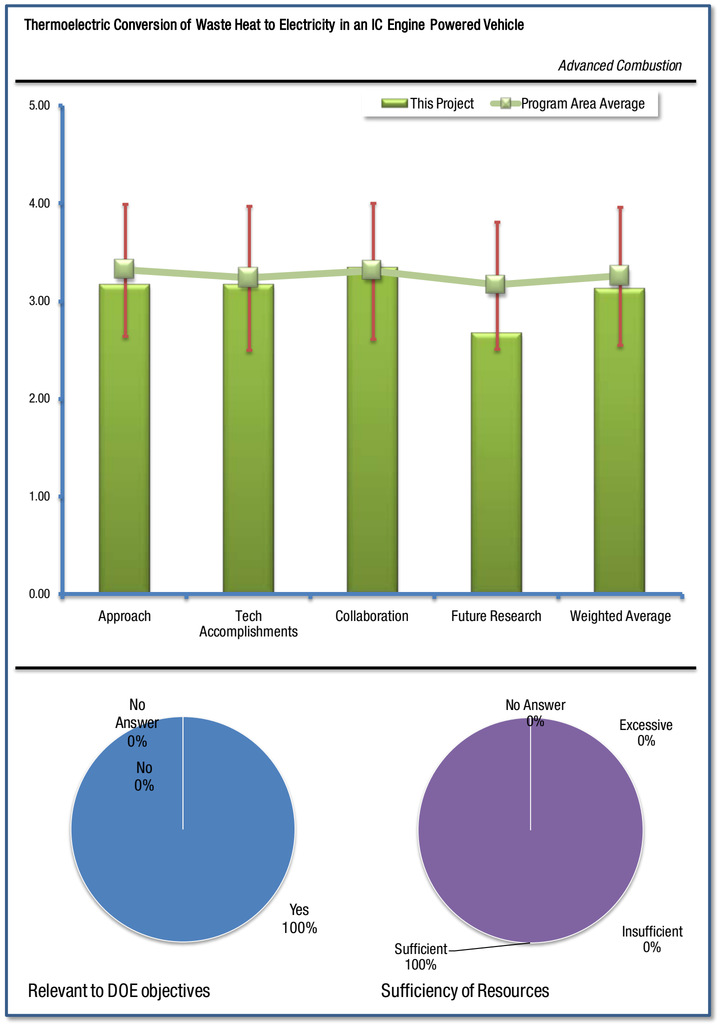
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they did not see a strong discussion of barriers in the future proposed research. Another reviewer asked if FE improvements can be increased. Otherwise this showed a good plan. Does further material research need to be conducted for better performance? One reviewer added the plans are clear, but seem similar to last year's. Comments from another reviewer noted the proposed future research is logical and technically sounds. However, the estimate cost of the devices in terms of dollars per watt should be included.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it seems like they have received very little of their FY09 funds. $700K per year doesn't seem adequate to perform this work. Another reviewer noted this project is very interesting and if it is successfully accomplished, we will benefit a lot from this program. This project should be continuously funded.

Thermoelectric Conversion of Waste Heat to Electricity in an IC Engine Powered Vehicle: Harold Schock (Michigan State University)



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the goal is to provide a 10% improvement in fuel economy for an over-the-road truck. Another reviewer noted thermoelectrics have the potential to improve vehicle overall thermal efficiency and reduce fuel consumption. One reviewer commented thermo-electric generators have the capability to use exhaust heat to create energy that can be put back into the vehicle system, lowering fuel consumption. Comments from another reviewer mentioned the project expects 3-5% efficiency improvement in large truck. However, the goal of the program is a 10% efficiency gain. Observations from one reviewer noted this project supports the overall DOE objectives of petroleum displacement since the TEG converts waste heat from exhaust gas to electrical power, thus the engine will be more efficient resulting in less fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the presentation was focused on materials development and increasing ZT. Discussion of other barriers was minimal. This is surprising, since the team that was assembled includes expertise over a broad range of skills. For example, there appear to be significant challenges in packaging the thermoelectric material in an effective manner, but full utilization of the team's cross-disciplinary strength in addressing packaging barriers was not evident. Indeed, the 14% efficiency that was included in the presentation is based upon surface temperatures of the thermoelectric material. The reviewer doesn't see how this definition of efficiency is meaningful, from the systems-perspective. Moreover, in the Q and A, it was indicated that the efficiency might drop to 3 or 4% if the efficiency is (appropriately) based upon exhaust and coolant temperatures. This implies that the primary barriers (10 or 11 out of the 14%) are not materials dominated, but are related to issues such as but not limited to: electrical and thermal contact resistances (CTE issues), control of convective heat transfer external to the thermoelectric material, and electronics control. Another reviewer commented the approach appears to be very sound, with good focus on addressing the overall system technical barriers and not just the material barriers. One reviewer asked does more work need to be done on basic materials? Is there a theoretical limit to these devices? Comments from another reviewer noted the focus is on development of high temperature materials with suitable thermal and mechanical properties. A number of different materials have been considered and they have shifted to skutterudites this year as a result of improved thermal stability. Observations from one reviewer added the project is well thought and all the barriers are addressed adequately.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the team has made impressive strides in materials development. However focusing on increasing ZT may be misleading. Something akin to "dollars per Watt" might be used. It is well known that increasing ZT will increase the efficiency of the thermoelectric material, but at a decreasing rate. This implies that an optimal ZT value exists, in order to maximize the dollar-per-Watt metric (and the optimal ZT value will not be ZT equals infinity). Another reviewer added this project has demonstrated excellent progress toward the goal of overcoming the barriers to TE technology, with more than one path to success as advancements and discoveries are made. One reviewer noted hopefully the second phase will be complete soon. They would like to see a demonstration on a truck. Comments from another reviewer mentioned that barriers appear to be in the basic material capability that is not covered by this project. Otherwise the progress in developing a system and manufacturing parts is impressive. Observations from one reviewer commented the project seems to have made major shifts in program over the last year and are now focusing on skutterudite materials developed at JPL. The PI needs to clarify relationship of materials development under this program and other government funding. No progress reported on development of segmented materials which is one of the objectives of this program. Underestimating the significance of cold side heat transfer is a problem. Another reviewer stated significant technical accomplishments have been demonstrated toward DOE goals.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the team that was assembled appeared to be cross-disciplinary. However, the reviewer did not see a strong evidence of coordination, given the focus on materials development. Another reviewer commented this is an excellent team and the partnership with Cummins will prove to be invaluable as the project moves forward. One reviewer mentioned there is a strong collaboration with JPL and Iowa State in materials development. The project will need a closer relationship with Cummins as they move toward generator integration. Comments from another reviewer noted they would strongly recommend that the TE material properties needed to be verified by NIST before commercialization.

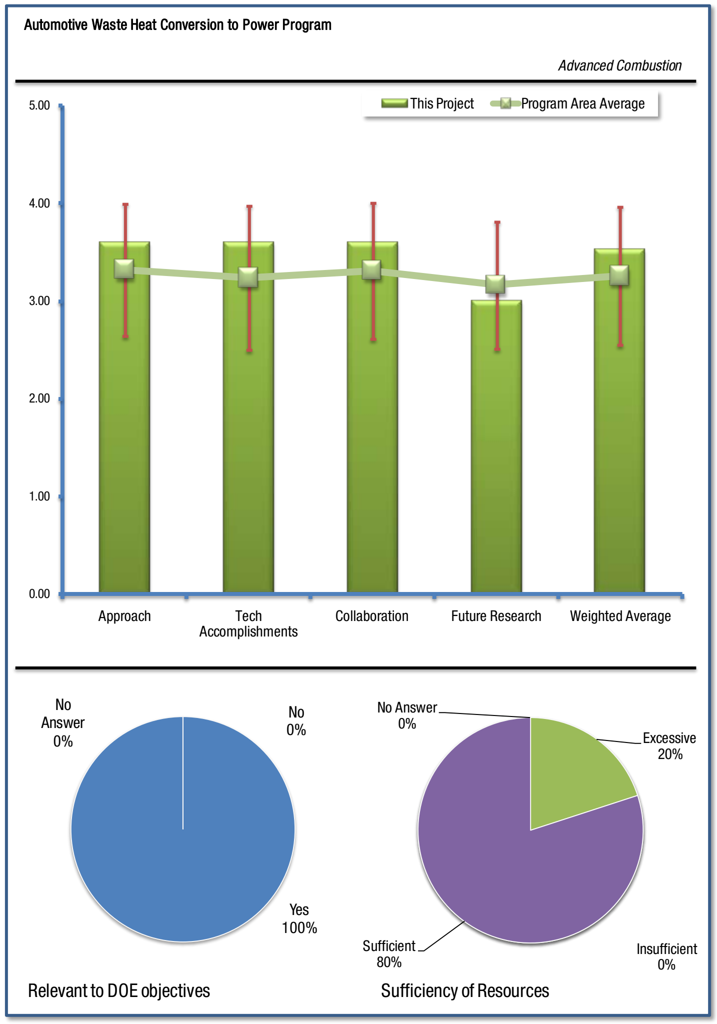
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they did not note a strong vision of future work. Another reviewer noted the plan for the future appears to be adequate to realize the proposed gains. One reviewer added it was mentioned that idling of busses in cities could be used to run APU's. Most large cities have anti-idling ordnances. Also, there is not a lot of heat in the exhaust of an idling diesel engine. High load appears to be where this technology would be effective. Comments from another reviewer mentioned it seems they still have parallel materials development of the segmented PbTe-PbS/LAST system and the skutterudites. At this point they should be making a down select and working on scaling selected approach. Observations from one reviewer commented the proposed future research is logical and technically sounds. However, the estimate cost of the devices in terms of dollars per watt should be included.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources appear to be sufficient. The team might want to focus more on optimizing the system behavior. Another reviewer added the resources appear to match the expected outcome. One reviewer noted the resources seem sufficient for level of effort while another reviewer said it is a very good project and it should be continuously funded.

Automotive Waste Heat Conversion to Power Program: John LaGrandeur (BSST LLC - Amerigon)



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated the project objective is to obtain improvement in fuel economy. Another reviewer noted this project is to develop TE technology supports the goal of increasing fuel efficiency. One reviewer commented the project has shown fuel efficiency improvements of 3% for available TE materials. Modeling indicates that a 10% improvement is possible, but that model may have unrealistic assumptions. Comments from another reviewer mentioned this project supports the overall DOE objectives of petroleum displacement since the TEG converts waste heat from exhaust gas to electrical power, thus the engine will be more efficient resulting in less fuel consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated a systems-level approach is taken. A very clear explanation of the many technical barriers was presented. This was the most impressive presentation this reviewer saw, based upon what they felt was a very clear identification of issues such as electrical and thermal contact resistance due to CTE mismatch, electrical control, materials development, and packaging. Another reviewer commented the approach appears to be very sound to identifying the barriers to this technology and plans to understand and overcome those barriers. One reviewer mentioned some novel solutions to the barriers are encountered. Cost benefit was not discussed. Evidently it is good enough for the OEM's to be proceeding. Comments from another reviewer added the project is evaluating a number of thermoelectric materials for performance at the couple as well as module level. The project plans to develop a segmented device with BiTe and selected high temperature material. A rigorous system level design approach used throughout. Observations from one reviewer noted the project is well thought and all the barriers are addressed adequately.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the technical barriers were clearly identified, and this has led to a novel stack design that shows promise. The efficiencies of the device were defined in terms of the overall temperature difference (from exhaust gas to coolant) in the system, which is relevant and was refreshing to see. An upfront discussion of efficiencies was provided, along with a discussion of the reported efficiencies not being maximized due to a mismatch with the electrical load used in the simulation. This is a very creative and exciting project. Another reviewer mentioned this section would have been rated outstanding had the single-cylinder engine test been accomplished - things certainly break during projects like this, so it is fair to acknowledge that; but the fact remains that there are considerable things to learn from implementing this technology on an engine. One reviewer commented this is a very well coordinated

and organized project. Comments from another reviewer noted the project has demonstrated 530 W of power production under realistic conditions using a segmented TEG. This is a major accomplishment. The project has also made progress on all components of system from new materials to power electronics. Thorough evaluation is needed of available materials and selected half Heusler alloys which are manufacturable in volume quantities. Significant modeling advancements were made this year, but haven't yet quantified system benefit of increased ZT. Observations from one reviewer added significant technical accomplishments have been demonstrated toward DOE goals.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated they did not see evidence of collaboration among institutions, but the systems-level approach suggests strong collaboration among individuals with different technical skill sets. Another reviewer noted this project appears to have excellent collaboration with the project partners, both OEM's, Tier I's, National Laboratories and Universities. One reviewer added there is great leveraging of OEM's and labs. Comments from another reviewer mentioned this is a very strong team. They have demonstrated their module on a Ford engine and plan demonstration this year using a BMW engine. These parallel paths strengthen possible commercialization of developments.

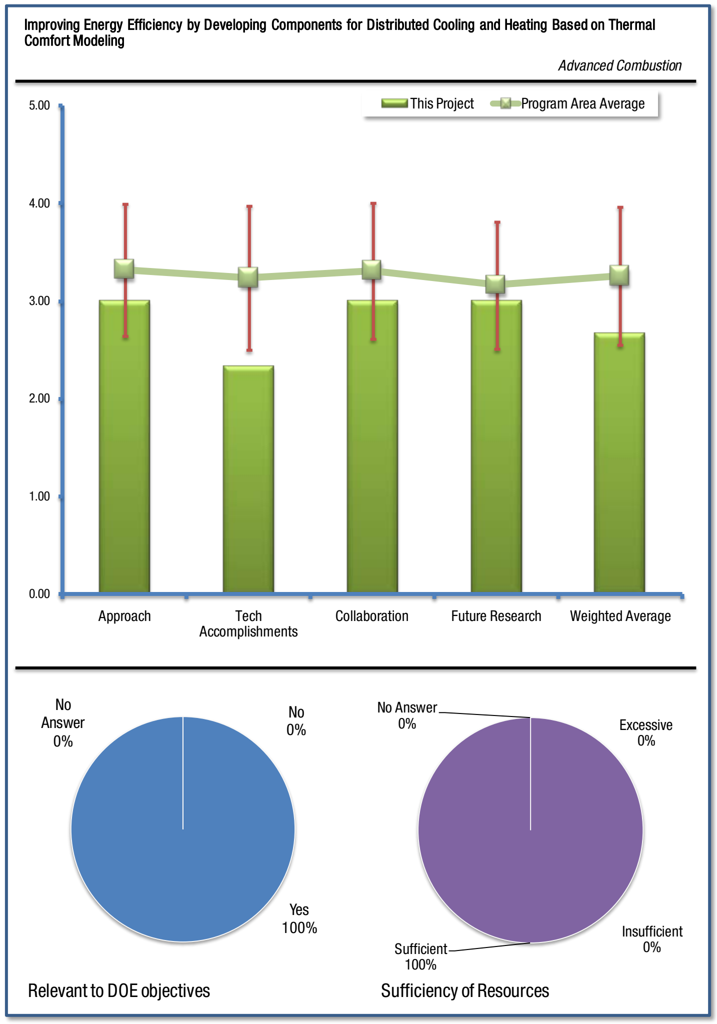
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they did not see a strong vision of future work. Another reviewer mentioned that installing this device at NREL to perform multi-cylinder testing is a great step. One reviewer commented the future work is tied to vehicle integration and scale-up issues appropriate for last phase of program. They are well positioned to demonstrate 500 W modules on actual engine at NREL this year. Comments from another reviewer noted the estimate cost of the devices in terms of dollars per watt should be included.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the only negative to this project is that it seems that the funding distribution is overwhelmingly DOE, with the industrial cost share is roughly 25% of the total, rather than the approximately 50% of the total in several other projects. Another reviewer noted the resources seem sufficient for level of effort. One reviewer mentioned it is a very good project and it should be continuously funded.

Improving Energy Efficiency by Developing Components for Distributed Cooling and Heating Based on Thermal Comfort Modeling: Ed Gundlach (General Motors Corporation)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the objective of this new project is to obtain increases in fuel economy by providing customized TEM-based thermal management for passenger comfort. The relevance to hybrid vehicles, all-electric vehicles, and high efficiency ICE-powered small vehicles, is evident. Another reviewer noted that improved energy efficiency through distributed TE cooling supports overall DOE goals. This program may have more significant impact on DOE goals than waste heat power harvesting. One reviewer mentioned this project does help the engine runs more efficient by using less fuel consumption for automotive HVAC system.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach being taken is interesting and appropriate, although some thought should be given as to the relevant metrics for system performance (for example, an uncomfortable passenger is likely to spend less time driving...). No discussion of technical barriers was presented, although the reviewer imagines these will become evident as the research progresses. Another reviewer commented the project plans to develop system model and distributed HVAC components for a light duty hybrid vehicle. There is a strong focus present on developing a human comfort model from human testing which can be integrated into their vehicle system design tool. This will lead to specifications for the cooling and heating components. The approach lacks depth on the technological innovation expected. The PI provided no details on thermoelectric materials for the HVAC application or components they plan to develop.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Three reviewers stated not applicable since the program is just starting. One of the reviewers went on to say the only reason they are giving this a "poor" rating is because the project appears to be so new that there aren't any accomplishments of note yet, and the technical barriers haven't been well-defined at this stage.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the collaboration with researchers at Berkeley is noted. The reviewer assumes further collaborations will be forthcoming. Another reviewer noted there are good partnerships with academia and will have to see if they deliver.

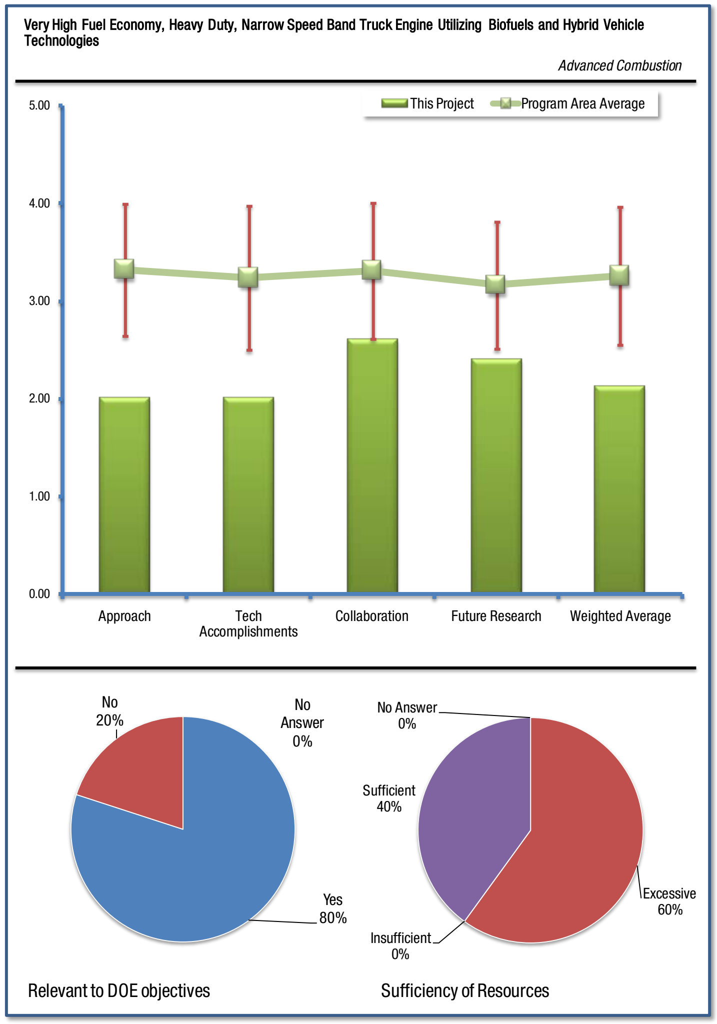
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the details are lacking and they assume these will become clear in the near future. Another reviewer commented the proposed research is consistent with goals and approach. Too early to tell how this will evolve.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated it is too early to say much. Another reviewer noted the resources seem sufficient for this project.

Very High Fuel Economy, Heavy Duty, Narrow Speed Band Truck Engine Utilizing Biofuels and Hybrid Vehicle Technologies: Chun Tai (Volvo)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this project does address several efficiency improving technologies, such as WHR and biofuel use. Another reviewer noted most of the class 8 trucks that use HD diesels cruise at more or less a constant speed over the interstate. The fraction that is subjected to stop and go driving is very small - as in waste haulers. As a result, the proposed strategy of an optimized engine for a narrow speed range compounded with mild hybridization offers very little promise to displace our oil usage. The benefits cannot justify the large investment by DOE. One reviewer commented the overall goals are acceptable, but it is not clear why there is not a specific goal for amount of fuel consumption reduction. Comments from another reviewer mentioned this activity appears to support efficiency/emissions activities toward reduced petroleum consumption. Mild hybrid, fuel research, and narrow band operation are all relevant topics. Observations from one reviewer added the project appears to be investigating a wide range of technologies that are all of interest and have potential to displace petroleum. The end point of the program is to build two demonstration vehicles featuring many advanced technologies. The presentation was not terribly clear, and many details had to be fleshed out during Q and A.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated this project does not seem to be well-integrated with regard to the various technologies that were under study/exploration. It isn't entirely clear which barriers were being addressed by each technology, and why they are better in concert than individually. There does not appear to be much effort spent integrating these project aspects and may be better served by focusing upon the narrow-band engine operation and the hybridization rather than the other aspects. Another reviewer added the initial reaction to the proposed strategy - of highly optimized narrow speed range HD diesel along with mild hybridization - is overwhelmingly positive. However, a careful review shows that with a typical class 8 spending 80% of its life cruising on the interstate, the technology offers very little promise. The idea of improving the tolerance to a variety of fuels while the basic concept itself is yet to be proven is not the right approach. Recommend a two stage process: (1) develop a HD diesel with improved system efficiency, and subsequently (2) improve the tolerance to a variety of fuels. One reviewer mentioned this appears to be a shotgun approach. It was difficult to put the pieces of the puzzle as presented and figure out how they fit together. These appeared to be three separate efforts and not connected to one another. The reviewer requested that the PI please show the tie in between these three areas and how they achieve some specific overall goal. Comments from another reviewer noted the overall approach was very difficult to understand. The Q&A cleared up some of the issues. Most notably was the presentation of a plan with four stages with current activities in the first stage. This status was estimated as 80% complete with overall completion in September 2009. Through further questioning, it turned out the proposed budget and plans were only for stage one. There appeared to be no clear plan (or at least explanation) for who would fund the last three phases of the activity. This project is very confusing overall. Also there was a slide on stoichiometric diesel with no real explanation who the purpose. Observations from one reviewer commented that after Q&A, the reviewer feels that the approach is probably adequate, although based only on the presentation one might conclude that it is a disjointed array of investigations. The reviewer is being generous and giving the contractor the benefit of the doubt with this score, but strongly recommends better preparation for the next Merit Review.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated again, it looks like there has been decent progress made in the areas of narrow-band engine operation and some progress made in turbocompounding, but very little progress or integration of the biofuel or other portions of the project. The "stoichiometric diesel" portion was particularly poorly explained with regard to why it addresses the DOE goals. Another reviewer commented per the presented material at the peer review it was apparent that very little thought went into charting a course or executing the program. It appeared to be a concoction of disjointed efforts. Details as to why a stoichiometric engine development was pursued, details of the waste heat recovery strategy, some schematics, would help evaluate this program better. In their absence, this program cannot be rated very high. One reviewer noted overall accomplishments were disappointing considering the level of funding received to date. FY09 funding was small. Comments from another reviewer mentioned as with the approach, this was very confusing. It was not clear that much technical progress had been made on the activity. The reviewer realizes it is extremely difficult to present a lot of accomplishments in such a short period of time, but the accomplishment seemed like a collection of random items. The reviewer thinks there is probably some good work here and it just did not come through in the presentation. Observations from one reviewer added the presentation and follow-up questions indicate that Phase 1 is 80% complete, but it did not appear that any decisions were forthcoming about the approach for subsequent phases.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the presentation was very unclear as to the roles of each partner and which portion of the effort was accomplished by each. There is a general impression of "lack of coherence" with the entire project. Another reviewer added from the presented material there was very little collaboration with other institutions. One reviewer mentioned maybe the project could include an academic institution too, particularly in the biofuel portion. Comments from another reviewer noted the list of partners was good and there is collaboration with the U.S. Government. There was not much explanation on the collaborations beyond the overview slide. Observations from one reviewer commented Volvo, Mack, SwRI, AVL, and Ricardo could certainly make a formidable team for development, design, and build up of a demonstrator vehicle. It was not clear that all team members contributed or what individual team member responsibilities are.

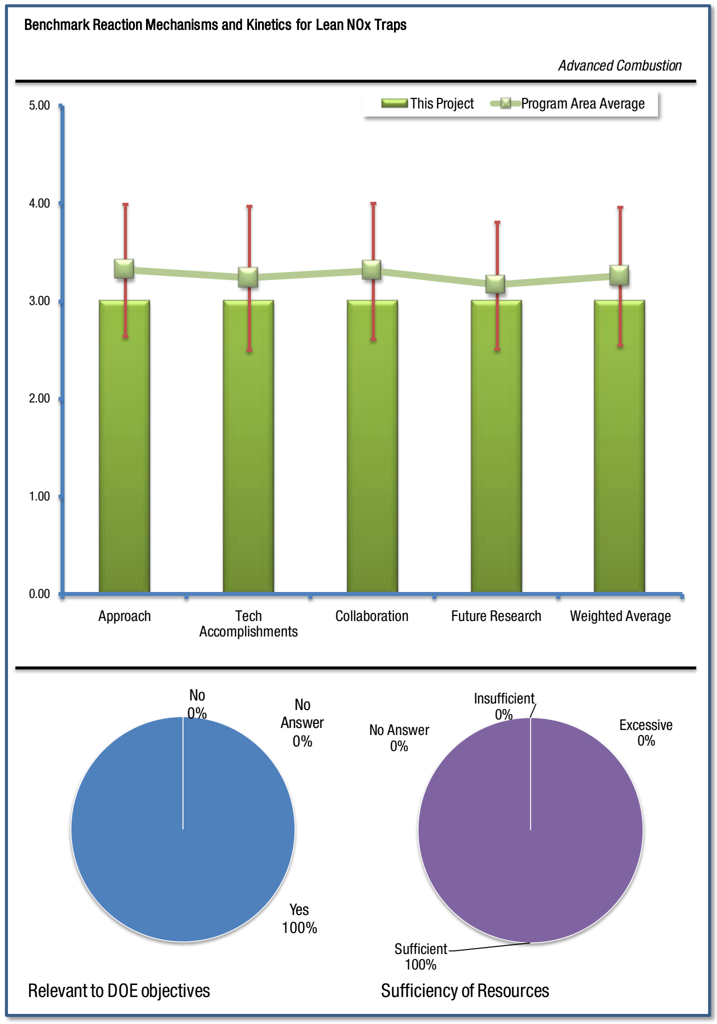
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated if the project focuses upon the portions of the project that have been successful to date, then it is worth continuing. However, there is no clear plan to describe how the future work will be integrated into the current work or how the current work will enable the other portions of the future work - i.e. biofuels etc. Another reviewer noted they recommend developing a project roadmap and a schedule. The one presented was very feeble. One reviewer commented please provide more detail on this for future reviews. Comments from another reviewer mentioned the plan forward sounds interesting. There are three more phases with demo vehicles in the end. What was not clear is whether this work would be funded internally or in part by the DOE. More detail on proposed timeline and funding sources would have been good. Observations from one reviewer added the plans may be better than what was presented, but based on presentation and discussion, the reviewer feels that the leaders of this program could be more focused.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources do not appear to balance with the limited, incoherent results. The project must be managed more effectively to accomplish the stated goals. Another reviewer commented the progress made is not commensurate with the lump sum award of $2.75 million. One reviewer mentioned this is a hard question to answer sometimes. The reviewer marked sufficient for resources due to collaborations and apparent commitment of Volvo to the four phases, but they simply could not understand what resources were being brought together for this activity. Comments from another reviewer noted it is not clear what the budget beyond the first $3 million of DOE funding would be. Industry cost share of $6 million is laudable. High risk technologies are worthy of government investment, but with limited government funds, DOE should look hard at whether better bang for the buck could be had elsewhere; or, DOE should fund future phases of this program only if the contractor can show a more convincing plan forward.

Benchmark Reaction Mechanisms and Kinetics for Lean NOx Traps: Richard Larson (Sandia National Laboratory (SNL)) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer stated after treatment component modeling is part of a comprehensive approach to optimizing after treatment architectures. This work is the most detailed micro kinetic like approach that we have on our collective plate. It is pre-proprietary and needs to continue. Personally the reviewer would prefer this detailed modeling to be directed toward ammonia SCR.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated they are not personally convinced that developing converter kinetics is best done using ramp and step reactor experiments. Those types of experiments are actually designed to provide a conceptual understanding of the component response. The reviewer believes that a comprehensive approach to developing kinetics involves the use of isothermal like experiments where the inlet concentrations are varied based on design of experiment type approach. The collaboration between SNL and ORNL has progressed to that unified approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated that refining the kinetics is a very difficult task. The PI has been solidly successful. It is disturbing that Rich has not been able to assign some of the prediction anomalies to specific sub models in the mechanism. That seems to imply that there are missing or incomplete sub models. Resolution of this situation is important.

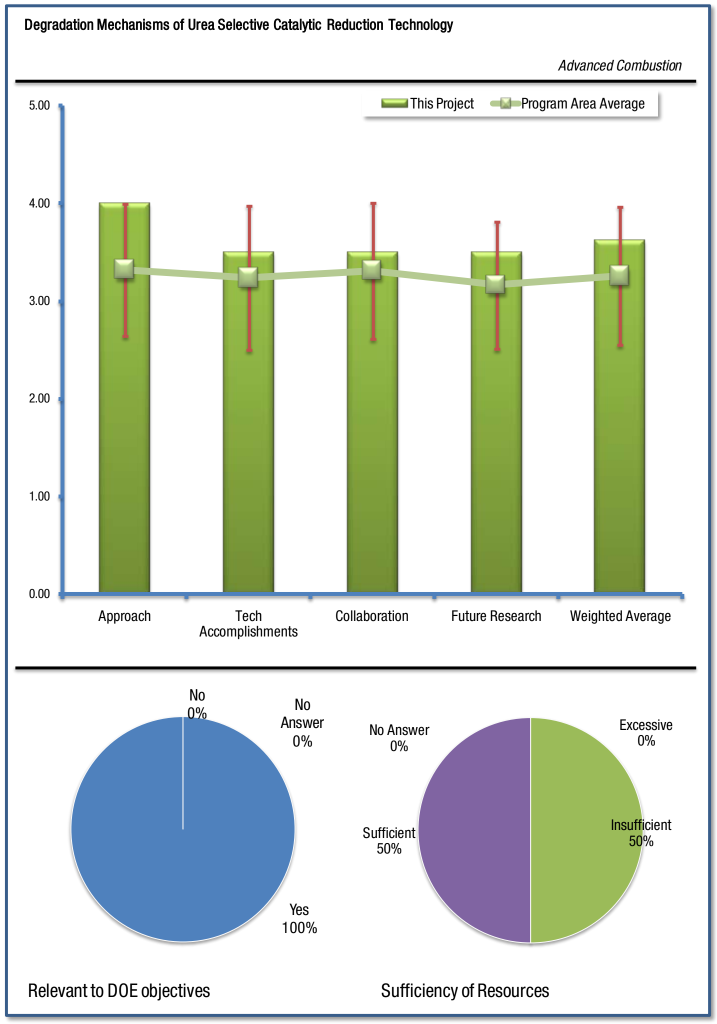
Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the interaction between SNL and ORNL is outstanding. They do believe that a more comprehensive approach to rate contact development which requires even more synergy between the experiments and modeling is needed.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the future plans are quite good at providing closure to this work. They are well designed to accomplish that goal.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated there is very nice utilization of resources at two separate National Labs.

Degradation Mechanisms of Urea Selective Catalytic Reduction Technology: Charles Peden (Pacific Northwest National Laboratory (PNNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated that SCR catalyst durability is critical to future diesel vehicle emissions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach capitalizes on PNNL core competency and addresses critical industry needs. Another reviewer noted the application of PNNL's state of the art analytical methods to production-like catalysts will provide very valuable insights on aging mechanisms.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Both reviewers stated the program just started and it seems to be on track for a good start.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated there is a good GM-PNNL interaction. Another reviewer noted there is collaboration with GM for CRADA.

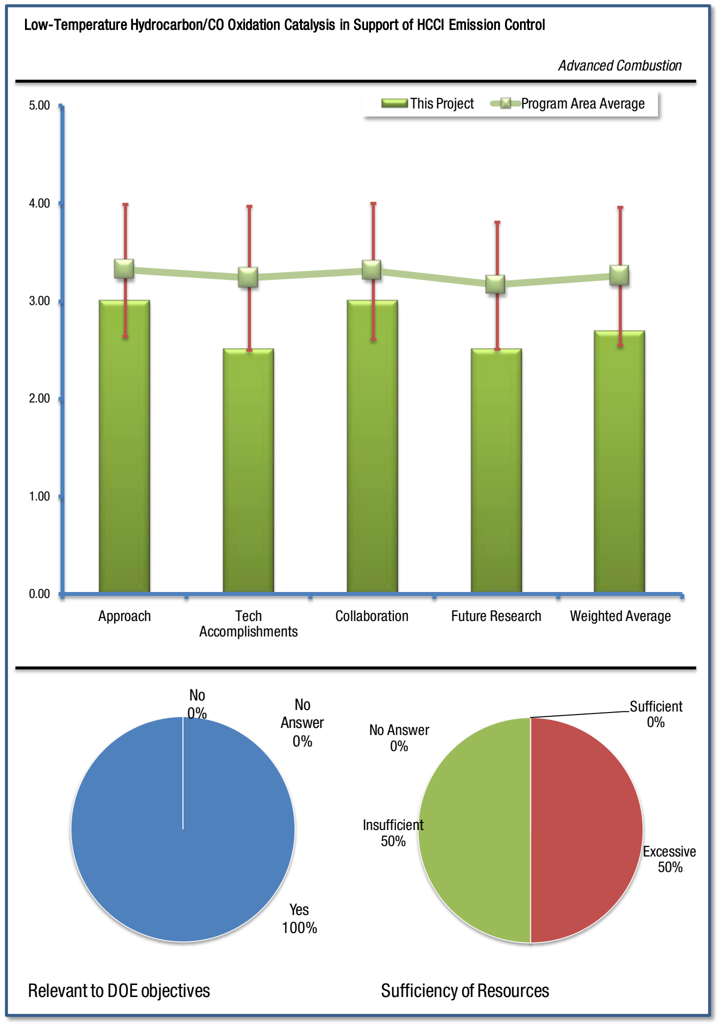
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated they suggest involving the internal GM customer (AT advanced dev team) into this for guidance and expedient tech transfer in the future. Another reviewer added there is a good plan to support development of improved catalysts.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated \$100K is part of a junior researcher; this really limits how much can be done.

Low-Temperature Hydrocarbon/CO Oxidation Catalysis in Support of HCCI Emission Control: Ken Rappe (Pacific Northwest National Laboratory (PNNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the goal does support the overall DOE objectives of petroleum displacement. They do believe however that the approach is seriously flawed. Another reviewer noted that low temperature oxidation of CO and HC is critical for future systems, especially hybrid.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the major weakness is the lack of catalyst aging. None of these results can be viewed as valid unless a reasonable aging was done on each sample. There was little point in investing much analysis time into any of these formulations until they are shown to have a reasonable resistance to thermal aging. Another reviewer added this is a good approach to find improved catalysts.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that without aging evaluations none of the conclusions can be viewed as relevant to the goal of the project. Another reviewer mentioned that good results were achieved.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated it is apparent that the interaction between Caterpillar and PNNL was regular and frequent. Another reviewer noted there was collaboration on CRADA with OEM manufacturer. Perhaps it would have been stronger is a catalyst supplier were willing to participate.

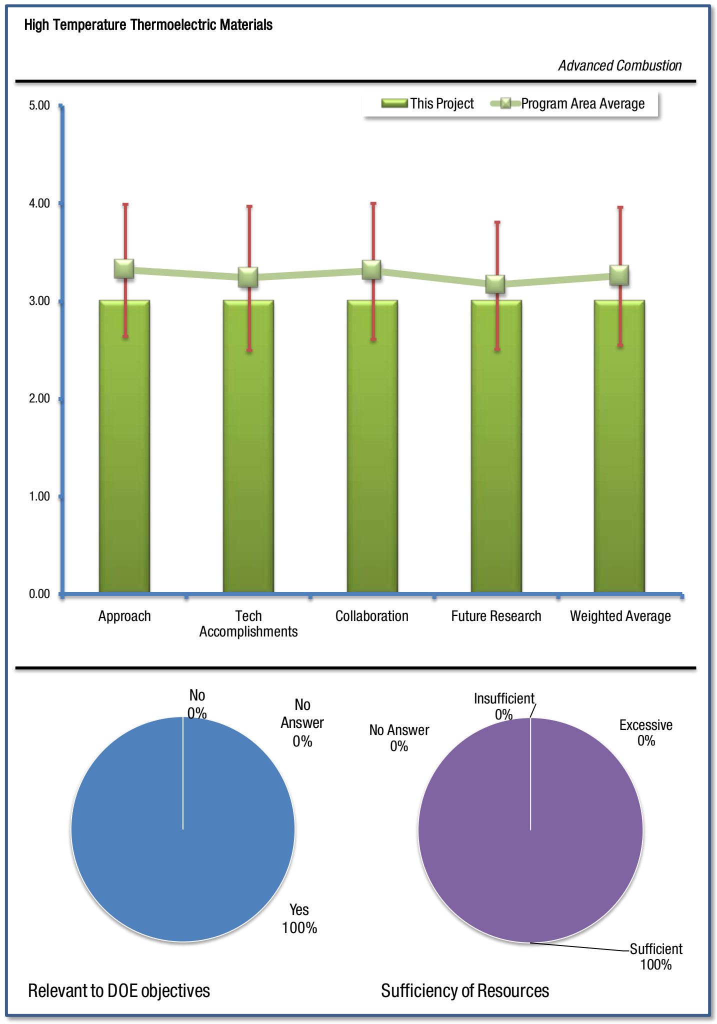
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Both reviewers stated the project is complete. One reviewer added if a continuation is contemplated then I believe a major overhaul of the approach is needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated since they believe the approach is flawed then too many resources were applied to this project. Another reviewer noted the program has ended so this question isn't relevant.

High Temperature Thermoelectric Materials: Norbert Elsner (Hi-Z) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

There was only one reviewer for this presentation and they didn't comment on any of the questions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

There was only one reviewer for this presentation and they didn't comment on any of the questions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

There was only one reviewer for this presentation and they didn't comment on any of the questions.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

There was only one reviewer for this presentation and they didn't comment on any of the questions.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

There was only one reviewer for this presentation and they didn't comment on any of the questions.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

There was only one reviewer for this presentation and they didn't comment on any of the questions.

5. Fuels and Lubricants Technologies

Introduction

The Fuels Technology subprogram supports fuels and lubricants R&D to provide vehicle users with cost-competitive options that enable high fuel economy with low emissions, and contribute to petroleum displacement. Transportation fuels are anticipated to be produced from future refinery feedstocks that may increasingly be from non-conventional sources including, but not limited to, heavy crude, oil sands, shale oil, and coal, as well as renewable resources such as biomass, vegetable oils, and waste animal fats. The impact of changes in refinery feedstocks on finished fuels is an area of relatively new concern to engine manufacturers, regulators and users. Advanced engine technologies are more sensitive to variations in fuel composition than were earlier engines, in addition to facing tightening emissions standards. This subprogram consists of two activities: Advanced Petroleum-Based Fuels (APBF); and Non-Petroleum-Based Fuels and Lubricants (NPBFL). The goals are: (1) to enable post-2010 advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; and, (2) to reduce reliance on petroleum-based fuels through direct fuel substitution by non-petroleum-based fuels. These activities are undertaken to determine the impacts of fuel and lubricant properties on the efficiency, performance, and emissions of current engines as well as to enable emerging advanced internal combustion engines. These advanced engines operate in low-temperature combustion regimes that are expected to become more prevalent in the marketplace because of their higher efficiency and continually improving emissions performance. These activities are coordinated with and supportive of EPA's fuels and emissions-related activities, as mentioned in their strategic plan.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
APBF Effects on Combustion	Bruce Bunting (Oak Ridge National Laboratory (ORNL))	5-5	3.33	3.00	3.50	3.17	3.17
Fuels For Advanced Combustion Engines (FACE)	Scott Sluder (Oak Ridge National Laboratory (ORNL))	5-7	3.67	3.80	3.67	3.50	3.71
Quality, Performance, and Emission Impacts of Biodiesel Blends	Robert McCormick (National Renewable Energy Laboratory (NREL))	5-9	3.57	3.43	3.50	3.43	3.47
Fuel Effects on Advanced Combustion: Heavy-Duty Optical-Engine Research	Charles Mueller (Sandia National Laboratory (SNL))	5-12	3.67	3.50	3.50	3.17	3.50
Mid-Level Ethanol Blends Test Program	Keith Knoll (National Renewable Energy Laboratory (NREL))	5-14	3.11	3.22	3.11	3.00	3.15
Advanced Lean-Burn DI Spark Ignition Fuels Research	Magnus Sjoberg (Sandia National Laboratory (SNL))	5-19	3.00	3.00	3.00	2.86	2.98
Non-Petroleum-Based Fuels: Effects on Emissions Control Technologies	Scott Sluder (Oak Ridge National Laboratory (ORNL))	5-21	3.56	3.56	3.11	3.33	3.47
Non-Petroleum Based Fuel Effects on Advanced Combustion	Jim Szybist (Oak Ridge National Laboratory (ORNL))	5-23	3.40	3.40	3.60	3.00	3.38

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Advanced Petroleum Based Fuels Research at NREL	Brad Zigler (National Renewable Energy Laboratory (NREL))	5-24	3.38	3.25	3.63	3.13	3.31
The Use of Exhaust Gas Recirculation to Optimize Fuel Economy and Minimize Emissions in Engines Operating on E85 Fuel	Ko-Jen Wu (General Motors Corporation)	5-26	3.13	3.13	2.00	3.00	2.97
DOE Optimally Controlled Flexible Fuel Powertrain System	Paul Kilmurray (Mahle)	5-28	3.40	3.20	3.20	3.20	3.25
E85 Optimized Engine	Apoorv Agarwal (Ford Motor Company)	5-30	3.29	3.14	2.43	3.00	3.07
Flex Fuel Vehicle Systems	Hakan Yilmaz (Bosch)	5-32	3.00	3.00	2.71	3.00	2.96
E85 Optimized Engine through Boosting, Spray Optimized GDi, VCR and Variable Valvetrain	Keith Confer (Delphi)	5-34	2.88	3.00	2.75	2.88	2.92
Investigation of Bio-Diesel Fueled Engines under Low-Temperature Combustion Strategies	*Chia-Fon Lee (University of Illinois at Urbana-Champaign)*	*5-36*	*3.50*	*3.00*	*3.00*	*3.50*	*3.19*
Fuel-Cycle Energy and Emissions Analysis with the GREET Model	*Michael Wang (Argonne National Laboratory (ANL))*	*5-37*	*3.50*	*3.75*	*3.25*	*3.50*	*3.59*
OVERALL AVERAGE FOR FUELS			**3.31**	**3.26**	**3.10**	**3.13**	**3.24**

NOTE: Italics denote poster presentations.

Overview of Fuels Technologies: Kevin Stork, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated the sub-program was adequately covered. They don't feel that some of the important issues and challenges were properly identified. For example, the new renewable fuel standard for advanced biofuels (next generation biofuels) is pushing for an immediate need to invest into non-corn produced biofuels. The challenge for this area is that these fuels simply aren't there yet, at least for commercial viability, and they think DOE has an opportunity to really get involved into funding the development of both cellulosic ethanol and higher alcohol biofuels. The reviewer thinks Kevin brings up an important point about trying to develop both petroleum and non-petroleum based fuels that are fungible in the existing infrastructure. Aside from a small presentation dealing with funding in the budget over the last three years, they don't know if progress was clearly presented. The reviewer also thinks this could be addressed by having some clearly defined goals in the budget. Another reviewer commented that the DOE Fuel Technologies sub-group has a clear understanding of the challenges and issues that must be dealt with prior to qualifying bio fuels and ethanol enhanced fuels. For several years this group has worked closely with the industry stakeholders who manufacture those products that are most susceptible to enhanced ethanol fuels. There has been some progress to date on the research and testing area and these efforts have been documented and made available to the stakeholders and public. In the short time period allowed for the presentations the program was very interesting and the material covered adequately. They weren't part of last year's review, so it would be difficult to compare the progress made since then. Two reviewers answered yes to this question, with one adding that the presentation covered the key areas addressed in ongoing projects. Interest in future research topics was provided, which can help to guide researchers' efforts to address future DOE needs.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated the evaluation of bio fuels, specifically enhanced ethanol in gasoline, needs to be thoroughly studied prior to its introduction into the U.S. fuel supply. They believe that the DOE group is doing a good job with limited funding and time which it has no control over. Their recommendation is that the testing be accelerated in light of the political effort to accelerate the introduction of E-15 and E-20. Another reviewer commented they think Kevin outlines a good general approach to dealing with some of the issues and challenges about proceeding with research of this kind. It is important to engage stakeholders and other government agencies in order to focus R&D on projects that not only perform well in the lab, but that also have tangible benefits in terms of emissions and public health by engaging in programs that can be applied nationally. Two reviewers answered yes to this question, with one adding some of the program emphases seem driven by political and year-by-year "reactive" responses to needs. Coal-to-liquids (direct and indirect) seems to be an area that has not received much attention, while one might say that there is excessive emphasis on ethanol. The emphasis on ethanol is counter to the larger DOE long term objective of efficiency improvement and dieselization.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

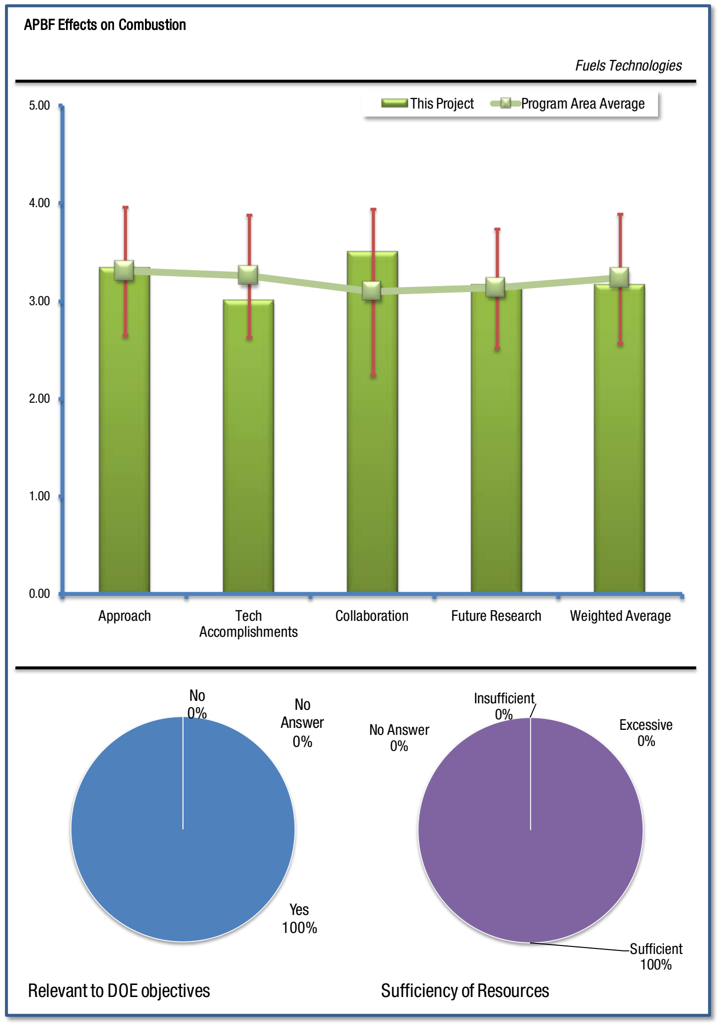
A reviewer stated the sub-program is focused and well managed, but the political agenda appears to be outpacing the R&D schedule in this area. The 280 day clock for EPA to approve or deny the E-15 waiver is running and this project needs to be the data source for making technical decisions regarding the introduction of E-15 and E-20 into the nation's gasoline supply. There is much work to be done in this area as gasoline is the fuel for our immediate future and any changes to the nation's fuel supply is of utmost importance. DOE (and specifically this subgroup) is chartered with this responsibility and the need for good data on ethanol enhanced fuels is great, with the Fuels group understanding these needs. Another reviewer noted the program does appear to be focused, well-managed, and effective. Two reviewers answered yes to this query, with one mentioning it is clear that political, as well as technical, pressures have driven the focus of the program to shift year-by-year, which can be detrimental to real problem solving.

It would help if this program were more insulated from political pressures and could be driven by National Research Council or other non-partisan programmatic reviews.

4. Other comments:

A reviewer stated more resources are needed in short term for E10+. They recommend more structured DOE/CRC planning. The reviewer also recommends refocusing fuel effects on advanced combustion into areas that are most likely to be commercialized. They suggest making best use of current commercial fuel (including biofuels) since need for new fuels will slow technology introduction. Another reviewer commented that it was very timely and an interesting issue and presentation. In summary they would like to see more R&D effort in the coming year in this area so that DOE can provide guidance to the nation on the issues, challenges and potential benefits of introducing ethanol enhanced fuels. One reviewer mentioned the NSF and DOE-BES are moving from cellulose-to-ethanol to cellulose-to-hydrocarbon biofuels strategies.

APBF Effects on Combustion: Bruce Bunting (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers unanimously expressed that this project supports DOE's objective to displace petroleum. Reviewers cited the fact that the project promotes advancement in engine hardware, and emissions control systems, as well as gasoline and diesel fuels technologies and related alternative fuels. More than one reviewer noted that the program supports the goals clearly outlined by the Energy Independence and Security Act of 2007 or that it improves energy security and energy efficiency. Reviewers acknowledged that improving efficiency of ICEs could be a very cost effective, emphasizing the importance of research in advanced combustion and enabling fundamental research on HCCI, fuel properties, and critical fuel parameters. An HCCI engine will be more efficient and use less fuel–fuel which may cost less to refine.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers were generally positive about the new system approach taken in this work. In fact, one reviewer suggested other programs should be patterned after this template. They cited the facts that collaboration between various laboratories and academic institutions is progressing well, that combustion experiments are difficult to base on first principles since the combustion phenomena are so complicated (thus the benefit of systems approach), and that the system approach provides a pathway for input and program modification as the data is developed. One reviewer added that this allows for changes to the core program while staying true to the research principles.

Suggestions were made by reviewers that this work be conducted with the latest engine technology since fuel effects depend on engine technology, that a focus be made on gasoline/ethanol blends due to increasing use of ethanol and potential for surplus in the gasoline pool, and that a wide range of fuels and vehicles be used–one reviewer emphasized that the use of bulk fuel properties like octane/cetane to optimize provide the benefit that fuel producers can optimize fuel production. It was also suggested that solicitations of private industry to partner in the research should continue.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers observed that the program continues to evolve relative to the data it has developed and its support of DOE policy goals. One reviewer noted that the recognition of new fuel blends and components is appropriate and worthwhile, and that even though the process may be lengthy, the information appears to be very useful, especially for comparative purposes. Furthermore, continued focus on optimizing fuel efficiency and engine performance with

nontraditional gasoline/ ethanol fuel blends (outside of E10, E85, etc) is key to improving the acceptance of new fuels and new fuel blends–it is "thinking outside the box".

Adequate funding for the project and the focus of the principal investigators has resulted in good progress toward the program goals. Reviewers noted that the project is about 75% complete and has made good progress toward understanding fuel effects. A reviewer noted there is no coherent fuel effect theory yet developed and results seem to depend on engine technology. Good progress in understanding fuel effects.

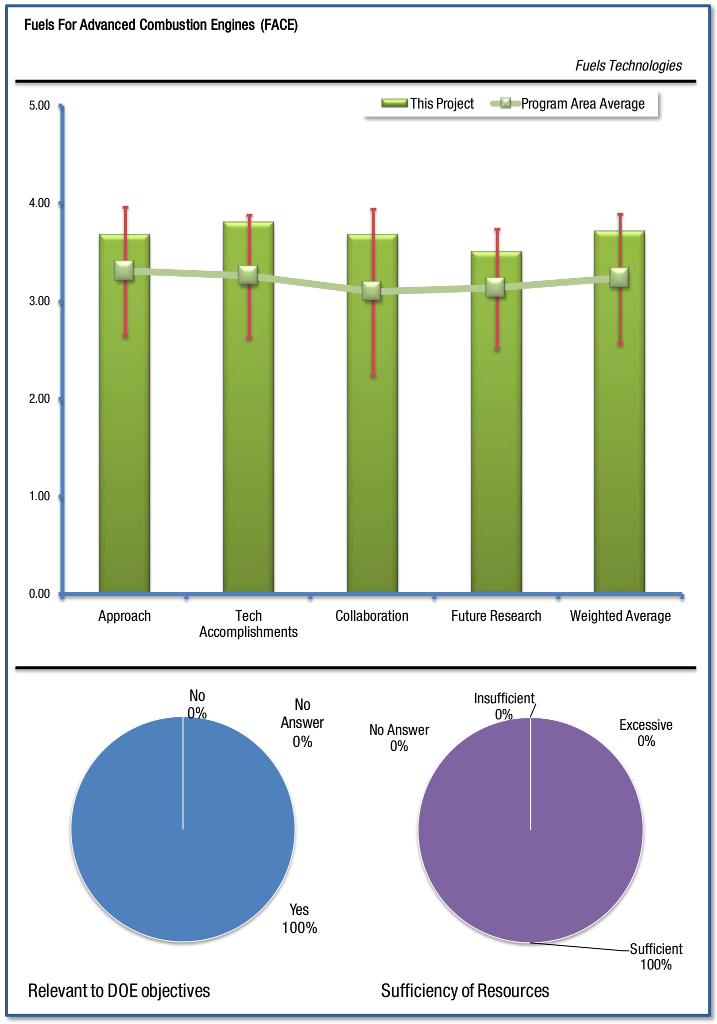
Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Most reviewers acknowledged good collaboration between this program and other institutions, noting in particular good collaboration between various laboratories and academic institutions, especially relative to HCCI information and the CRC FACE team. The CRC is a premier organization for research. There was a suggestion that there could be improved contact with certain OEMs.

The project includes current and future engine design for both gasoline and diesel, but, with the exception of Cummins, OEMs did not seem to be included as partners in the research. DOE programs have traditionally worked closely with all affected industry members, and solicitations for collaboration on future fuels and fuel changes being considered proves the effectiveness of this open approach. Continued nimbleness in this research approach will serve the fuel industry and consumers well. One reviewer would like to see the DOE renewable fuel programs include more of the renewable fuel industry producers--noticeably missing were any ethanol and biodiesel producer partnerships. These relationships should be developed as they are the future fuel suppliers.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Reviewers had a few suggestions relative to planning future work. More than one lauded the inclusion of ethanol blends in future work; one questioned whether compression ratio studies of higher level ethanol blends might be limited by the test engine. One reviewer suggested that greater focus is needed such that the program is not trying to handle too many variables and is focused on a few technical conclusions in more depth. Another reviewer made the suggestion that emission evaluation is a great next step since it is necessary prior to commercialization–concluding that continued availability of the data generated by this program is highly recommended. Finally, one reviewer commented that the program should do well to progressively evaluate fuels so as to provide insight on HCCI.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Reviewers felt funding should be continued. They noted that the recognition of new fuel blends and components is appropriate and worthwhile. They further noted that continued focus on optimizing fuel efficiency and engine performance with nontraditional gasoline/ ethanol fuel blends (outside of 10%, 85%, etc.) is key to thinking outside the box and improving the acceptance of new fuels and new fuel blends.

Fuels for Advanced Combustion Engines (FACE): Scott Sluder (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers strongly felt this program supports DOE’s overall goals. One noted that the overall goals are very well defined and are closely related to promote advancement in future engine hardware, emissions control systems and fuels technologies. A couple of reviewers commented that the data being collected could be instrumental in creating useful research tools used to improve fuel quality and to better understand fuel property impacts on advanced combustion processes and efficiency. The future-reaching technology effort for this activity makes is appropriate for meeting the DOE objectives. It was noted that this program for FACE fuels for both gasoline and diesel provides a benchmark for various researchers investigating HCCI and alternate cool combustion technologies. This coordinates the fuels for these tests so comparisons and insight can be made.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers very favorably commented on the approach used by this program. One noted that bringing researchers together to cooperatively combine efforts on new combustion systems is outstanding and well above the normal approach of separate limited collaboration on a challenging area of research. Another reviewer felt the program was very well planned and they really liked to see the FACE group mission statement enclosed as a part of presentation. Another noted the approach is methodical, based on understanding of collective stakeholders. A suggestion was made, even though it's difficult to create a manageable number of fuels in the test matrix, that gasoline-ethanol blends and potentially other higher alcohol-gasoline blends should be in the matrix somewhere. Good or bad, ethanol is here to stay, and DOE is putting a lot of funding toward testing non-petroleum based fuels. One potential barrier faced by the team was developing a mechanism by which researchers could obtain the standardized set of fuels. A reviewer commented that the team overcame this barrier by identifying an industrial fuel blending company that was willing to make batches of fuel with the desired properties and to make them available for purchase to the researchers. To a large extent, this project is addressing the barriers well.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers felt the sharing of data will be very useful toward DOE goals and improving the understanding of new combustion approaches, as well as the quality/performance of petroleum based fuels. One reviewer felt it will be very useful to stakeholders and other government agencies to have the results of this research at their disposal. Others echoed that, noting the sharing of diesel fuel analysis and research supports the main program objectives. Data sharing appears to be working well, which is key to advancing the general understanding of new combustion approaches. Reviewers understood that there may be the need for some focus on a gasoline fuel matrix as well.

Reviewers were impressed with the progress made, especially with the detailed analytical characterizations that have been conducted with diesel fuels (both standard ASTM analyses and emerging advanced characterization techniques). This work will be very useful to relating fuel composition and properties to results that combustion researchers obtain with these fuels and to help optimize performance in advanced combustion engines. They noted that the team developed a diesel fuel set matrix based on three key properties of importance to combustion. It then worked with fuels blender to make those fuels. They sensed the effort was successful and fuels are now available for purchase by researchers from the blending company.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found a strong theme of collaboration in this program. DOE has selected a good mix of stakeholders and government agencies to work on the development of this project. Reviewers noted that FACE should be a model for other programs within DOE, that very good collaboration was obtained through the FACE subcommittee of the CRC/AVFL committee, and finally that the collaboration between various laboratories, academic institutions, energy companies, auto companies, and engine manufacturers was excellent.

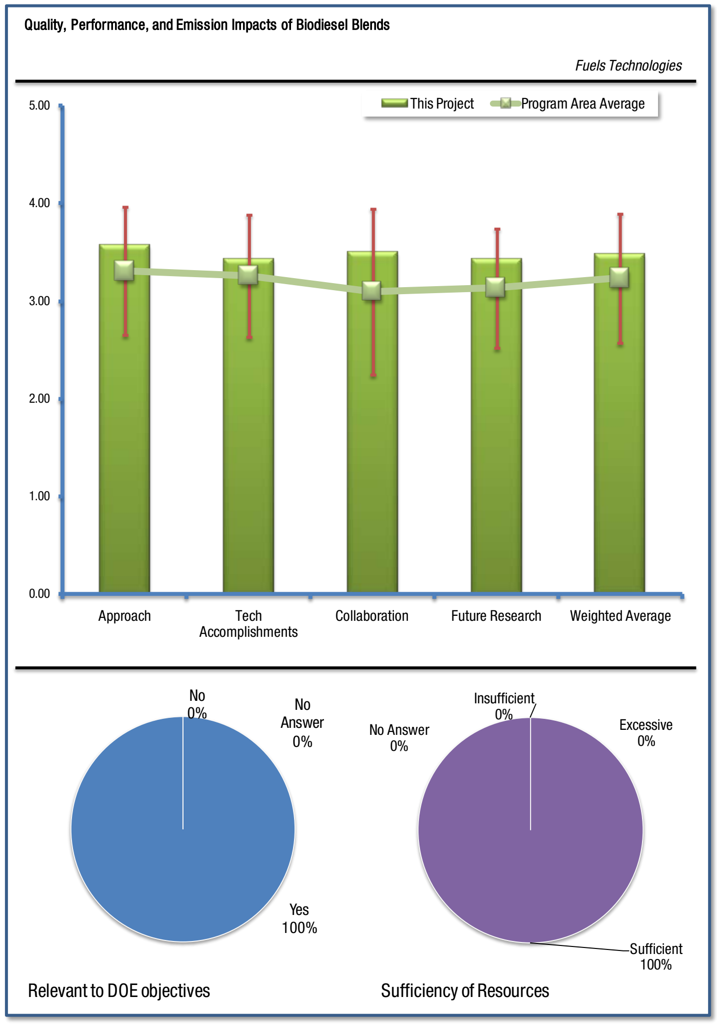
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers felt there is very good focus in this program, with not too many variables proposed to be examined. One reviewer emphasized there is a very good plan to extend the successful work with diesel fuels to gasoline fuel set. Also, given the vast political interest in increasing renewable fuels rapidly over the next decade, it is difficult to develop an appropriate fuel matrix that will include new feedstocks or gasoline-alcohol blends. That being said, it is going to be necessary to put some fuels in the mix in order to get a closer more "real world" approximation. One reviewer agreed, noting that with the gasoline and diesel matrices identified, and alternate feedstock effects being contemplated, the plan for future work is well guided.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers commented that CRC has allocated funds through AVFL Committee and beyond that, little information was provided but resources are evidently sufficient.

Quality, Performance, and Emission Impacts of Biodiesel Blends: Robert McCormick (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers agreed that this program supports DOE goals to displace petroleum. The overall goals tie in to promoting advancement in engine hardware, emissions control systems and fuels technologies. One reviewer favored biodiesel versus corn ethanol, noting that biodiesel serves the key function desired by the DOE of displacing petroleum with a domestic and renewable resource. Moreover, it does it with a much higher "Fossil Energy Ratio" than corn ethanol. Biodiesel is the one "first generation" biofuel that has sufficiently desirable characteristics to be maintained in the future as part of the fuel solution, while corn ethanol does not.

One reviewer noted the core values and questions being answered by this research program support both the continued understanding of the properties of this fuel and commercial side of the fuel industry. The support of the fuel industry through the analytical support and data generation to eliminate barriers to market development is key. The data developed in support of the regulatory and safety concerns, ASTM and UL, has tangible results that are sometimes forgotten in long range research projects. No doubt that these activities promote the continued and increased use of biodiesel in diesel fuel. Again, this is important because it helps with energy security, petroleum dependence. This work has brought data to the table enabling the advance of biodiesel in the U.S. market by way of improving quality.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers felt this program was well-designed to overcome technical barriers it is addressing. A reviewer expressed that it includes consideration of fuel production, use and aftertreatment effects. Furthermore, it continues to produce informative and authoritative results, such as the biodiesel quality survey, which is helping to reform the biodiesel industry and protect consumers. Also, the impacts of biodiesel on advanced vehicle platforms with state-of-the-art aftertreatment systems is essential to anticipate problems in the field as we head into 2010 vehicle systems. Another reviewer continued, noting that a broad cross section of fuel industry, both petroleum and renewable, engine manufacturers and research organizations were utilized. The flexibility to respond to industry needs must continue in support of advanced use of nonpetroleum based fuels. They also noted that performance testing and chemical analysis of commercial fuels are planned, and that engine and vehicle dynamometer work will commence soon.

The work is well-designed to successfully overcome barriers, with good reliance on development of technical information that directly relates to fuel performance. This approach has resulted in the improvement of bio diesel quality in the U.S. This has upset some biodiesel stakeholders because they were not focused on making a quality product for the U.S. diesel fuel market, but in the end, this work has improved the viability and reputation of the biodiesel fuel component.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers understood that the quality survey and fuels effects studies address key challenges with biodiesel and help to protect the consumer and the biodiesel industry from bad fuel and potential adverse effects of biodiesel. A reviewer noted this project continues to produce essential knowledge to guide industry and consumers. An example is the UL listing for B5, which was based on NREL data on fuels impacts. The program is geared to be responsive to industry needs, which is excellent. The commercial attributes of this program are directly in support of the overall goals of the research: to eliminate the barriers to additional NPBF production and use. As some of the DOE research programs develop technology advancements looking several years out, this program is directly supporting the present challenges in today's fuel industry.

Another reviewer suggested there should be continued work in support of identifying the synergistic effects of fuel components and nontraditional fuel blends. The concomitant effects on fuel performance continue to be a developing concern and need further exploration. As increasing renewable content in fuel is incorporated, additional information needs to be developed and identification of primary effects will steer the industry to the optimal fuel blends. The fuel quality work directly supports the commercialization efforts and was not only timely, but widely recognized, and the quality of the analytical data is to be commended. Also, continued work in the engine emission arena is in direct support of the EPA goals to clean up diesel exhaust emissions.

Other reviewers noted that, although good sets of new data were generated, lubricant/after treatment studies recommended by reviewers in 2008 had not been conducted. The reviewer felt nonetheless that the list of publications was impressive. Noted too were the completion of the nationwide B20 survey, the approval by ASTM of biodiesel properties standard—an important step—and the validation of low temperature operability and minor species tests for biodiesel blends. There was excellent progress on understanding cold flow and emissions issues as well.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers felt that collaboration between various laboratories and academic institutions, CRC, and OEMs is progressing well. A reviewer noted that the industry partnerships developed and utilized here should be the example of the DOE programs. A broad cross section of fuel industry, both petroleum and renewable, engine manufacturers and research organizations were utilized. The flexibility to respond to industry needs must continue in support of advanced use of nonpetroleum based fuels. One reviewer added that the project involves a great many stakeholders and collaboration with standards organizations (ASTM, UL). Greater reliance on University collaboration could help to provide additional fundamental information on biodiesel impacts and help to identify fuel chemistry, materials development and process chemistry changes that could circumvent or alleviate problems with biodiesel. The collaboration with the Colorado School of Mines on biodiesel analyses is a good example of the benefits of University collaboration with this project, but more such collaborations are recommended.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

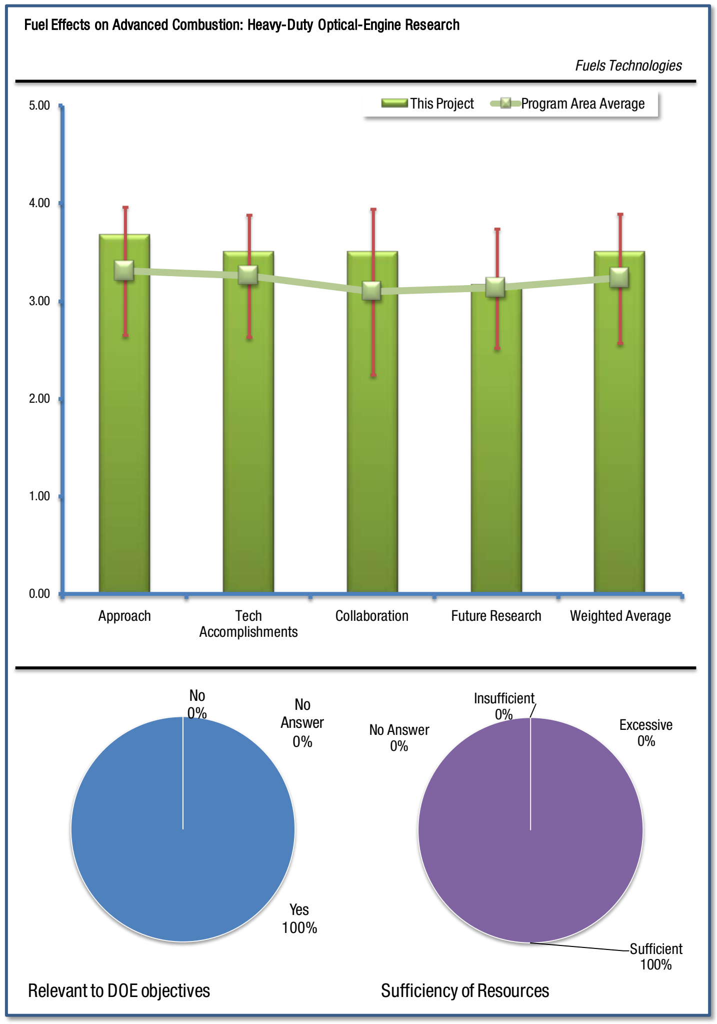
Reviewers made some recommendations relative to future work. One noted that long term programs (like fleet testing) are not defined in detail. A suggestion was made that work be conducted to support use of biodiesel blends in petroleum product pipelines. This would significantly reduce cost of using biodiesel. One main issue is small quantities in jet fuel. Stability and CF work are also high priorities. As EPA continues to ratchet down the emissions from diesel engines, new technologies will be developed to assist with these efforts and evaluation of the compatibility will be needed with various fuel blends. And work toward understanding the fundamental aspects of biodiesel cold flow properties is a critical research area.

Reviewers also noted that the past success of the program supports the plan to continue this work. The DPF durability study is timely and may help to address longer term concerns with customer acceptance of clean diesel technology and biofuels. The cold weather HD truck tests demonstrated what is needed for winter use of quality biodiesels. And increasing the understanding of minor components/processes by products found in biodiesel fuels is needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers expressed that, given the breadth of this project and its need for on-vehicle and long term experiments, as well as fundamental bench top experiments, more resources would be justified. This is especially the case since biodiesel remains the largest contributor to renewable content in the diesel fuel supply. One reviewer suggested that growing the effort to include more university involvement would be beneficial. Another reviewer felt that the resources were appropriately scaled at present. All felt the program was in good shape with current funding.

Fuel Effects on Advanced Combustion: Heavy-Duty Optical-Engine Research: Charles Mueller (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found the program supportive of the DOE objective of petroleum displacement. One commented that the program's goals of promoting advancement in engine hardware and fuels technologies are closely related to the overall goals. Another noted that a better understanding of fuel effects on heavy duty combustion will lead to improved engine efficiency and lower emissions. The advancement of the fuel effects and engine combustion science base is essential, commented another. The project is designed to search for the root causes of NOx contribution and improve efficiency using bio diesel. Bio diesel is being used in engines and improvements in emissions and efficiency are the goals of the DOE program. Further, one noted that the work may lead to identification of an optimal non-petroleum based diesel fuel. Lastly, it was commented that the work is responding to the 21st Century Truck Partnership Roadmap.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Overall, reviewers were very positive in response to the approach taken by this program. One mentioned that outstanding analytical tools (lab equipment and expertise) were focused on understanding and more importantly attempting to solve real-world technical barriers. It was also noted that program is well planned, with detailed program goals and deliverables. Other reviewers observed that the use of optical engine to better understand combustion is an excellent approach, utilizing good graphic examples. Lastly, a reviewer did express some doubt regarding combustion and emission formation of NPBF. They were unsure if optical engines can simulate the real world situation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers found the program well explained and expressed clear understanding. They found the project was on schedule and had accomplished its goals. A reviewer found the relevant accomplishments were clearly stated and aimed at improved fuel efficiency and petroleum displacement. Also, there appeared to be interesting fundamental knowledge achieved regarding early Di operating conditions. Another reviewer noted that results suggest plausible reasons why (some) researchers have seen NOx increases with biodiesel. Good work was done showing that higher volatility fuel leads to less wall impingement, which in turn leads to lower emissions. One reviewer felt it was good recognition that another option is to change fuel injection strategy. One reviewer noted "the explanation of biodiesel NOx effect was the most concise and easy to understand of any explanation I've heard." Avoiding wall impingement by increasing fuel volatility to control liquid penetration length is an interesting concept to lower emissions. They expressed it may be of interest to study for both biodiesel and heavy end molecules in ULSD.

A couple of questions were raised. The first was whether a mechanism was formulated to explain NOx increase with biodiesel. The second expressed curiosity about composition effects–i.e. is there a need to understand and predict fuel composition effects?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found the program coordinated well with other institutions–it was well connected with industry, especially for a basic research activity. One reviewer found the collaboration between various laboratories and industry progressing well–with particular mention by another of the very good linkage with industry via AEC Working Group and CRC. One reviewer was aware of the project from the biomass conference and found it useful to his industry.

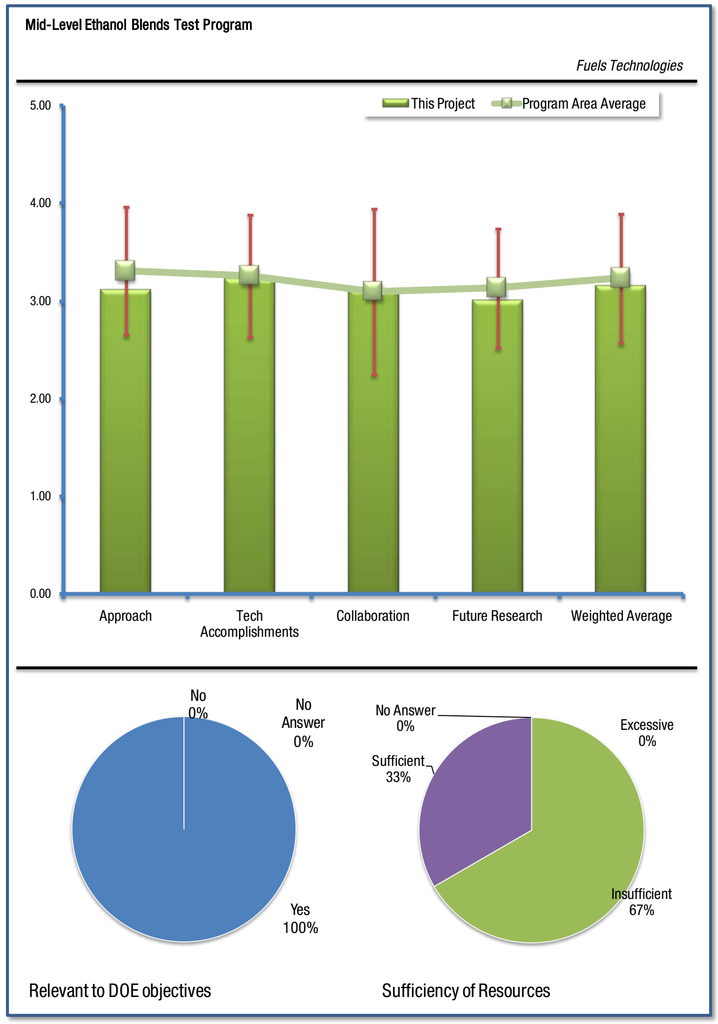
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers had several suggestions regarding the program. One found it was very good, if not as strong as previous work. It was expressed that more detailed definition of the goals for AVEL-18 program are needed, though other reviewers found the future work is carefully planned. There was a clear focus on continuing to better understand fuel properties on liquid phase fuel penetration. It was also suggested that capabilities could be increased by implementing new high pressure common rail fuel injection system. Also, diesel surrogate development work should be very useful for linking fuel properties to performance in engines.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found the project funding appears to be sufficient and that it is on schedule.

Mid-Level Ethanol Blends Test Program: Keith Knoll (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 9 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers broadly expressed that this project supports DOE objectives. One noted that directly higher level ethanol blend directly displaces petroleum meeting both DOE and congressional objectives. The overall goals are closely related to promote advancement in engine hardware, emissions control systems and fuels technologies. A reviewer echoed that, stating that the US cannot meet renewable fuel targets with ethanol unless the E85 vehicle dramatically expands. Another viable option is to increase the blend ratio in conventional SI vehicles. This work enables getting past the "E10 wall" which may or may not be a practical limit in the current vehicle fleet. Some corn market experts have said that E20 is the best overall option for ethanol use in terms of impact and efficiency, which this project can help to enable. Another reviewer felt this program absolutely supported DOE goals–the project is designed to evaluate the effects on engines when operated using E-15 and E-20. This is critical information as the political agenda is to require that E-15 be permitted in the nation's gasoline supply.

Other reviewers expressed that the program supports the goals clearly outlined by the Energy Independence and Security Act of 2007, in particular, by focusing on the advanced use of alternative fuels and on improvements to both current and future engine engineering and design for both gasoline and diesel. The core values and questions being answered by this research program support both the continued understanding of the properties of this fuel and commercial side of the fuel industry. It was expressed that the program is a very high priority for research in the U.S. to determine whether E15 will work with hundreds of millions of vehicles and non-road engines in our country.

Another reviewer agreed, noting that the program directly addresses the ethanol blend wall by looking at whether increasing ethanol content above the legal limit of 10% is feasible for existing vehicles that may not be designed to use fuels containing 15 - 20% ethanol. Increasing ethanol content of conventional gasoline and burning it in as many vehicles as possible in today's on-road fleet is one solution to meeting the 2007 EISA renewable requirements.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Most reviewers supported the approach taken in this program. Several noted that extracting the science-based views from the politics-based views is difficult. Indeed, one reviewer stated that we must keep political views of the pro's and con's of ethanol out of this program and just report good science. Another reviewer put it simply that, with an issue this sensitive, it will be difficult if not impossible to satisfy the requirements for all interest parties. That being said, the data being generated through this project will not only inform an EPA waiver decision, but also aid in the development of regulations involving air quality rulemakings. More work could be used to address phase separation and corrosion issues with underground storage tanks for fuel. The safety/warranty issues being examined through the durability study (V4) is the first of its kind, and given the amount of resources necessary to conduct these tests, DOE has done a good job of focusing a program that answers the uncertainty of the effects of intermediate blends on a representative fleet (as measured through vehicles miles traveled). Other reviewers noted there was broad partnering with industry groups and stakeholders, combined with the capabilities of several laboratories. One noted it is a large program with many sites and participants, which seems the best approach to generate comprehensive and authoritative results. Using variety of driving cycles to probe multiple means of fuel (ethanol) effects on emissions, performance and system durability is helpful. Another simply said the program took a very good approach of testing the ethanol blends in real equipment. Another reviewer expressed an understanding of the positive aspects of partnering with industry and other government organizations, but also that the limitations to data publication for this project drag out the release date and data availability, and the collaboration that has developed is thus all the more appreciated. Any improvement for future programs for data release would be beneficial to industry. The programs are thorough and address the concerns that have been expressed by the regulating bodies and industry. Concerns were also raised. One reviewer felt lubricant considerations seem to be missing from the program. Another major concern expressed was that many final reports seem to have been written with the agenda to qualify the use of ethanol enhanced fuels, while the data do not support this. The reviewer noted: “The presentation I reviewed today was more forthcoming in its evaluation of the challenges and I would like to see future final reports better reflect the actual test results.”

Still another reviewer commented that there are many tasks to this project. Most of the tasks do an outstanding job of focusing on technical barriers. For instance, V1 was a pilot program that looked for quick problem areas to address. There is concern that on some of the other tasks, the test plan has been scaled back to meet available funding or to address a perceived need to collect as much E15 data as possible for an EPA waiver, without due regard for impact these changes will have on the quality of the scientific data to be generated. For instance, on task V4, it looks like the goal has shifted from identifying problem models/years to finding as many new models as possible that will run on E15. This approach is fair at best. What is the test tolerance? Should the testing be done at E20 to prove E15 works? Original plan was to run E0, E10, E15, and E20 on all models. What do the statisticians say when many models will only collect data on E0 and E15? Will there be enough data to find an acceptable ethanol range for non-adapting vehicles, or will these tests have to be repeated to collect the missing data points?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers expressed their overall understanding of the technical accomplishments achieved by this program toward DOE goals. One noted that DOE has made effective changes at expediting the mid-level test program; however, it just takes a long time to run vehicles for 120k miles. One reviewer cautioned that greater focus and more resources are needed. It was noted that some results were already published and contributed to the Biomass Action Plan announced by the previous Energy Secretary.

A reviewer noted that the program demonstrated only minor effects on emissions for E15 and E20 and the first round of results (V1) has guided the subsequent test designs. The reviewer continued, noting completion of two of three phases in the second round tests (V2). This shows good progress for the program. What is unclear is whether more fundamental questions of the mechanisms of E20 impacts are being examined, which could be done through extensive post mortem analyses of the test vehicles. There appears to be good progress and extensive testing so far on a number of the projects in the program. Another reviewer was especially pleased when it was mentioned during the question/answer period that DOE plans to test marine and non-road engines.

One reviewer noted benefits and provided suggestions for the program. They noted the data being developed by this program is clearly in support of the EISA 2007 legislation, which calls for a systematic increase of renewable fuel content in transportation fuels. The "canary in the coal mine" approach was necessary and proved to be an essential part of the data development in the mid level ethanol blends investigation. However, once no fatal preliminary results were found and as supporting data continues to be developed, additional resources and funding should be allocated to this research. The time line for these projects appears fixed and neither dynamic nor responsive to the research results. With that said, projects of this magnitude and scope should proceed in a purposeful direction and that does appear to be the approach by DOE. Additional resources should be allocated to this project in support of the research findings.

Unlike other fuel producers, the renewable fuels industry feels that the data analysis and summary conclusions are well supported by the data that was developed. DOE takes a neutral, if any at all, position on data conclusions. Additional negative feedback, as was expressed during the question and answer portion of the session, from the small and nonroad engine communities, further underlines their own limitations and lack of responsiveness to changing energy forms.

One reviewer cautioned that, while there were good accomplishments to date, data results were a little weak on the hand-held equipment evaluation of E10+. We should have had toxic emissions reported (aldehydes) on the hand-held equipment since this is an important aspect of E10+ evaluation for EPA's decision.

Again, many tasks to this project and some tasks are achieving outstanding progress, while others appear to be good. Driveability and evaporative emissions tasks seem to have been well run. Not much data will be available by end of E15 waiver request comment period this summer. However, many tasks should be completed by Spring, 2010 in time for EPA to take into account before making any final ruling. As data is collected, it will be interesting to see if extensions or new areas of study will be initiated to address knowledge gaps as these are identified.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers generally expressed, given the complexity and controversy surrounding this testing program, that DOE has admirably engaged interested parties from many sectors. One felt this program has been very open to discussion with manufacturers. Industry seemed to be well represented though involvement of CRC, OPEI, ISMA, NMMA, and MIC. Collaboration between various laboratories and academic institutions is progressing well too, noted another reviewer. Yet another found university involvement to be “minimal” and questioned whether fundamental questions were being answered. One expressed that the level of coordination was not so clear and thought that more university involvement would be beneficial toward analyzing aftertreatment catalysts and engine components. Although no side has gotten exactly what they wanted--mainly because of financial and logistical constraints--DOE has done well to find compromises that may address the questions.

One review felt the industry partnerships developed and utilized here include a broad cross section of fuel industry, petroleum, engine manufacturers and research organizations. This reviewer would like to see the DOE programs that include renewable fuels to include more of the renewable fuel industry producers. Noticeably missing were any ethanol producer partnerships. These relationships should be developed as they are the future fuel suppliers.

Finally, a review observed a perception that collaboration with other institutions can be improved. Project V1 seemed to be run mostly in-house, where the body of interim report has good information in it, but a lot of key findings/areas of concerns did not make it up into the executive summary. This report was updated recently, but reviewer comments suggested changes be made (especially to the executive summary) have not been addressed yet. Even on projects where part of the work is co-funded from outside sources, more collaboration on research goals, changes to test plan when goals shift, and even on sharing of raw data in a timely manner is needed for close coordination with partners.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers, in general, found the program to be heading in the right direction relative to future planning. There are several areas with "shovel ready" programs that are in need of funding which could potentially benefit from the increased interest in increasing ethanol consumption to meet national standards. This is an important ongoing process that could have immediate effects. EPA and others are relying on this information and data decisions on ethanol content in fuel. I believe that this project is still in the R&D phase rather than developing plans for implementing ethanol enhanced fuels. This is the proper place for this project to be at this time.

There were some questions raised. One reviewer did express the desire for a summary of data analyses from proposed programs. Cellulose to ethanol production is lagging way behind the targets established for ethanol production. Will the need for mid-level ethanol blends really become a reality? It is unclear if the NSF and DOE-BES shift to an emphasis on cellulose to hydrocarbons will impact the future need for this work. One reviewer cited the completion of unfinished work by 2010 and the uncertainty of availability of combined dataset. And another noted the flexibility to respond to policy and industry needs must continue in support of advanced use of nonpetroleum based fuels. The future investigations are supported by concerns voiced by government and industry. It was hoped that EPA's decision on E10+ lets us complete this work to make an informed decision.

Finally, one reviewer stated that plans build on past progress and generally are addressing barriers to overcome. In some areas, like task V4 for instance, focus on just E15 fuels to address EPA's need for data on the E15 waiver request ignores the fact that a partial waiver only moves the ethanol wall a year or two into the future. To adequately address this barrier, data needs to be collected on a larger portion of the existing fleet (i.e. older vehicles) and data needs to be collected with E20 fuels. Because of changing fuel properties as new batches of gasoline are made, adding an E20 vehicle later on Task 4 really means adding two vehicles, since you need a base case (E0) vehicle to compare to. This doubles the cost of running an E20 vehicle later versus keeping it in the test program now. Also, repeating models later in the program will make it difficult to compare data back to the E15 test fuels if the fuel properties change significantly.

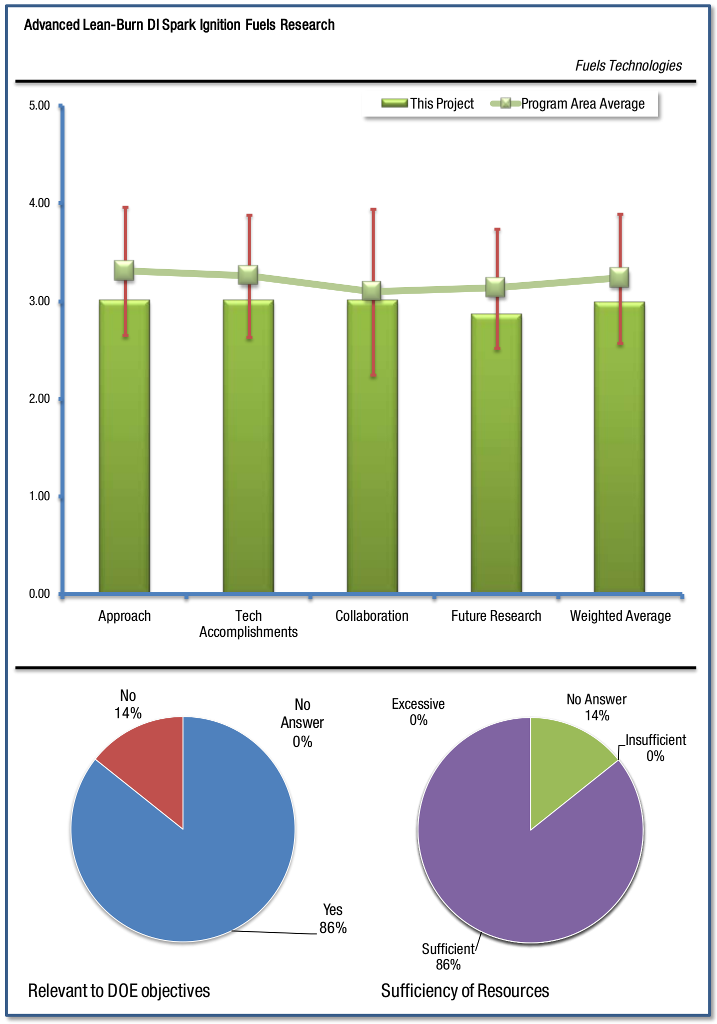
Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers held strong views on how sufficient and how well utilized are the resources for this program. One reviewer felt this test program is perhaps one of the most comprehensive test programs for the effect of a fuel on vehicle and engine performance. Notable areas that need more funding/focus are: the health effects study and the OBD study. Now that funding from ARRA and FY2009 are fixed, perhaps DOE should explore financially backing this area. The reviewer concluded that increased resources would help other areas of this evaluation. Another reviewer felt that as long as ethanol remains the primary route to meeting renewable fuels targets, this program needs to be funded. A further reason is because E20 is the best route to increased ethanol use. It is unclear if the NSF and DOE-BES shift to an emphasis on cellulose to hydrocarbons will impact the future need for this work. Other reviewers cited the fact that this project has become a major data source for government decisions regarding the ethanol content in gasoline, and that for timely completion, these programs need enormous resources.

One reviewer stated flatly that this project is grossly underfunded. This is significant, because there are areas that we don't even know what we don't know yet. Although not highlighted in the presentation, there are critical tasks that have not even started due to lack of funding. For instance, is there any engine durability testing? Won't that be needed, no matter if any future waiver is for E15 or E20? As some of the tasks stand now, the focus has shifted to collecting data just on an E15 waiver; but doing this and not collecting critical data on E20 will increase the overall program cost if have to add back in later. Any rush to get partial data out as quickly as possible may significantly degrade the quality of data collected. Principal Investigators should have sufficient project management control to say when good science and sound statistical analysis is taking a backseat to funding and/or time constraints.

Finally, another noted, the time line for these projects appears fixed and not dynamic nor responsive to the research results. With that said, projects of this magnitude and scope should proceed in a purposeful direction and that does appear to be the approach by DOE. Additional resources should be allocated to this project in support of the research findings.

Advanced Lean-Burn DI Spark Ignition Fuels Research: Magnus Sjoberg (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers had mixed opinions about the direct injection spark ignition research in the program. Reviewers acknowledged that lean-burn, highly-boosted SI engines can provide a significant increase in thermal efficiency/fuel economy and thereby displace petroleum through reduced demand. They further noted that coupling that advanced engine with alternative fuels (ethanol) provides additional potential to displace petroleum. They expressed interest in seeing what information is generated from this lab as this project moves forward. The comment was made that some objectives appear to be of academic interest.

In a related comment, one reviewer noted that due to the demand increase for HD diesel as economy expands and increased ethanol supply, improvement in gasoline/ethanol blend efficiency should have higher priority than LD diesel research.

One reviewer did not find the DISI effort to be sufficiently long term, stating this is not an activity for a national lab, but rather competitive research for industry. Project funding should be diverted to longer range R&D, not R&D for the OEM's. The reviewer emphasized the sentiment is not biased against the researcher or Sandia, but that this project is not long term R&D.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Most reviewers found the work to be a good blend of experimental tests and modeling, and a useful effort that could result in fuel efficiency gains. One noted that by looking at ethanol/gasoline blends, the project retains practical relevance. Suggestions were made that other fuels options would make sense, such as butanol, which is a competing option to ethanol with significant benefits relative to ethanol. Also, building a boosted DISI engine lab capability and doing boosted HCCI work on ethanol blends would be helpful. When the advanced DISI optical engine is available, the impact of operating parameters on robustness, performance and efficiency could be considered. There is also opportunity for companion work in combustion simulation.

One reviewer felt it was a good idea to use both an optical version and metal version of the same engine platform. Another agreed that it was a very good design. The lab will be valuable in collecting information on technology and its impact on fuel efficiency using various fuels. Reviewers noted that the existing lab and engine is used as a basis for improvement, that the lab collaborated with General Motors, and that optical diagnostics could be applied and kinetic modeling could be conducted.

Finally, one reviewer found it unclear from the presentation what main barriers are. And another strongly felt that work studying conventional gasoline and ethanol in SIDI engines is not a subject for taxpayer dollars, but rather should be done by OEM's in-house using their funds.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

All reviewers noted good progress was made in developing the lab, including specific comments applauding the design considerations made in the operation of the optical engine, innovative work to ensure balancing of the engine (which is a concern for single-cylinder engine systems), and the completion of the ethanol-gasoline boosted HCCI study.

One reviewer noted the purpose of this project is to provide the science-base needed by industry to understand how future fuels will impact the performance and robustness of new light-duty engines that employ advanced combustion strategies such as highly boosted direct-injection stratified-charge spark-ignition (SI) combustion. A few reviewers noted the project is on schedule, has made good progress in developing engine tools, but it is still early in its development to fully evaluate performance. One added that understanding ethanol performance in advanced combustion is high priority.

Finally, one reviewer acknowledged that the lab’s set-up is good but disagrees with the project premise.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found this program had marked collaboration with industry and the national labs, and some with academia. Reviewers cited the engine simulation activities with GM and the Advanced Combustion MOU, work with LLNL and indirect involvement with the University of Galway. Also noted was interaction with the AEC. One reviewer commented that the new engine should be a good resource to support other DOE fuel and advanced combustion engine projects.

One reviewer acknowledged collaboration with this effort, but stressed that this is really competitive research that should be funded by industry and not performed at one of our premier national labs.

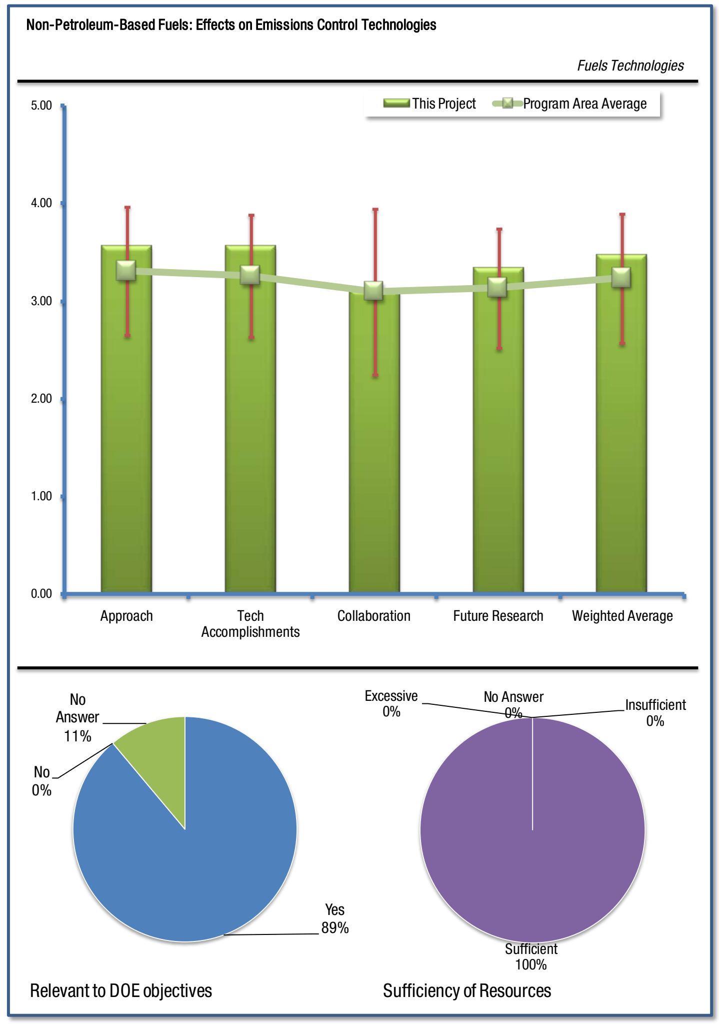
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers noted the future work is relatively well planned although the effort is in its early stages–most of the experimental work is yet to be completed since the facility had to be developed first. A reviewer commented the project should be performing boosted DISI work by 2010. They suggested including butanol in the test matrix since it may compete effectively with ethanol, and that it should continue the evaluation of gasoline and ethanol. A comment was made that key barriers are unclear. And, finally, one reviewer emphasized that no further work should be done by Sandia on this project.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer noted that a highly capable and innovative facility like this requires significant investment. But, previous facilities at Sandia have provided enormous benefits relative to the investment in their development. Another reviewer was unsure of the funds, while a third objected to funding the project altogether, suggesting that it should be ended.

Non-Petroleum-Based Fuels: Effects on Emissions Control Technologies: Scott Sluder (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 9 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Most of the reviewers found this program does support DOE goals. Reviewers noted that application of emissions controls to engines burning alternative fuels is an appropriate role for DOE, whereas EPA's focus should be on existing commercial fuels. DOE's objective of displacing petroleum is closely related to promoting advancements in engine hardware, emissions control systems and fuels technologies. This is a fundamental study of the combustion particles from diesel vs. biodiesel and significant mechanical and chemical differences between the two. It was noted by more than one reviewer that biofuels, while addressing sustainability and energy security—lessening the dependence on petroleum—may have adverse (and/or beneficial) impacts on exhaust aftertreatment. If biodiesel is producing more soot than ULSD it is important to understand why and how to minimize it. Another reviewer noted that fuel property effects on combustion, engine and emission control systems are important. So are an improved understanding of EGR cooler fouling processes and an increase in engine efficiency. All of these effects must be understood to maintain vehicle system durability and to promote clean diesel technology.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

All responding reviewers found the approach worthwhile. They noted the real world application of research such as this is the most valuable approach—they found it very well-planned, a fundamental knowledge program with detailed program goals and deliverables. It was found that the program has a very good approach of linking engine test results to lab kinetics tests and analytical characterization techniques.

Reviewers added that examining fuels effects in engine and aftertreatment systems with various diagnostic techniques and high level materials characterization strategies is needed. And the project identified the issue well and also identified the problem associated with EGR cooling—thus this is a good approach with good focus.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers were favorably impressed with the progress and technical accomplishments. They found the program is addressing some interesting issues, with impressive progress made about understanding EGR cooler fouling. The program further elucidates effects of soot characteristics (including condensable hydrocarbons) on soot oxidative reactivity. One found it explored and explained differences in the organic fraction of particulate matter, answering an old but important question about VOF vs. SOF. Considering EGR cooler fouling and examining impacts of biodiesel, one reviewer observed that B20 did not worsen EGR cooler fouling, but provided significant insight into deposit formation rates and PM oxidation kinetics.

Another reviewer noted very good progress was seen to date in following areas: understanding soot formation from various biodiesel blends and reasons for similarities and differences with conventional ULSD; analyzing composition of soot and linking composition to performance issues such as EGR cooler fouling & valve sticking; and determining how the biodiesel PM oxidizes differently than ULSD PM. One reviewer also noted the chemical analysis of the combustion products is providing some insight to the effectiveness of exhaust after treatment technology.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Most reviewers found collaboration among other institutions. While the program is addressing topics of interest to industry, and commercial applications, one reviewer did not find deep involvement from stakeholders to be apparent, and another noted that the quality of data interpretation would improve if a lubricant additive manufacturer were included. Most reviewers, however, did sense collaboration, citing CLEERS, several auto makers and engine manufacturers (GM, Ford, & Cummins) and universities (University of Wisconsin & Penn State). One reviewer said that expanding external collaborations with other institutions, such as the collaboration with Vander Wal, is an excellent idea to bring more techniques to bear on the soot characterization research.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

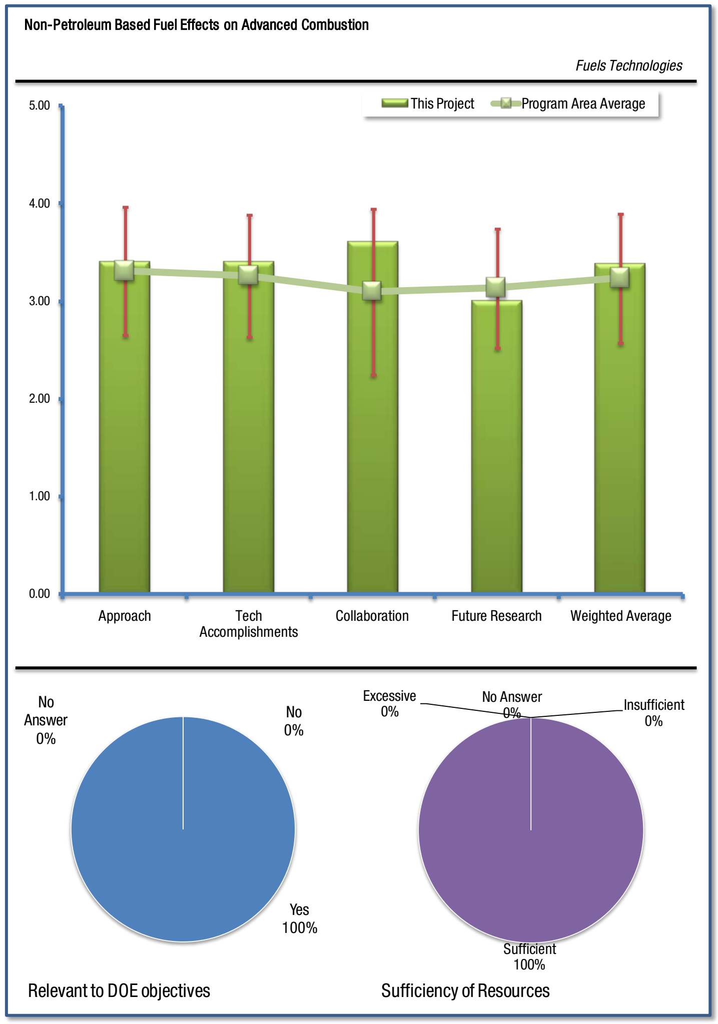
Reviewers found there were a few aspects of the future work that could be augmented. It was suggested that the program foster deeper involvement of potential commercial users in design and participation of future programs. It was also suggested that detailed chemistry of deposits formation should be examined. It was also noted that the program is yielding significant insights and the program plan continues in these paths, with an added collaboration with NREL on the soot characterization.

One reviewer observed that the future plans build on recent progress, with a focus on continuing to address fundamental causes of issues in real engines (such as EGR cooling fouling and DPF monolith failure) and possible solutions and comparing performance of biodiesel to conventional diesel. And finally, it was noted that soot oxidation kinetics, analytical development, degradation of a DPF monolith cause are planned for future research–and that plans for future are consistent with alternative fuel developments.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found that that the budget appears to be sufficient for work underway, but that the significant importance of these problems would merit further support.

Non-Petroleum Based Fuel Effects on Advanced Combustion: Jim Szybist (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers had some reservations about the program, though one did note that advanced fuels and advanced combustion systems are appropriate for DOE work. The concerns centered on the relatively few barriers to use of biodiesel and tar sands in advanced combustion. Another reviewer cited a lack of adequate data and predictive tools available to assess fuel property effects on advanced combustion, emissions and engine optimization, though another reviewer did note that biodiesel fuel is available and needs to be optimized.

Question 2: What is your assessment of the approach to performing the work?

To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found the program was very detailed and produced extremely high quality work, focusing experimental and data analysis and chemical kinetics. Fuel effects experiments were well designed. That said, a reviewer did mention it was not clear whether there are any significant barriers to use of biodiesel/tar sands in advanced combustion.

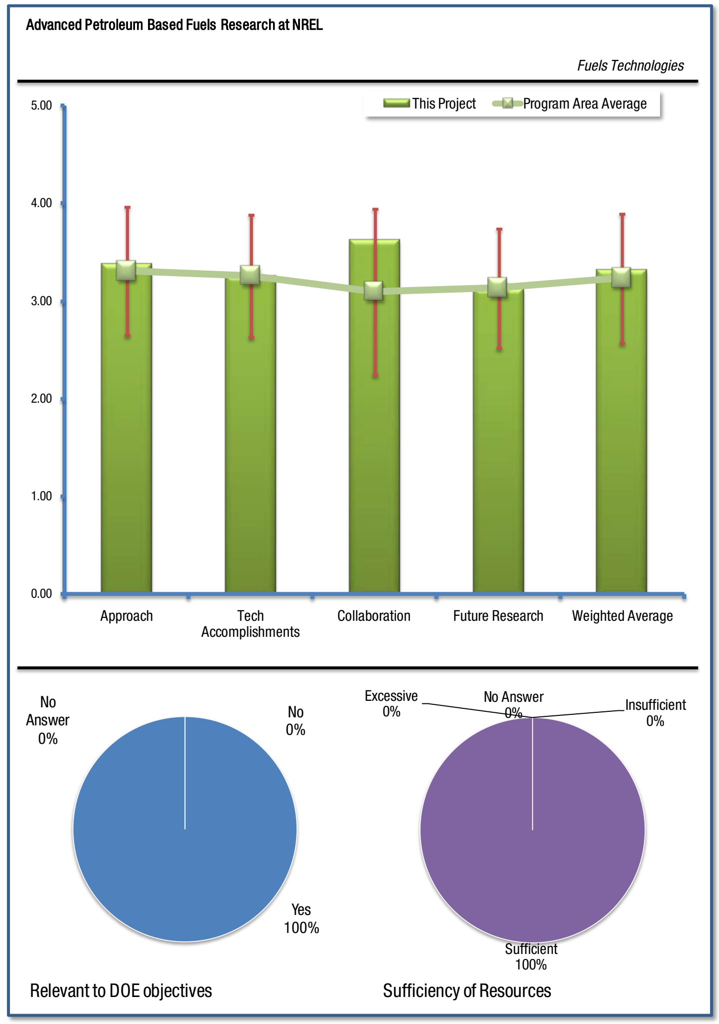
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers who commented found detailed results were reported on fuel effects and that good progress has been made.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Four reviewers commented on collaboration, noting there was very good research collaboration with the stakeholders via the Model Fuels Consortium, through engine/fuel groups, and others.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Reviewers found some shortcomings in the plans for future work. While a number of fuels related research efforts are planned, one reviewer found the multi-cylinder HECC engine plans for 2009 need strengthening. Another recommend additional focus on gasoline/ethanol and it was suggested work on oil dilution with biodiesel.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Two reviewers commented on allotted resources, one finding funding adequate, the other expressing they were not sure.

Advanced Petroleum Based Fuels Research at NREL: Brad Zigler (National Renewable Energy Laboratory (NREL))



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

All reviewers found the program supportive of DOE goals. The work on advanced fuels and advanced combustion in advanced engines are all needed to promote cleaner and more efficient combustion, thus displacing petroleum. Reviewers agreed that fuel effects on advanced combustion and long term impact of lubricants and emission control systems need to be characterized to understand how to enable advanced combustion.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found good use of new instrumentation to get at data to overcome barriers in this project, with a variety of activities underway. One reviewer notes that considering fuel properties, via programs like FACE, and impacts on lubricants permits consideration of how to change fuel to enable advanced combustion. This involves application of IQT and a new single cylinder test engine. The work supports the broader FACE program through the CRC, in turn supporting improved tools and models for engine development. And, it bridges fundamental combustion experiments to engine combustion.

Another reviewer found it was a good approach in trying to correlate fundamental fuel ignition/combustion parameters to performance in IQT instrument and other engines. There is a need to quantify fuel effects and lubricant effects. There is a concern about use of IQT to evaluate NOx emissions since not clear that IQT is relevant to engine conditions.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers found a good linkage of the effort to DOE’s goals with NREL's Biomass Program through testing butanol and various ethanol blends. One reviewer felt there is a need to have improved focus on deliverables and their applications and how these are coordinating among the various activities.

Another found the published work on the FACE program through CRC, working on a single cylinder engine facility and adding MS capability to the IQT instrument to be positive. The IQT work is a key part of the APBF and FACE activities at NREL and other labs. The engine is installed but a new dynamometer instrumentation is in progress. The team members are also developing the advanced techniques for speciated exhaust emissions that were needed, as was having preliminary results from the CLOSE project on lubricant and fuel derived emissions impacts.

One reviewer found that the program is making good progress. The reviewer cited the ignition parameters of the CRC FACE diesel fuels that have been characterized in the IQT instrument. This should be useful information for combustion researchers using the FACE diesel fuels. The reviewer also noted: that the work to set up a single cylinder engine has been initiated; that in CLOSE program, testing has been completed on the light duty vehicles; and that advancements have been made in quantitatively speciating unregulated exhaust emissions.

And another reviewer noted the optimization of fuel chemistry for advanced combustion engines, the enhancing of IQT research capability, the characterization of pure compounds and the development of fuels for FACE. With all the new construction and starts of new projects, it was difficult to understand if the rate of progress is modest or significant.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found good, multi-stakeholder collaborations. They cited partnerships with University of Michigan, WVU, LLNL, ORNL, UC Berkeley, Colorado School of Mines, SwRI and many other entities through the CRC. Reviewers commented that a good choice was made to use the 1.9L Opel engine in order to correlate data with other projects, and commended the focus on IQT work to support other projects.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

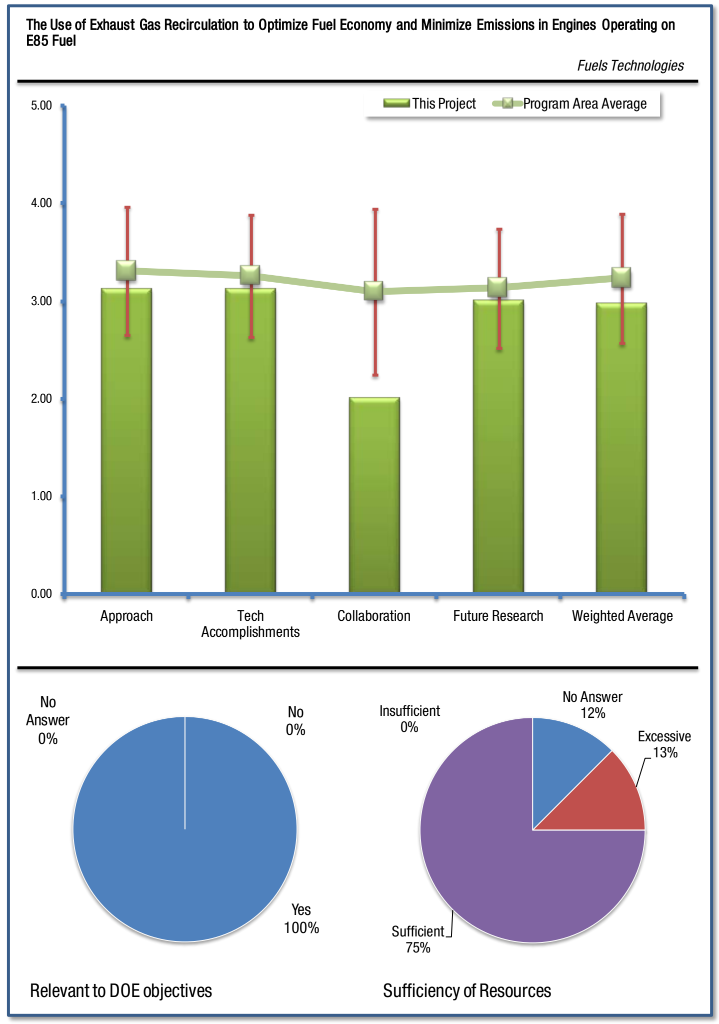
Reviewers held mixed opinions on the plans for future work. Most found the plans linked well with past accomplishments, though some suggestions were raised. One reviewer noted a need to build a stronger future plan showing the benefits of each activity. A reviewer did note that both fuels impacts advanced fuel and lubricant impacts are being studied.

A reviewer noted the GM engine will permit DISI work on FACE gasolines and addition of the MS capability for IQT will permit enhanced understanding of reaction kinetics. It will continue work on fuel impacts on advanced combustion and will expand CLOSE to include lubricant development for advanced combustion engines. It is not clear why this latest engine is being added to the NREL facilities, since such engine test capabilities have typically been located at ORNL. Another reviewer noted that supporting increased emphasis on gasoline would de-emphasize diesel emissions control as these systems are becoming commercial.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Three reviewers commented on the funds for the program, one noting that there is a large budget across many activities, and another that there is ample research funds provided in the project. The third was not sure.

The Use of Exhaust Gas Recirculation to Optimize Fuel Economy and Minimize Emissions in Engines Operating on E85 Fuel: Ko-Jen Wu (General Motors Corporation)



Reviewer Sample Size

This project had a total of 8 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers were clear that this program attempts to increase fuel efficiency, which itself advances DOE goals. Since energy content for E85 is lower, increasing fuel efficiency for FFVs would lead to more appeal for E85. One reviewer found this an excellent application project for DOE to improve fuel efficiency of alternative fuel and vehicle system.

Consideration of ethanol combustion in advanced combustion (high boost and EGR) operation supports improved efficiency, clean combustion using renewable fuel and thereby addresses key DOE objectives of displacing petroleum through efficiency improvements and use of domestic renewable fuels.

Another reviewer noted this program supports the goals clearly outlined by the Energy Independence and Security Act of 2007. This project focuses on the advanced use of alternative fuels, namely E85, as well as includes improvements to both current and future engine engineering and design for flex fuel vehicles. Lastly, a reviewer felt the project is relevant but not as important as optimizing fuel economy for lower level blends since volumes of E-85 are smaller.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers were impressed with the approach taken in this program, noting, for example, the outstanding approach of leveraging technical know-how from industry. Optimizing for E85 operation in a flex fuel vehicle was lauded. Reviewers were impressed that experiments were preceded by engine simulation to define engine design parameters. Also impressive was the shift of the scope of the project to a smaller vehicle platform in response to market trends.

One reviewer expressed some skepticism, expecting that GM would be farther along on this project. Another felt the barriers and opportunities for optimizing E85 were not clear from the presentation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer commented that it is difficult to measure achievement without dynamometer data. However, another noted outstanding improvements in alternative fuel-vehicle performance. It was observed that the project timeline is 50% complete but project objectives are only 34% complete, and that some aspects of the project scope were changed. And there was identified a 4 cylinder crossover SUV vehicle platform for the demonstration of the results, this in the midst of an "applied research and exploratory development" phase. One reviewer added that if the goal of the project is to study technology for optimizing E-85 then GM is doing that. Work to optimize the current engine parameters and improving existing engine design is more easily incorporated and has a shorter payback period. Research and improvement of emission control equipment or fuel delivery affecting emission control equipment supports compliance with stricter environmental goals. Today's flex fuel engine design and settings "tolerate" ethanol blended fuels and more work needs to be done to optimize the engines to run efficiently on gasoline/ ethanol fuel blends, primarily where ethanol is the primary component in the fuel. Flex fuel vehicles are expected to increase in availability over the next few years and understanding the needs in engine/ fuel system design and controls in order to maximize vehicle performance and efficiency. Since there is only simulation results thus far, progress assessment is more difficult. And it was noted that this is a fast track project, with the goal of commercialization.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers did not find much collaboration on this project–it is largely GM specific. One reviewer noted that aside from providing money, DOE did not seem to have much of a role in this project's development. At least, the presentation did not mention DOE's contribution. The program involves built in integration of the technology.

Another reviewer agreed, noting the project is GM specific comprising largely internal product development. It is unclear that any partners, particularly National Labs or Universities, are involved. Technology transfer appears to be focused toward future GM flex fuel products.

Another reviewer felt this question was not applicable, noting it is a GM-only project. This reviewer recommended that Mr. Wu plan to publish an SAE paper when the project is complete.

The industry partnership developed and utilized here should be the example of the DOE programs. Partnering with the largest flex fuel vehicle manufacturer to improve design in support of legislative goals is fantastic. The most important aspect of this program is that the findings of the research are being considered for incorporation into vehicle designs. Commercialization of the research provides tangible payback for the project.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

The reviewers all found this project's future plan to be well established, with progress nearing completion. There was excellent move to in-house development of the final deliverable. The program will move to vehicle and controls integration in 2009 and begin vehicle testing.

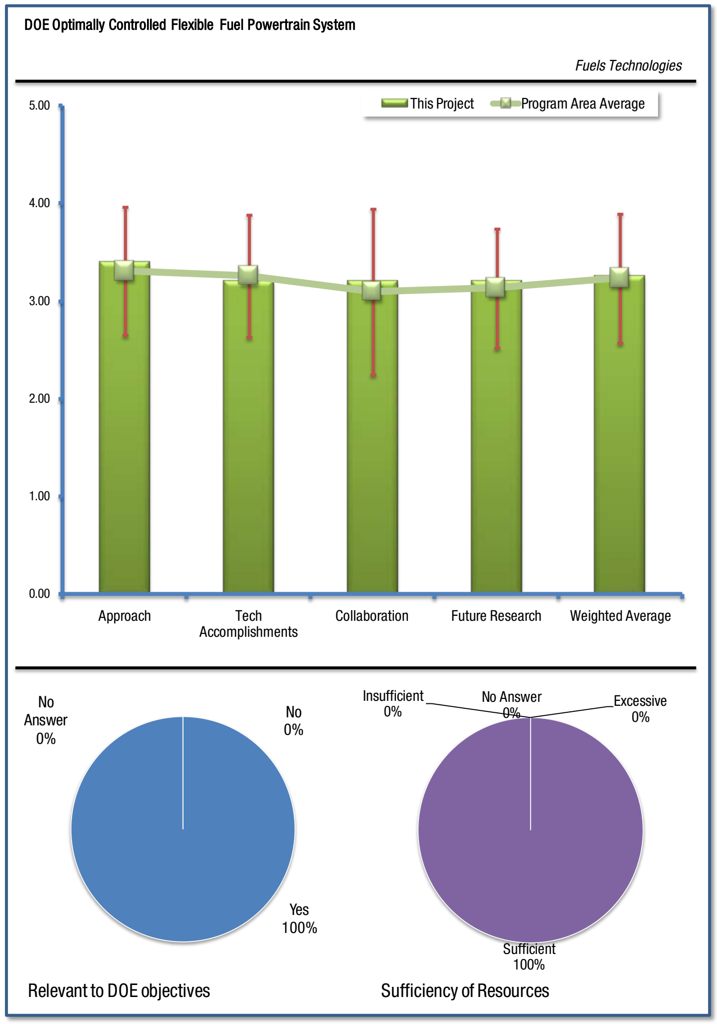
One reviewer felt this was DOE-subsidized product development. They noted optimization of FFV is an important goal. It was speculated that if FFV were fully accepted and fuel was readily available, GM and other engine manufacturers would be optimizing these engines on a very fast schedule. It appears that this project is nearing completion and final steps of the research program will be completed. Another reviewer looks forward to the future project updates and eventual SAE paper when dyno test data become available.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Most reviewers found the project well supported. One noted there is excellent leveraging with industry. While this engine and vehicle development activity is a company-specific product development, it is responsive to national needs. Further support should be predicated on the commitment by GM to deploying this product in the marketplace.

A reviewer agreed, noting GM Powertrain has the resources to improve efficiency on its products that use E-85. It is an interesting project and if FFV and E85 become more prevalent this data will be useful. It will be interesting to see if significant FFV improvements drive the market. None of the reviewers foresee additional large scale financial obligation for this project.

DOE Optimally Controlled Flexible Fuel Powertrain System: Paul Kilmurray (Mahle)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found this program beneficial toward achieving DOE goals. One noted that if successful, this project would help decrease the loss of fuel efficiency in FFV's while using ethanol-gasoline blends up to E85. Spending more effort to design engines to run on E85 will hopefully lead to greater FFV production and E85 utilization in those FFVs. Another supported expanding the use of alternative fuels, and suggested optimization of FFV's is important.

Another reviewer said the project aims to optimize E85 engine development to enhance public acceptance and use of E85, which will displace gasoline and fulfill a major DOE objective. Improving fuel economy of lower level blends is more relevant, said another. Many system components could also be applied to low-level gasoline/ethanol blends.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found the approach taken in this project to be very positive. They noted this appears to be a very realistic, intuitive approach to improving FFV fuel economy. The economic/social analyses are relevant and a nice addition to this project. Another noted there is an excellent detailed program plan to meet performance objectives.

One observed that engine simulation was used to define engine design and operating parameters, with the optical engine being developed for validation of diesel to permit transition to a product. Technologies include low pressure DI, turbocharging, increased compression ratio, variable valve timing and EGR in closed loop control.

Reviewers felt the technical barriers have been addressed. Development of a flexible fuel powertrain is the basis, and the project milestones and deliverables are clear, using a variety of tools.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers noted several technical achievements. One noted the simulation data seems very promising, and that it will be interesting to see how increasing the compression ratio will yield further efficiency benefits, or if these savings can be maintained after development. Engine modeling completed with contour plot documentation and vehicle simulation modeling with Advisor were highlighted.

One reviewer summarized the project, noting it is considering a high compression ratio variant of a current gasoline engine. Engine simulations were completed, showed that the E85 fuel economy has a penalty from 30% to 9%, but that the 0-60 mph acceleration time was reduced by 20% by increased engine torque. Also simulated the GHG emissions using GREET and showed a 33% reduction via E85 operation. Mich State University is developing a companion optical engine. Baseline engine operation at Argonne was completed on a GM engine for comparison. Finally, detection of ethanol and combustion phasing through ionization detection is a nice accomplishment.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found a well coordinated program, with good cooperative relationship with Michigan State University, Visteon and Argonne.

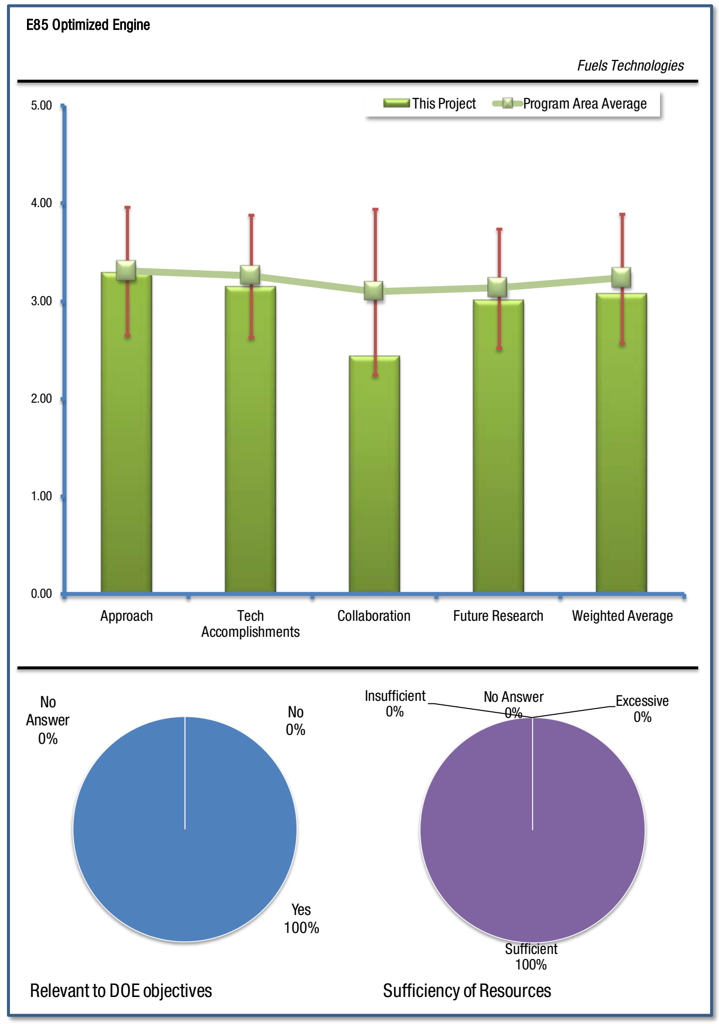
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers identified a few aspects where the project has defined well its future work and some where it fell short. One reviewer would like to see a clearer plan to bring this to commercialization, but another found an excellent research plan for future work–specifically a plan to evaluate optical and metal single cylinder engines, and move to assembly and testing of the prototype engine. Another aspect is to finalize injector design and evaluate performance of single cylinder engine with E85 blends and gasoline.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

While one reviewer was unsure, two of three with a response found funding sufficient in the program.

E85 Optimized Engine: Apoorv Agarwal (Ford Motor Company)



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers feel this program supports DOE's goals for displacing petroleum demand. Optimizing E85 operation will provide significant petroleum displacement potential by reducing petroleum demand and permitting efficient use of bio-ethanol. However, it is unclear with the strategy of this project just how much E85 would be consumed. The net ethanol use may be much lower over the duty cycle of the vehicle.

This project supports the goals clearly outlined by the Energy Independence and Security Act of 2007. This project focuses on the advanced use of alternative fuels as well as includes improvements to both current and future engine engineering and design for flex fuel vehicles, namely light-duty trucks.

One reviewer did question whether this research should be funded by DOE or if it is competitive technology that should be done by OEMs. Project would use E85 as a local octane boost to an SI engine running on gasoline.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers mostly found the approach sound and beneficial. One reviewer noted the goal is to obtain diesel-like cylinder pressures and, using an on-demand dual fuel injection approach, to leverage the characteristics of gasoline and E85. Injection of E85 is timed to prevent knock depending upon engine operating conditions.

Another reviewer found the project well defined, even that the industry partnerships developed and utilized here should serve as the example for the DOE programs. The incorporation of new analytical tools, such as the spray pattern mapping, is very interesting and believed to assist in the determination of improved design.

Reviewers also observed that these can be more difficult optimization problems compared to other E85 projects. It is a good approach to addressing these issues by using variety of tools. Finally, one reviewer did find the approach okay, but wanted to know if visual modeling would benefit the understanding of the technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers noted a number of technical accomplishments. One mentioned the project has defined the engine system and performed simulations of engine operation and optical and single-cylinder investigations of fuel spray behavior. It has also designed a multi-cylinder engine and procured components for the engine build. The reviewer noted that, due to delays, there was a two month no-cost extension to permit time to complete project objectives–predominantly

Phase 1 is on schedule. And there has been better progress in transitioning to engine-testing compared to competing projects.

Another reviewer noted the incorporation of new analytical tools, such as the spray pattern mapping, is very interesting and believed to assist in the determination of improved design. A greater understanding of engine performance on E85 fuels is needed and this research supports that goal. To another reviewer, it was unclear if the findings of this program could easily be incorporated into the existing Ford engine design. Dual fuel tank systems have been used in Brazil however it's unknown if acceptance would be granted here in the US.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers noted there was good collaboration with other partners, if somewhat limited in national lab or university involvement. And one thought it sounded like competitive research for one company's benefit. Reviewers commented that AVL Powertrain and Ford are partners.

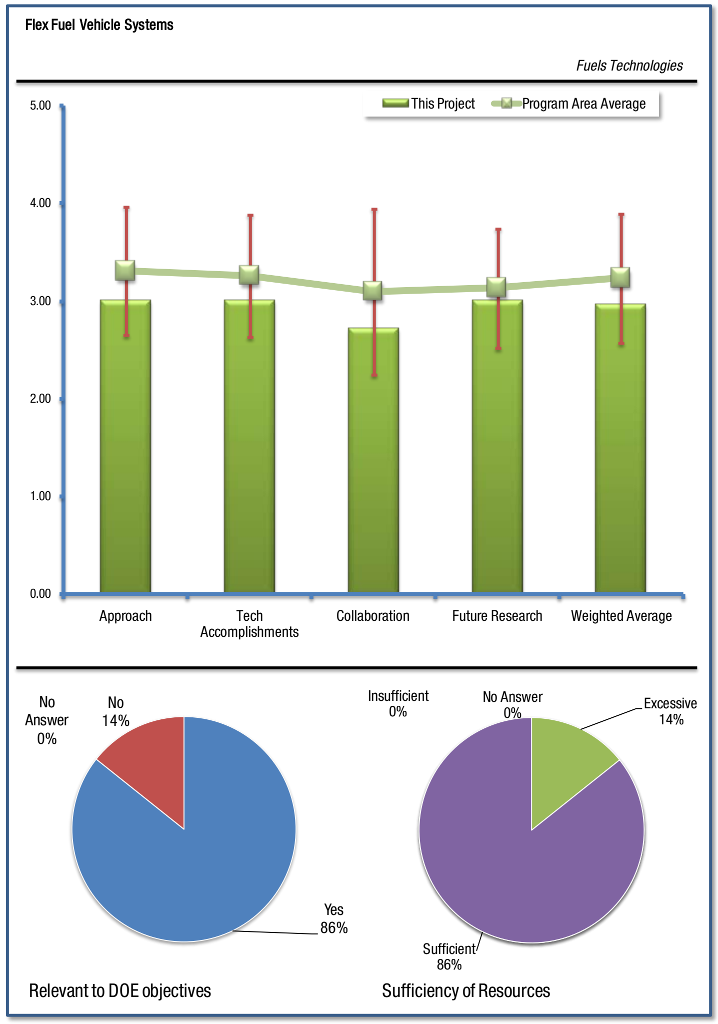
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found the project to be nearing completion, with final steps of the research program certain to be completed. The plan to evaluate engine performance and efficiency using the dual fuel strategy and to evaluate cold start emissions and map a practical engine while considering vehicle level attributes for an optimized engine design should be completed. Reviewers thus found future plans well in line.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found funds to be sufficient to meet project objectives. One noted they did not see further financial commitment needed as the project's scope is being realized, with targeted completion dates being met, and no problems with resources.

Flex Fuel Vehicle Systems: Hakan Yilmaz (Bosch)



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
All reviewers found the project effort to increase the efficiency and attractiveness of E85, while achieving ULEV emissions, to address the DOE objective of petroleum displacement. Wider use of E-85 will reduce amount of petroleum derived gasoline. A reviewer commented that this is conventional research into improving the operation of a FFV. The DOE should not be in the business of doing vehicle research for the OEMs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found the approach to be modest and feasible, with clear, excellent goals for achieving fuel efficiency of an E85 vehicle while targeting SULEV emissions. The approach does a good job of specifying targeted fuel economy improvements. One commented that the improvement in ethanol sensing is good, but needs better accuracy. The engine controls are also attractive with production-like ECU. One reviewer found the approach, with testing in real vehicle platforms, to be good.

A reviewer observed the use of engine controls and injection strategy for E85 in a DISI approach to obtain improved engine efficiency during E85 operation. Tasks include engine optimization using low level adjustments to a base engine, development of a DI fueling strategy to improve emissions, ethanol detection to guide the operation of the engine and model based controls development. The reviewer the approach particularly innovative or ambitious since the efficiency improvement is modest and the strategy is rather conventional. And another felt this project should be stopped and funds diverted to longer term R&D. As the project exists today, this is taxpayer money going toward OEM R&D that should be done by the OEM's, not DOE.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers expressed their understanding of the technical accomplishments. The ethanol measurement method is impressive. Design accomplishments are impressive. One is looking forward to hardware performance results. Another noted the completion of the piston design for increased compression ratio, engine hardware designs for high peak pressure and ethanol operation, and the abd cam design for late intake valve closure.

Reviewers felt there was good progress, especially on developing control strategies and sensors, and in moving to engine tests. However, one reviewer felt accomplishments on a project that should be stopped are not meaningful.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers observed there was collaboration with Ricardo, University of Michigan, and Bosch. It was suggested that collaboration be made with an outside organization to confirm performance. A criticism was raised that this project benefits OEMs on current vehicles.

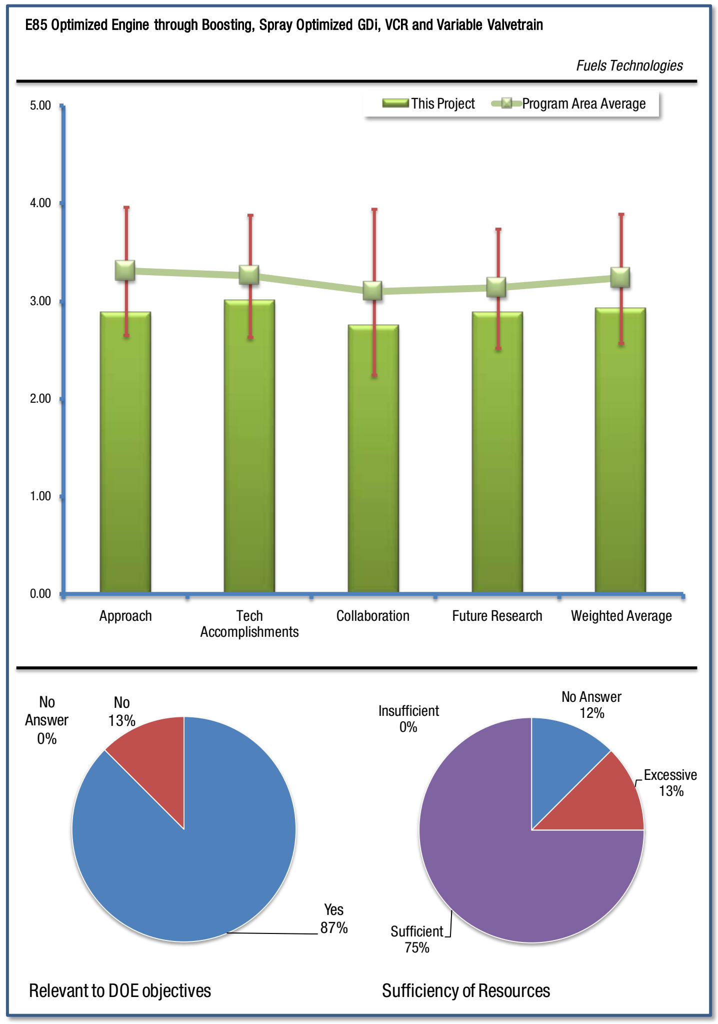
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found that attempting to meet SULEV targets will further increase the attractiveness of this approach, and make FFVs more attractive; however, the project was criticized as being beneficial to current product. Some reviewers found that with the designs in place, the next steps seem reasonable, building on recent progress. Another found, however, that there should be no future work on this project funded by DOE.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found the project was either adequately funded or over funded. Some found there was no indication that resources are not appropriate. Yet others found funds to be more than ample, perhaps a bit high, for a project with such modest objectives. Another agreed, noting no resources funded by DOE should be used for this project.

E85 Optimized Engine through Boosting, Spray Optimized GDi, VCR and Variable Valvetrain: Keith Confer (Delphi)



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers found the prospect of increasing fuel efficiency for FFVs and thus the attractiveness of E85 to be consistent with the DOE objective of displacing petroleum. Overall goals, said one reviewer, are closely related to promoting advancement in engine hardware, emissions control systems and fuels technologies. Another noted that wider use of E-85 will ultimately decrease quantity of petroleum derived gasoline, assuming wider availability of E-85 vehicles and fuels. Another found this to be his favorite presentation from a company-sponsored study.

Another reviewer questioned DOE's funding of this project–it is the third of three projects on E85 in the Fuels Technologies group. This project is research and development on conventional FFVs to improve mileage and utilization of E85 fuel–a noble goal for the OEM's but not for DOE to do competitive R&D for the OEM's. This project has no relevance for DOE, but maybe one of the OEM's with their funding.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers had mixed responses to this project. The project was found to be feasible and it attempts to better utilize the properties of E85 fuel. It was also found to be a well-planned program with detailed program goals and deliverables.

One reviewer found seeking variation of compression ratio combined with DISI in a variable valve train to be an ambitious controls and hardware challenge, with a high potential payoff. The project will use variable valve train to prevent knock on gasoline operation by decreasing effective compression ratio. It does not include high peak cylinder pressure, they noted, which could have provided more power density had it been considered.

While several said it is a good approach, with a good mix of modeling and hardware development testing, one found this project to have the wrong approach for short-term improvement of FFV's mileage using E85, and that OEMs should do this work not tax-payer funded DOE.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers were mixed on the approach taken in this project. Some found it to be making progress where others found it lacking. One noted that progress seems to be going well with the construction of the E85 optimized valve train, ignition, pistons, and injectors, plus preparing for dynamometer testing. But another felt a better focus is needed,

noting researchers need not to try to handle too many variables; they should focus on few and provide depth in technical conclusions.

One reviewer found the project demonstrated optimized injector spray, prepared a single cylinder test engine and performed engine and injector simulations. It also developed high pressure and temperature test chambers for injector verification. The modeling analysis suggested a 12-15% overall improvement in fuel economy. Planned engine tests will help to verify these analyses. Lastly, one reviewer felt the project should not be continued and did not find much accomplished thus far.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Most reviewers perceived limited collaboration. The work with Wayne State University and Delphi were mentioned, along with an unnamed OEM, but the number of collaborators was small relative to other programs. A reviewer did find collaborations to be progressing well, yet another saw no collaboration and expressed disapproval, noting this is competitive research and development for the OEMs.

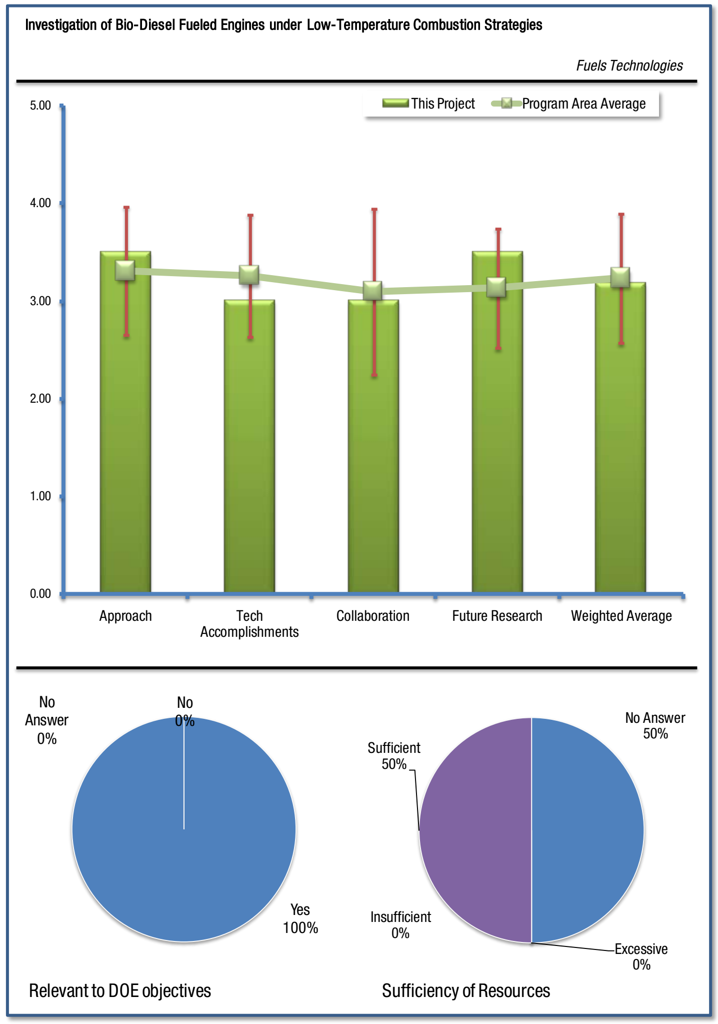
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers held mixed assessments of the future plans for this project. One reviewer expressed hope that there are good results from the project. Another noted the project plans to verify engine hardware optimization and implement the engine in a test vehicle. Another noted the planned work seems reasonable and appropriate. The planned engine testing will be critical to verifying modeling results, another noted. Finally, one reviewer felt no future work using tax payer money should be done on this project.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found funding levels either sufficient or wrongly allocated. Two reviewers noted funding level appears to be appropriate to meet the project objectives. One found assessing all fuels technologies projects difficult to evaluate. And one felt no DOE resources should be used for this work.

Investigation of Bio-Diesel Fueled Engines under Low-Temperature Combustion Strategies: Chia-Fon Lee (University of Illinois at Urbana-Champaign) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The two reviewers found that the project aims to enable and improve biodiesel combustion, which can displace petroleum directly and lower fuel demand–a primary DOE objective. It was noted this investigation is key toward understanding the effects of biodiesel and biodiesel blends on low temperature combustion.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found a combination of modeling, optical engine studies and firing engine studies in the project–an ambitious research plan. Also, it was found to be fundamental experimental work and modeling of the LTC combustion process.

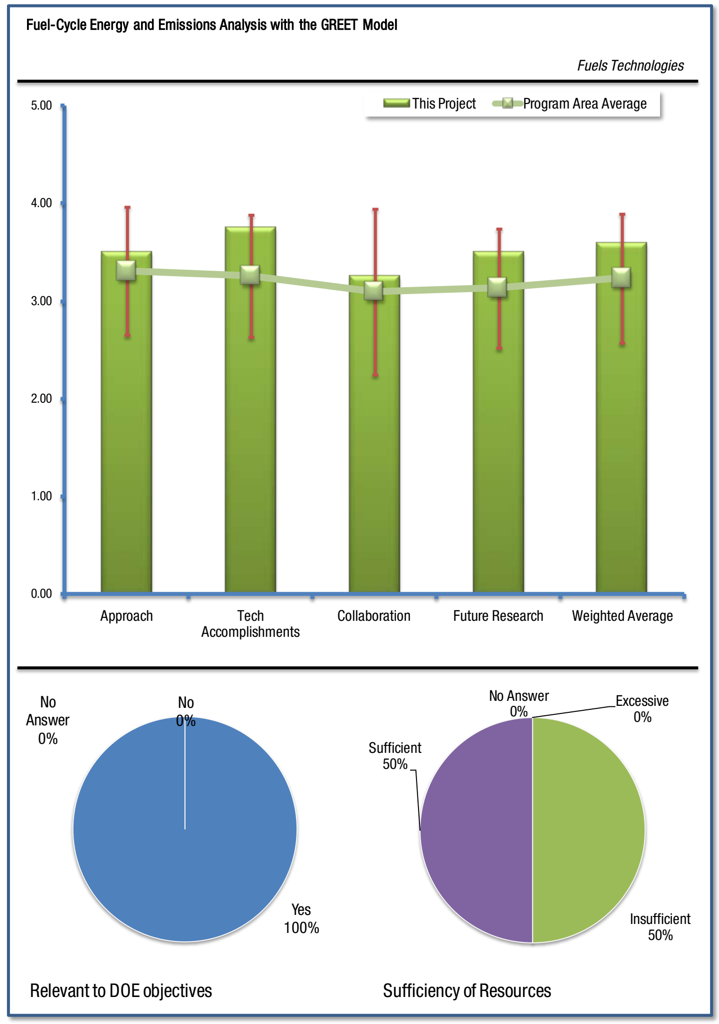
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A number of papers have been produced from this work and a variety of interesting results have been generated. Many of these measurements have previously been performed elsewhere, such as at Sandia, NREL and various universities, with regard to in-cylinder visualization on biodiesel combustion, spray luminosity and NOx emissions. They found it to be novel work, with good progress made in the injector studies and difficult combustion measurements.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
The reviewers found the project had a good mix of industrial partners in the test plan.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Reviewers found a good future work plan to further the base of understanding on biodiesel low temperature combustion.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Reviewers found ample funds for this work.

Fuel-Cycle Energy and Emissions Analysis with the GREET Model: Michael Wang (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found this project positively supportive of the DOE objective of displacing petroleum–the GREET model is an outstanding analysis tool essential for evaluation of options of interest to DOE and U.S. economy. A reviewer noted, the GREET model is an internationally recognized tool for examining vehicle and fuel impacts on emissions of pollutants and greenhouse gases and on energy efficiency. It permits making informed choices between fuel and vehicle technology paths.

A reviewer cited the Energy Independence and Security Act (EISA) of 2007 which included a directive for life cycle analysis for transportation fuels. The GREET model is the most widely accepted, peer reviewed model for determining the green house gas impact of individual fuel production processes and logistics schemes. This is the only publicly available tool for industry to evaluate their individual production process. Continued support and update of the GREET model are critical to the advancing environmental goals established by the EISA, the reviewer stated. Another agreed, noting the GREET model is the standard for LCA and emissions evaluation.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers unanimously found the project to be wholly worthwhile. The GREET model approach is time proven and internationally recognized. Reviewers noted the GREET model continues to serve to provide guidance on technology pathways that can be adopted to solve fuel supply and utilization challenges. A reviewer commended Argonne for being open for discussion of and education on the various intricacies of the model.

Reviewers continued, noting the approach of adding more pathways and features to the GREET model has been thoughtful and organized. A concern was raised about criteria pollutant estimates since these are regional effects and not global (e.g. greenhouse gas emissions). But this issue is minor compared to the overwhelming utility of GREET.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers found the effort has a long history of productive research. Various WTW and vehicle technology implementations have been analyzed and numerous publications produced. One reviewer remarked that the continuous improvement of the GREET model is critical for industry utilization of this evaluation tool. The dynamic structure of the model shows not only its relevance but also continues to add to its already established credibility. Maintaining the relevance and credibility must be a priority. The technical support of the model given by M. Wang and M. Wu by participating in the life cycle analysis discussions and policy development taking place in the US and abroad is greatly needed and strongly encouraged to continue. One reviewer continued, noting as experts in this field of growing popularity, the experience and knowledge of the scientists supporting the GREET model must continue. Another reviewer noted that progress on the GREET model has been steady.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All reviewers found extensive collaboration on an international basis among many government agencies and industries. A broad network of users and partners exist. GREET is used by students and professionals and has penetrated broadly in the technical community. Its further development benefits from its broad use and acceptance.

A reviewer also said, as the GREET model is developed and maintained by ANL, the partnerships and collaboration for this project come into play with the implementation and usage of the model. Good collaboration exists with industry and government. The recognition of new technologies and continued expansion of the model's ability are to be commended and strongly encouraged to continue. Lastly, one reviewer personally had worked with Mr. Wang and the GREET model on alternative fuel studies and found him to work well with others offering input to the model.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found the future research plans to be valuable. They noted consideration of advanced vehicles and XTL pathways is essential to help judge the many pathways available to try to solve the fuel supply and greenhouse gas emissions problems.

A reviewer further noted the additional fuel production pathways added both recently and future production pathways identified are both relevant and necessary. They encouraged the evaluation and inclusion of developing technologies and improvements for existing petroleum and non petroleum processes.

One reviewer noted the future work for GREET has often been driven by the demand of the government looking toward policy decisions and impacts. This reviewer suspects with RFS#2 with LCA included, this will become more intense.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers generally found that this project is in need of additional funds, for its importance. There are many uncertainties remaining on LCA, it was said. Certainly more support would benefit this important program, and it would be a wise investment.

Continued support and updates of the GREET model are critical to the advancing environmental goals established by the EISA 2007, according to another reviewer. This model will continue to undergo in-depth evaluation and scrutiny; the robustness of the model will continue to be challenged and additional resources may be needed to maintain the respect and transparency already inherent in this modeling tool.

One reviewer found resources seem to be adequate.

6. Materials Technologies

Introduction

Advanced materials, including metals, polymers, composites, and intermetallic compounds, can play an important role in improving the efficiency of transportation engines and vehicles. Weight reduction is one of the most effective ways to increase the fuel economy of vehicles while reducing exhaust emissions. The use of lightweight, high-performance materials will contribute to the development of vehicles that provide better fuel economy, yet are comparable in size, comfort, and safety to today's vehicles. The advanced materials research conducted under the direction of the U.S. Department of Energy's Vehicle Technologies Program will help ensure the nation's transportation energy and environmental future by making affordable full-function cars and trucks that use less oil and produce fewer harmful emissions.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Materials Characterization Capabilities at the High Temperature Materials Laboratory and HTML User Program Success Stories	Edgar Lara-Curzio (Oak Ridge National Laboratory (ORNL))	6-5	3.50	3.00	3.00	3.00	3.13
Low Cost Carbon Fiber Research in the LM Materials Program Overview	David Warren (Oak Ridge National Laboratory (ORNL))	6-9	3.50	3.50	3.00	3.00	3.38
Low Cost Carbon Fiber from Renewable Resources	Fred Baker (Oak Ridge National Laboratory (ORNL))	6-7	3.33	3.67	2.33	3.00	3.33
Advanced Oxidation & Stabilization of PAN-Based Carbon Precursor Fibers	Eng-Felix Paulauskas (Oak Ridge National Laboratory (ORNL))	6-9	3.25	3.00	3.25	3.00	3.09
Precursor and Fiber Evaluation	Dave Warren (Oak Ridge National Laboratory (ORNL))	6-11	3.75	3.50	3.00	3.25	3.47
Polymer Composites Research in the LM Materials Program Overview	Dave Warren (Oak Ridge National Laboratory (ORNL))	6-13	3.00	2.67	3.00	2.67	2.79
Carbon Fiber SMC	C.S. Wang (General Motors Corporation)	6-14	3.33	3.33	4.00	3.33	3.42
Structural Automotive Components from Composite Materials	Libby Berger (General Motors Corporation)	6-16	2.67	3.00	3.33	2.67	2.92
Predictive Technology Development and Crash Energy Management	Khaled Shahwan (Chrysler LLC)	6-18	2.33	2.00	2.00	2.33	2.13
TMAC User Program	R.E. Norris (Oak Ridge National Laboratory (ORNL))	6-20	3.25	3.00	3.00	2.75	3.03
Engineering Property Prediction Tools for Tailored Polymer Composite Structures	Mark Smith (Pacific Northwest National Laboratory (PNNL))	6-22	2.67	2.67	3.33	3.00	2.79

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Natural Fiber Composites: Retting, Preform Manufacture & Molding	Mark Smith (Pacific Northwest National Laboratory (PNNL))	6-24	3.50	3.00	2.50	3.00	3.06
Overview of Joining Activities in Lightweighting Materials	Dean Paxton (Oak Ridge National Laboratory (ORNL))	6-25	3.25	3.00	3.00	3.25	3.09
Friction Stir Spot Welding of Advanced High Strength Steels	Glenn Grant (Pacific Northwest National Laboratory (PNNL))	6-27	3.00	3.00	3.33	2.50	2.98
Non-Destructive Inspection of Adhesive Bonds in Metal-Metal Joints	David Moore (Sandia National Laboratory (SNL))	6-28	3.33	3.67	3.00	3.33	3.46
Magnesium Powertrain Cast Components	James Quinn (General Motors Corporation)	6-30	3.33	3.67	3.67	3.33	3.54
High Integrity Magnesium Automotive Components (HIMAC)	James Quinn (General Motors Corporation)	6-32	3.50	3.00	4.00	3.00	3.25
Ultra Large Castings For Lightweight Vehicle Structures	James Quinn (General Motors Corporation)	6-33	3.67	3.67	4.00	3.33	3.67
Development of High-Volume Warm Forming of Low-Cost Magnesium Sheet	James Quinn (General Motors Corporation)	6-34	3.33	3.33	3.67	2.67	3.29
Magnesium Front End Research and Development AMD 604	James Quinn (General Motors Corporation)	6-36	3.50	3.50	3.50	3.00	3.44
Magnesium Front End Design and Development AMD 603	James Quinn (General Motors Corporation)	6-38	3.33	3.33	3.33	3.00	3.29
Low Cost Titanium Propulsion Applications	Curt Lavender (Pacific Northwest National Laboratory (PNNL))	6-40	3.00	3.00	3.00	3.00	3.00
Auto/Steel Partnership: Advanced High-Strength Steel Research and Development	Roger Heimbuch (A/SP)	6-41	3.00	2.67	3.67	2.67	2.88
NSF- 3d Generation Advanced High Strength Steel	Roger Heimbuch (A/SP)	6-43	3.67	3.33	3.33	3.33	3.42
Characterization of Thermo-Mechanical Behaviors of Advanced High Strength Steels (AHSS)	Mark Smith (Pacific Northwest National Laboratory (PNNL))	6-45	3.50	3.75	3.50	3.00	3.56
Auto/Steel Partnership: Fatigue of AHSS Strain Rate Characterization	Roger Heimbuch (A/SP)	6-47	3.33	3.33	3.33	3.00	3.29
Auto/Steel Partnership: Hydroforming Materials and Lubricant Lightweight Rear Chassis Structures Future Generation Passenger Compartment	Roger Heimbuch (A/SP)	6-48	3.33	3.00	3.67	2.67	3.13
Overview of Recycling Technology R&D	Ed Daniels (Argonne National Laboratory (ANL))	6-50	3.67	3.33	3.67	3.33	3.46
Post-Shred Materials Recovery Technology Development and Demonstration	Bassam Jody (Argonne National Laboratory (ANL))	6-51	3.00	3.00	3.00	2.50	2.94
Recycling Technology Validation	Joe Pomykala (Argonne National Laboratory (ANL))	6-52	3.50	3.50	4.00	3.50	3.56

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Electron Microscopy Catalysis Projects: Success Stories from the High Temperature Materials Laboratory (HTML) User Program	*Lawrence Allard (Oak Ridge National Laboratory (ORNL))*	*6-53*	*3.00*	*2.00*	*3.00*	*2.00*	*2.38*
Advanced Battery Materials Characterization: Success Stories from the High Temperature Materials Laboratory (HTML) User Program	*Andrew Payzant (Oak Ridge National Laboratory (ORNL))*	*6-54*	*3.60*	*3.20*	*3.40*	*3.25*	*3.33*
Residual Stresses for Structural Analysis and Fatigue Life Prediction in Vehicle Components: Success Stories from the High Temperature Materials Laboratory (HTML) User Program	*Camden Hubbard (Oak Ridge National Laboratory (ORNL))*	*6-57*	*3.67*	*3.33*	*3.33*	*3.33*	*3.42*
Diesel Particulate Filtration (DPF) Technology: Success Stories at the High Temperature Materials Laboratory (HTML) User Program	*Amit Shyam (Oak Ridge National Laboratory (ORNL))*	*6-59*	*3.50*	*3.50*	*3.00*	*3.00*	*3.38*
Selection of a Wear-Resistant Tractor Drivetrain Material: Success Stories at the High Temperature Materials Laboratory (HTML) User Program	*Peter Blau (Oak Ridge National Laboratory (ORNL))*	*6-61*	*3.50*	*3.00*	*3.00*	*3.00*	*3.13*
High Temperature Thermoelectric Materials Characterization for Automotive Waste Heat Recovery: Success Stories from the High Temperature Materials Laboratory (HTML) User Program	*Hsin Wang (Oak Ridge National Laboratory (ORNL))*	*6-63*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*
OVERALL AVERAGE FOR LIGHTWEIGHT MATERIALS			3.33	3.20	3.28	3.02	3.22

NOTE: Italics denote poster presentations.

Overview of the Lightweight Materials Sub-program: Joseph Carpenter, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated the program area was well presented and all light weight material projects within the program are critical to reducing fuel consumption and to extending electric and hybrid vehicle range. This is especially critical that new fuel economy standards have been set. Another reviewer commented that the area was adequately covered, not only in Joe's presentation but also in the Q&A session. The presenters were very transparent in terms of issues and challenges and progress made over 2007/2008.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated as they mentioned at some of the presentations, NVH is not considered in any of the projects, even though NVH may be favorable in some lightweight material options, e.g., polymer matrix composites. The question arises whether or not light weighting of a vehicle affects NVH? The issue of safety is of course addressed and essentially answered: size matters! So keeping the size of the FreedomCAR constant, how does light weighting affect NVH? Another reviewer suggested that some of the projects need to be speeded up and funded as needed before there is no domestic auto industry or supplier base. They are also concerned about foreign companies copying or working around the intellectual property being developed and keeping the manufacturing capability off shore.

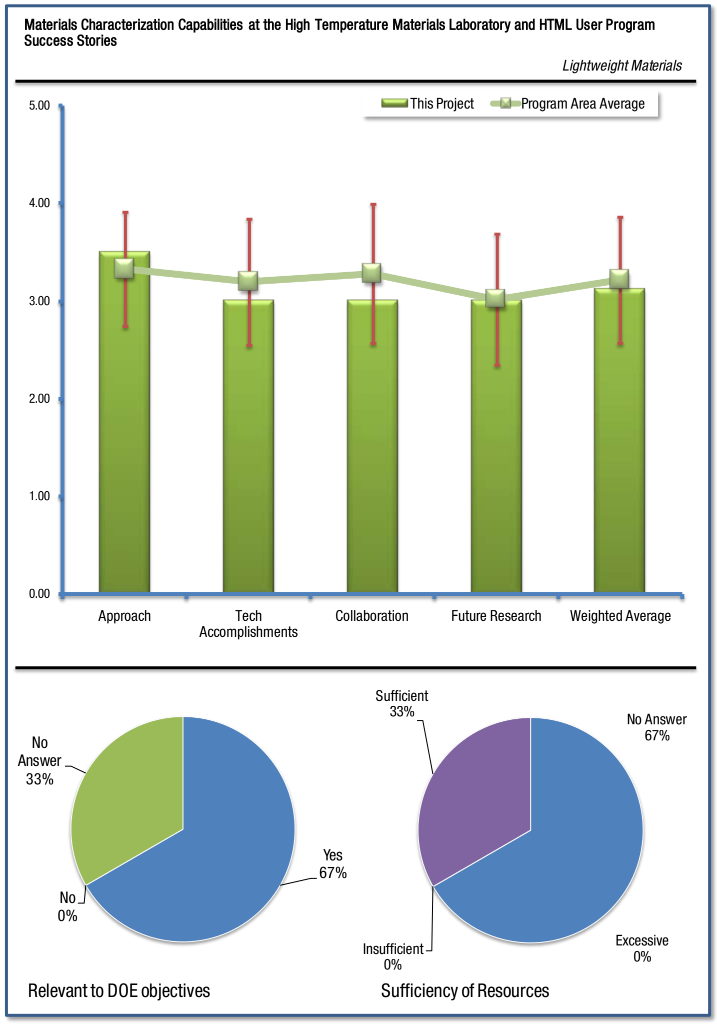
3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

Both reviewers answered yes to this prompt, with one adding as far as the current program is structured based on the facts and issues at the time of conception. However, there seems to be difficulty in setting up gates in the sense of modifying programs as new facts arise. No provision for new concepts to be studied, as funding for most of the older projects is set with no cutoff to change horses if necessary or desired.

4. Other comments:

A reviewer stated there were not enough aluminum projects in spite of the fact that this material far outstrips magnesium in light weighting vehicles. The reason for this may have been lack of cooperation from aluminum companies in the past, but with the aluminum industry now strapped and times are different, perhaps it is the right time to approach the industry to get more cooperation. Also, concerns about Chinese control of the magnesium industry and their control of primary production and manufacture of magnesium structural components makes one wonder who benefits from all the DOE work on magnesium? Another reviewer mentioned the presenters all did a great job in this multifaceted program.

Materials Characterization Capabilities at the High Temperature Materials Laboratory and HTML User Program Success Stories: Edgar Lara-Curzio (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer observed it wasn't easy to see for sure because the presentation was an overview of a very large array of projects. Having said that, it would appear that the work is directed at lightweighting and improving the performance of heat engines, both of which would tend to displace oil. Another noted lightweighting is the easiest way of displacing petroleum.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer again found it was a little hard to quantify the appropriateness of the approach because of the breadth of the presentation. It did appear from the examples given that the approaches to each of the projects described are appropriate.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer noted it would appear that progress on many issues has been excellent. The reviewers also noted many of the projects are fairly long-term and so it is hard to predict when they would be commercialized - and thus begin to contribute to decreasing the need for foreign oil.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer responded, noting the range of partnerships with industry and academia was indeed, impressive - although they all seemed to be U.S. based. The reviewer was not sure if this is a mandate, but often these types of projects are being done abroad as well.

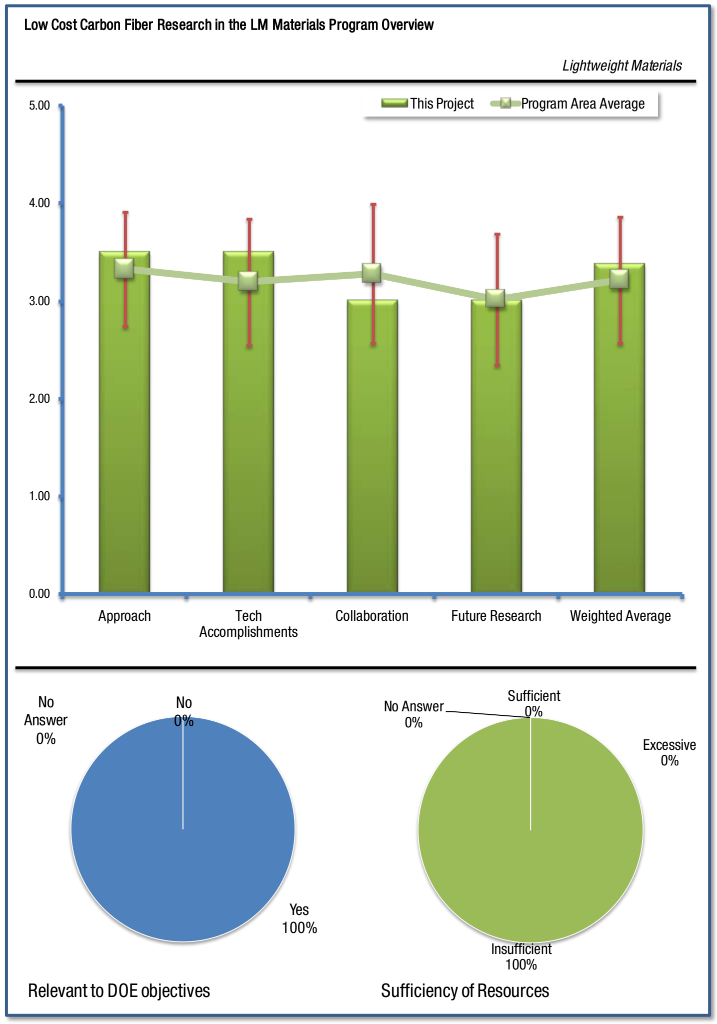
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer noted the project sounds good.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer responded, noting they were not sure, but that it seems okay.

Low Cost Carbon Fiber Research in the LM Materials Program Overview: David Warren (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Both reviewers found the project to find use life cycle beneficial. Questions remain about the production phase part of the life cycle and recycling. But there is a significant weight reduction potential.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Both reviewers found the approach beneficial, and the projects well organized and sharply focused. A reviewer noted that manufacturing processes need to be simplified for high volume production transition.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer responded, noting they cannot argue with the progress and technology so far, and the reviewer looks forward to the work on PE.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

No comments.

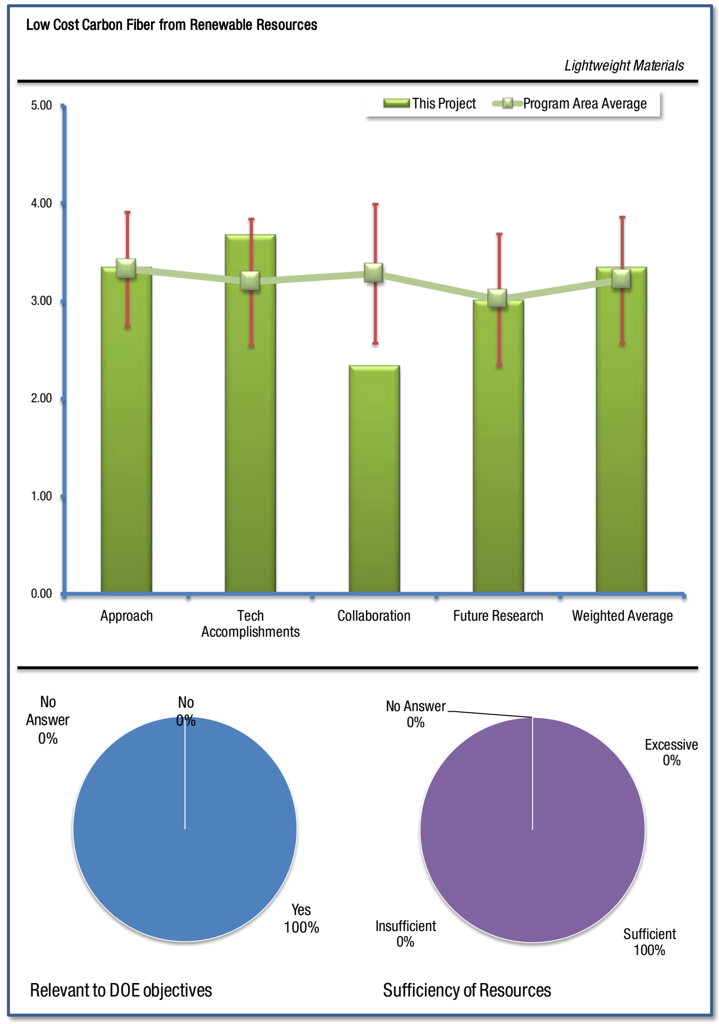
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

No comments.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

No comments.

Low Cost Carbon Fiber from Renewable Resources: Fred Baker (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

All three reviewers found the project meets the objectives of DOE. One noted it was able to meet lightweight materials objectives. Another observed that carbon fiber is a strong candidate for lightweighting - and this project could address the key problem of cost. Lastly, it was noted vehicle weight reduction is critical to improving fuel economy, driving range for electric and hybrid vehicle and carbon fiber can do that if the cost comes down dramatically.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Two reviewers noted some barriers in the approach, though it has potential. This project provides some methods to overcome some of the obstacles. The withdrawal of the key partner (MeadWestvaco) is a blow - but the whole project seems to be have recovered pretty well. The explanations provided for the economics and business aspects of the project were very helpful, as was the little video. Another reviewer noted that the barriers are well defined along with the focus areas to overcome them. This reviewer liked the fact that multiple feedstocks are being evaluated because different manufacturers may be able to use locally derived feedstock.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

All three reviewers found the project plan to be very good in meeting objectives; however, there are many technical challenges which have to be solved. One reviewer noted, given the difficulties with the partner, things seem to be going very well. Achievement of the strength target will be a key goal for the next stage of the work now that the cost target appears to be in-hand. The presentation was somewhat curtailed (due to poor pacing) which prevented complete presentation of technical achievements and so a summary slide would have been helpful and quicker, commented one reviewer. Another noted the progress made on the winding speed will be significant in lowering fiber cost.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers held mixed opinions on the collaboration. One felt it was good; another found current partners to be the only suppliers of the feedstock, with the exception of the Swedish Research Institute. A suggestion was made by one reviewer that the project should get inputs from the final component manufacturers.

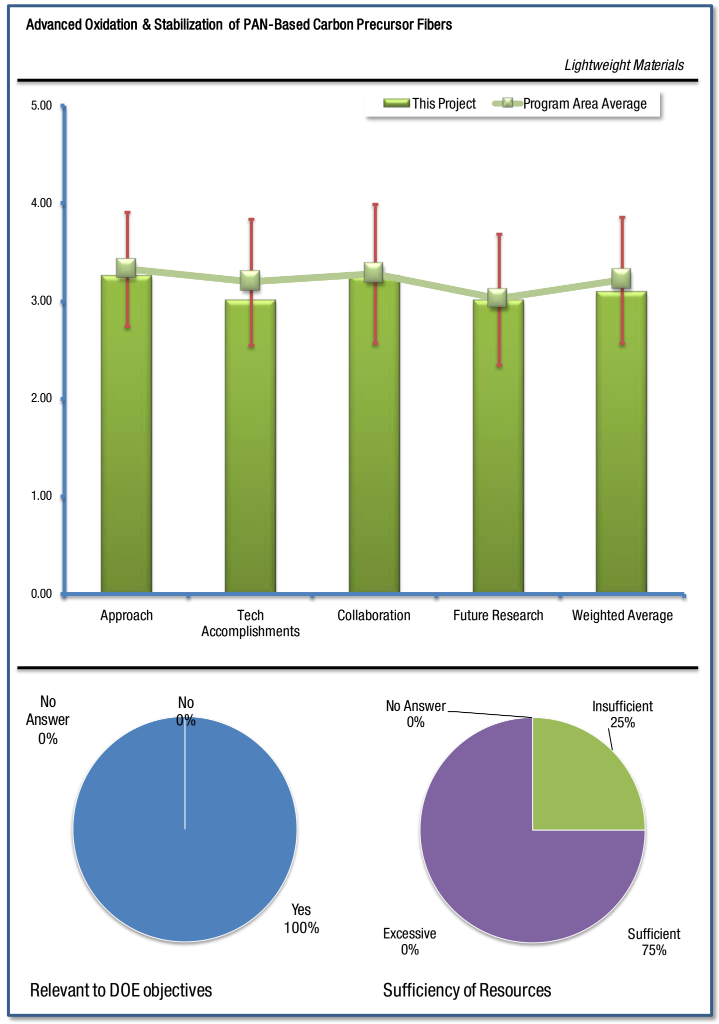
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Two reviewers found the project well planned, with aggressive targets. A couple of suggestions were made–one that the project needs to get domestic companies involved that may set up production in the U.S. Another suggested that the project needs some focus in its future research plan.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that resources seem sufficient.

Advanced Oxidation & Stabilization of PAN-Based Carbon Precursor Fibers: Eng-Felix Paulauskas (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

All reviewers felt the project supported DOE goals. Two reviewers noted the use of lightweight materials displaces petroleum fuel, by improving fuel economy. Another mentioned that precursors are key to the production of carbon fibers–also positive. Finally, one reviewer commented that technology would address issues to achieve a cost effective LM product for transportation industries.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers were concerned about two aspects. One was that a three times reduction in oxidation/stabilization is already demonstrated. Another was that the approach may be good for the laboratory, but will be very difficult for commercial production. A complaint was raised that the presenter tried to pack too much information in the allotted time. Another reviewer found the effort addresses the time and cost pictures of materials manufacturing.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers noted the three times reduction in oxidation/stabilization time was demonstrated. Two found this project had made excellent progress, with one noting property enhancement on oxidized/stabilized tow was demonstrated. Others disagreed, noting there seemed to be not much progress with respect to last year presentation, and that better coordination between proposed metrics and achieved metrics should be presented. Another reviewer noted, in multi-year projects, there should be comparisons between each year's results in order of increasing progress.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers appreciated that the project had difficulties with an industry partner who went bankrupt. They noted it does need commercial partner. But, in spite of difficulties with partners, very good effort was made to find replacements.

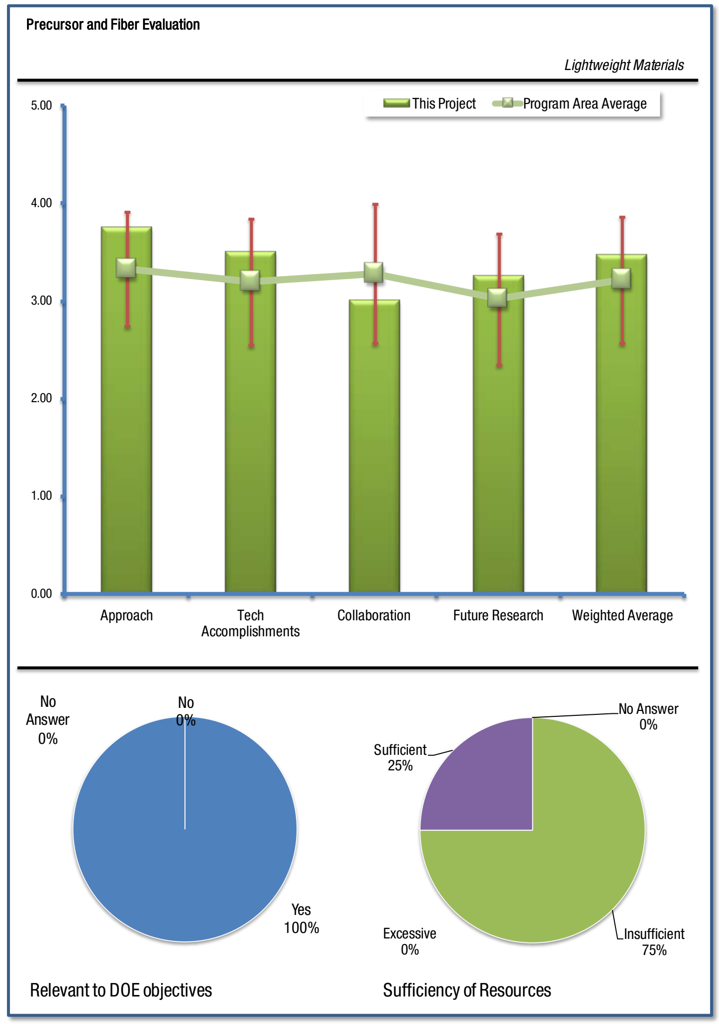
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers were mixed over the project's future plans. One noted it is a well focused research program that has built up an impressive technological background, which leads to well established barriers that can be addressed. Another noted the project should focus on some variables of the production process to overcome barriers. And a third noted the plans for next year's research should be strengthened.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers responded with comments regarding the project resources. One found resources were sufficient until a commercial partner becomes seriously involved. Another said not enough information was provided to estimate whether resources were sufficient of not.

Precursor and Fiber Evaluation: Dave Warren (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers agree that lightweighting supports the overall DOE objective. One noted carbon fiber is a strong candidate for lightweighting of future vehicles - if the cost barriers can be overcome. Given the strong DOE program in developing new ways of making CF precursors, it is critical to have a reliable and accurate method of evaluating these new materials. Another agreed, noting carbon fiber has the greatest potential to reduce the mass of a vehicle which will improve vehicle fuel economy and save many hundreds of thousands of barrels of oil per day. The material is also critical for electric vehicles to extend their range and also for hybrids and plug-in hybrids. The major impediment to use of carbon fibers in automotive applications today is the fiber cost. Current fibers are for aerospace applications and have much higher performance standards than will be needed for automotive applications. It was observed by another reviewer that this project seeks hardware to bring product to a reality that would enable introduction and commercialization of LM in the industries.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers were pleased with the approach taken in this project. One noted it looks really good. Another explained that the pilot facility at ORNL will greatly speed up the research and allow the researchers to try many new methods within their own laboratory and not have to go to outside vendors. Once success at the pilot level has been demonstrated, much of the risk for commercialization will be reduced and domestic manufacturers may be willing to get into the low cost automotive grade carbon fiber business. One reviewer did note that the project is well described but there were no quantifiable deliverables.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers had mixed understanding of the project. One found it a key project that will enable a large amount of other work. Another was impressed with how much has been done in such a short period of time and with such a limited budget. This reviewer was concerned that the project may end in 2015, however, questioning whether there will be a domestic auto manufacturer or supplier left by then. The project should be ramped up, partners brought in, and large scale production should be in place before the scheduled end date, the reviewer suggested.

Another reviewer found no comparison made in the presentation on technical metrics; it was thus very difficult to judge whether progress was made. The reviewer noted there was extensive comparison and evaluation about cost projections–this is excellent but a better correlation between costs and technical metrics would be helpful. Still another reviewer felt that the work, being still in a laboratory and prototype scale, needs significant improvement to be applied in manufacturing.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers disagreed on the collaboration. One found great collaboration, noting hopefully that more CF work will come to North America because of this whole program. A second reviewer observed from the presentation that almost all of the work is being done at ORNL. Demos and sample materials are being made available but that is not enough, they noted.

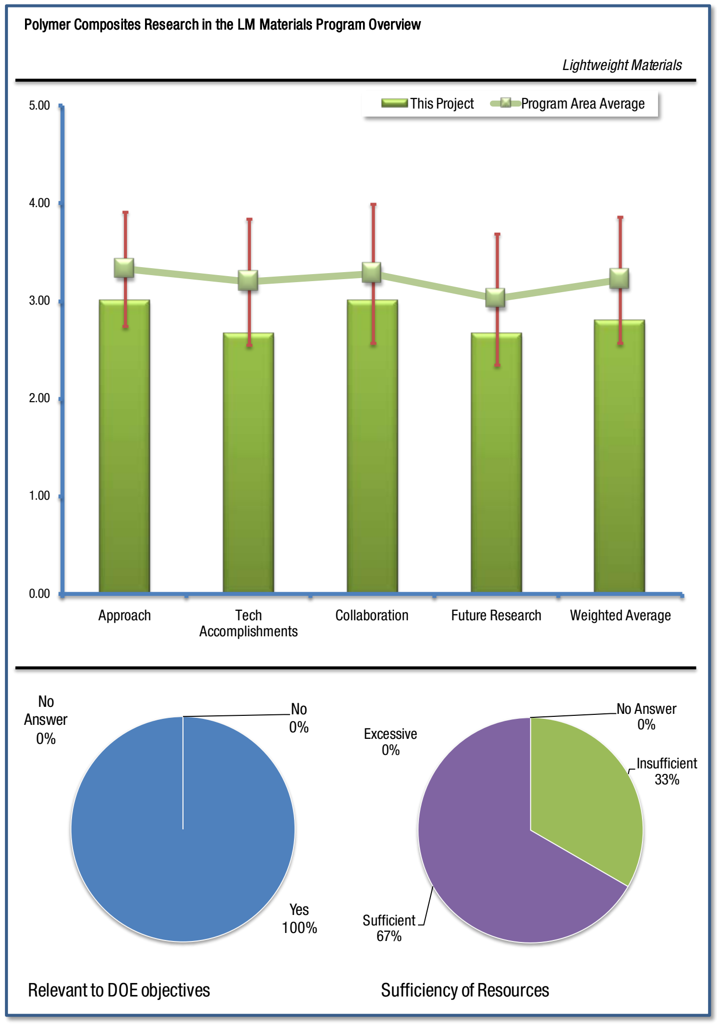
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers held mixed opinions on the plans for future work. One saw a great plan going forward and another felt it should be sped up. Still another felt a lack of stated numerical goals, wondering if this is because they are proprietary. Finally, a reviewer found cost projections to be well presented.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer felt budget control seems solid. They suggested that the facility needs to grow rapidly to a pilot scale. The further suggested that EERE VTP should consider a solicitation in the near future for a cost share commercialization project(s). One reviewer found the discussion inadequate to really determine whether the project has sufficient funding, and doubts that it does.

Polymer Composites Research in the LM Materials Program Overview: Dave Warren (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers agreed that polymer composites are an excellent candidate for lightweighting of automotive structures and trim parts, and that lightweighting supports the DOE goals. One reviewer added that the project seeks Critical Materials Technology to achieve light weighting.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found the approach seems fine, with a good summary presented.

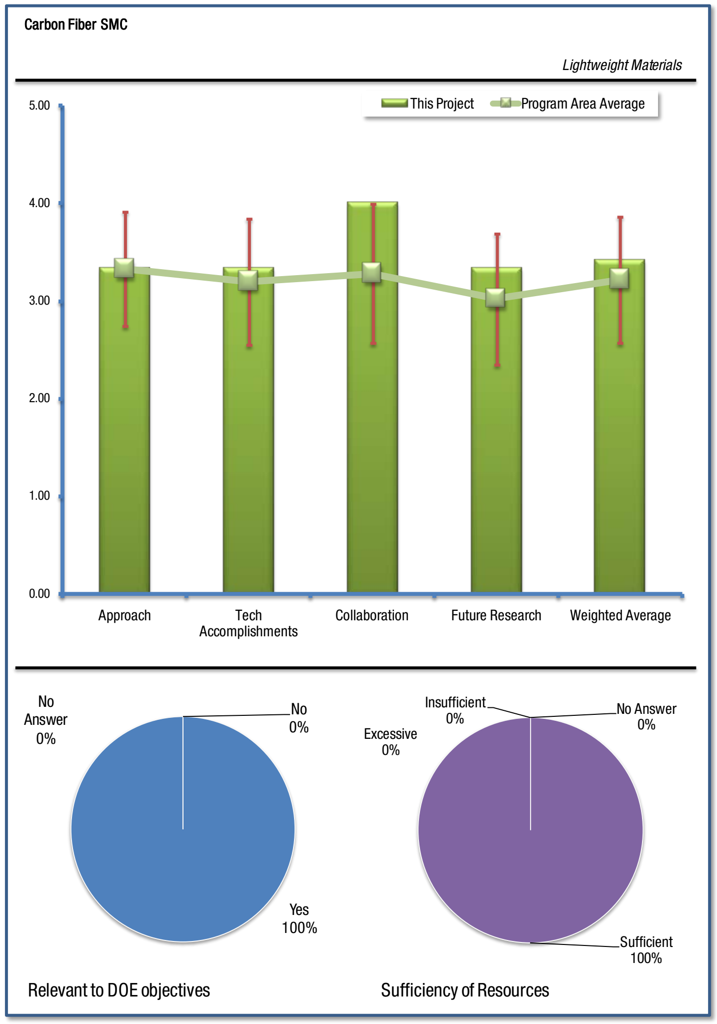
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers were brief in their responses, noting the project was okay, though the presentation could be a bit more specific.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers found this work to be interesting because it is dealing with structural components whereas much of the work elsewhere is directed at non-structural parts. One reviewer hopes to see more collaboration with other groups in the future. Another reviewer felt it seems to be very well integrated with others.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Two reviewers responded, with one noting the plan is sound going forward, the other finding the plan a bit too nebulous for his taste.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Reviewers indicated that resources probably seem okay.

Carbon Fiber SMC: C.S. Wang (General Motors Corporation)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers all agreed that lightweighting with carbon fiber no doubt saves fuel in use. Questions remain about breakeven mileage to compensate for CO_2 puff up front (includes scrap in trim and overall production as well as CO_2 generated in production of carbon fiber SMC), and whether the cost and processing/ production barriers can be overcome.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers largely agree this is a good research project, that the approach is focused toward solving barriers: the project is identifying the key issues (such as bond line read-through) and addressing them, but manufacturing barriers remain to be resolved. One reviewer feels that the whole issue of adhesives really requires a more active effort (it sounded as though the adhesive issue was merely a side issue in the present project). Reviewers also agreed it is difficult to make significant improvements. Nonetheless, the overall approach appears to have a good likelihood of success.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers unanimously found good progress was made, with several barriers overcome.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found that the close collaboration with the full range of participants is well coordinated. There is good inclusion of production suppliers, according to one reviewer. Another reviewer suggests that this group contact Dr. Pascal Hubert of McGill University in Montreal (pascal.hubert@mcgill.ca). He is working on the issue of class-A surfaces and meeting with good success.

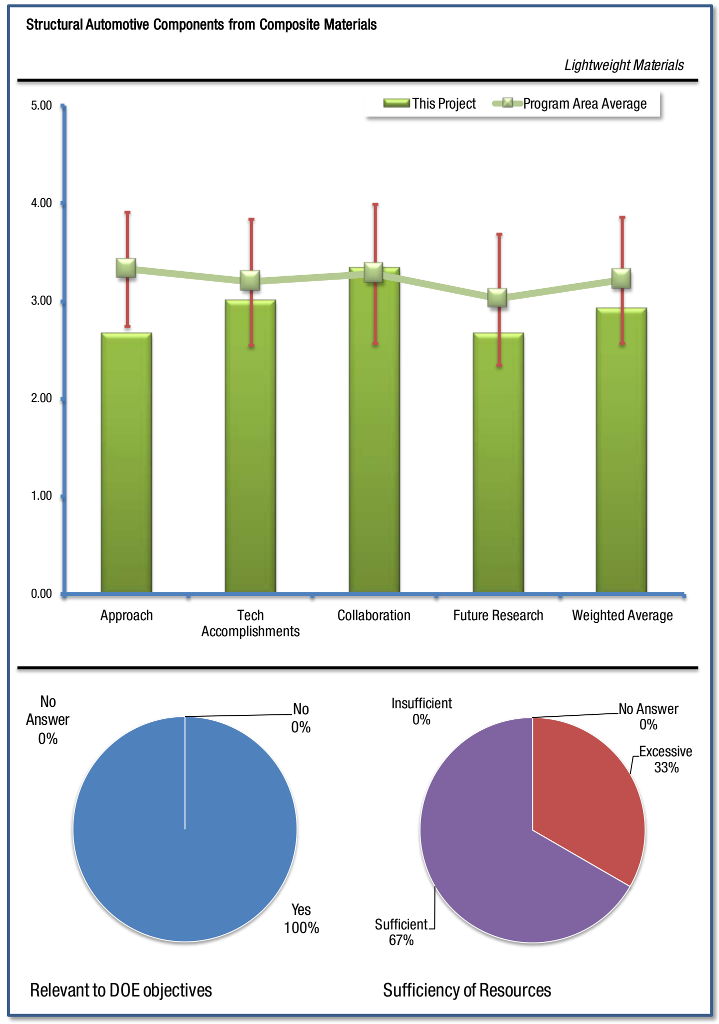
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers agreed the program is right on schedule and sharply focused on barriers, with a very good project plan. One suggested someone should look at NVH of carbon fiber composite structures versus glass fiber composite and metallic structures. And the concern was reiterated about adhesives.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer responded, finding resources okay.

Structural Automotive Components from Composite Materials: Libby Berger (General Motors Corporation)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers noted weight savings is obvious and as mentioned in earlier reviews, petroleum (fuel) displacement will occur in use phase. Questions arise about breakeven mileage for initial CO_2 puff in terms of CO_2 total vs. steel, aluminum, and magnesium. One noted the use of composite will help to reduce weight which will help to improve fuel economy. Another noted the importance of technology validation for LM implementation.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers were critical of the approach due to the many barriers. One noted underbody and seat structures are so disparate in terms of requirements that each have their own barriers with little crossover. High costs vs. alternative competitive materials may never be overcome. The reviewer did note the project has a generally effective approach. Another reviewer felt the project plan is not sound and the automotive needs have not been truly addressed. Composite materials are not good candidates for underbody applications. Also, seats are not good candidate for composite materials. Mg could be a better material.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Two reviewers responded, noting that significant progress was made but there is room for improvement, perhaps due to the many difficult barriers that still have to be overcome.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer noted there was close and appropriate collaboration with institutions and partners.

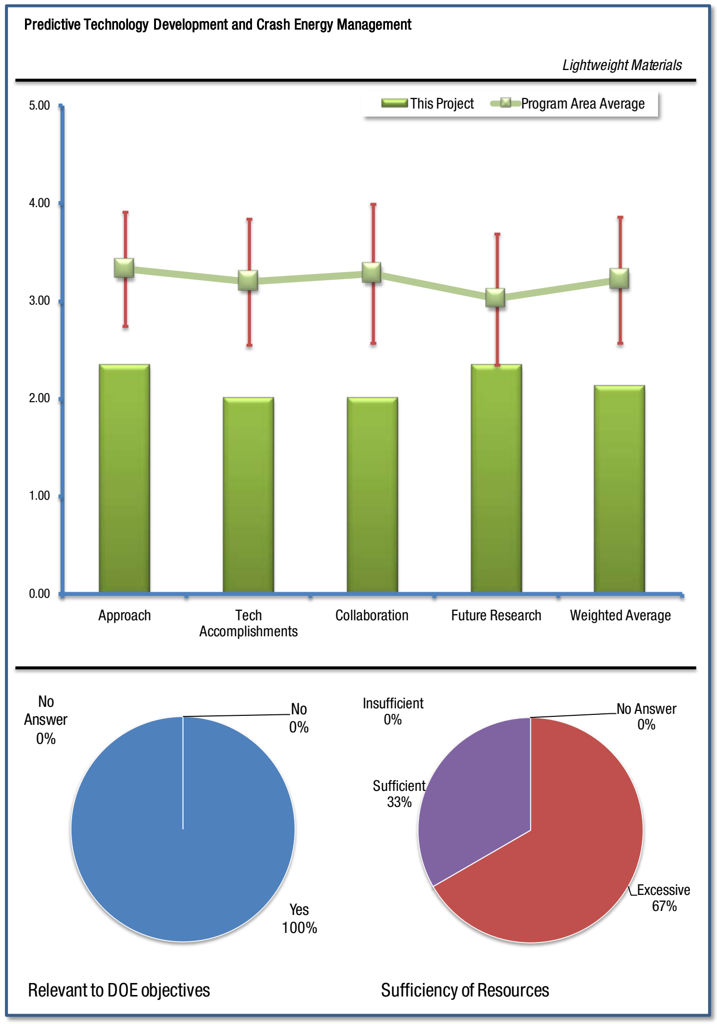
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found cost barriers relative to alternative materials are generally addressed but vague and not sharply focused. One reviewer speculated that the program may be waiting for low cost carbon fiber, and noted that NVH is not included in study. Another reviewer found the research program okay.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer responded, noting resources are sufficient to achieve the technical but not the cost milestones–the latter barrier may never be breached.

Predictive Technology Development and Crash Energy Management: Khaled Shahwan (Chrysler LLC)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers were mixed in this assessment. One questioned if the carbon footprint or life cycle analysis for carbon fiber composites had been examined. There is no doubt that the use phase of the lighter weight carbon fiber composite will displace petroleum fuel, but in life cycle analysis we need to include total life from manufacture of fiber, to transport of product, to use phase, to end-of-life. Another reviewer noted composites will be a key factor in lightweighting, as well as in making smaller production runs more competitive - both of which are key to the successful recovery of the North American auto industry.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers were critical of the approach in this project. One commented that the length of the project, in terms of coming to a conclusion, was brought up in the Q&A discussion. The reviewer questioned: Where is the cut off before moving on? Hasn't this work been done before and, if so, is the progress marginal?

Another reviewer found the project has significant weakness in relation to the actual behavior in crash–suggesting the project should be redefined. Another agreed, noting the project seems OK on the surface - but a good deal of work has been done on crack growth and damage in composites by the aerospace sector and that work should be drawn upon if at all possible (while recognizing the differences in cost and material characteristics).

Still another reviewer observed that political issues within the project team seem to be a major concern as well - this must be dealt with promptly and firmly. The research approach should mirror planned production methods (mat versus chopped, etc.) - or the program must be sufficiently flexible to accommodate all methods of manufacturing.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer referred the project team to comments in Question 2 regarding the length of project–seeing no end in sight, etc. Comparative data on competing materials would be helpful in this regard. It is time to make a choice on competing materials not only in cost but in crash energy management. Another reviewer agreed, citing that progress is very slow, having continued for the last two decades–perhaps we can't overcome the barriers. Still another reviewer agreed, stating the project needs a strong change in direction to get the results required.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers would like to see a good literature survey on this subject with previous work identified. Collaboration with those who conducted previous work might save time and money. There seems to be a lot of work already done in this area, and not just for aerospace. One reviewer saw coordination with academia to be very good, but progress is slow. Too many universities are involved and coordination between them is not very good. Another reviewer reiterated something mentioned previously, that, as an academic exercise this project sounds like a great effort and a lot of fun, but as an important part of a major industrial thrust, it is much less effective and the problem may be that the team is simply not made up the right group of people.

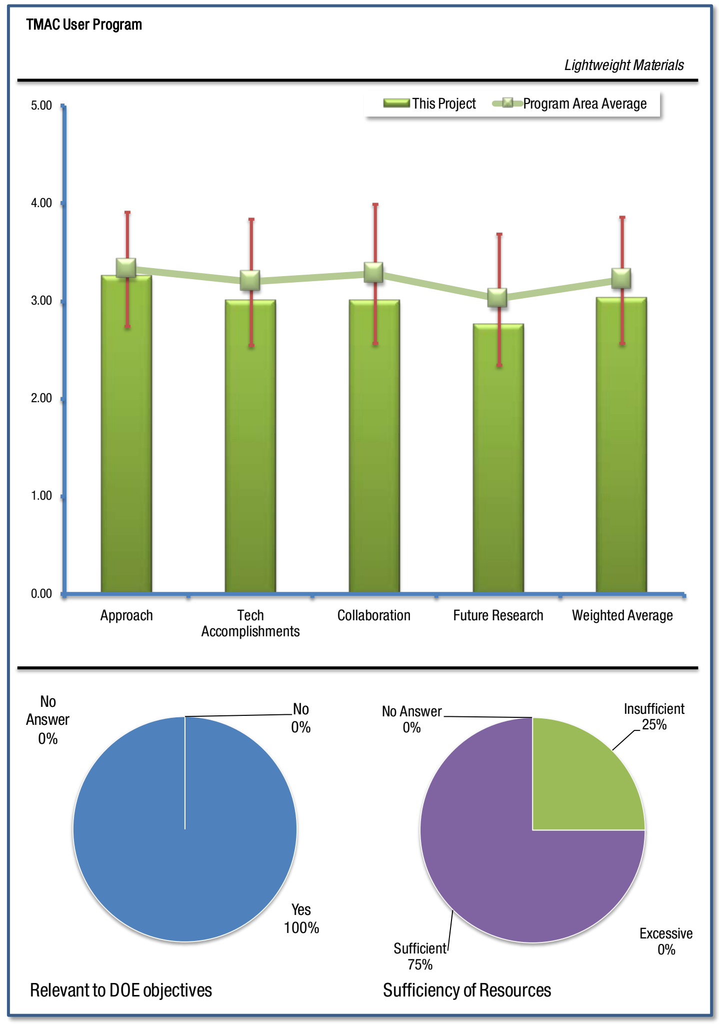
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer noted that questions about improvements and difficulties in overcoming barriers have been raised in the Q&A. Another reviewer noted the effort should focus on only few variables rather than solving many barriers at the same time. One reviewer stated that the plan looks good but the "proof will be in the pudding." In short, this activity needs to get on-track to keep pace with the rest of the program.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer suggested it may be time to analyze data and see what has been done and determine how much can be gained by more resources being added to this project. Another noted that resources seem okay, but it is a little hard to say given the other difficulties noted above. One reviewer specifically expressed appreciation for Hamid Kia's frank and open words, noting they were reassuring and his efforts to lead this project under challenging circumstances laudable.

TMAC User Program: R.E. Norris (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewer observed that the TMAC equipment can aid in implementing automotive lightweighting by clarifying the crashworthiness of these competing materials. One reviewer noted that development of testing procedures to increase the use of lightweight materials helps to improve fuel economy. There are two sides to LM_10: a) user program and facility that can be tapped by the external community; and b) LM implementation enabler.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found that the technical barriers are identified clearly and have been attacked with a sound approach, albeit with slow progress in overcoming barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers found excellent progress to date, though at a slow rate of progress. One reviewer questioned how the data collected in this program is transferred to other programs. Another reviewer noted two observations: a) collisions seems to be at relatively low speed, so this begs the question how useful is it at high speed, say 20 m/s or more? b) large scattering of results of measurements: it is not clear whether one can make correlations. Finally, one reviewer found the technical strategy well defined, and that it would result in implementation.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer noted that coordination about crashworthiness of competing lightweighting materials is fair but needs more focus. The reviewer questioned: How do we assemble all the data (e.g., ala Ashby plot) so as to compare materials in terms of crashworthiness? Another noted that coordination with OEM and university is very good, but that data collection by different groups could be better coordinated. Yet another noted that this effort has a very large potential user base, and was surprised not to see more companies taking advantage of such a facility.

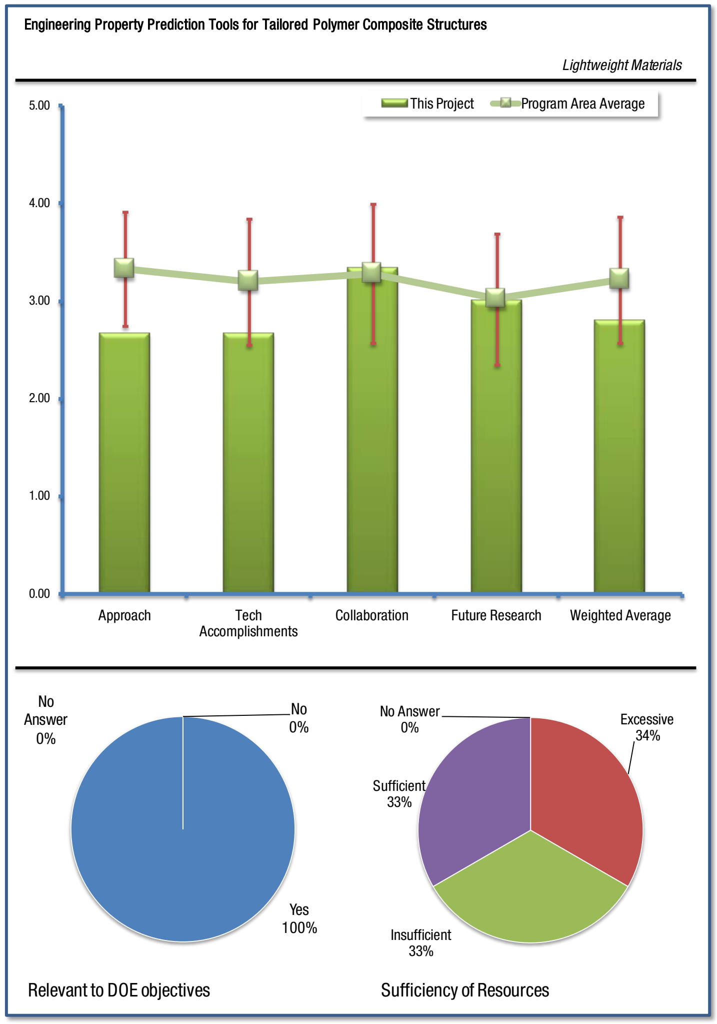
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One reviewer questioned how to jump the gap between tests conducted on particular samples (tubes) and finished components with different geometries and performance requirements. Another noted that the project plan for

Advanced Preforming Project should be focused with smaller number of variables and should validate the proof of concepts. Still another found the future plans rather timid.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer found resources sufficient as far as the milestones are concerned. Jumping the gap between the TMAC test data and actual components will require more resources. Another reviewer found 2007 and 2008 funding clearly insufficient; they found resources for the current work potentially adequate but that the presentation was unclear on information on which to base a judgment.

Engineering Property Prediction Tools for Tailored Polymer Composite Structures: Mark Smith (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

All three reviewers agreed that prediction of polymer composite behavior helps to introduce more polymer materials toward improving fuel economy. One noted composites are a key means of lightweighting and building a reliable database of properties and computer design tools are critical steps in the implementation of this technology.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers felt generally that the project plan is good but there were some shortcomings. One reviewer noted that it looks good - this is a tough area to deal with and this project appears to be taking a good approach by involving top-notch analysis package developers and good researchers in a well-designed program. Another noted that the predictive model and actual performance for validation is not sufficient. A third said that materials availability and tool design seem to be key factors of the work–materials availability may limit the impact of such project. It was suggested that maybe DOE should have a special budget item to procure specific materials for research and maintain a sufficient stock.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers found progress was made, though there is a need to validate predictions with actual performance. Also, another reviewer agreed that the project should be granted an extension. Lastly, another reviewer noted there were measurements, validation of models, lots of milestones but no metrics: so lots of words! One reviewer noted they found the creep results interesting.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found collaboration with two national labs and a university to be very good. It was suggested the project work closely with manufacturers and users, and it was strongly recommended that the project contact the University of Windsor when the project moves into the DLFT portion of the work to take advantage of the impending experimental development facilities that are planned for that locale.

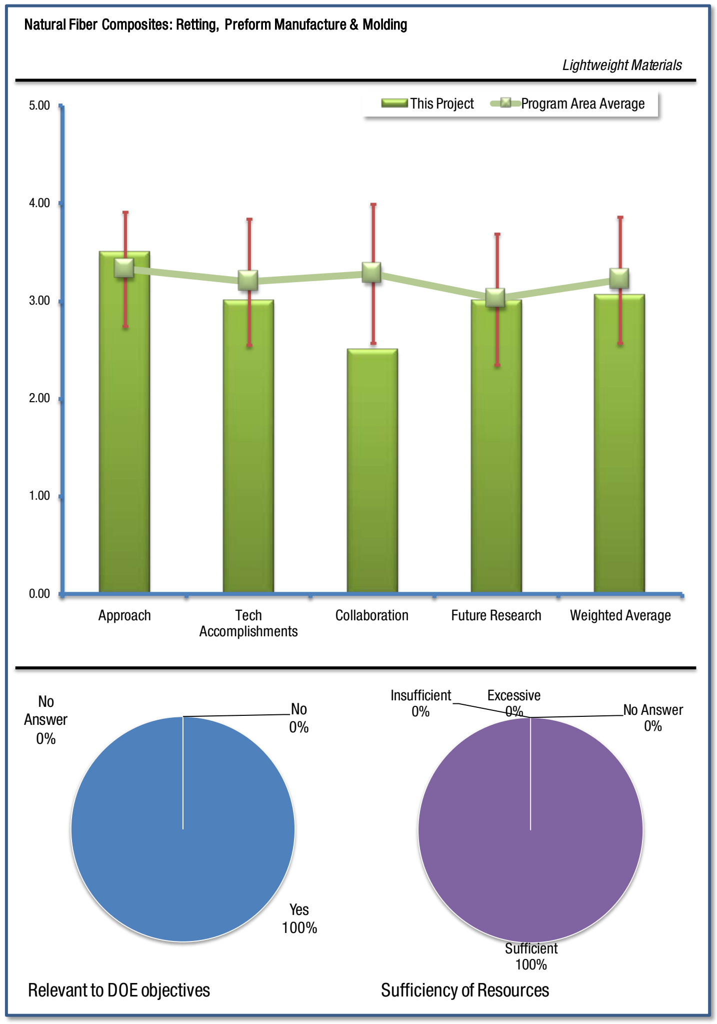
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers liked the project plan, but suggested that it bring in the molders to this project. They should be an integral part of this program. Another believed the two year extension should allow the project to bear fruit. One reviewer thought the extension may not be enough time given the amount of work to be done.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer felt funding is excessive in compared to the project deliverables. Another found resources to be okay, though they were not sure what the impact of the 2-year extension is going to be on resources. They added that this is an important project with very promising results to date - so more resources would not be misplaced.

Natural Fiber Composites: Retting, Preform Manufacture & Molding: Mark Smith (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers found the project supportive of DOE objectives. The use of composites with biomaterials will help to reduce weight which will improve fuel economy. And natural fibers, in addition to a small lightweighting effect, can displace petroleum through decreased use of oil for the production of polymer resins.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found the approach to the work to be solid, with good progress towards deliverable milestones. The basic problems with natural fibers have been identified and reasonable approaches are being proposed.

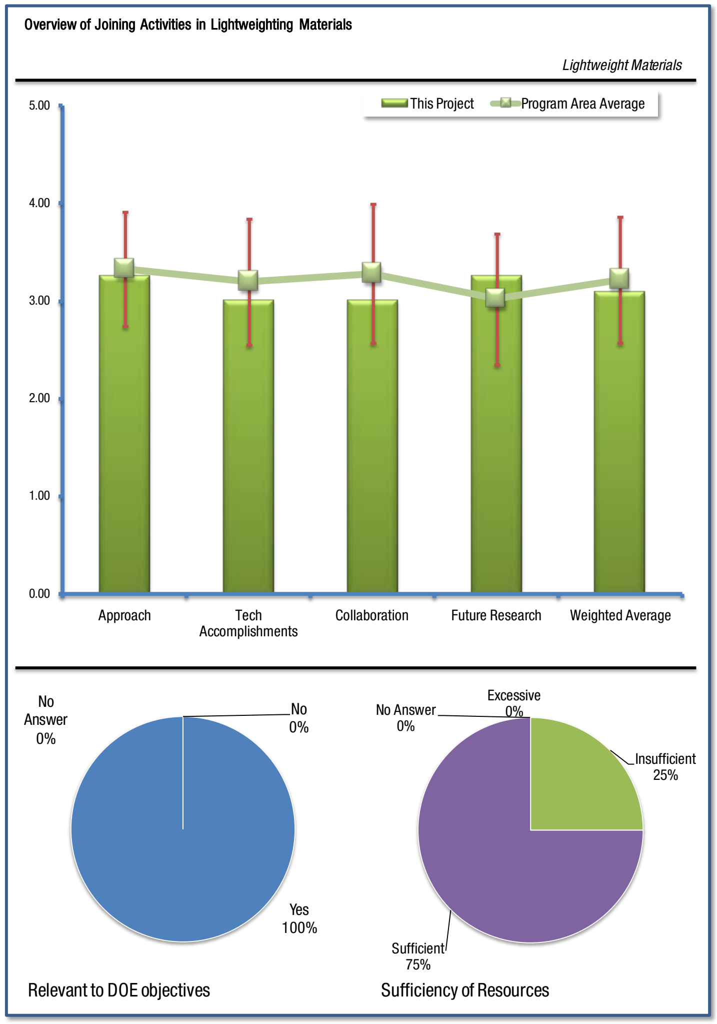
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers found that good progress was made, with some barriers overcome. A reviewer noted that progress is okay, but it seems that closer collaboration with the similarly aimed Canadian research may help to advance this work more quickly. Dr. Mohini Sain at Univ of Toronto and his colleagues are doing very well on many of these issues and they are working with some of the same partners and others with good success.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers found collaboration with academic institute such as MIT is very helpful to achieve goals. As noted above, one reviewer suggested contacting Dr. Mohini Sain at the University of Toronto.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Reviewers found the future plan to be good, with a couple of caveats. One reviewer would like to reiterate that closer collaboration with researchers abroad would likely help to move things along faster - especially given that implementation of natural fiber materials is actually fairly advanced outside of the U.S. Another reviewer raised the concern about odor issues with natural fiber materials.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer commented on the resources, noting they seem okay given the issue raised.

Overview of Joining Activities in Lightweighting Materials: Dean Paxton (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers generally noted that HSLA, complex alloyed steels, and the joining of all lightweight materials are important in the lightweighting of vehicles, with spot welding as the most common joining method. One reviewer noted that joining is a core competency for implementation of any material and building a knowledge-base in joining is critical step in bringing new materials into the auto industry. Thus, this project must be seen as a core task in lightweighting - which will be needed to decrease petroleum usage in future vehicles.

Question 2: What is your assessment of the approach to performing the work?

To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewers found the project's approach generally good and effective at overcoming barriers for bare AHSSs. One reviewer considers it an important piece of work, though did reference concerns about collaboration discussed in Question 4. One reviewer noted the project is well planned, with barriers identified. However, these steels are mostly used in a coated condition (galvanized, galvalumed, etc.), and the surface coating can throw the results off substantially. The reviewer wondered if this is a major barrier that was not considered.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers acknowledged progress toward objectives, but they also cautioned that work could be accelerated, that choice of materials might not be entirely appropriate–something pointed out in the discussion–and that the project should take measures to assure it stays close to what the industry people need. One reviewer suggested that the project presenters again refer to the Question 2 discussion on barrier resulting from coatings. Significant progress made toward objectives on modeling and experiments on bare AHSSs.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers generally found coordination among a large pool of collaborators, including PNNL, A/SP, OEMs and USCAR, but also had several suggestions. One reviewer suggested collaboration with steelmakers and other institutions about coatings, and asked if coatings differ from producer to producer; and what the effect of oxide and lubricant layers on the AHSSs is (oxidation/rust, white rust due to oxidation of Zn, solid or liquid lube films).

Another reviewer noted that perhaps even better progress would result by working with non-US researchers such as Randy Bowers at Windsor (rbowers@uwindsor.ca), Norman Zhou at Waterloo (nzhou@mecheng1.uwaterloo.ca) and Moyra McDill at Carleton (Ottawa). In particular, Dr. Moyra McDill has 25 years of experience in developing nonlinear thermo-elastoplastic finite element models, new specialized elements and automatic adaptive meshing algorithms which are specifically designed to deal with situations like welding and casting. Her work has been used by Saab, Volvo, Rolls-Royce and others. She can be reached at: mmcdill@mae.carleton.ca.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

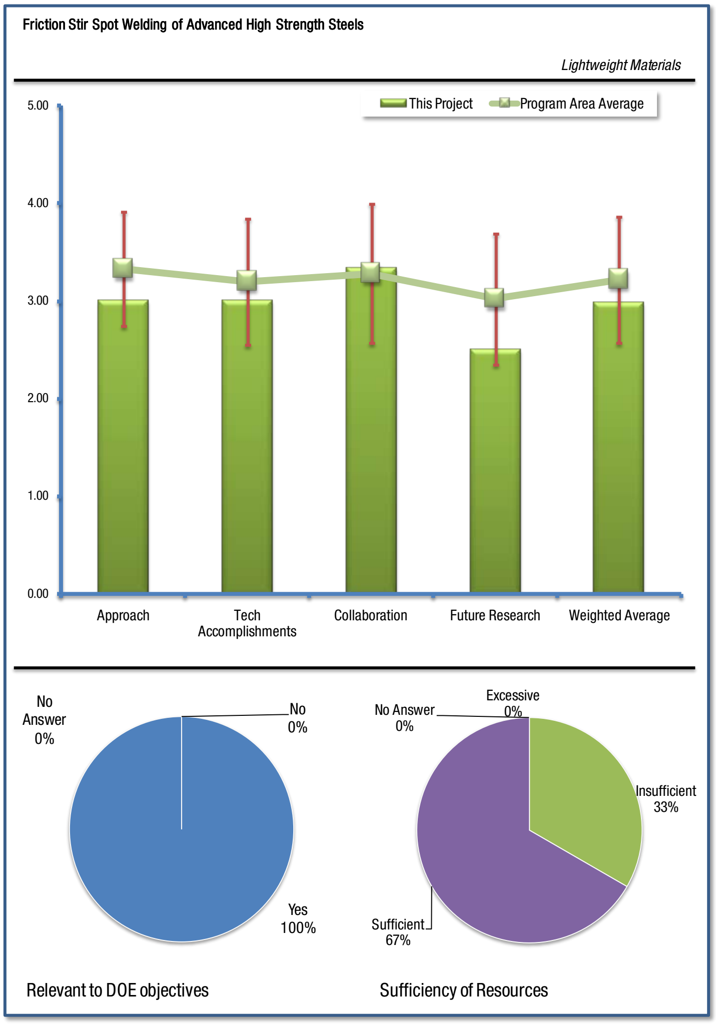
Reviewers held mixed views about the plans for future work. One reviewer noted that the project is focused on solving critical barriers. One reviewer was concerned whether the project is meeting the needs of industry people. Another reviewer found that a good summary was given on what needs to be done, but questions the depth which this group will be able to achieve.

One reviewer was concerned that future work sounds a lot like more of the same–with no effect of coatings! And comparative properties of spot welds on AHSS and aluminum alloy sheet not compared. The reviewer added that the aluminum industry has done a lot of work on spot welding; also on FSW and FSSW.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found the project to have sufficient resources to achieve the stated milestones, while doing some preliminary work on coatings.

Friction Stir Spot Welding of Advanced High Strength Steels: Glenn Grant (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found the project does support DOE goals. One noted AHSS will play a key role in the future lighter car, and joining this material is clearly a major barrier to implementation. Another agreed, noting FSW is part of the tools to render vehicles lighter. And still another noted that process optimization is needed to enable lightweight materials' introduction into production.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found the approach very solid and straightforward. One reviewer wondered if a laser-assisted process might be worth trying to heat-up the target area to improve cycle time.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers found good progress is being made on the project. Improvements have been achieved on cycle time as well as tool wear. Affordability remains a concern - as are the above two issues. Crash worthiness of FSS welds remains an area that needs investigation. A reviewer noted that silicon nitride is interesting–it runs hotter and reduces welding time. They noted tool design is described but trials seem to have been reduced to one or two configurations.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found collaboration to be okay, with partnership between two groups in two national labs, and good synergy. One reviewer noted that direct collaboration with users is needed.

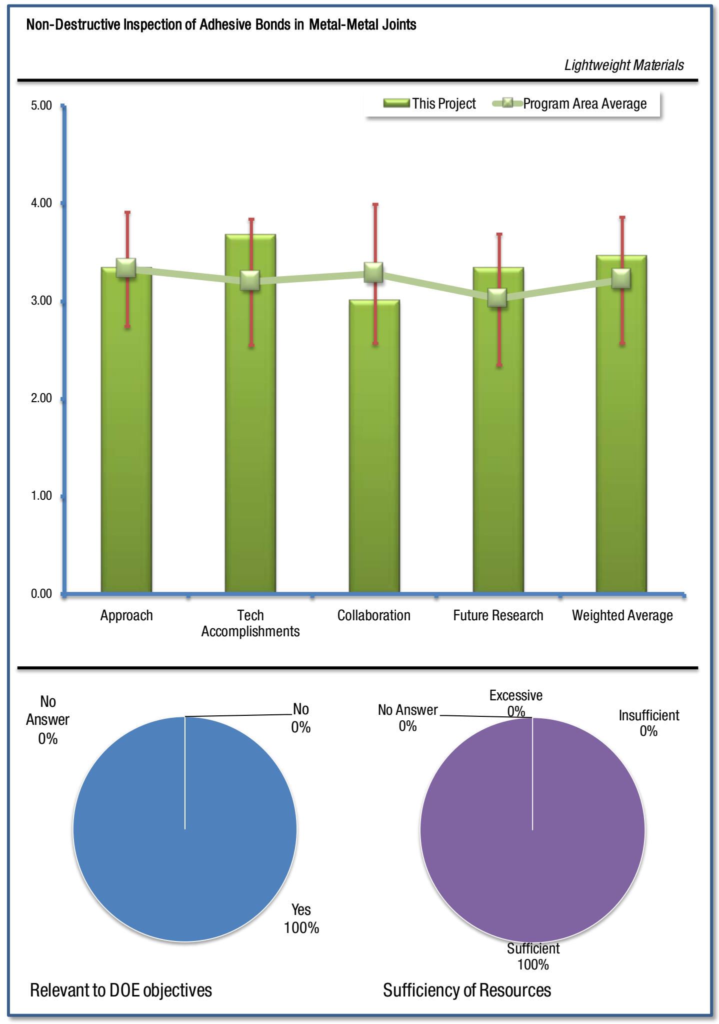
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A sole reviewer responded, noting the project has a good plan for the future.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers commented, noting that resources seem okay, but that FSW needs much more funding to be useful to the industry.

Non-Destructive Inspection of Adhesive Bonds in Metal-Metal Joints: David Moore (Sandia National Laboratory (SNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers unanimously agreed that adhesive bond reliability and non-destructive testing of adhesive joining methods address barriers to lightweighting and related fuel efficiency, especially on some of the new lightweight materials. A reviewer pointed out that having reliable and fast NDE methods will be critical to the successful introduction of these new materials and manufacturing processes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found the approach very sensible, with the phased array approach a correct approach considering the alternatives–many of which require two-sided QC. A reviewer noted that the project is well defined but also should be focused on specific barriers such as environment and time to complete the tests.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers found there was excellent progress on milestones, in particular for metal-metal bonds working, apparently overcoming the barriers for metal-metal bonding. This work should be pursued aggressively in order to use more adhesive bonding, another reviewer agreed. In order to form a kissing bond, maybe adhesive bonding of galvanneal steel can be used since adhesive bond strength is very poor bond with galvanneal materials. A reviewer commented that the usual problems with NDE development programs have come up and are being addressed (obtaining known "bad" bonds and correlating to actual production-rate methods).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found collaboration with OEMs in this project to be good. One noted that partners in project may need to be expanded to include more adhesive suppliers, more outside NDT equipment makers. They questioned if this approach work for all adhesives, included hot melts and tapes. Are there other NDT equipment makers working on the same approach?

Another reviewer suggested another possible method to include in the round-robin testing, that being worked on by Dr. Roman Maev at University of Windsor. Work there has included efforts with Chrysler on an acoustic microscopy NDE method for welds for years with excellent results. Dr. Maev’s company (Tessonics) is now commercializing this work. He can be reached at: maev@uwindsor.ca.

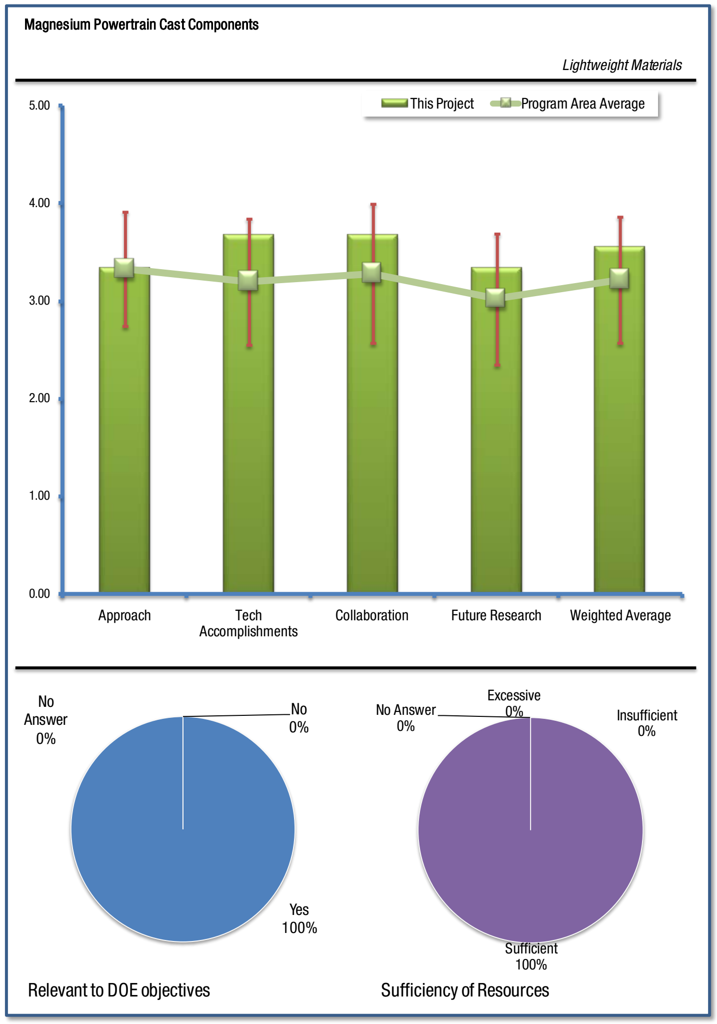
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers generally felt milestones have been achieved. One noted that without a major field trial, actual feasibility cannot be known. As far as lab work, a major remaining issue involves using this UT method on composites. The reviewer expects completely different results with composite-composite and composite-metal compared with metal-metal.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found resources in this project to be sufficient so far. One noted a field trial would demand more resources.

Magnesium Powertrain Cast Components: James Quinn (General Motors Corporation)



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
All reviewers noted this significant weight reduction in powertrain applications will be multiplied and support fuel economy. One noted it may do so more than any other lightweight materials project reviewed.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found this a positive approach. One reviewer noted the project has a well structured, patient, and comprehensive approach to maximizing weight loss and performance–very commendable. The reviewer added some open questions for the planners of the project: what were the modifications to the Duratec V6 engine, which is made of aluminum alloy(s), to accommodate the magnesium alloy(s)? Would a totally redesigned magnesium alloy engine be more robust, effective, etc.? Originally, why weren't high-Si aluminum alloy sleeves used instead of cast iron? Another reviewer found the project plan to be very sound, involving many stakeholders helping to transfer the technology when it is fully developed. They added that major barriers were identified as well.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers found the project made significant progress, achieved deliverables according to the milestone described earlier. One reviewer noted this is one of the highest profile DOE materials lightweighting projects, and the progress toward objectives is commendable in light of the difficult barriers to overcome.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers noted collaboration with numerous groups. One reviewer questions why some of the European organizations and companies that have made significant progress on magnesium engines were not tapped. Another noted the potential, with collaboration of 36 suppliers and developers with OEMs, to accelerate the developments and help to transfer the technologies into production applications.

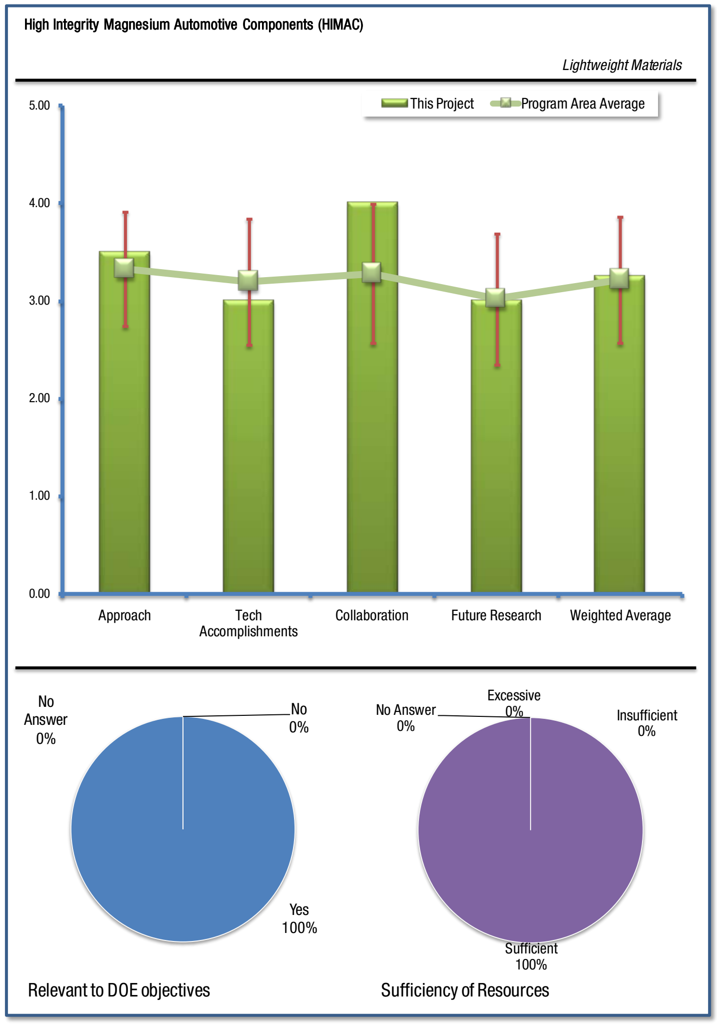
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
One reviewer noted this project is essentially in the a mop up stage of operation, as progress was substantial and then many things have changed since, especially considering the increasing dominance of China in controlling magnesium

supply, and only one North American magnesium supplier exists. Planning R&D in such a vague economic and changing environment for such a critical component is difficult.

Another reviewer noted the recent extension of the project is justified, and that this is a very good project in developing new technologies and new applications of magnesium.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer commented that resources for the project are sufficient for taking it to a meaningful conclusion.

High Integrity Magnesium Automotive Components (HIMAC): James Quinn (General Motors Corporation)



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Both reviewers agreed that magnesium is a key material for lightweighting the future car, thus increasing fuel efficiency and reducing energy demand.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer commented, noting it is an excellent approach to a complex project.

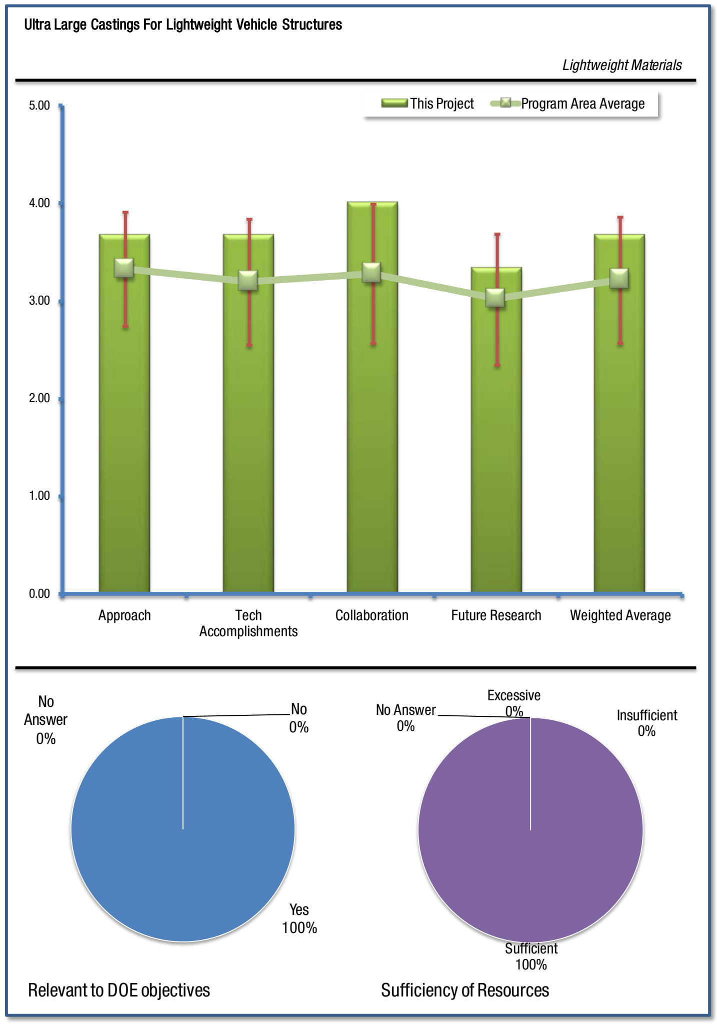
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer acknowledged lots of difficult issues were faced on this project, but it appears that good progress is being made.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer responded, noting this was among the best collaborative projects he had seen.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer noted the project has good plans going forward.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The reviewer found resources satisfactory.

Ultra Large Castings for Lightweight Vehicle Structures: James Quinn (General Motors Corporation)



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers all found this project very much in support of DOE goals. The consolidation of parts, lightweight structures, lightweight magnesium, etc. all support cost effective fuel savings. Magnesium is a key material for the future vehicle due to its low density and high specific strength.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found the approach in this project has worked very well, with barriers well defined and surmounted.

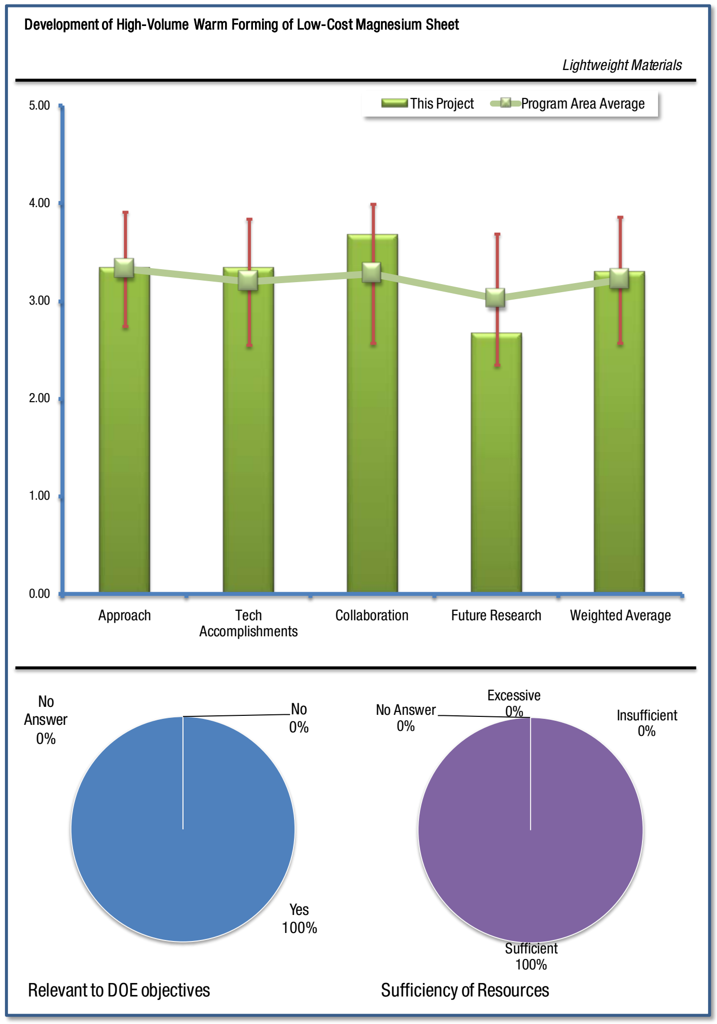
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers found the work achieved validates the technical accomplishments in the project–the real world component met all technical criteria. The F-150 radiator support validates the approach and R&D achievements. One reviewer noted significant progress has been made, however the cost of the magnesium is varying widely. Joining will be a challenging barrier and should be addressed from the beginning.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers found close collaboration was critical to achieve the results realized in the project. It is a well coordinated project, especially considering the stretch with these advanced casting processes. Another reviewer commented that coordination was very good between casters and OEMs. Another added the design analysis was very good.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Reviewers noted that the project was hampered by instability in the magnesium market price and loss of the project leader (Mike Maj). They found testing of the components in a real world application to be a very good idea. One reviewer added that technology transfer should be a high priority from this development.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Reviewers found the resources in line with the mission essentially accomplished to date, with the available funding.

Development of High-Volume Warm Forming of Low-Cost Magnesium Sheet: James Quinn (General Motors Corporation)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers generally found this project supports DOE goals, with one caveat. One reviewer found increased use of magnesium in wrought form will help to reduce more weight in the closure panels and help to improve fuel economy. However, another reviewer pointed out that, while in the use phase of the magnesium life cycle, petroleum may be displaced by efficiency gains, questions arise about the total life cycle analysis, which includes recycling. Magnesium is not considered as recyclable as aluminum or steel.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?
Is the project well-designed, feasible, and integrated with other efforts?

One reviewer found the project seems to be derivative, i.e., the approach is similar to the warm forming of AZ31 sheet practiced by the aerospace industry since the 1940s. The new equipment (sheet heating, robotics, more automation) may have addressed some of the technical barriers better than in the past. The big difference is the use of continuous cast (CC) strip that is cold rolled and annealed to specification. The first item -- obtain low cost AZ31B sheet -- was a big challenge. We did not hear what the price point was, but it probably would not compare with aluminum alloy sheet. Another reviewer found it is a great project on technology development of Mg applications in wrought form.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers noted many barriers were addressed and solved. One cited good progress considering the difficulty of forming Mg alloy sheet. The main technical accomplishment is the promotion of continuous casting technology for lowering cost. Low cost CC aluminum sheet is available (Fata-Hunter) and probably significantly beats the cost of the CC magnesium sheet. No mention was made of new technology with nano-Mg sheet being developed by Thixomat (mention was made of this technology at the recent TMS show in San Francisco). At a critical low grain size, the HCP structure of Mg sheet apparently does not pose a formability problem. What about other Mg alloys for sheet?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found coordination very good among partners, including suppliers, academia, and OEMs. Reviewers especially noted the Mg sheet producers. They also suggested looking into the nano-grain Mg work being done at Thixomat (Ann Arbor) and at other institutions and companies.

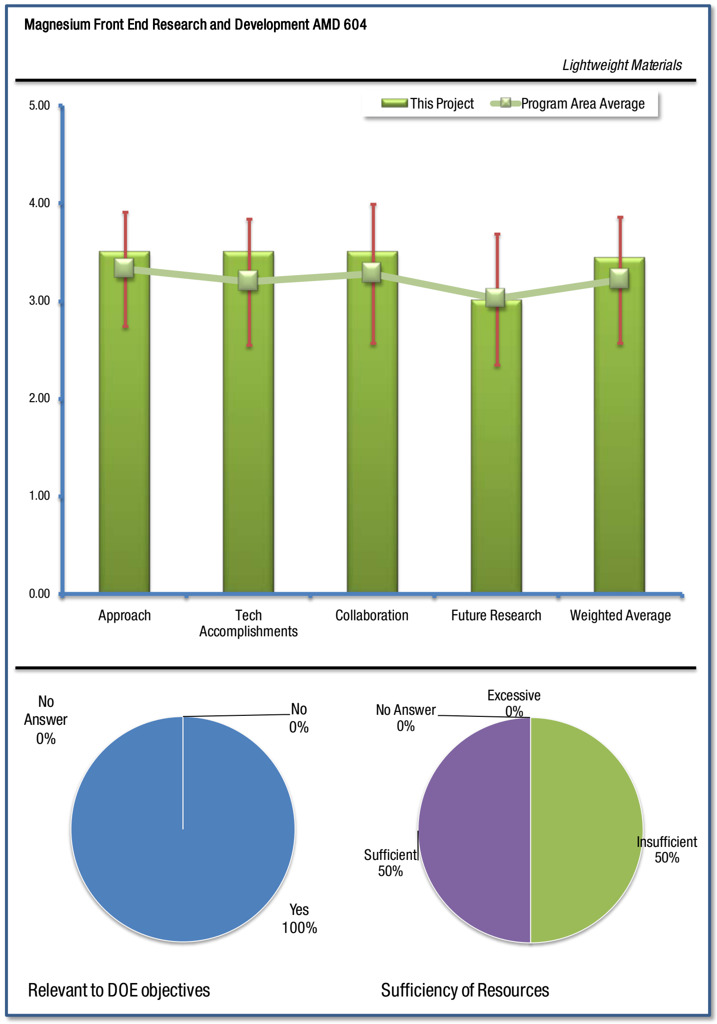
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers raised questions about future work. New Mg alloys coming on the horizon are not mentioned. They asked whether they will be addressed in this project. Also, are the effects of grain size on formability, especially nano-sized grains going to be considered?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer provided comment, noting that resources seem sufficient until the cost effectiveness is really proved. Low-cost magnesium alloy sheet was the goal, which may be more a barrier now with the high cost of magnesium relative to aluminum.

Magnesium Front End Research and Development AMD 604: James Quinn (General Motors Corporation)



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found the project does support DOE goals. A reviewer noted magnesium is a key candidate for the future car due to its strength properties and light weight. Another reviewer agreed, noting lightweight material transportation subsystems improved energy efficiency.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer found the approach simply excellent from a scientific standpoint. Another noted the key issue really is to figure out how the US and Canada can benefit economically (and in terms of jobs) from this whole project. If we don't do that, we will simply accelerate the pace of technology export to China. Another commented that vehicle architecture optimization needs to be considered for sub-assembly design and energy management.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers noted excellent progress; however, one noted key barriers to success, specifically: corrosion, crash energy management and sheet forming (in terms of processing energy required and die performance with complex shapes). Another noted initial results and findings are promising for further optimization and technology transfer.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found collaboration remarkable in its scope and depth as well as in the results. Once again though - the key point is to figure out how to actually make some money doing this commercially. One key defect in the slides is the omission of the AUTO21 Network as a Canadian partner. The fact is that AUTO21 is funding much (if not most) of the work being done in Canada outside of the work done at CANMET, and it is a misrepresentation to not include AUTO21 in the list of Canadian partners. A reviewer added he would appreciate it if this could be corrected in all future presentations.

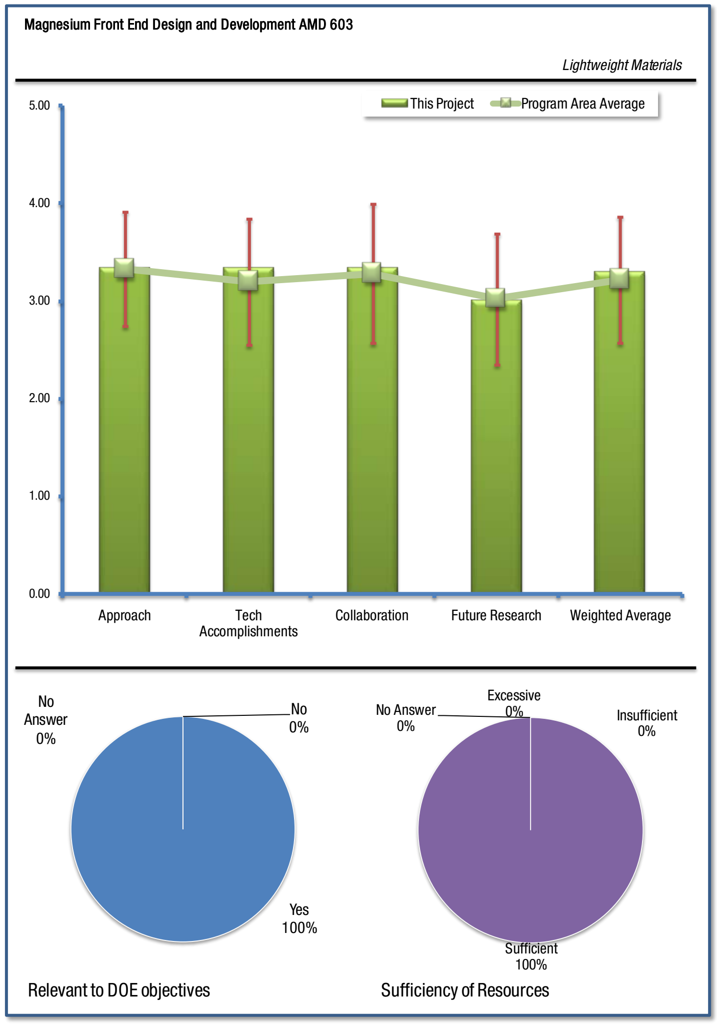
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found that while future plans look good, there still is a need to address both the technical issues (see above) and at least try to talk about the commercial / political ones in the future program.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer opined that much more money will be needed to do this properly in the future as we move toward commercialization.

Magnesium Front End Design and Development AMD 603: James Quinn (General Motors Corporation)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Significant reduction of mass with use of magnesium would improve fuel economy. Magnesium is a key material for the future car - widespread implementation of it will almost certainly lead to decreased petroleum use–a fantastic weight reduction here means fuel savings. However, as mentioned earlier, a total life cycle analysis for Mg vehicle components akin to those for Al and steel components would settle the issue. The reviewer added: don't forget end-of-life.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found it an extremely focused program considering the technical barriers and cultural barriers, and that it was a very well thought-out approach. One reviewer commented that fatigue life, galvanic corrosion, etc., with other materials would be a significant challenge. It should be considered in the design stage and barriers should be solved. Finally, another reviewer noted, aside from the issues about corrosion, crash and cost (energy and dollars), the following caveat: how do we make this effort pay off in jobs and business for North American companies?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers held mixed assessments of the progress thus far. One noted significant progress on some fronts (SVDC, thixomolding, etc.); but not enough progress on wrought Mg components. Others felt that work should be continued as planned. Technical cost model is very important and should be aggressive pursued. A crash model should be developed and verified. One stated the project appears to be on-track and working well.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

All reviewers found very good collaboration. One noted unbelievable collaboration considering the institutions and partners are Canadian, Chinese, and U.S., and there is no written agreement. Coordination is excellent considering language barrier, thanks to the internet, video conferencing, and face-to-face conferences and seminars. One reviewer added that while collaboration was very good, there was less emphasis on this aspect is evident than was noted on the other MFERD project.

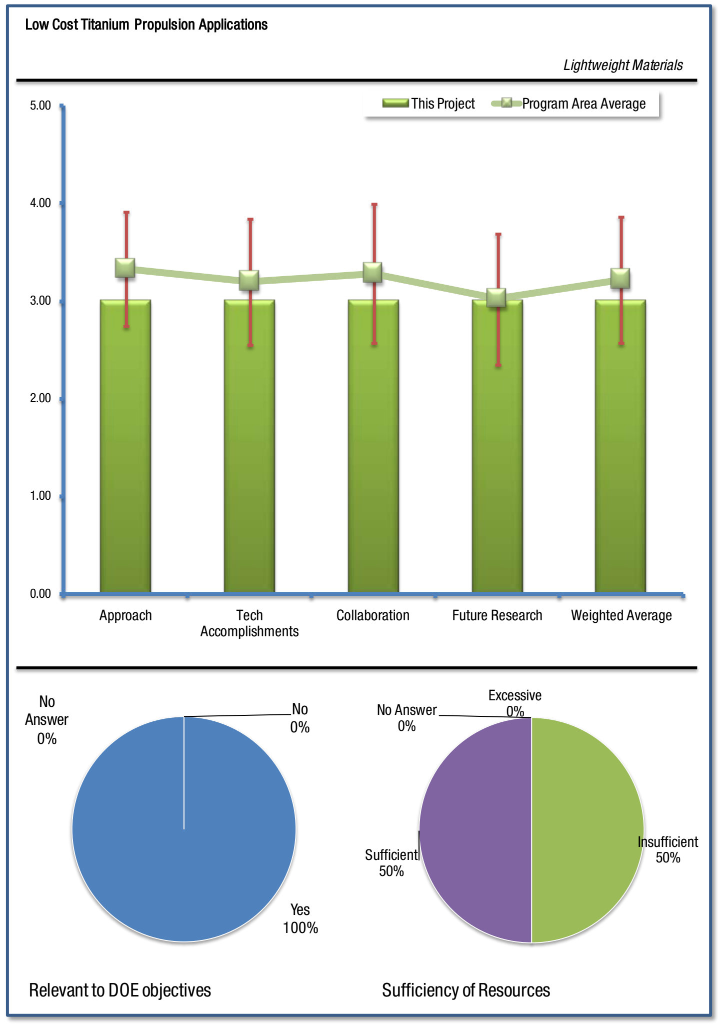
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found future plans for the project look good. One noted, considering some of the barriers being nearly impossible, the effort must address overcoming them in a general way. One noted the final outcome should be transferred to the design engineers to achieve the final objective of this project.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Two reviewers provided comment on the resources involved, noting they seem sufficient as long as cooperation continues on a hand shake basis.

Low Cost Titanium Propulsion Applications: Curt Lavender (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Both reviewers agreed use of titanium would help to reduce the weight of powertrain components and improve fuel economy.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers noted that cost is the main issue, not the applications or manufacturing of components. Lowering cost of powder should be the main focus of this project.

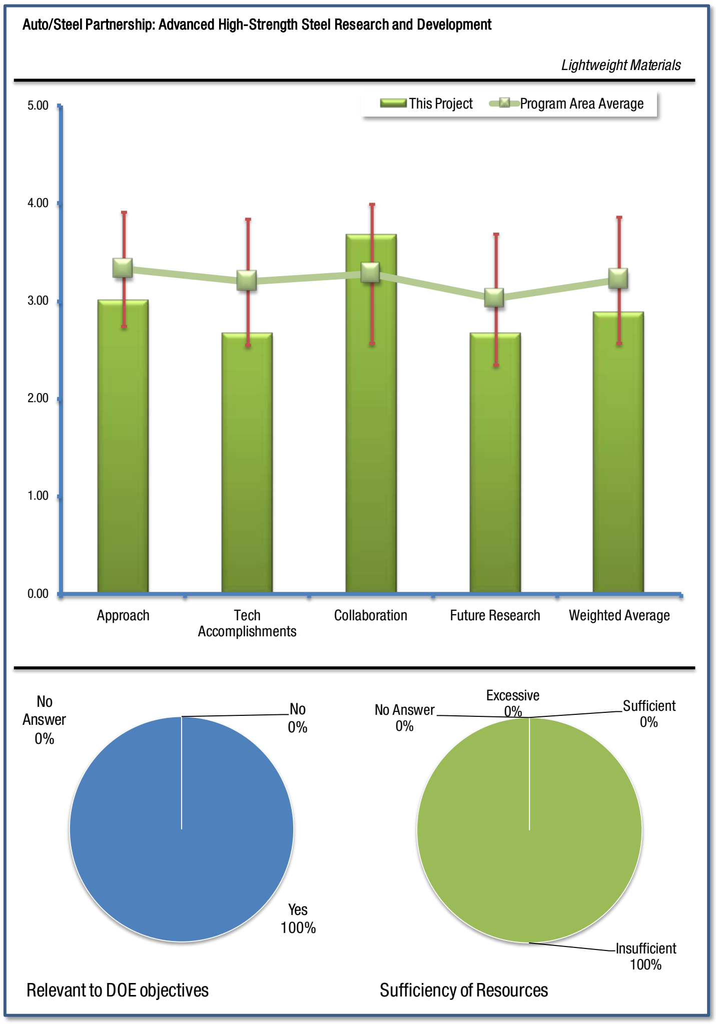
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
No comments.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
No comments.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
No comments.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer suggested the project needs more resources to make is a success.

Auto/Steel Partnership: Advanced High-Strength Steel Research and Development: Roger Heimbuch (A/SP)



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers found the project supportive of DOE goals. One noted decreasing petroleum usage will require making auto parts lighter and this means either using different materials - or using thinner sections of existing materials. Thinner sections imply that materials must be stronger to enable them to withstand the loads called for in the future automobile. Another noted the most likely solution will be a combination of both new and existing materials - the leading one of which is steel. Therefore, making steel stronger while maintaining its ability to be formed, welded and painted will be a critical part of making the future automobile use less energy.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
All reviewers were supportive of the approach taken in this project. One found it a well-planned and important program of impressive scope. Another said it is also vital to the support of the North American steel industry - as well as to the auto sector. And, for that reason, the support of DOE (and in Canada of CANMET and AUTO21) is warranted and an entirely worthwhile investment of public funds. One found the presentation a good summary of the strategy for introducing third generation AHSS for vehicles' lighting. Fatigue appears to be more difficult than planned; perhaps explanation about why would be helpful. The graph of lightweighting vs. time showing that AHSS can yield almost a 50% weight reduction was very interesting. Another reviewer added that efforts may be directed towards base materials innovations to avoid obstacles in manufacturing processes of functional products. Manufacturing cost of parts is too high for new materials introduction.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers saw good potential in this project. The accomplishments to date have been excellent - and a remarkable success story for the steel industry. One felt the only thing holding the program back is a shortage of funds - and this should be corrected if at all possible. Another remarked the modeling shows significant weight reduction, even if not 50%, it is clearly a good effort showing AHSS can be used more.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer provided that the AS-P is a remarkable display of collaboration among competitors, government and academia.

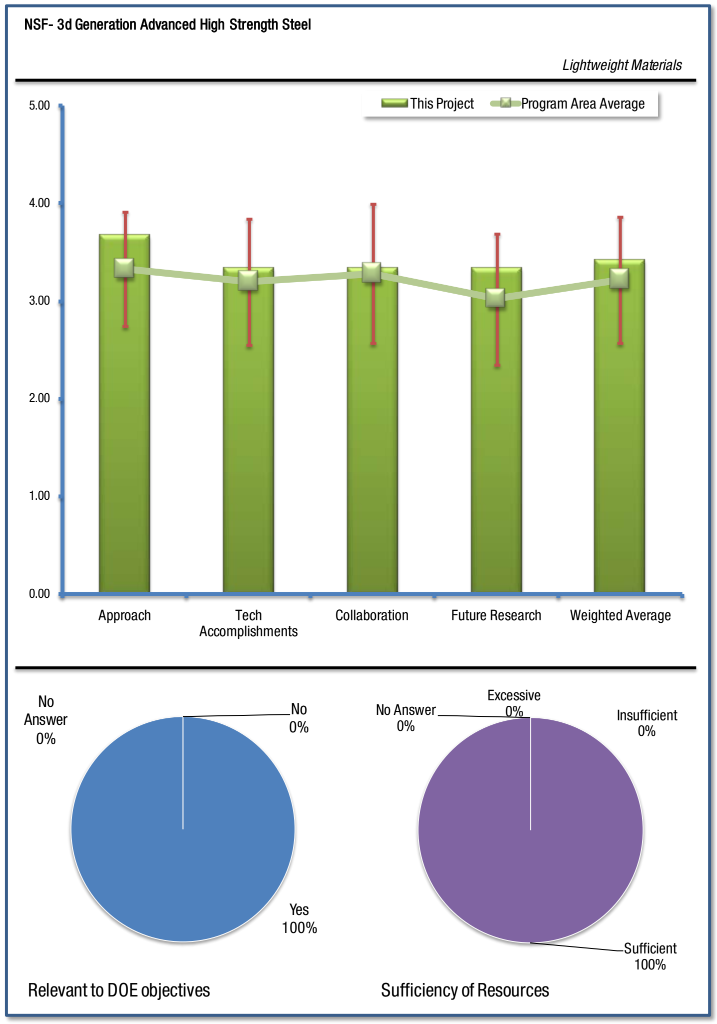
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer felt the project's future plans look good, but there seems to be a funding gap which should be addressed on a priority basis. Another noted significant potential for development.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers felt additional resources are a must. This effort warrants an increase in funding.

NSF- 3d Generation Advanced High Strength Steel: Roger Heimbuch (A/SP)



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
All reviewers agreed that lightweight steel is the prime material used in lightweighting vehicles. Introduction of more AHSS, especially third generation AHSS, would significantly reduce weight of automobiles, further resulting in improved fuel economy.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers found the A/SP has done an outstanding job focusing on achieving 40% weight reduction (with mass compounding) from all aspects of auto manufacture. A reviewer noted the funding by the DOE has accelerated the progress no doubt. Steel has a cost advantage over alternative lightweight materials, and this is a technical barrier that is low for steel but high for the competition! Another noted the project plan was very good. Fundamental understanding of third generation of AHSS would help to produce new material more cost effectively.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Reviewers found the progress to be slow but worth the wait. One reviewer suggested progress should be accelerated, with focus on barriers to be overcome. Another noted that it is still early to assess. A third noted, that although Dr. Heimbuch has briefly covered the technical accomplishments, the progress toward weight reduction has been exemplary, which means the technical accomplishments overcame the lightweighting barrier (high for steel).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers unanimously found collaboration in this project outstanding, followed with a few suggestions. One specifically cited good collaboration with worldwide steel companies that would be the envy of the aluminum and magnesium industry. And there was outstanding collaboration with universities and national laboratories due to the A/SP efforts in promoting advanced high strength steels as a research topic. One reviewer noted interaction between different universities and steel industry is outstanding. Significant development is going on steel microstructure with heat treatment and carbon partitioning–a great program. One reviewer agreed, though also suggested that some great people in Canada could contribute to the overall effort which would benefit the program. For example, Stephen Yue (McGill Univ.), Michael Worswick (Waterloo) and Randy Bowers (Windsor) are all established researchers with a great deal of experience in the issues facing this important effort.

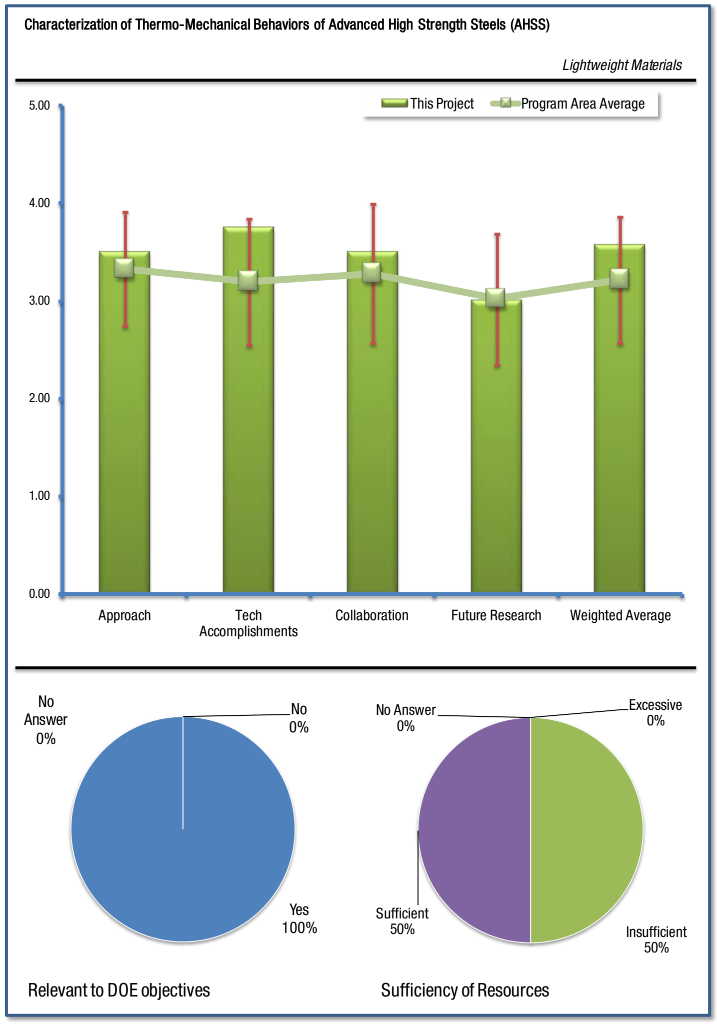
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers were mixed on the plans for future work. One believed too much concentration is made on ultra-, ultra-high strength steels that will require thinning of the sheet to achieve light weight. This concentration will lead to problems with buckling in structures (localized and general), recycling, and cost, essentially raising new barriers to progress. Another felt future plans look good, while a third felt the proposed research program is very good, but due to time constraints to complete the project, development work should be accelerated.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer found the technical accomplishments achieved with the resources that have been available have been exemplary. This reviewer felt resources should be maintained and should yield good results in achieving the stated milestones. Another reviewer needed more information to make a determination, though felt the budget seems to be okay.

Characterization of Thermo-Mechanical Behaviors of Advanced High Strength Steels (AHSS): Mark Smith (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found the project directionally supportive of DOE and FreedomCAR program goals, although one did note that the timeframe is long–perhaps 10 years. One reviewer noted AHSS materials are important bedrocks of the FreedomCAR program and support petroleum displacement in the total lifecycle of vehicles. Another added the increased use of new AHSS would lead to reduced weight and meet 50% weight reduction goal of FreedomCAR.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?
Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found the approach taken in this project to be commendable. One reviewer lauded the effort to characterizing the effects of microstructure and thermo-mechanical effects on basic mechanical properties and fatigue resistance, important in modeling automotive components made from AHSS. Another added the basic understanding of mechanical behavior of these AHSS is very important for modeling. Basic understanding of welding of these materials is important for predicting mechanical behavior of these materials. So this work is very valuable. Still another reviewer remarked about forming and welding influences on microstructures that more depth is needed to establish whether the approach is outstanding or not.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers found progress proceeding well. One reviewer remarked that although the presentation was just a glimpse of the R&D, it is understood that the technical accomplishments were first class and achieved project goals. Basic understanding of interaction between microstructure and mechanical behavior would lead to the development of modeling for future material use. Depth of work is outstanding. Another reviewer found the results good, but a question was raised about the very homogeneous microstructure, pointing to rather small samples, and whether it is scalable. Another reviewer noted there was good understanding of the welding part, together with modeling; the quality of results was outstanding.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found a narrow level of collaboration, with two good groups of two DOE labs. Although there aren't as many partners in this project, it was noted, they are fairly well coordinated. One reviewer specifically did note the coordination of both National Labs and steel companies is very good.

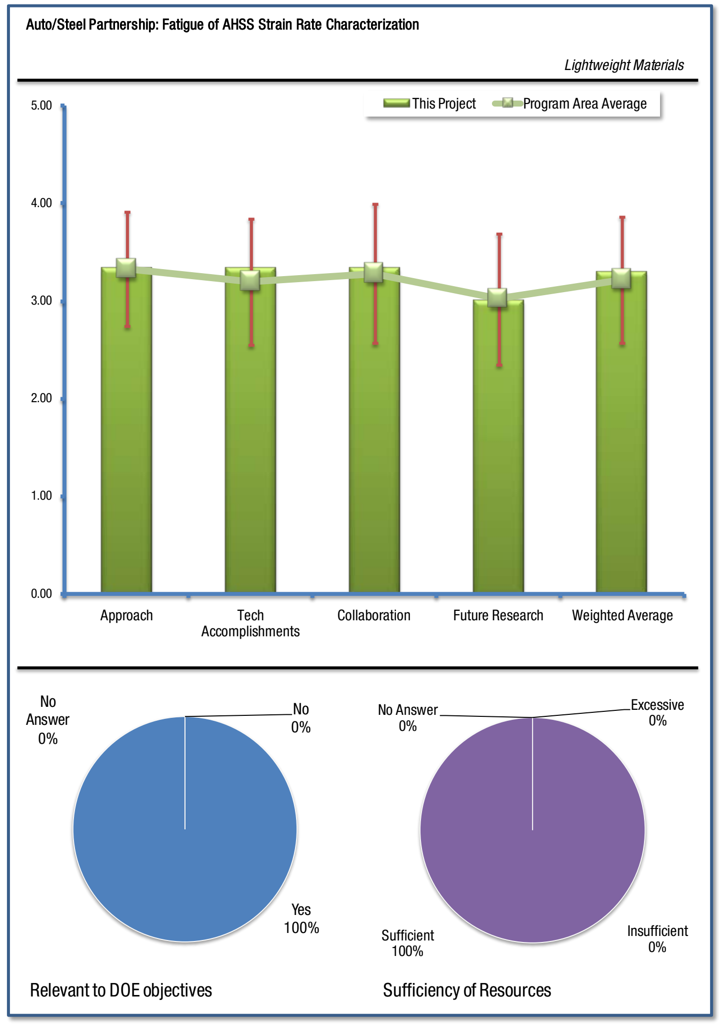
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers were disappointed that the presentation did not explain future plans. One reviewer noted the presentation doesn't clearly establish the proposed future research, but it has been stated that these results will be useful in modeling applications for AHSS. A question was raised: how will these models be applied to actual production components? In comparing the results from this program with those in the following presentation (LM26), there seems to be a contradiction. LM26 concluded that fatigue of welded joints of most of the AHSS sheet materials was only affected by weld parameters and sheet thickness irrespective of composition. The results of LM25 and LM26 need to be compared and explained as to the contradiction. One reviewer did suggest that works in modeling should be accelerated, and that tech transfer to steel companies, OEMs and parts suppliers should be one of the prime objectives in the future plan.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer found milestones were achieved in this project and that it has sufficient resources; however, another reviewer felt it needs to be expanded.

Auto/Steel Partnership: Fatigue of AHSS Strain Rate Characterization: Roger Heimbuch (A/SP)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found this project very important work for modeling the applications of AHSS in achieving petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found this project did a great job in identifying an important issue with AHSS relative to effect of weld geometry, AHSS steel composition, sheet thickness on fatigue. Strain rate data are critical to crash modeling, and approach gives desired results. It looks to be a very solid and well-planned project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers felt this project achieved exemplary, work with excellent progress toward objectives and promising results. One noted significant work still is to be done. But all agreed that conclusions are critical to designing light weight vehicles with AHSS sheet.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found this project has outstanding collaboration by A/SP with AHSS suppliers, users, and R&D personnel. One reviewer suggested, for additional input in weld modeling, that the researchers contact Dr. Moyra McDill at Carleton University (mmcdill@mae.carleton.ca). She has 25 years of experience in modeling transient processes such as welding and the cooling of castings as well as the development of automatic meshing algorithms that refine and coarsen the mesh in response to transients.

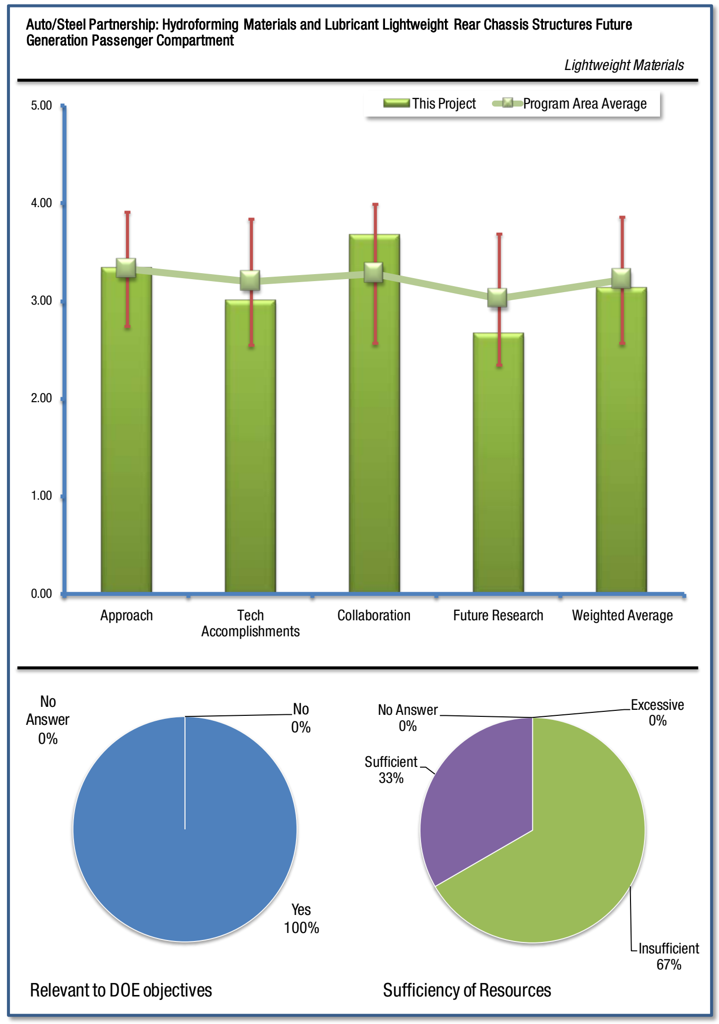
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found future work plan to be in order. One reviewer noted the application of data in modeling is generally addressed but there is a need for clarification as to how modeling will make use of the data. The general idea that a given number of welds are needed based on design and not on type of AHSS is a plus in assessing a new design.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers disagreed on future funding for the project. One found stated milestones are achievable with resources available. The other felt more funding could be useful for this task.

Auto/Steel Partnership: Hydroforming Materials and Lubricant Lightweight Rear Chassis Structures Future Generation Passenger Compartment: Roger Heimbuch (A/SP)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers found obvious weight reduction and life cycle analysis supports petroleum displacement. Achieving lightweight structures and application of these components would achieve towards the goal of FreedomCAR.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found the approach generally effective, though with some criticism. One reviewer did find that except for the approach taken on the hydroforming project, the approaches on the rear chassis and passenger compartment were creative and generally effective. Although significant progress was made on the rear chassis and passenger compartment -- all made with 100% AHSS -- the question is begged: if the multi-material vehicle is anticipated to achieve the FreedomCAR goals, why doesn't the A/SP include these materials along with AHSS to help the program along? It seems that most of the DOE projects are uni- and not multi-material in approach. Another reviewer found the financial and technical problems appear to have partially derailed the effort.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers had mixed reactions to the progress in this project. One noted that two out of three objectives essentially achieved isn't bad. The use of a multi-material concept (plastic/AHSS roof component) in the passenger compartment may be a step toward what is brought up in Question 2 above. Another reviewer noted this project seems to have suffered from more than the usual amount of technical and financial difficulty, which is unfortunate. Significant progress has been made, noted another reviewer, and this should be transferred to OEMs and parts suppliers. Still another reviewer noted that overall, this effort appears to have worked well and been worthwhile (10-30% weight reduction and a 63% stronger roof).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers agreed that, as usual, A/SP does a great job in collaboration with institutes and participants.

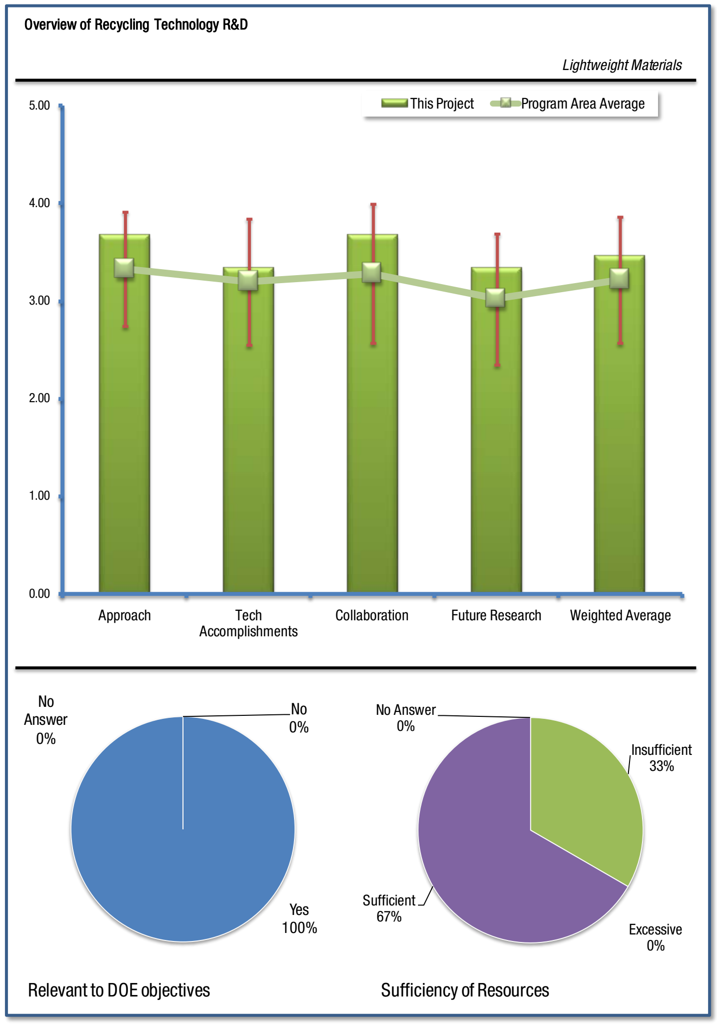
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found the forward plans seem to be good - assuming sufficient resources can be secured. One reviewer noted that achieving the tough weight reduction targets may necessarily require a multi-material approach, which is not recognized presently in the AHSS project portfolio. Another noted it is a good research program and should be completed according to milestones. Another noted the presentation dealt with several tasks - some of which are winding down and others are still in progress.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers found additional resources are essential to success of this project. One noted, to achieve stated milestones (50% weight reduction), a multi-material focus may need to be introduced into the AHSS programs that involve lightweight vehicle designs. The current resources are insufficient for this focus. Another found the mix of tasks somewhat difficult to assess, but overall it sounds as though more funding would be helpful.

Overview of Recycling Technology R&D: Ed Daniels (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers agreed that, especially with the 4:1 energy advantage with the recovered plastic, this project supports DOE goals. Recycling is one of the goals of the FreedomCAR program and is essential to meet the DOE goal.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Considering the difficulties and high technical barriers to recycling polymers from this waste, the approach here was highly focused on that which was difficult to improve, especially considering the results. Another reviewer noted all the recycling projects were well defined and met the objectives. Still another noted the project is well structured but could be better detailed and developed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer did not find sufficient detail in the presentation to make an assessment. Another reviewer found excellent progress. The chemical engineering processes to remove and separate the polyolefin and ABS polymers are directly transferable to the new demonstration plant. Another reviewer found all the deliverables were met as planned.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found collaboration to be excellent in the project. All the partners and institutions helped and collaborated closely, leading to a successful result and good future prospects.

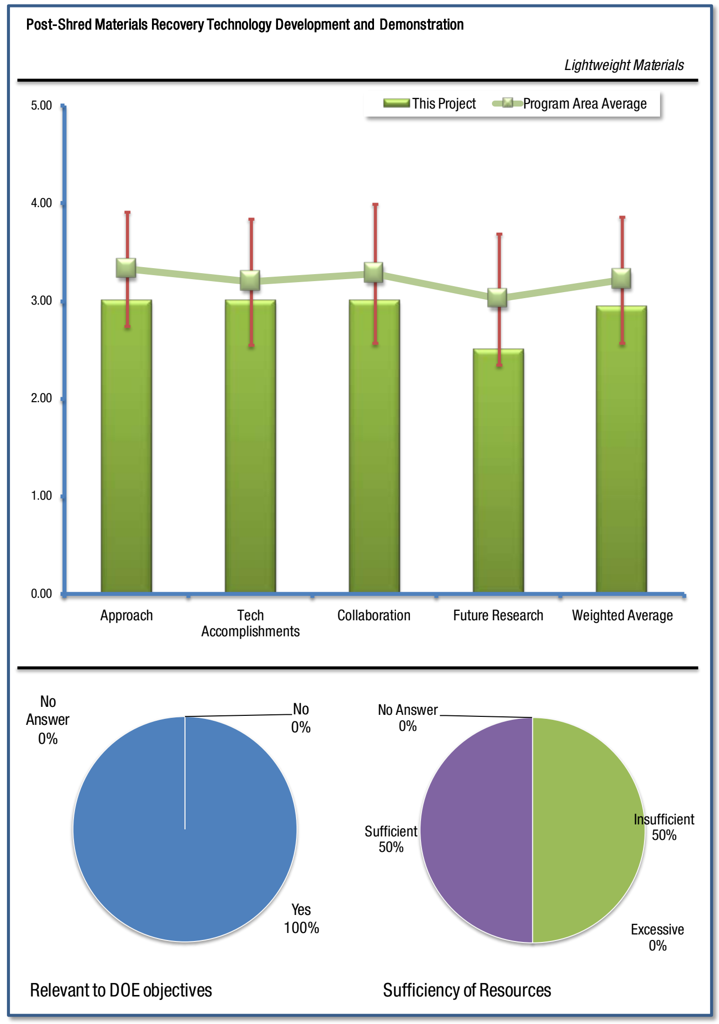
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers noted the demonstration plant clearly builds on past progress and is sharply focused on success in overcoming barriers. The PCB is a real problem but, overall it is limited.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that although resources seem sufficient, this is an assumption as the costs of building and operating the demonstration plant may be understated.

Post-Shred Materials Recovery Technology Development and Demonstration: Bassam Jody (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer noted that while recycling does not directly decrease petroleum usage, it is certainly related in that it can assist by making the economics of lightweight materials more attractive. In addition, recycling of existing or used lightweight metal parts is much less energy intensive than making new LW metals from ore. Therefore, recycling is a useful and important means of obtaining raw materials for use in new lightweight auto parts. In this way, the recycling project does contribute to the reduction of energy use and thus, to the usage of petroleum. Another reviewer added that any recovery of material will displace petroleum.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers found this to be a very sensible approach but it appears to be just about the same as last year's.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers were mixed on the perceived progress of the project. One reviewer liked the scale-up scheme to a validation scale unit and use of mold try-outs with recovered plastics. Another reviewer noted, even though milestones from two previous years were displayed, it's difficult to see progress. It was noted that nano particles are promising.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

One reviewer noted the collaboration seemed good but did not notice a comprehensive listing of the partners involved.

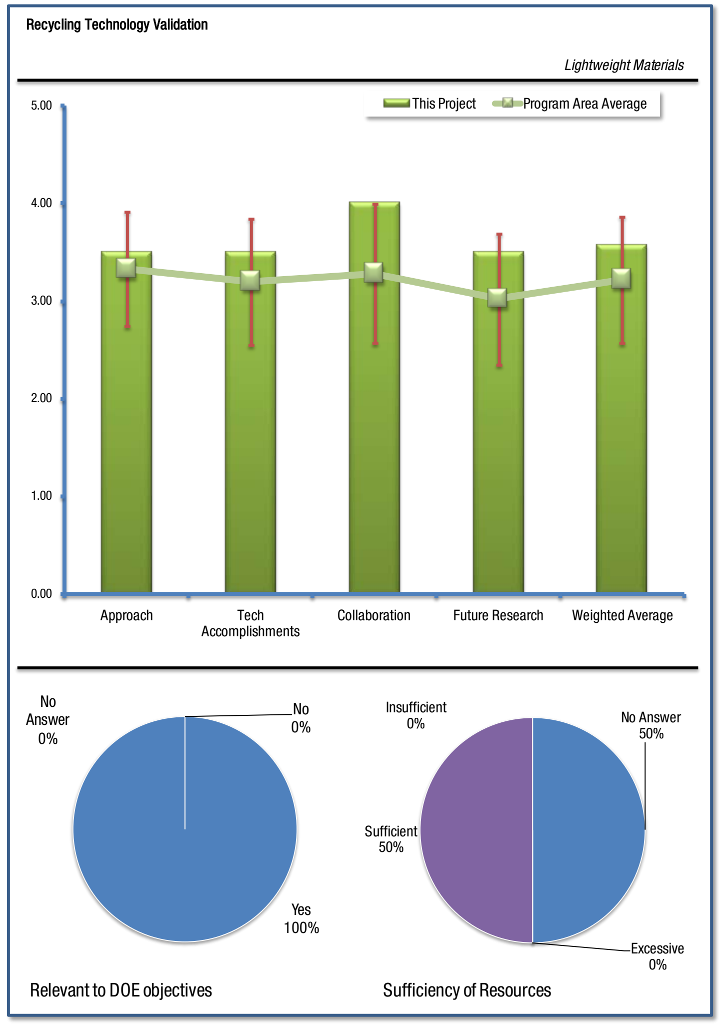
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer found the future plans to be reasonable. Another felt it should be more developed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer noted that the resources seem okay but that not much was said about resources and the project is winding down this year.

Recycling Technology Validation: Joe Pomykala (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer noted the validation plant will follow the petroleum displacement described in LM28 and LM29. Another noted any recovery of material will displace petroleum.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer found the approach seems okay. Another reviewer noted, following up on the approaches in LM28 and LM29 and the detailed cost model, the technical and economic barriers are addressed.

Question 3: Characterize your understanding of the technical accomplishments
and progress toward overall project and DOE goals.

Reviewers noted that completions of layout, electrical and plumbing designs are expected soon and suggest that the barriers (now mostly cost) will be overcome. One reviewer noted it would appear that the project has achieved a good and useful set of results and is on-track to benefit from the start of the pilot plant which is presently under construction for commissioning shortly.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers found close cooperation with partners and equipment builders and that should result in start up on or close to schedule. Another added that the collaboration is important to fostering technology transfer.

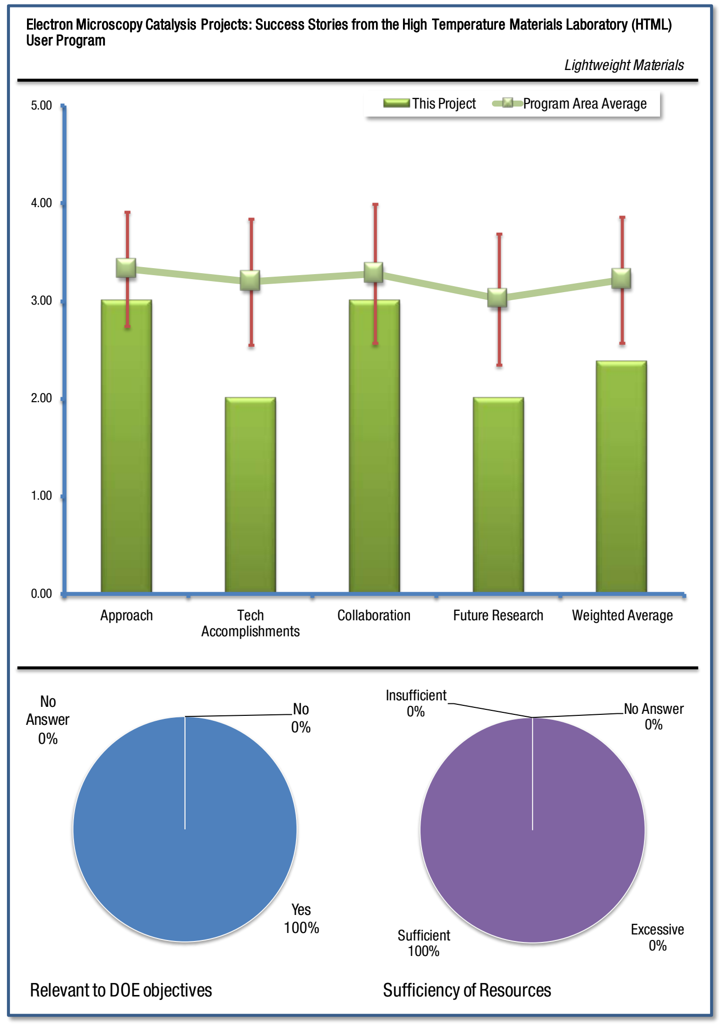
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers found planned future work to be commendable, with efforts building on past progress and a sharp focus. One reviewer did note the project is winding down.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer assumes, with such good cost modeling, that the project leader/team has secured sufficient funds and resources. Another reviewer is not sure how to answer the question–the research and validation preparation work is going to end this year with the start-up of the new validation plant. Another found the requested budget going forward is to support the start-up of operations of the plant and so it is somewhat speculative as to how much money will be needed.

Electron Microscopy Catalysis Projects: Success Stories from the High Temperature Materials Laboratory (HTML) User Program: Lawrence Allard (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
The reviewer didn't comment on this question.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer stated the investigators could have shown how (through analysis and performance projections) how increases in catalyst performance impact/effect fuel cell performance or catalyst rates or oxygen reduction reactions in one particular case. PNNL section or case example was particularly lacking in effects on how progress overcomes barriers or impacts system performance.

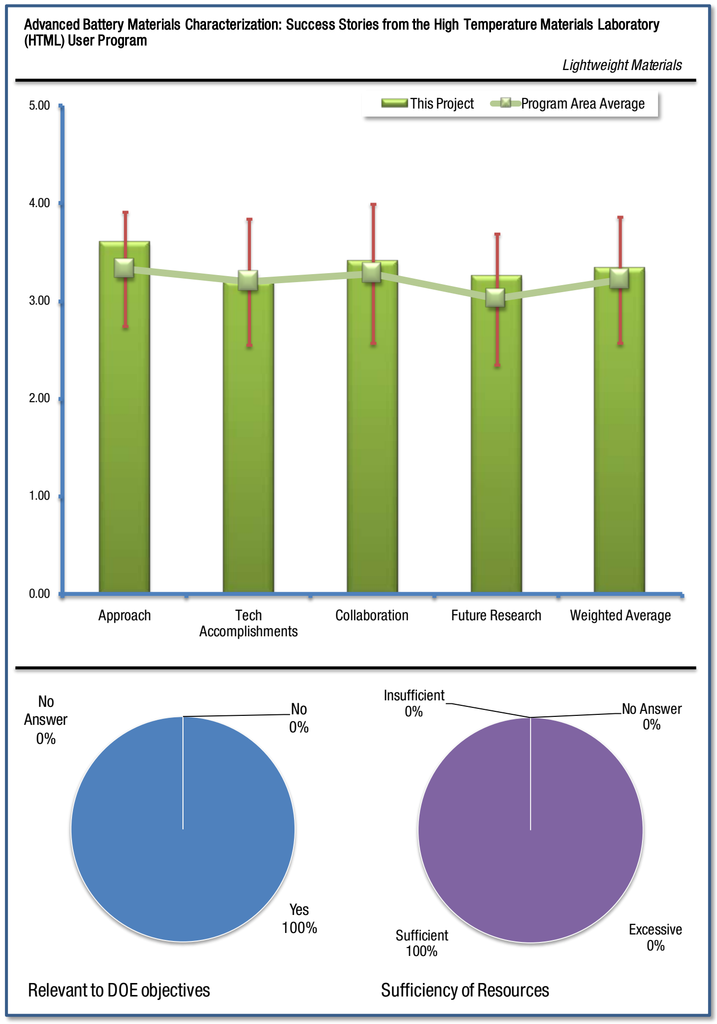
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated it is very hard to judge progress on barriers because of comments discussed above in item #2. The investigators need to more strongly tie their progress shown to impacts and affects on fuel cell performance, catalyst performance in a system operation, or catalyst rates.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
The reviewer didn't comment on this question.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated this was very hard to assess because there was no future or planned research shown or mentioned.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
No comments were provided.

Advanced Battery Materials Characterization: Success Stories from the High Temperature Materials Laboratory (HTML) User Program: Andrew Payzant (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the battery materials characterization user projects highlighted in this presentation address technology development issues associated with abuse-tolerance, durability and power density. Another reviewer noted yes this is the kind of study that associate industry and National Lab will necessarily help to support DOE objectives. One reviewer commented the clarification of basic mechanisms impacting safety and performances of Li battery materials is fundamental in allowing for a large diffusion of EV and HEV and then significantly reducing petroleum use. Comments from another reviewer mentioned this HTML user program addresses advanced battery materials. These batteries are applicable to vehicles and so this topic is relevant to petroleum displacement. Observations from one reviewer added in situ measurements of batteries are important to addressing performance gaps. Specifically the work of this poster highlights efforts to understand internal short and crystal structure during charge and discharge may have benefits to improving safety.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated in this poster three HTML User Program projects focused on the characterization of materials for batteries were highlighted. Thermal runaway is an important safety and reliability issue for Li-ion batteries. The battery industry does not have a standard method to test production cells. The HTML is working with Motorola to develop a reliable method to test cells for potential of thermal runaway due to internal short. Thermal conductivity of the cell materials determine how fast heat can be dissipated in an event of internal short. If local temperature reaches a critical point, thermal runaway will occur. This reviewer went on to say high-speed infrared imaging was used to determine the temperature distribution in batteries. For the Brookhaven project the changes in electronic and crystal structures for both uncoated and carbon coated LiFe1/4Mn1/4Co1/4Ni1/4PO4cathode materials during charge-discharge cycling were determined using the in situ x-ray diffraction capabilities of HTML's X14A synchrotron beam line at the National Synchrotron Light Source (NSLS). Synchrotron x-rays were used to determine the site occupancy of dopants in the olivine structure, with particular emphasis on identifying site mixing and site vacancies for the MIT project. Another reviewer commented the development of in-situ techniques are always helpful to better understand the mechanism that limit battery's performance, life and abuse tolerance. Oak ridge has very unique capabilities. One reviewer added the idea of an independent laboratory able to investigate fundamental phenomena of Li battery materials is excellent. The approach clearly addresses key technical barriers, whose comprehension is functional to a larger use of such batteries. Comments from another reviewer noted the program highlights 3 major projects involving IR imaging and in-situ x-ray diffraction for phase analysis. Observations from one reviewer mentioned they think the BNL effort is good and raising awareness is also good so that industry and academic partners can come forward to study problems. They question the value of Motorola's research developing a destructive QC test for a problem which is dependent on individual cells seems to not be very sound. Destructive sampling QC makes sense when there are systemic flaws but not as a method for detecting problems which are more related to individual units.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer stated the HTML User Program provided valuable characterization support for three User Projects investigating advanced battery materials. Another reviewer mentioned that all three cases shown are very impressive in term of results. One reviewer commented the results are not yet complete but seem quite interesting and in line with the scope and objectives of the HTML efforts. For example, the development of new evaluation methodologies, such as the use of infrared imaging for thermal runaway analysis, is of a wider importance, because it can be applied at various configurations, and it is already a very good result. Comments from another reviewer added the IR imaging project addresses thermal runaway in Li ion batteries. Thermal runaway and battery safety remains a concern. The availability of the IR imaging instrument in this HTML user program will enable researchers to study this problem and will improve the safety of battery technologies. The other 2 battery-related projects examine in-situ x-ray diffraction during charge/discharge cycles. These projects are also extremely meritorious.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer stated the project has collaborated with five institutions in battery materials research. Only three interactions were highlighted. Another reviewer added the collaborations are good and based on clear rules, even if the impression is that they are the result of casual commitment and interest. The HTML should be better integrated in the Battery Subprogram, as part of the basic characterization of the materials and batteries under investigation. The full involvement of the participating organizations and their coordination is well defined in the rules for asking the scientific support of HTML. One reviewer noted this program highlights collaborations with an industrial laboratory (Motorola), a university (MIT), and a national laboratory (Brookhaven National Laboratory). This shows a very diverse cross-section of users/collaborators. Comments from another reviewer mentioned the strength of this program is the need for external partners to propose and staff research - excellent collaboration. The reviewer really likes the model.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
A reviewer stated the ORNL researchers working at HTML publicize the HTML facilities at scientific conferences and their website. Access to the HTML is provided through the HTML User Program proposal process. Research proposals are reviewed by a committee and approved based on scientific merit, relevance of the proposed research to the mission of DOE’s Vehicle Technologies Program, and feasibility. Research is completed within 24 months. The research plan is set up by the users. A research plan is complete when the results are published in the open literature and/or presented at a professional conference. Another reviewer noted the prosecution of ongoing projects is reasonable, while the start of the new projects is interesting but not based on a coordinated or strategic plan. This implies that not necessarily the most interesting research needs are evaluated with the powerful expertise and instrumentation of HTML. One reviewer mentioned each user program has 2 main ways in which they are able to address future research plans:

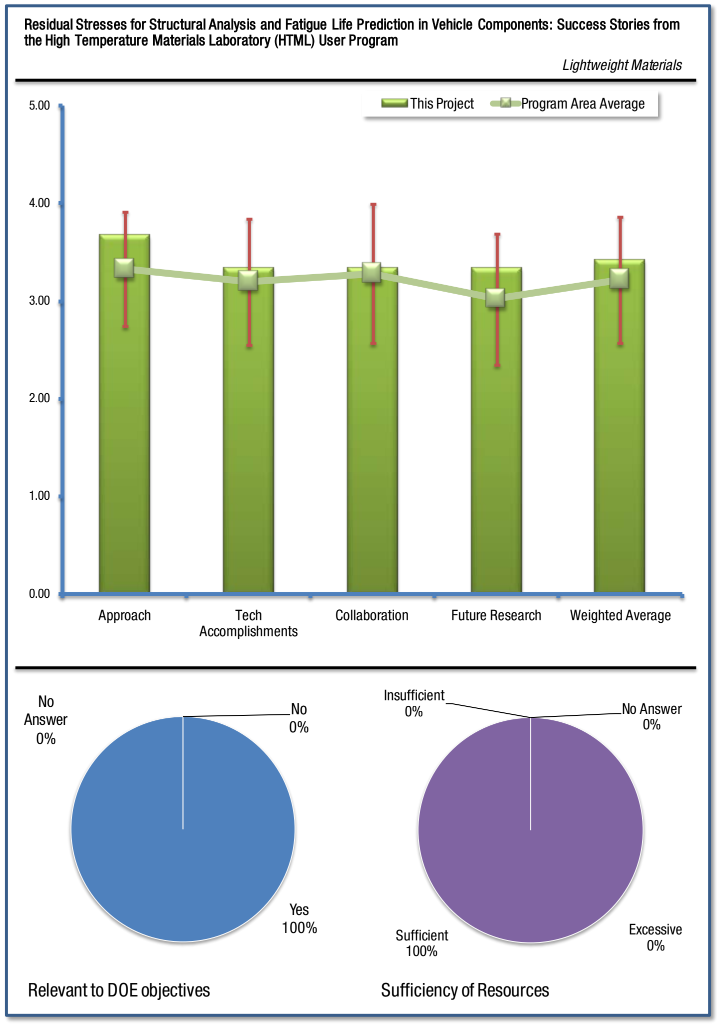
(1) to increase the number of users and ensure strong user base-- presentations are delivered at conferences and workshops, and results are published in peer reviewed literature; and

(2) a list of state-of-the-art instrumentation is maintained by the director of the HTML user program. This list is revisited and reprioritized on a regular basis-- ensuring availability of cutting-edge techniques to the user community.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated sufficient resources are provided for these HTML projects. Another reviewer commented the level of resources is clearly related to the number of projects accepted or scientific services required. One reviewer noted the resources seem appropriate but would depend on partner demand - in view of the queue length - on the order of a month or two - seems appropriate.

Residual Stresses for Structural Analysis and Fatigue Life Prediction in Vehicle Components: Success Stories from the High Temperature Materials Laboratory (HTML) User Program: Camden Hubbard (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the user project described in this poster presentation is relevant to the mission of the VTP, because they address the goals of material and manufacturing technologies for high volume production vehicles that enable/support the simultaneous attainment of reduction in the weight of vehicle structure and subsystems and affordability, and increased use of recyclable/renewable materials. This project assesses the impact of common hole-making processes on commercial vehicle side rail durability, specifically the residual stresses and crack growth properties. Another reviewer noted this X-ray and Neutron HTML user program highlighted projects which involved mechanical testing and residual strain measurement for vehicle components.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach for hole making, fatigue crack growth measurement, and baseline materials properties were established by Metalsa. Metalsa worked with the researcher at HTML making use of the neutron residual stress mapping setup. The approach taken is the right one to evaluate the detrimental effects of manufacturing processes. The results of this approach enable Metalsa to optimize fabrication parameters, process variables and choice of alloys to meet requirements of truck manufacturers. Another reviewer commented the projects described in the poster examine alternative light weight materials and process evaluation for vehicle applications. The overall goal is a 15-25% reduction in chassis weight for large vehicles. One reviewer added the investigator provided a nice discussion on the project and how it clearly led to overcoming vehicle weight reduction barriers.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated there is lots of data but it is not clear what the accomplishments were. It would be nice if the accomplishments were summarized in one or two slides. There are too much details and it’s very difficult to find the accomplishments. Another reviewer noted the program highlights projects involving residual stress mapping using neutron diffraction. The work is collaboration with industry, the Metals Roanoke Company. The project assessed fatigue life of components and hole-making processes (thermal vs. mechanical processes). Key findings are reported which highlight the relationship between residual stress and cooling rate. Neutron diffraction and strain analysis was also used to assess the heat affected zones of processed materials. One reviewer mentioned there was a very good discussion on how their industrial collaboration led to vehicle weight reduction and how it affected trucking industry nationwide.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated Metalsa submitted a user proposal in October 2007. This proposal was selected and HTML researcher started working with Metalsa. It appears majority of the work was done by Metalsa. Another reviewer commented this HTML user program collaborated with 20 different user projects. At least 8 of the users were university-based research teams. Three companies were also represented in the user community. One reviewer noted the investigator takes a nice approach to collaboration with industry in properly planning measurement sequences, procedures, measurement parameters and metrics.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated this project with Metalsa is scheduled to end in June 2009. No future work for this project was presented. Another reviewer added the investigator demonstrated good follow-on research and measurement plans with industry. One reviewer mentioned each user program has 2 main ways in which they are able to address future research plans:

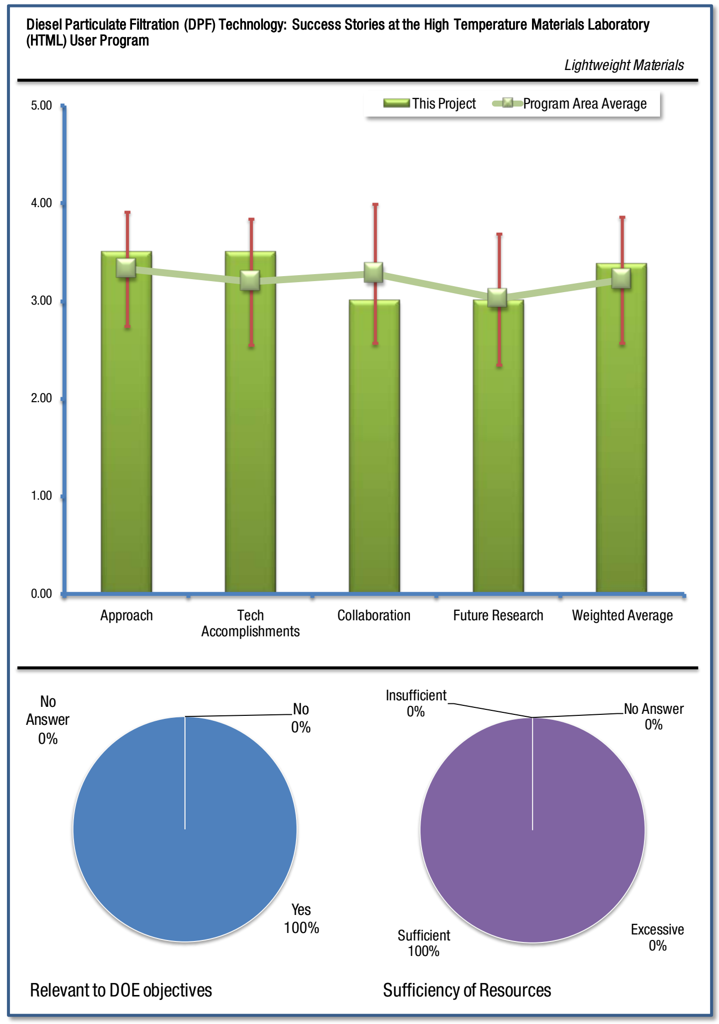
(1) to increase the number of users and ensure strong user base-- presentations are delivered at conferences and workshops, and results are published in peer reviewed literature; and

(2) a list of state-of-the-art instrumentation is maintained by the director of the HTML user program. This list is revisited and re prioritized on a regular basis-- ensuring availability of cutting-edge techniques to the user community.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that sufficient resources are provided to HTML by DOE to carry out this short term user facility research.

Diesel Particulate Filtration (DPF) Technology: Success Stories at the High Temperature Materials Laboratory (HTML) User Program: Amit Shyam (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the user projects highlighted in this presentation address barriers associated with engine efficiency reduction by measures to reduce emissions identified in the Advanced Combustion and Emission Control Technical Roadmap for Light-Duty Powertrains and the Roadmap for the 21st Century Truck Partnership. In this poster four HTML User Program projects on diesel particulate filters were highlighted. Another reviewer noted this HTML user program assesses diesel particulate filtration technologies and is relevant to DOE objectives of petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated in this presentation four HTML User Program projects on diesel particulate filters were highlighted. The approach for the project with CEO2 Technologies is to utilize techniques developed at the HTML to prepare test specimens of porous materials and determine their fracture toughness and thermal conductivity. Utilize scanning electron microscopy to characterize the microstructure of these materials. The approach for the interaction with University of Wisconsin is to utilize UV-illuminated optical microscopy and an environmental scanning electron microscope to determine penetration depth in porous substrates. The reviewer went on to say this approach is followed to understand the fundamentals of soot deposition in DPFs and to quantify soot penetration depth in DPF walls. The approach for the University of Utah project is to use laser flash thermal diffusivity and differential scanning calorimetry to determine the thermal diffusivity and specific heat of soot deposits as a function of deposition temperature. In-situ Raman spectroscopy and a diamond indenter were utilized to quantify the effect of stress on the beta-eta phase transformation in eucryptite in the project with Colorado School of Mines. Another reviewer mentioned the program shows projects which have used SEM, Raman spectroscopy, thermal conduction measurement, and UV microscopy as a part of the HTML user program on diesel particulate filtration. The project performed quantitative SEM to examine the cross-linked microstructure of mullite (and industrial collaborative project with GeO2 Technologies). Two universities were highlighted in the poster. One of the university research teams (Univ of Wisc) was interested in examining soot deposition into diesel particulate filter walls and used Raman to examine the penetration depth of the soot as a function of engine operation conditions. This reviewer also said the other university research team (Univ of Utah) was interested in examining the thermophysical properties (thermal conductivity) of soot generated by combustion under various conditions. Low thermal conductivity will lead to thermal expansion of the soot, thereby applying stress to the filter and subsequent cracking. Both projects were well focused and the user program provided the appropriate instrumentation for assessment of relevant problems (relevant to displacement of petroleum technologies).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the test methods developed at the HTML were utilized to determine the mechanical properties of novel fibrous materials developed by a small business (GEO2 Technologies). Using in situ Raman spectroscopy, the feasibility of phase transformation toughening in beta-eucryptite was demonstrated, which could lead to the use of this material for tough, durable and cost-effective diesel particulate filters. The thermophysical properties of soot deposits were determined, and the effects of engine operating parameters on soot penetration on porous substrates were quantified. Such information will help optimize filtration systems. Another reviewer commented the technical accomplishments highlighted were meritorious and resulted in several publications (3 listed in the presentation).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the HTML is a National User Facility that supports the missions of DOE, EERE and the VTP in particular, by working with industry, universities and other national laboratories to develop energy efficient technologies that will enable the U.S. to use less petroleum. The project has collaborated with four institutions on diesel particulate filters. Another reviewer noted the user projects highlighted in the poster were from universities and industry. This demonstrates a diverse user base for this HTML user program.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated the ORNL researchers working at HTML disseminate the HTML facilities at scientific conferences and their website. Access to the HTML is provided through the HTML User Program proposal process. Research proposals are reviewed by a committee and approved based on scientific merit, relevance of the proposed research to the mission of DOE's Vehicle Technologies Program, and feasibility. Research is completed within 24 months. The research plan is set up by the users. A research plan is complete when the results are published in the open literature and/or presented at a professional conference. Another reviewer mentioned each user program has 2 main ways in which they are able to address future research plans:

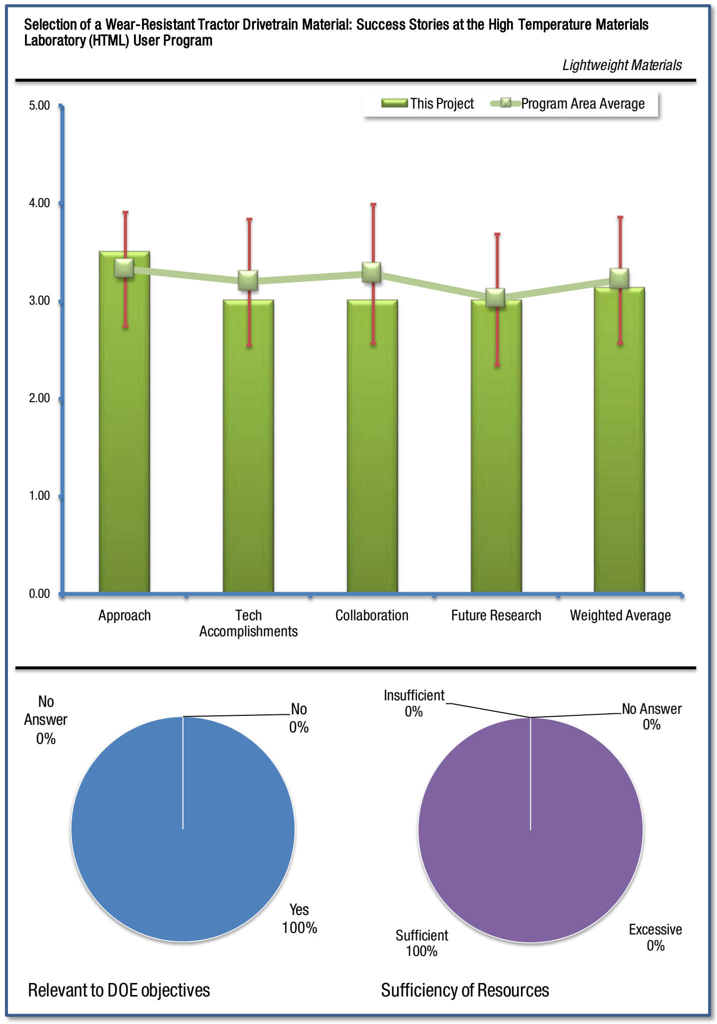
(1) to increase the number of users and ensure strong user base-- presentations are delivered at conferences and workshops, and results are published in peer reviewed literature; and

(2) a list of state-of-the-art instrumentation is maintained by the director of the HTML user program. This list is revisited and re prioritized on a regular basis-- ensuring availability of cutting-edge techniques to the user community.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated the resources are sufficient to achieve the milestones in a timely fashion. During FY2008, students and professors from 32 universities participated in the HTML User Program.

Selection of a Wear-Resistant Tractor Drivetrain Material: Success Stories at the High Temperature Materials Laboratory (HTML) User Program: Peter Blau (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated the objective of this HTML User Facility Project is to identify which of three candidate alloys for transmission spools (used to couple the differential ring gear to the axles in a rubber-tracked tractor) represent the most cost-effective means to enhance the wear-life of the drivetrain. Work involves the development of a wear test plan for candidate spool materials under lubricated conditions. Another reviewer noted this HTML User program focuses on drive train components in tractors (to prevent loss of durability). Wear resistance testing of cast iron tractor splines was reported.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the approach selected an appropriate contact stress, sliding speed, type of motion, test duration, and lubricant type to enable an adequate simulation of the contact conditions. Another reviewer added this facility has a unique set of tribological measurement equipment. The researchers are actively involved in developing ASTM standards-- and tests done at this laboratory follow ASTM standard procedures.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated that wear and friction tests were conducted on four candidate materials. These tests were based on ASTM Standard G 133 (reciprocating pin-on-dlat, developed at ORNL). Correlation between Brinell hardness and the wear resistance of both lubricated and non-lubricated material combinations were established. Unfortunately the poster presenter was not present to answer questions. This reviewer walked by this poster numerous times. The reviewer was told that this particular presenter had several posters to manage. This is not good. Another reviewer commented the tractor spline test setup was appropriately comparable to the in-service motion of the component. The facility offers a variety of tribological test options. The research on tractor spline components resulted in a publication.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated this is a John Deere project utilizing the resources at ORNL-HTML. The effort seems to be well coordinated. There is no follow-up to this project. Another reviewer noted only 1 collaborative work was presented in the poster. The author was able to describe several other user teams-- however, there seems to be primarily industrial users (rather than universities). The reviewer would encourage the scientists associated with the tribological wear measurement team to attend conferences and visit universities to describe their user facilities. Given the wealth of instrumentation and expertise in tribological measurement, this reviewer believes that many mechanical engineering, materials science, and aerospace engineering departments across the U.S. would have compatible applications and become users at this HTML program.

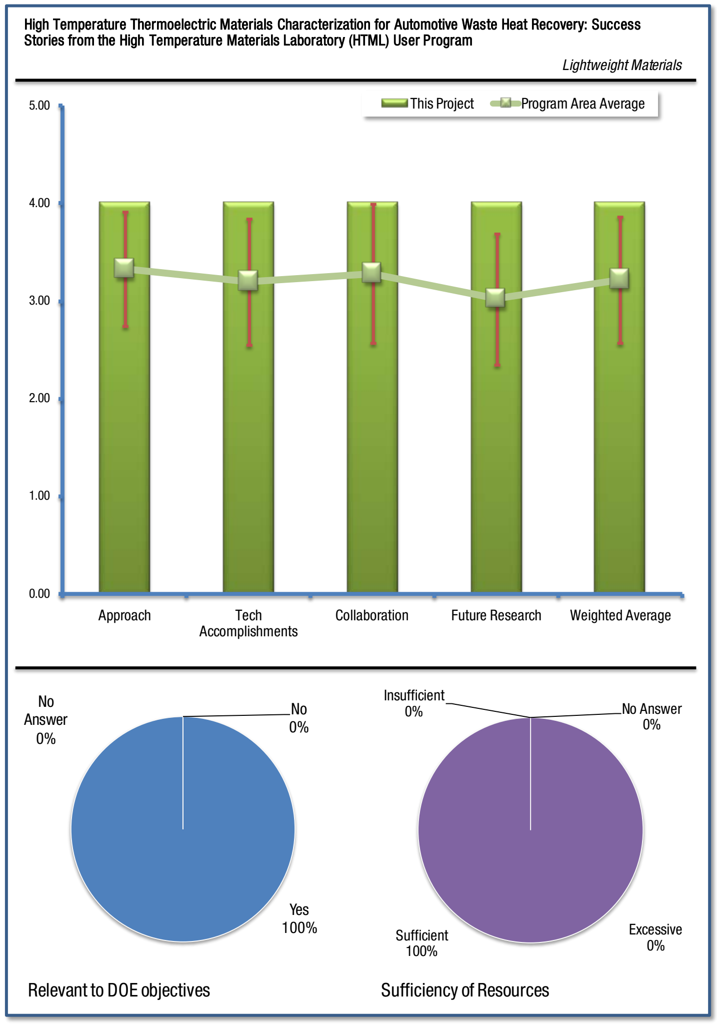
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated this HTML user project has been completed (March 2009) and therefore no future work was presented. Not clear what this PI has done to attract new proposals. Another reviewer added each user program has 2 main ways in which they are able to address future research plans: (1) to increase the number of users and ensure a strong user base-- presentations are delivered at conferences and workshops, and results are published in peer reviewed literature; and (2) a list of state-of-the-art instrumentation is maintained by the director of the HTML user program. This list is revisited and re prioritized on a regular basis-- ensuring availability of cutting-edge techniques to the user community.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer stated that sufficient resources are provided for this work.

High Temperature Thermoelectric Materials Characterization for Automotive Waste Heat Recovery: Success Stories from the High Temperature Materials Laboratory (HTML) User Program: Hsin Wang (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer stated this HTML user program assesses thermoelectric materials for automobile waste heat recovery (transformation into electrical energy). Many advanced materials compositions are studied at this facility. Another reviewer noted this project fits nicely with waste heat recovery efforts.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated the project highlighted in the poster was a GM project in which thermal conductivity measurements and high temperature electrical property measurements were performed. The data reported showed electrical characterization and thermal conductivity from 20C to 800C. The instruments are capable of achieving temperatures ranges from cryogenic up to 2200C. Another reviewer mentioned this is a nice example of state of the art user facility application to research problems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer stated the unique instruments made available through this HTML user program assessed the thermal conductivity and elevated temperature electrical properties of BaGaGe clathrates and skutterudites (for thermoelectric applications). The technical outcomes included 3 publications. Another reviewer commented these facilities enable quality data that would not likely have gotten done without them.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer stated the participating institutions include both industry and academia. The institutions were GM (industry), Univ. of South Florida, the University of Michigan and Michigan State University. Another reviewer added that putting experts and world class instruments together with researchers who need data is a great use of DOE funds.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer stated to keep up the good work. Another reviewer noted each user program has 2 main ways in which they are able to address future research plans: (1) to increase the number of users and ensure a strong user base--

presentations are delivered at conferences and workshops, and results are published in peer reviewed literature; and (2) a list of state-of-the-art instrumentation is maintained by the director of the HTML user program. This list is revisited and re prioritized on a regular basis-- ensuring availability of cutting-edge techniques to the user community.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

None of the reviewers commented on this question.

7. Materials Technologies: Propulsion Materials

Introduction

Advanced materials, including metals, polymers, composites, and intermetallic compounds, can play an important role in improving the efficiency of transportation engines and vehicles. Weight reduction is one of the most effective ways to increase the fuel economy of vehicles while reducing exhaust emissions. The development of propulsion materials and enabling technologies will help reduce costs while improving the durability, efficiency, and performance of advanced internal combustion, diesel, hybrid, and fuel-cell-powered vehicles. The advanced materials research conducted under the direction of the U.S. Department of Energy and the Vehicle Technologies Program will help ensure the nation's transportation energy and environmental future by making affordable full-function cars and trucks that use less oil and produce fewer harmful emissions.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Materials Compatibility of Power Electronics	D.F. Wilson (Oak Ridge National Laboratory (ORNL))	7-4	2.80	3.00	2.20	2.80	2.83
Electrochemical NOx Sensor for Monitoring Diesel Emissions	Robert Glass (Lawrence Livermore National Laboratory (LLNL))	7-6	3.50	3.25	3.25	2.75	3.25
Fuel injector Holes (Fabrication of Micro-Orifices for Fuel Injectors)	George Fenske (Argonne National Laboratory (ANL))	7-8	2.25	2.25	2.75	2.50	2.34
Hydrogen Material Compatibility for Hydrogen ICE	Mark Smith (Pacific Northwest National Laboratory (PNNL))	7-10	3.00	2.80	3.60	2.40	2.90
Design Optimization of Piezoceramic Multilayer Actuators for Heavy Duty Diesel Engine Fuel Injectors	H.-T. Lin (Oak Ridge National Laboratory (ORNL))	7-13	3.33	2.67	3.00	3.00	2.92
Materials-Enabled High-Efficiency Diesel Engines (CRADA with Caterpillar)	Michael Kass (Oak Ridge National Laboratory (ORNL))	7-15	2.75	2.50	3.00	2.25	2.59
Fatigue Enhancements by Shock Peening	Curt Lavender (Pacific Northwest National Laboratory (PNNL))	7-17	3.33	3.00	3.33	3.67	3.21
Tailored Materials for High Efficiency CIDI Engines (Caterpillar CRADA)	Glenn Grant (Pacific Northwest National Laboratory (PNNL))	7-19	3.20	3.20	3.20	3.40	3.23
Durability of Diesel Engine Particulate Filters	Thomas Watkins (Oak Ridge National Laboratory (ORNL))	7-21	3.00	3.50	3.00	3.00	3.25
Thermoelectric Mechanical Reliability	A.A. Wereszczak (Oak Ridge National Laboratory (ORNL))	7-23	3.20	3.20	3.20	3.20	3.20
Thermoelectric Materials by Design, Computational Theory and Structure	David Singh (Oak Ridge National Laboratory (ORNL))	7-25	3.00	3.00	3.00	3.00	3.00

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Thermoelectric Nanocarbon Ensembles	D.M. Gruen (Argonne National Laboratory (ANL))	7-27	3.50	3.25	3.00	3.50	3.31
Proactive Strategies for Designing Thermoelectric Materials for Power Generation	Terry Hendricks (Pacific Northwest National Laboratory (PNNL))	7-29	2.80	3.00	3.00	2.80	2.93
Mechanisms of Oxidation-Enhanced Wear in Diesel Exhaust Valves	*Peter Blau (Oak Ridge National Laboratory (ORNL))*	*7-31*	*3.00*	*3.00*	*2.50*	*3.00*	*2.94*
Materials for High Pressure Fuel Injection Systems	*Peter Blau (Oak Ridge National Laboratory (ORNL))*	*7-33*	*3.50*	*3.00*	*3.00*	*3.00*	*3.13*
Super Hard Coating Systems	*Ali Erdemir (Argonne National Laboratory (ANL))*	*7-35*	*4.00*	*3.50*	*3.50*	*3.50*	*3.63*
Lithium-Ion Battery Recycling Issues	*Linda Gaines (Argonne National Laboratory (ANL))*	*7-36*	*3.00*	*3.00*	*2.00*	*3.00*	*2.88*
Solder Joints of Power Electronics	*Burak Ozpineci (Oak Ridge National Laboratory (ORNL))*	*7-37*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Materials for HCCI Engines	*Bruce Bunting (Oak Ridge National Laboratory (ORNL))*	*7-38*	*3.00*	*2.50*	*3.00*	*3.00*	*2.75*
Materials Issues Associated with EGR Systems	*Michael Lance (Oak Ridge National Laboratory (ORNL))*	*7-39*	*3.50*	*3.00*	*4.00*	*3.00*	*3.25*
Durability of ACERT Engine Components	*H.-T. Lin (Oak Ridge National Laboratory (ORNL))*	*7-41*	*3.00*	*3.00*	*3.00*	*2.00*	*2.88*
High Performance Valve Materials	*Philip Maziasz (Oak Ridge National Laboratory (ORNL))*	*7-43*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Materials for Advanced Turbocharger Designs	*Philip Maziasz (Oak Ridge National Laboratory (ORNL))*	*7-44*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Catalysts via First Principles	*C.K. Narula (Oak Ridge National Laboratory (ORNL))*	*7-45*	*3.00*	*2.00*	*2.00*	*3.00*	*2.38*
Compact Potentiometric NOx Sensor	*Dileep Singh (Argonne National Laboratory (ANL))*	*7-46*	*3.00*	*3.50*	*3.00*	*3.00*	*3.25*
Residual Stress Measurements in Thin Coatings	*Dileep Singh (Argonne National Laboratory (ANL))*	*7-48*	*3.50*	*2.50*	*3.50*	*3.00*	*2.94*
NDE Development for ACERT Engine Components	*J.G. Sun (Oak Ridge National Laboratory (ORNL))*	*7-49*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Catalyst Characterization	*Thomas Watkins (Oak Ridge National Laboratory (ORNL))*	*7-51*	*3.00*	*2.00*	*3.00*	*2.00*	*2.38*
Environmental Effects on Power Electronic Devices	*A.A. Wereszczak (Oak Ridge National Laboratory (ORNL))*	*7-52*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Erosion of Radiator Materials by Nanofluids	*Dileep Singh (Argonne National Laboratory (ANL))*	*7-53*	*2.50*	*2.50*	*2.50*	*2.00*	*2.44*
Low Cost Titanium Propulsion Applications	*Curt Lavender (Pacific Northwest National Laboratory (PNNL))*	*7-55*	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Magnetic Material for PM Motors	*Iver Anderson (NASA Ames)*	*7-56*	*3.25*	*3.25*	*3.25*	*3.25*	*3.25*
Ultra-high Resolution Electron Microscopy for Catalyst Characterization	*L.F. Allard (Oak Ridge National Laboratory (ORNL))*	*7-58*	*3.50*	*3.00*	*3.50*	*2.50*	*3.13*
OVERALL AVERAGE FOR PROPULSION MATERIALS			**3.09**	**2.97**	**3.04**	**2.91**	**3.00**

NOTE: Italics denote poster presentations.

Overview of Propulsion Materials: Jerry Gibbs, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated most of the presentations had a clear overview of the challenges. Providing last year's reports and reviewer's remark enabled a good understanding of progress made in the various projects. Another reviewer commented the subprogram area was well covered and the important issues were identified. Two reviewers answered yes with one adding the sub-program covers critical enablers to support advanced combustion, thermoelectric, and hybrid-drive systems. The sub-program fulfills the goal of improving efficiency of advanced vehicles through innovative materials solutions. Important issues and challenges in the propulsion materials areas were identified. This sub-program also collaborates with Advanced Combustion Engine, Hybrid Electric Systems, and Fuel Technologies.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated that the information on the plans was limited for remote reviewers. No GANTT charts were provided making it difficult to assess if a project was running according to plan and budget. Another reviewer mentioned the plans were well identified and there are no gaps in the project portfolio. Two reviewers both answered yes, with one commenting areas of commonality and project alignment are clearly identified. Research projects were aligned to address technical challenges in each area. The other reviewer also said gaps are not surprising in a diverse set of projects for materials that enable so many other projects.

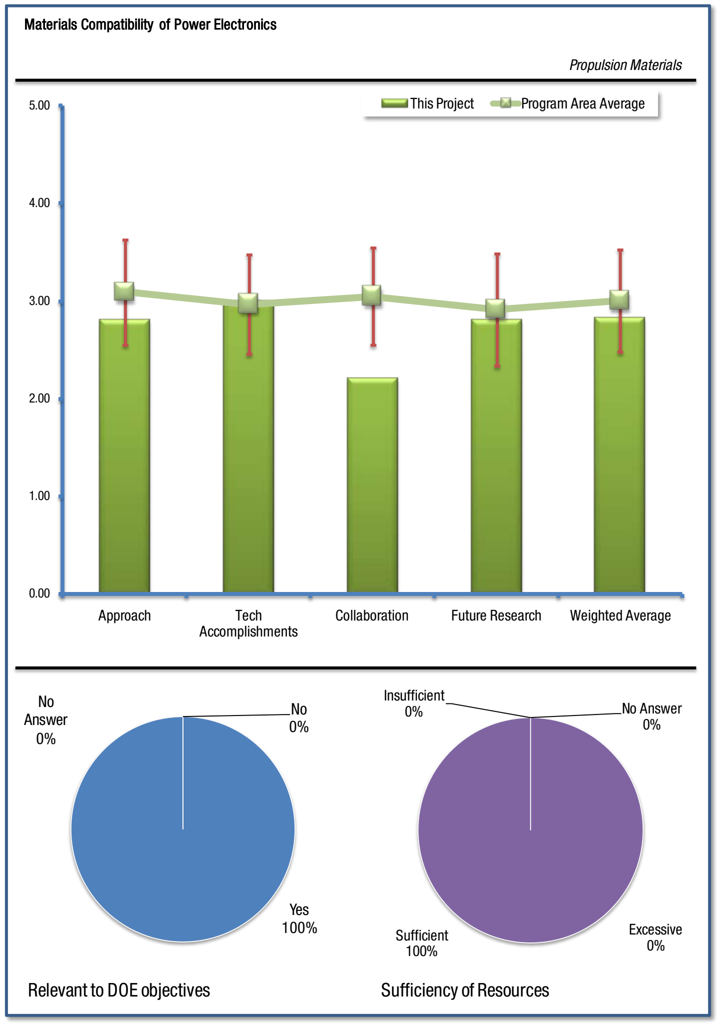
3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

A reviewer stated the projects show a good coherence a sufficient focus is available. Three reviewers all answered yes with one adding the sub-program area is focused and well-managed. The existing activities are evaluated annually. About 12% of activities are retired each year. A well-balance of research projects are in place to address the DOE Vehicle Technologies.

4. Other comments:

A reviewer stated the materials projects within this program will provide important support to allow new energy and renewable technologies to have the reliability and low cost that is necessary to succeed in the real-world automotive marketplace. Another reviewer commented the material research program is well managed and progressing well. One other reviewer mentioned this is a well constructed and managed program.

Materials Compatibility of Power Electronics: D.F. Wilson (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers commented on the strength of the link between evaporative cooling and petroleum displacement. One reviewer perceived that success in this work will allow smaller, lighter-weight power electronics, and that electrical machine systems utilizing power electronics are key to petroleum displacement and reduction. A reviewer suggested developing lab methodology in evaluating power electronic components. Another reviewer noted that the importance of this problem is evident, especially when considering the strong correlation between electronic component performance and temperature. Evaporative cooling is one of a number of approaches to address this problem. A concern was that future presentations should endeavor to make the connection between electronic cooling and petroleum displacement in stronger terms. Another reviewer said that the reduction in petroleum reduction will be relatively small. The reviewer noted that in the presentation there was a claim on improved energy efficiency based on the assumption that a single system outperforms a double system. This should be backed up by an energy balance for the two possible solutions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Among the positive comments was that it is a good choice to measure impacts in testing heat transfer. The investigators are to have experiments with data on the heat transfer under different experimental conditions. Bubbles left on the surfaces may reduce the heat transfer. Various regimes can be mapped out and quantitative approximations for heat transfer in each regime can provide a means to use the results in engineering applications.

Reviewers also focused on identifying the technical barriers. For instance, one reviewer felt that technical barriers are not described with clarity: while the project is crafted in somewhat broad terms, the actual plan revolves around one somewhat narrow electronic structure, namely the ‘Powerex IGBT’ board. How is this representative? A clearer case should be made for the configuration selected. It was unclear precisely what the test system was designed to accomplish and what specific questions it was intended to answer.

Another reviewer suggested building test systems and validating the tests, using direct side-stream cooling to decrease weight and size of PE, and mimicking in-service use. An integrated approach to compatibility issues is being developed. A reviewer noted that R-134a may ultimately be phased out in the U.S., as is happening in Europe. The reviewer asked if any provision has been made to test a back-up refrigerant/coolant. Additionally, use of an A/C side stream to cool power electronics suggests the A/C compressor must operate any time the vehicle does. Does this imply the need for a dual-capacity compressor so that the full power demand of the A/C system isn't always imposed on the main power plant? A barrier to be overcome by this project is abuse tolerance and ruggedness of HTIPE systems. One would expect to find evidence that the chosen test conditions have a correlation with the condition found in existing applications, but this is not shown in the presentation. The choice to focus on one cooling system is a good approach to reduce cost and volume of the cooling system.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer felt the project reached its past milestones in a timely manner, and that the milestone for 09/09 is well on its way to be reached on time. By the end of the project, there will be sufficient evidence to substantiate the start of the development of a single-circuit PE cooling system. This is especially valid in case there remains a good exchange with industry through the National Transportation Center. Another reviewer felt that it was good to see the documentation by photography of bubbles. It is also good to see temperature measurements. The suggestion is have more data (bubble images and temperatures) analyzed for estimating the thermal transport properties. A third reviewer noted that a rest system was designed and built for accelerated evaluations, no failure was observed, and that enhancements were made to the test system.

A reviewer perceived that while a test methodology was developed for the Powerex board, and the PIs have obtained some results with it, it is unclear precisely what they were going to do with their results (i.e. temperature measurements, influence of current, etc). The results seemed to raise more questions than they answered. Specifically, what is the cause of high frequency temperature oscillations (is it an artifact?) Is the configuration designed for forced nucleate boiling, and if so what direction is the flow? How do CHF measurements compare with literature values? The reviewer felt the experimental design was not clearly defined and presented.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer cited coordination with DOE teams, but not with the industries yet. Another noted that the limited extent of integration (as cited in the question period) is only through an institute arrangement. A reviewer felt that there was no evidence of more partners found in the provided slides. Only cooperation with the National Transportation Center was mentioned. Another reviewer felt the collaborator element of the project might have been strengthened with a clearer statement of the partnership. The presentation materials did not appear to include any outside partners (though the reviewer apologizes if the PIs do have an extensive team of outside advisors; it is just that these were not evident from the presentation).

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

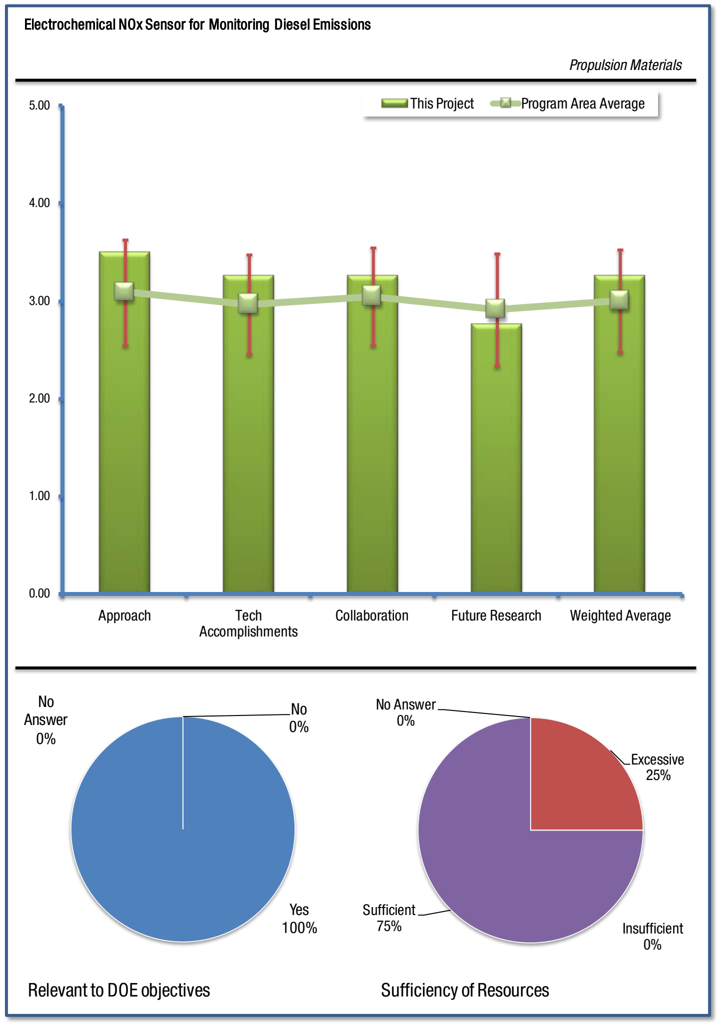
One reviewer thought the task to validate the test methodology seems good, though a clearer set of rules for establishing go/no go points would have been appreciated. Another reviewer found that the investigators are making process, and would like to see more quantitatively analyzed results in the future. A reviewer felt that the proposed steps are in line with the proposed approach. The reviewer also felt that it might be expected that the project will lead to sufficient proof of the feasibility of direct cooling with R134a refrigerant. What is missing is an indication on the use of the given methodology in case of a new/alternative refrigerant. It is likely that R134a is replaced in the near future.

Another reviewer also suggests developing a "go-no-go" criteria of failure, along with using more prototype board, and confirming the feasibility of cooling approach.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer comments were that good progress made in the research project, and that the reviewer is looking forward to seeing more cooperation with industries. Another reviewer felt that no information is provided on the spend budget. Indication is that 40% of the project is completed; this would indicate that the project is more or less running according to budget.

Electrochemical NOx Sensor for Monitoring Diesel Emissions: Robert Glass (Lawrence Livermore National Laboratory (LLNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer thought that this project supports the overall DOE goals of petroleum replacement. However, de facto, development of new sensors would achieve this end as an ability to sense NOx is an important capability for improving energy efficiency. The quantitative linkage between results of this project and petroleum replacement was not stated. Another reviewer felt that the project assists diesels in meeting NOx emissions, noting that diesels are some of the most fuel efficient systems. A reviewer noted that the project enabled technology for diesel engine NOx sensor and work with Ford, and it develops low-cost, durable sensors for NOx.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer noted that only one type of NOx sensor is commercially available, but does not meet present or future diesel emission requirements. The reviewer also suggested refining criteria for sensor materials and configurations and improve sensor platform to consider design constraints in 2008, and noted that LLNL developed a unique design and measurements strategy.

Another reviewer responded that in casting their effort in the context of the state of the art, the PIs should more clearly articulate existing sensor technologies. The reviewer questioned why the design is better than the one currently commercialized: what are the issues and challenges with their sensor and with the commercial one? This will help make the case for more funding and to the industry at large.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer saw significant barriers remain after many years of working on this concept. The PIs have tried to resolve some of the barriers, but there are still issues, and it is no fault of them. However, there should be a clear go/no go point. Another reviewer noted that promising results for a lab prototype using alumina substrate that focuses on a more commercial design was presented, longer-term stability at operating temp of 650°C was demonstrated, a more advanced prototype was developed, an engine successfully tested the sensor using a urea-SCR system, the projected completed initial long-term stability testing, and that there was improved electronically conducted oxide substrate.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers focused on the collaboration with Ford. One felt that the collaboration with Ford is good, if not essential. However, the apparent failure to attract other partners for this technology could be a sign that its promise may not in the end be realized. Another noted the work with Ford from the beginning, built on the patent issued by

Ford, and the project made significant improvements in the sensor design. Moreover, Ford will be working with suppliers to commercialize the sensors.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

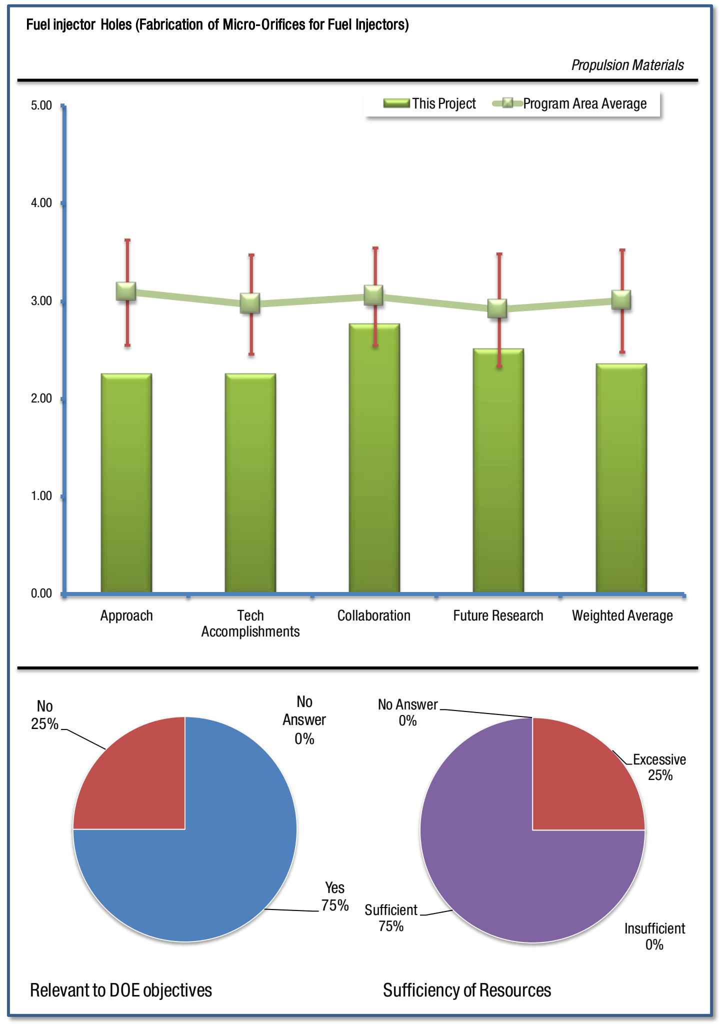
One reviewer would like to see ammonia cross sensitivity earlier. Perhaps it has been done, but this is difficult to determine from the slides. Another reviewer is uncertain precisely where this project goes from here. With seven years of funding thus far, one might have hoped for a stronger plan to commercialization. Mentioned was some potential from Ford in this regard, but it is somewhat unclear if this will materialize. There still seem to be some issues with long-term stability to resolve.

Another reviewer suggested improving mechanical stability, evaluating cross-sensitivities, continuing characterization, and developing strategies to reduce cross-sensitivity and increase accuracy.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Most reviewers felt that resources are sufficient, with one noting good progress and good collaboration with industries. One reviewer believed that resources have been excessive, commenting that the resources invested in this project, being in excess of $2 million for the life of the project to date, seems a bit high for the results obtained to date.

Fuel Injector Holes (Fabrication of Micro-Orifices for Fuel Injectors): George Fenske (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Among positive evaluations, a reviewer felt that very significant progress has been made over the past 5 to 10 years in in-cylinder emissions control. The reviewer questioned, Does this approach offer sufficient remaining potential (vs. aftertreatment) to justify this work toward ever-smaller injector orifice diameter? Another reviewer noted that enabling smaller orifices in fuel injector nozzles lead to lower emissions. This increases the operating window for combustion control. This will lead to lower fuel consumption. The somewhat disappointing improvement in fuel efficiency over the recent years is partly caused by the need to improve emissions.

One reviewer felt it was unclear whether fuel economy will actually improve. It is also unclear if smaller hole will actually reduce emissions significantly to reduce the need for aftertreatment. Another reviewer noted that the development of new injector designs can improve fuel efficiency and reduce particulate emissions. Therefore, de facto, an effort in this area would impact petroleum displacement. Precisely how much, however, for this particular project is unclear.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers latched on to the concept of varied injector orifice diameters. A reviewer felt that the technical barrier addressed is clear. The approach has a trial and error character. There is no evidence provided that a third production run will be successful. In the provided material, no characterization of the EN baths was shown. This will be a critical parameter to bring this process to an industrial level in future. Surface cleanliness is clearly important in this process. The improvement of cleanliness in general not only achieved by more aggressive cleaning, but by a full control of all steps in the production process. Another reviewer saw that engine dyno evaluation of the effect(s) of very small injector orifice diameters could be brought forward in time to validate the potential of this approach to PM reduction.

A reviewer felt that the approach taken is to design a multi-hole injector, with hole sizes to vary over a prescribed range. The basis for the idea seems to be a study dating to 2005 which showed that smaller hole diameters reduce emissions. For the present study, it was not clear precisely how the present study fit into this prior work, nor why having holes drilled in the side of the injector in the manner described in the presentation is the right approach. Presumably, droplet trajectory will exert an influence as well but this was not discussed.

Another reviewer saw that the approach seems to be flawed because commercial nozzles were used that had unknown materials and heat treatments. A better approach might be to utilize experience from a knowledgeable specialty steel manufacturer and list the conditions the investigators are attempting to achieve: how to achieve small holes sizes in a nozzle, what is the best material(s) that should be investigated, and how to approach the problem.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer felt that the accomplishments over the past year seemed to involve developing processes for drilling holes. With such an effort in this area, it would be assumed that the end result will be a significant reduction in PM and increase in fuel efficiency. With so much invested (last year) in fabrication, it was unclear if the payoff would be worth it. Concerns were expressed, namely one reviewer commenting that this item is difficult to assess. No evidence is provided to prove that bath conditions are under control to produce flawless specimens. The nature of the studied processes results often in an exploratory phase in a project. It is indicated that the penetration rate of 50 micron orifices was small. No indication is given of the used injection pressure. At least injection pressure influence could have been studied.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Among the positive comments, one reviewer stated that a good cooperation with EPA was shown, as was cooperation with industry partners. Another noted that industry collaboration was good.

Another reviewer felt that collaborations with industry should have been more clearly stated. Rather broad references to "OEMs", "Engine OEMs" and "Small Business" are mentioned, but no specifics are given. Nor were the industry roles discussed, or interaction with industry partners. A reviewer stated that it did not appear that the right industries or partners were involved based on the slides.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer felt that the transition from the present results to future work in the next year seems somewhat uninspired. The reviewer hoped for more than refine coating protocols, EPA flow studies, and return nozzles to shop in a plan for future work. Perhaps the most important question to address, since the project seems in part to be based on it, is the mechanism for an orifice size reduction on particulate emissions. This does not seem to be established, yet it apparently forms the basis of the project. A reviewer felt that the coating process may not work, and that no alternative plan seems to exist. It is important to ask the question, 'What steel or stainless steel microstructure would help us achieve the goals?' It seems that the investigators continued down the plating path and perhaps there are better approaches.

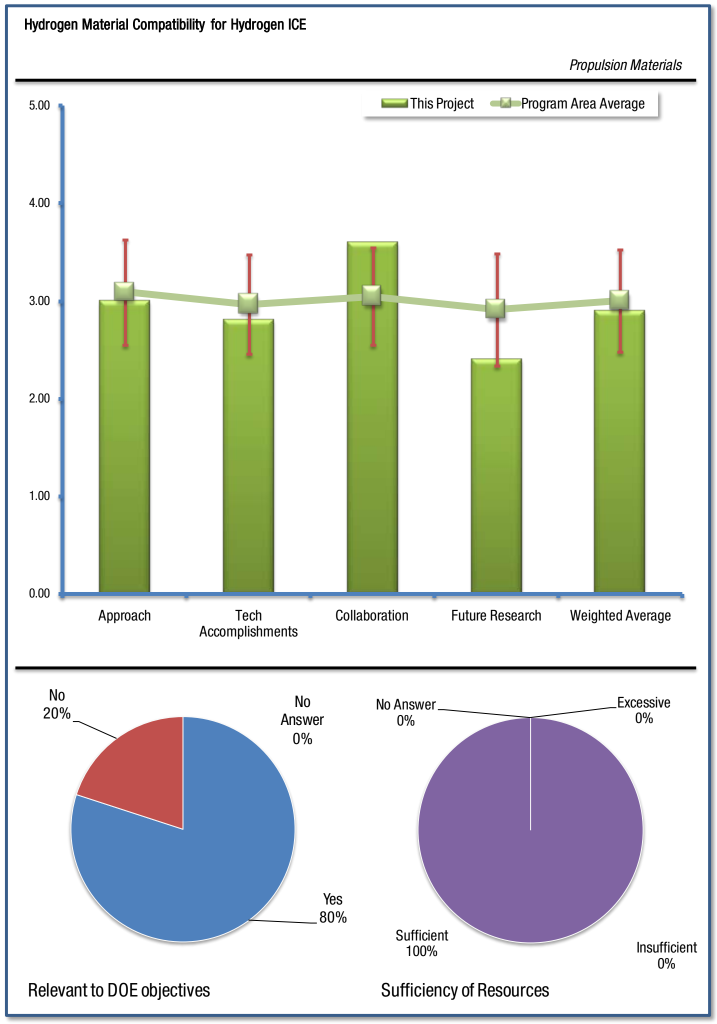
Another reviewer saw the value in investigating in the future the effect of smaller orifices on emissions. Also, the study on durability of the coatings is a necessary step for future implementation of the process.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Of the reviewers who felt that the resources were sufficient, one commented that while resources are sufficient, somewhat more results should be possible for the $350k annual budget. Another felt that this project may be deemed to be funded at an excessive level, depending on answer to question posed in Question 1.

A reviewer saw the program resources as being excessive, and commented that with $1.5 million invested to date, it seems that more might have been expected, especially given the somewhat tenuous linkage between orifice size and particulate emissions.

Hydrogen Material Compatibility for Hydrogen ICE: Mark Smith (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Of reviewers who saw that the project supported the objective of petroleum displacement, one posited that the use of hydrogen-fueled engines would certainly impact petroleum displacement. Another saw that the goal of the project is to solve one of the barriers for introducing hydrogen as an alternative fuel in internal combustion engines. As such it supports the overall DOE objectives. A third reviewer noted that the project supports technology advancement in direct injection of H_2 for ICE, studies impact friction at injector nozzle, improves injector durability and performance, and measures wear and friction of injector materials and coating system. Another reviewer is of the opinion that success of this project will aid the adoption of hydrogen fuel technologies. If the hydrogen is made from a non-fossil-fuel source, the combustion will eliminate decrease the amount of petroleum that is needed. For example, if hydrogen comes from nuclear-electric, there will be an advantage. The non-fossil-fuel generation of hydrogen may require many years.

A reviewer had the opinion that H_2-fueled ICEs suffer, in addition to the unique problems outlined in this presentation, from the overarching problems attending all hydrogen-as-mobility-fuel schemes, namely, where does the hydrogen come from, at what cost and what's the fate of the CO_2 co-produced in the most straightforward H_2 generation processes? As a "bridge" to H_2 fuel cell vehicles, H_2-fueled ICEs seem even more questionable.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Several reviewers noted that the project had a reasonable approach. Specifically, one reviewer saw that the concept of direct injection is reasonable. The focus on injector design seems to be one of a number of aspects that have to be solved to develop a commercial hydrogen-fueled engine. Another reviewer felt that the approach is reasonable, but the barriers are numerous, daunting and the practical means to overcome them suggest production costs of hydrogen injectors will be excessive, which will inhibit (or prohibit) their commercialization.

Another reviewer focused on feasibility. The reviewer stated, while the approach for improving scuffing resistance by applying hard coatings is straight forward, a better description should be provided on the approach to improve the hydrogen uptake behavior, this to define piezoelectric materials suited for a hydrogen environment. This goes beyond measuring and model developing and is more related to material property engineering. Perhaps it is possible to describe the advanced analytical techniques used to characterize the coatings. An important one would be the internal stresses. And in case of multi layer systems the correct matching of stiffness of the layers to reduce hertzian stresses.

Integration was the focus of another reviewer. The reviewer thought that the work is bits and pieces of trouble-shooting. It is good that the work is integrated with the OEM and the fuel injector manufacturer. The reviewer does not hear a physical understanding of why hydrogen causes such friction and wear problems. So the approach appears to be one based on trial-and-error. A reviewer noted that the project addressed potential failure sites at needle and nozzle, conducted hydrogen in-situ friction wear tests, looked at DLC coating, nanolaminate coatings, and tailored properties, and looked at Actuator as another potential failure sites.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Several of the reviewers generally thought that the project showed good progress. Among these reviewers, one said that the PIs have made good progress in their study of a hydrogen injector and an evaluation of failure mechanisms. Another noted that with an empirical approach, solid data need to be present. The degree of success with the nano-coatings is reported only at 15,000 cycles. For a fuel injector, this number of cycles is far short of a prototype-test level need. The combination of a non-physically-motivated approach with a limited number of test cycles is a little unsatisfying. It is recognized that there are multiple sub-parts of this work. Even without physical interpretation, the solid experimental work is valuable. A reviewer focused on the coating development, commenting that the progress reported on the coating development is very good; it's very likely that the addressed barriers are overcome. This is less clear for the progress made in characterizing different piezoelectric materials with respect to hydrogen uptake. Another reviewer noted that the project measured and modeled H2 take-up, and conducted sliding impact wear tests, which showed good performance in coating.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers saw close cooperation. One said that The PIs have a good collaboration with Ford, ANL and Westport. Another reviewer saw excellent collaboration among many entities and national labs, including Ford, Westport, PNNL, ORNL, and ANL. A third reviewer concurred. The reviewer saw exceptionally close cooperation in responding to OEM test concerns. Hopefully, there will be opportunities for physical understanding over time. Another reviewer commented that in this project there is an excellent mix of industry and institutes. The report showed that there is a close collaboration between them. Also, the involvement of international parties strengthens the consortium.

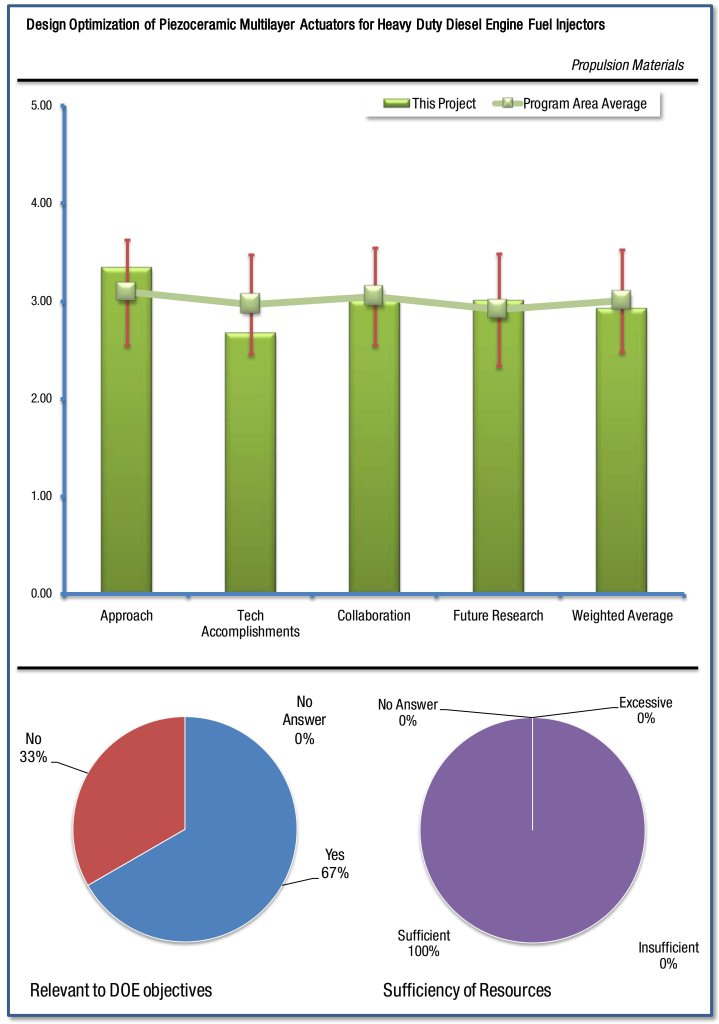
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers commented on the time horizon of the project. For instance, one reviewer saw that the work is short-term, and would like to see more opportunity for physical understanding in the longer term. Other situations like natural-gas-driven stationary engines have special valve materials for similar exceedingly low-humidity wear situations. Another reviewer felt that the future plans seem reasonable. However, the PIs may be treading uphill because of the well-known issues with hydrogen. If the infrastructure and storage issues cannot be solved (and the prospects for such seem unlikely at least in the short term), this project will not have much of an impact when considered in light of competing energy technologies. This is no fault of the PIs but the unfortunate consequence of the proliferation of other energy sources. A third reviewer saw that the indicated activities are a logical continuation based on the results so far. The description however is not sufficient to have a clear picture on the change of overcoming barriers; this is especially the case for the PZT research. Another reviewer noted further development with ORNL in sliding impact tests, use analytical technique to support a model for hydrogen diffusion, and continue to test DLC and nanolaminate coatings

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer felt that funding seems adequate for the tasks carried out. A second was of the opinion that it is very difficult to give a good opinion on this question. No Gantt chart is provided in which the progress against the original timing and budget are made visible. The progress reported is well in line for the mentioned budget of $300k. A final reviewer noted that the project will be ending in FY2009.

Design Optimization of Piezoceramic Multilayer Actuators for Heavy Duty Diesel Engine Fuel Injectors: H.-T. Lin (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer felt that with the prospect of HD engine/vehicle fuel economy standards, the additional degree of fuel injection control potentially available from this technology becomes significant. A second reviewer felt that this technology provides improvements to diesel combustion. So, this work will be able to provide further improvements beyond the gains from the category change of going to diesel fuel. Another reviewer commented that the PIs did not clearly link their efforts with injector design to petroleum displacement. According to this reviewer, presumably, there is a link- their design would create smaller droplets, larger fuel surface area, greater evaporation, lower emissions , etc. But these were not outlined for the audience.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One of the reviewers saw that the work gives an analytical basis for mechanical reliability of PZT actuated fuel injectors. Another reviewer saw a mixed bag, commenting that the approach to measure mechanical properties of PZT piezoceramics, develop test methods for reliable qualification of piezoactuators, and adapt their design to heavy-duty diesel engines seems reasonable. However, this reviewer is unclear if the piezoactuation concept for injector design is the way to go. It has some attributes, but how it fares in comparison with existing designs should be strengthened.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

For one reviewer, considering the investment, the pursuit of mechanical strength testing of piezoceramics seems reasonable, though a bit modest. Another noted that complex mechanical property measurements were made with electric field applied. However, this reviewer was concerned that the cracks in the stack example (shown later in the presentation) are in a different orientation than the cracks in the ball on ring geometry tests. If there is a way to measure the strength with the cracks in the orientation of the stack failure mode, it may be possible to correlate the strength values to the life prediction task. If the metal in the metal ceramic bond melts, then the failure mechanism may be complex.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Several reviewers recognized the collaboration with Cummins. One reviewer saw only one industry partner, but that the partner was an excellent choice. There were other comments about the CRADA. One reviewer noted the collaboration with Cummins, but commented that though a three-year Cummins-ORNL CRADA was approved last year, Cummins' role was unclear. Another reviewer also noted the CRADA with Cummins, and commented that regarding the confidentiality of the work, it should be noted that similar piezo-injectors are already in mass production for diesel applications.

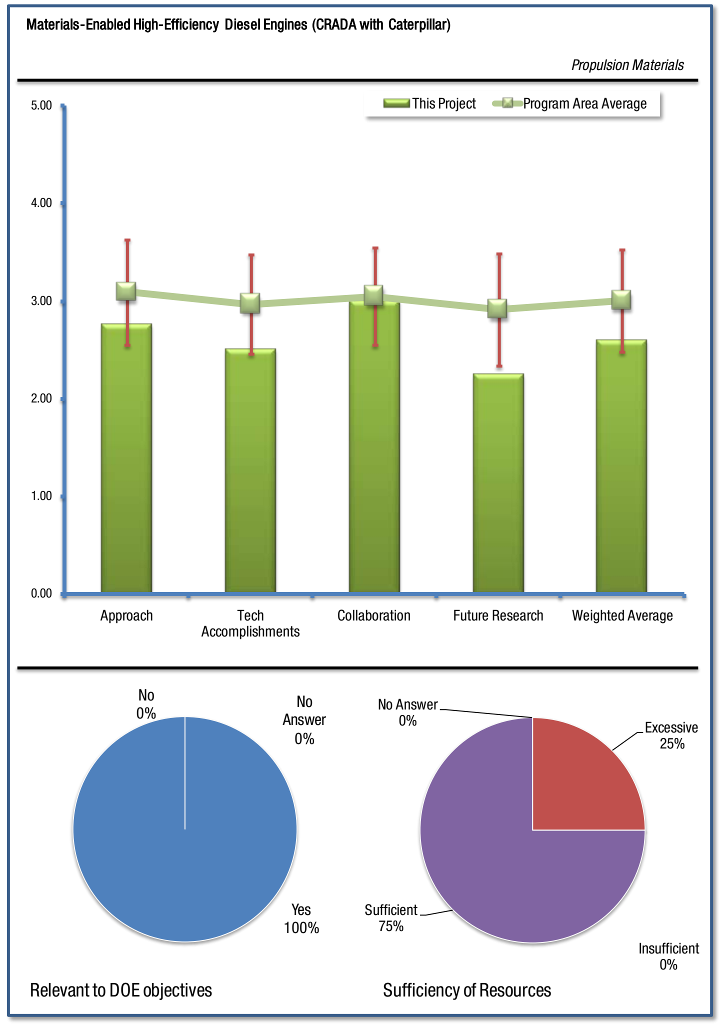
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Among positive reviews, a reviewer was looking forward to seeing how the materials information will help design optimization for future iterations. Another reviewer felt that the proposal for accelerated tests is reasonable, but it was unclear how the approach for future work will translate to an improved design.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

There were no comments on the resources.

Materials-Enabled High-Efficiency Diesel Engines (CRADA with Caterpillar): Michael Kass (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer commented that the project aims at developing new material application to enable 55% engine efficiency. Important is the addition of the demand for a one million mile endurance of the material solution. Another reviewer saw that, generally, high strength, high thermal conductivity and lightweight materials will lead to improved efficiency and thereby assist in petroleum displacement. It was unclear to this reviewer that the engine test facility development that seemed to have been the focus of the effort over the past year could accomplish a 55% efficiency target.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Among positive reviews, one commented that the planned approach is reasonable. Another reviewer felt that the behavior of materials under real engine conditions has always been difficult to translate to laboratory conditions. This project will avoid this problem by going directly into an experimental engine.

A third reviewer felt that assessment was too early to determine. Another reviewer did not feel a rationale was provided for the particular engine selected for study - the C15 ACERT engine- except that it seemed to have been donated by Caterpillar. It was unclear to this reviewer how results from this engine could be generalized to the wider range of designs in current use nationally. No mention of generalizing the results was included in the effort. Further, the PIs mention "inadequate design and performance data" but do not tell us what these "data" are, nor why their approach of carrying out tests on this particular engine will be relevant. They also mention "advances in thermal management and advanced combustion" but again do not elaborate. The motivation and approach are crafted in only the most general of terms. For this reviewer, perhaps the most curious aspect about this effort was that while it concerned "materials", no specifics of precisely what materials, or how they would be fabricated, was included in the presentation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Most reviewers felt the project was in its early stages. Specifically, one reviewer commented that it is too early in project to evaluate progress. Another reviewer noted that the project is mostly infrastructure building. A third reviewer commented that the project is still in its preparatory phase. Therefore, no results with respect to the main goal are available, though the engine test-cell is operational. Another reviewer commented that the PI has developed an engine test facility for the Caterpillar engine with significant effort and has "instrumented" the engine for temperature, pressure, flow rate and "chemistry" (the meaning of the latter was unclear). Precisely what they would do with the data they would obtain was not certain, which was somewhat the problem with this study. Further, a logical rationale for engine testing, materials development and generalization of the results to beyond the particular engine of interest to this study was not provided.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Several reviewers commented on the collaboration with Caterpillar. For instance, a reviewer noted the cooperation between ORNL and Caterpillar, making it a small consortium. This reviewer also noted the cooperation with Caterpillar WFO on modeling, but was unclear how this is included in the program; it should be stated more clearly. Another reviewer felt that CRADA involved only one partner, but a highly credible one. However, this reviewer expressed a concern, commenting that Cat has announced its intention to exit the highway diesel engine market within a year. Will proprietary considerations inhibit the commercialization in the highway sector (by others) of any technologies arising from this project?

A third reviewer felt that the CRADA with Caterpillar was good, especially the donation of the C15 ACERT engine. However, it was not clear precisely what Caterpillar's interest was in this study except to provide the engine and have ORNL do tests on it. The PI mentions a "materials-by-design approach to high temperature, high pressure engine operation." but it is not clear what this means, in quantitative terms. It seems more like a buzz phrase. The PIs should be more specific and elaborate in their presentation.

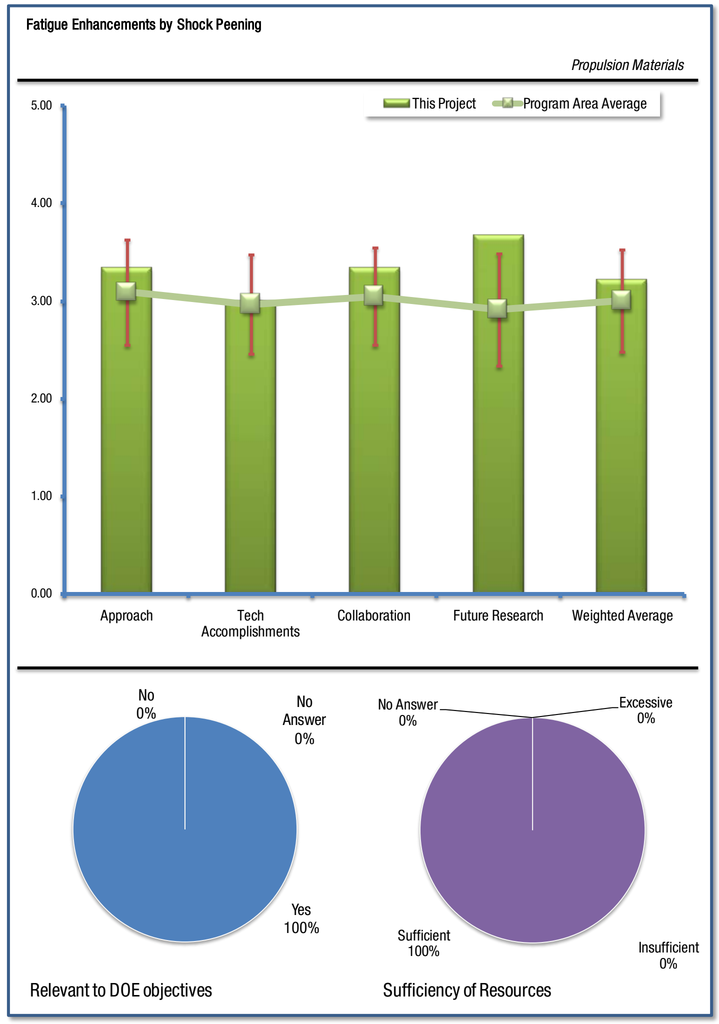
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer commented that this was difficult to determine, and that economic conditions may alter industry participation. Another reviewer noted that although the general approach of using an engine as a test bed is good, there is only very limited information on what type of testing is done with this engine. A third reviewer commented that with the various measurements proposed in their new facility and engine, the PIs did not clearly state precisely what they would do with the data they would obtain, what range of conditions they would examine, how they could generalize the results beyond the particular engine selected for study, what efficiency gains they would expect and (most curiously) what materials they would examine.   Presumably they have this information and presented it in their original proposal but it was impossible to judge the efficacy of the approach to achieve results that could have a real impact on improving engine efficiency.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that, looking at the achievements of 2008, the budget is in line with the results, but that no Gantt chart was provided showing accomplishments in relation to the original planning. Another reviewer was unclear how infrastructure development of a new engine test facility at ORNL will contribute to the 55% efficiency target (one would have thought that ORNL already had the requisite test facilities). The funding seemed only to provide funding to supplement ORNL's internal support of developing this test cell.

Fatigue Enhancements by Shock Peening: Curt Lavender (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Among positive reviews, one commented that improvement of fatigue performance of materials will open the road for further fuel efficiency improvements. Another reviewer felt that the project could be important enabler for advanced combustion system and conventional engines, particularly from economic standpoint. However, another reviewer felt that the presentation did not clearly make the case for how this project would actually lead to petroleum displacement. In future presentations, the PIs should be encouraged to do so.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer recognized that the overall concept studied is to incorporate higher injection pressures to derive improved efficiency (a somewhat well-known approach). Higher pressures place greater strains on materials. Surface modifications can enhance material strength and fatigue. The PIs use cast-iron as their base material. The Laser Shock Peening/water jet peening approaches are interesting, though somewhat well known. For the LSP method it was unclear how the shock was generated through the water curtain; more discussion on this point should be included in future presentations. It was also unclear how uniform surface modifications were obtained by the method for curved materials as the schematic seemed to indicate a planar treatment. The reviewer questioned, was the material somehow rotated through the beam?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewers recognized the project's progress. One reviewer felt that the PIs have obtained a lot of data in the past year which show effects of surface treatment. Another commented that clear progress is made in the area of LSP and water jet peening, resulting in a technological deployment activity by Cummins. The friction stir welding activities on cast iron do not seem do have made much progress towards the objectives.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers noted that collaboration with Cummins. One reviewer commented that the collaboration is good, and that the CRADA seems to indicate a strong interest on their part to use the results of the surface treatment approach to improve material fatigue. Another reviewer noted how the CRADA is a cooperation between Cummins and PNNL, and that cooperation is well coordinated. The project is linked to a cooperation between South Dakota School of Mines and Cummins.

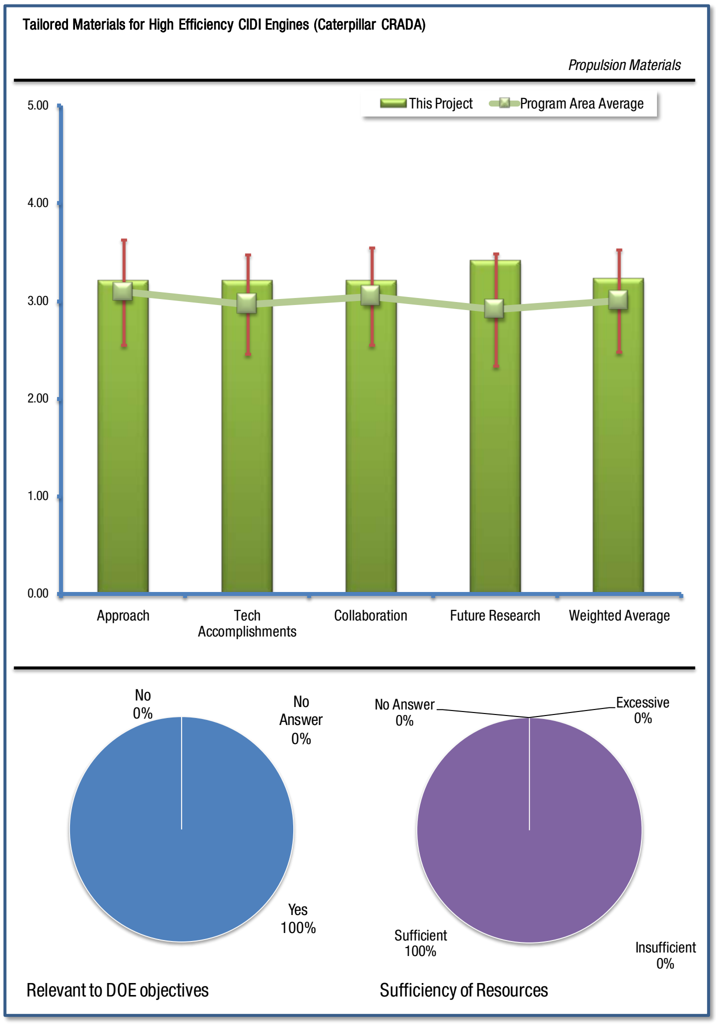
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A positive review was that the proposed future work is well in line with the results so far. To start with screening trials for friction stir welding is a good approach. In case of study of the combination LSP finer surface finish, the same surface finish process as in previous tests must be used. Another reviewer stressed that there is a lot of testing to be accomplished. At some point, the PIs should stop and ask themselves how they can generalize their results and transition them to commercializing a process. For example, will their surface treatment approach be applicable to mass-produced items?

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer felt that the future plans and mentioned budget are in line. Another felt that the funding of $350k seems a bit high for what seems like a testing project.

Tailored Materials for High Efficiency CIDI Engines (Caterpillar CRADA): Glenn Grant (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Several reviewers noted the potential for improved efficiency. One reviewer commented that success in this work will provide improvements in reliability of large diesel engines. As such, the carbon-measured fuel efficiency of diesel over other hydrocarbon fuels can be more broadly implemented to reduce petroleum consumption in these transportation applications. Another reviewer commented on FSP, which could be an important economic enabling technology for both conventional and advanced combustion engines. For another reviewer, the project poses an interesting proposition to locally improve material properties that may allow higher pressures and temperatures in combustion chamber. A mixed review recognized that high strength materials will impact petroleum displacement through improved engine efficiency, but the PIs in the future should endeavor to show a more quantitative connection of their efforts with petroleum displacement. One wonders if the hope for enabling "new combustion processes" like HCCI by the materials development effort that this project concerns can actually be realized. Another reviewer noted improved fuel efficiency, thermal management, and develop lower cost materials by using friction stir processing.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Some reviewers felt the approach was interesting. Specifically, a reviewer felt the friction stir processing method (to convert a cast material to wrought) for creating an engineered surface is interesting. Improvements in strength, ductility, fatigue and wear resistance are anticipated. The incorporation of carbon nanotube composites is interesting. Another reviewer commented that the project was an interest approach. A third reviewer mentions the surface engineering approach has a long history of benefits in materials technologies for engines. The past gains with fatigue property improvements with the specific process of friction stir processing make this topic a promising area for further development. Another reviewer notes work on aluminum alloys in FY08/09 and develop tool screening studies for steel FSP, and thermal fatigue of bowl rim of aluminum pistons as potential applications.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer addressed how the investment to date in developing machine with post-stir heat treatment has good potential for future accomplishments. At this point (25%), there are not many accomplishments in hand. From his knowledge of other work with friction stir, the presenter seems to know the direction headed. Time will tell. Separately, the particle size narrowing information of the presentation (with distribution expressed as "percent greater than the average [mean]" would be better expressed as a distribution width parameter, such as standard deviation of a log normal fit. Another reviewer mentioned good work in a novel "cladding" process, but it's difficult to determine from the slides if the carbon nanotubes were successful at accomplishing the objectives. Another reviewer mentioned the PI's have demonstrated that the FSP method is possible for flat aluminum alloys. They investigated this process for carbon nanotube and nanofiber composites. They found significant improvements in fatigue performance. This reviewer feels the PIs should think about comparing composites made from single walled and multi-walled carbon nanotubes. Some discussion on cost and availability of SWNTs and MWNTs would be useful to have in future presentations.

A reviewer noted how the project completed of FSP of cast hypo-eutectic aluminum alloys for cylinder head applications, and showed improved fatigue strength after FSP; successfully stir in new components into piston alloys for improved bowl rim thermal fatigue; developed tool for FSP and processing parameters; and work started on FSP of steel.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers responded positively to collaboration with Caterpillar. One reviewer posited the CRADA with Caterpillar is good. Another commented the project has worked with Cat on this project from beginning and have potential engine testing of engine components. A reviewer agreed, noting good collaboration with the CRADA partner is evident.

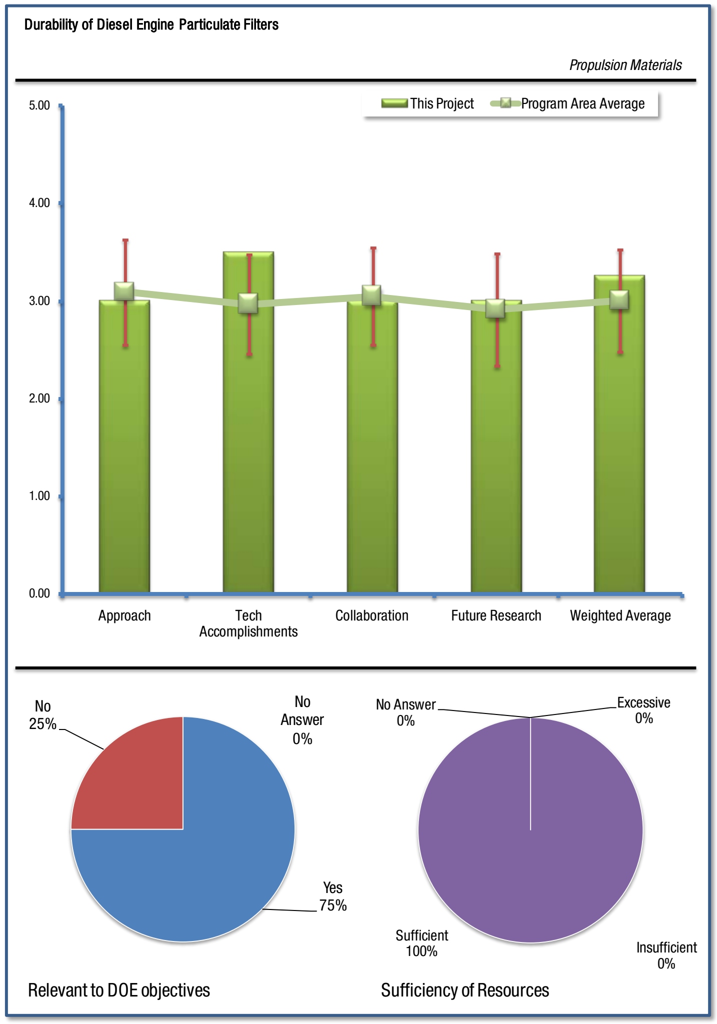
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers made suggestions about what kind of work to perform in the future. For instance, a reviewer commented that the project is doing good work, and added that investigators may want to think about residual stress control in addition to the carbon nanotube for thermal conductivity improvement. Another reviewer feels the plan for future work appears on the same trajectory of the past year's effort. It will include a similar program of testing and evaluation. In spots the plan was vague (i.e., what does "develop strategies..." mean?). In others it was unclear what would be done with the information or why the particular material choices were made. A third reviewer noted thermal and mechanical testing of carbon nanotube mixed pistons, begin working on steel components, and to consider "Constrained thermal fatigue tests" developed by Climax Research Inc.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer noted the 50% cost share with Caterpillar.

Durability of Diesel Engine Particulate Filters: Thomas Watkins (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Many of the reviewers commented on the link between the project and petroleum displacement. For instance, one reviewer recognized that work is very important from CI engine emissions and costs perspectives, but does not seem directly or strongly to impact petroleum displacement. Another remarked that part of the performance of combustion devices is to burn fuels cleanly. This effort contributes to that, though the connection to "petroleum displacement" was unclear. Future presentations should endeavor to make the link to "petroleum displacement" more clearly. For another reviewer, improved understanding of the durability of DPF's can lead to improved regeneration strategies reducing fuel consumption. Remark has to be made that this will be a relative small improvement. For a reviewer, the success of this work is important to clean diesel engine acceptance. Larger acceptance results in larger percentages of conversion to diesel, with the resulting reduction in use of petroleum.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Among positive reviews, one commented the approach appears well designed to facilitate engineering optimization of an indispensable CI engine emissions control technology. A reviewer stated this work is helping to put into public domain information that gives a rationale for the commercial introduction of these materials -- which has already occurred. It is good to have the materials data available to serve as underpinning of the existing commercial successes. Another reviewer felt with respect to the improvement of durability of the DPF material the approach chosen is focused on the correct topics. Also integrating analysis of DPF's coming from the field will lead to an improved applicability of the results. On the NDE activities the approach is less clear. This is based on the goals of having this type of measurement available during truck service operations.

To a fourth reviewer, it was a bit unclear precisely how the data to be obtained on porosity measurements, fracture toughness, etc. are to be used to develop new DPFs. The data are important and relevant but the design process for using the results to develop improved filters was not clearly articulated.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers mentioned the amount of data collected. For instance, one reviewer felt a lot of data were obtained over the past year (e.g., CTE, elastic moduli, porosity), but the PIs now need to tell us what they are going to do with these data and how their efforts to obtain them will produce improved DPFs. Another reviewer commented the mechanical properties have been measured which relate to the illustrated failure mode. These are important contributions to the public domain literature. The focus on porosity is appropriate. A reviewer noted the good progress being reported towards characterizing properties that influence the lifetime of DPF's. This will lead to a computational methodology for a lifetime prediction model.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A positive review mentioned how the cooperation between partners is well coordinated, and also mentioned how cooperation is sought with SUNY Stony Brook in the area of NDE to create progress in this area. While another reviewer recognized Cummins and Corning are involved with the PIs, the reviewer felt their precise roles should be better articulated in future presentations.

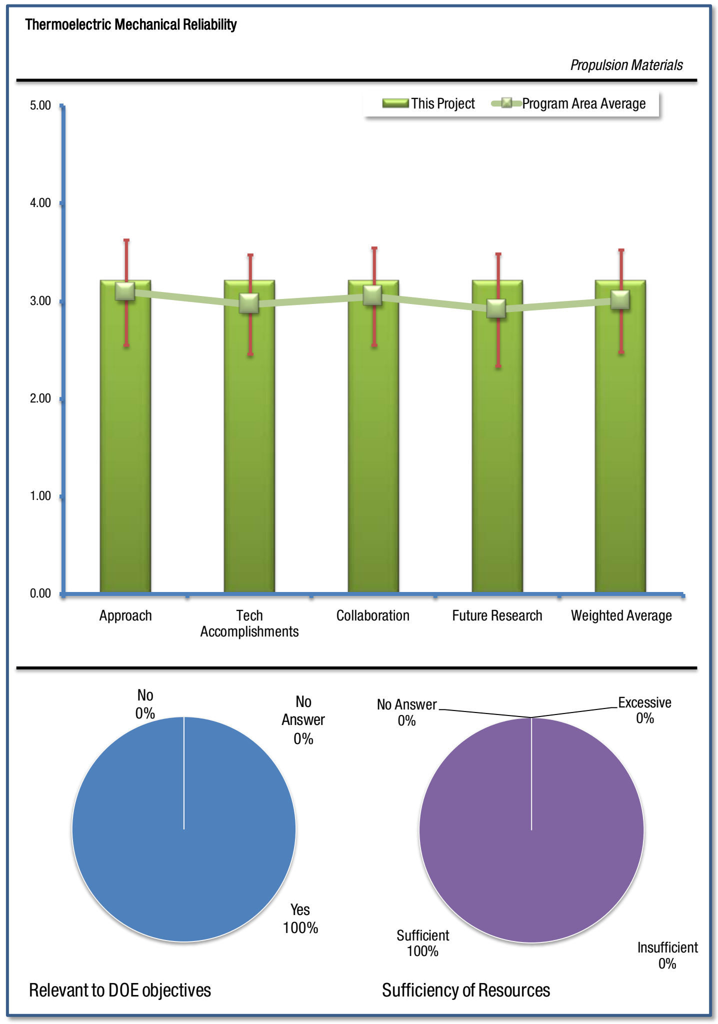
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

One reviewer was pleased that such highly-advanced characterization will continue. Another reviewer commented on how plans are in line with the outcomes of earlier research and are focused on overcoming remaining barriers, but in the field of NDE the plans are not so clear and it is less clear that barriers are overcome. A reviewer felt the future efforts seem to be on the same trajectory as the work performed in the past year. Some of their plans are vague (e.g. "collaborate with Dr. Sampath": what does "collaborate" mean?). Again, the PIs need to make a stronger effort to indicate how their data would be used.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented the amount of results is in line with the budget provided.

Thermoelectric Mechanical Reliability: A.A. Wereszczak (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Several reviewers commented on the potential for positive outcomes. One reviewer stated the project does support DOE's objectives, and as support offered how the PI is carrying out experiments that would ultimately allow for improved models of TE material packages. The PI states that mechanical properties are the weakest link in TE material development for waste heat recovery. Another reviewer stated the project is focused on solving barriers that are preventing TE materials to be used in automotive industry. These materials will improve the overall fuel efficiency of cars and trucks as such supporting the overall DOE objectives. A reviewer focused on potentially positive outcomes, commenting thermoelectric systems offer promising means to recover heat that would otherwise be rejected; this is a direct way to increase the utilization of energy input to heat engines. It was also noted, in another review, that the project is addressing TE materials are inherently brittle nature and susceptible for thermal-induced fracture, will achieve 5000 hours of life, and will combine measured data to design TE components to perform expected life.

A mixed review noted how scavenging of waste heat provides an increment of efficiency. For automobile applications, the "capital cost-for-efficiency gain" seems marginal and diminishing as technologies such as diesel allow more of the energy to be captured in the primary engine, with lower and lower exhaust temperatures resulting. With lower exhaust temperatures, the arguments for thermoelectric recovery tend to become weaker.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

For one reviewer, while the approach is well suited to find out what parameters are important to improve the lifetime of TE materials, it's not very clear how the endurance target is met. No clear approach to reach this target is provided. For another reviewer, the practical reliability of designs with brittle materials for electronic applications can benefit from use of the engineering tools that have been developed for heat engine materials. The experiments incorporate measurements to describe the anisotropy of the materials. The FEA tools provide good promise of selecting improved designs, without the reliance on the out-dated thermal-shock stress approximations.

A reviewer noted how there is a lot of testing in this project. Further, the PI is on the right track to provide data for the models that would be developed. The TE package may lend itself to failures of the types of interest here. The PI should consider examining other types of packages for TE materials which might be configured to provide better resistance to the sort of expansion that would lend itself to such failure. Interfaces are important. The PI should attempt, if possible, to measure thermal contact resistance and the role of interfaces in his continuing testing. Another reviewer noted how the project will generate thermomechanical property database on a candidate material in 2008, compare properties against those of mature TE materials, and execute FEA to model thermomechanical stresses.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

The reviewers recognized the great amount of data accumulated. For instance, one reviewer commented lots of good data on present commercial materials properties have been produced. This set of results is evidence of good progress. Another reviewer echoed this sentiment, commenting the progress during last FY was good. A great number of material data were measured. These data were combined with probabilistic methods to create insight and use of these data in modeling activities.

Another reviewer commented on the focus on R_{therm}. It should be as large as possible to provide a resistance of shock. Yet, a large R_{therm} is counter to an effective TE material which requires a high ZT which means low k. The reconciliation of the two was unclear. A reviewer noted how the project established a strength database for reference TE material, studied fracture in a reference TE material, examined the roles of independent parameters on strength, measured thermal conductivities, CTE, E, and Poisson's ratio of a reference TE material; and possible failure initiation locations in leg area were identified.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The collaborations were received positively by several reviewers. One reviewer mentioned the collaboration with Marlow, GM, and Michigan State, with the focus here on developing mechanical properties of certain selected TE materials. The reviewer felt the collaborators are good, and that Marlow will provide materials. The PI will test the materials provided to him. Hopefully, advice will flow from the PI to the manufacturers to help improve their product and the collaboration will not be entirely passive. Another reviewer mentioned the collaboration with Marlow Industries, General Motors, and Michigan State. A reviewer mentioned the cooperation with Marlow was formalized, and how there is collaboration with automotive manufacturers and other research institutes however, in the report it is not visible how the different partners provided input for the mentioned results.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

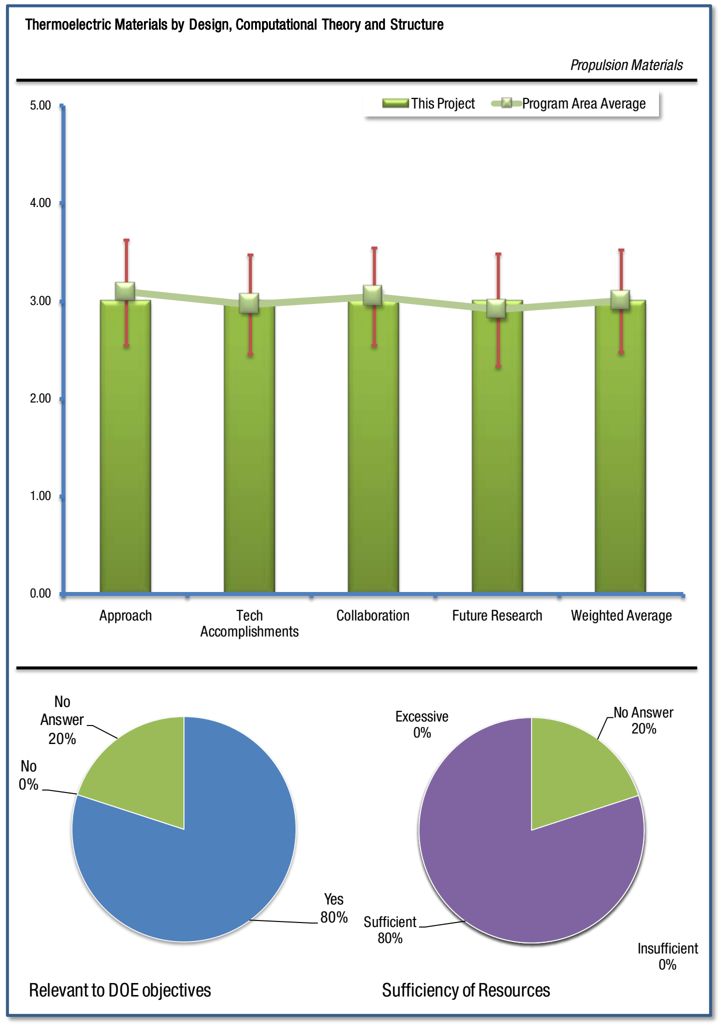
A reviewer commented that the work presented so far will be the baseline for mechanical testing of innovative compositions in the future. With planned work for mechanical tests with thermal gradients present, the researchers may be able to use FEA to say which of the (out-dated, but simple) approximations for thermal shock (i.e., with or without a thermal conductivity term) is a better approximation for these low thermal conduction materials. Another reviewer felt the three proposed activities for the future are sharply focused on barriers. It will be important to have insight on the effect of flaw distributions. This could be of use in future quality control measures during production.

One reviewer suggests better coordination between ZT (which is not considered in this project) and Rtherm. They are not entirely unrelated regarding developing an effective thermal module for TE waste heat recovery. A high Rtherm and high ZT seem to be a bit contradictory. Some elucidation of this point should be considered in future work. Another reviewer suggests work with a manufacturer and contribute to the reliability improvement of their candidate TEM, develop a thermomechanical test system, and develop method to quality strength-limiting flaw population.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer felt the results are in line with the budget mentioned for 2008. It would be nice if a Gantt chart was provided comparing current achievements with the original planning. For another reviewer, resources are adequate, though the precise breakdown of what the funds are used for was not provided. A third reviewer noted how the project has funding for 2009.

Thermoelectric Materials by Design, Computational Theory and Structure: David Singh (Oak Ridge National Laboratory (ORNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Most reviewers commented that the project has positive outcomes. One reviewer commented TE devices for waste heat recovery can be very important for waste heat recovery. The target is waste heat recovery as an application is relevant. The PI indicates a high ZT (>2) as a target for his efforts. Another reviewer remarked that it does support DOE objectives a little, and that scavenging of waste heat provides an increment of efficiency. For automobile applications, the "capital cost-for-efficiency gain" seems marginal and diminishing as technologies such as diesel cause the energy to be captured in the primary engine, with lower and lower exhaust temperatures resulting. With lower exhaust temperatures, the arguments for thermoelectric recovery become weaker. Another reviewer noted how the project discovered practical material that can yield fuel saving of 10% in vehicle, developed lower cost TE materials, and used science base approach for design TE materials.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Some reviewers reacted positively to the technology. A reviewer commented that the technology looks like very good basic research that could have significant pay-off. Another reviewer remarked the emphases are on a high ZT and to identify materials that would allow high values to be obtained. The analysis appears quite rigorous and good, being based on first principles calculations. A range of materials are considered, including metallic oxides which is very anisotropic. It was unclear how the anisotropic effects are accounted for in the analysis; presumably this point could be addressed (or clarified) in future work.

Another reviewer notes how the project applied first principles calculations to obtain electronic structure and vibrational properties, focused on materials such as oxides and chalcogenides that promise potential low cost, and focused on 3D materials. A more mixed review described how the fascinating physics of thermoelectrics -- so far -- have not meshed well the constraints for automotive, namely, hazardous materials restrictions and need for low cost. Further, the continued pursuit of lead and arsenic is not reasonable in the light of RoHS regulations today. Of course, the difficult problem is made only more difficult with such automotive constraints. Many technologies do not "make it" in automotive.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers continued to focus on first principles calculations. For instance, one reviewer felt first principles calculations are being performed of some of the electric properties which are providing good insights into performance of candidate materials for TE. The results are cast in terms of "thermopower". The PI has provided good insights from his calculations on such things on phonon scattering or dispersion which relates to why conductivity can be low. The reviewer also feels it would be good to attempt to provide estimates of ZT if possible, which is the accepted measure of performance. Design rules for oxides were provided (some attempt to synthesize them). The PI identified some high performance oxide candidates, focusing on materials with reasonably isotropic properties and potential low cost. This reviewer also is of the opinion it might be worthwhile to consider finding ways to both create high low k but high Seebeck coefficient.

Another reviewer noted how many materials are being examined experimentally. There appear to be many parallel efforts to find high thermoelectric performance compounds. What might distinguish the EERE funded work would be a focus on materials with properties that influence packaging and reliability aspects favorably. A reviewer also noted how GM data supported the predictive curve, LDA band structure is shown to be in quantitative agreement with experiment, Spinel type titanates, $YCuO_2$+x Delafassite were studied, the project showed doping can be controlled by treatments, and the project identified principles for thermoelectric performance in PbTe and La_3Te_4.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

While one reviewer felt the collaborators are quite good, but do not include a company which fabricates TE packages (e.g., Marlow, BSST, etc.). Perhaps they should consider adding such a partner. Another reviewer saw the work has evidence of good interchange between the physical theorists and experimentalists. The combination is powerful to establish properties. A reviewer noted work with GM R&D, Oregon State, and North Carolina State.

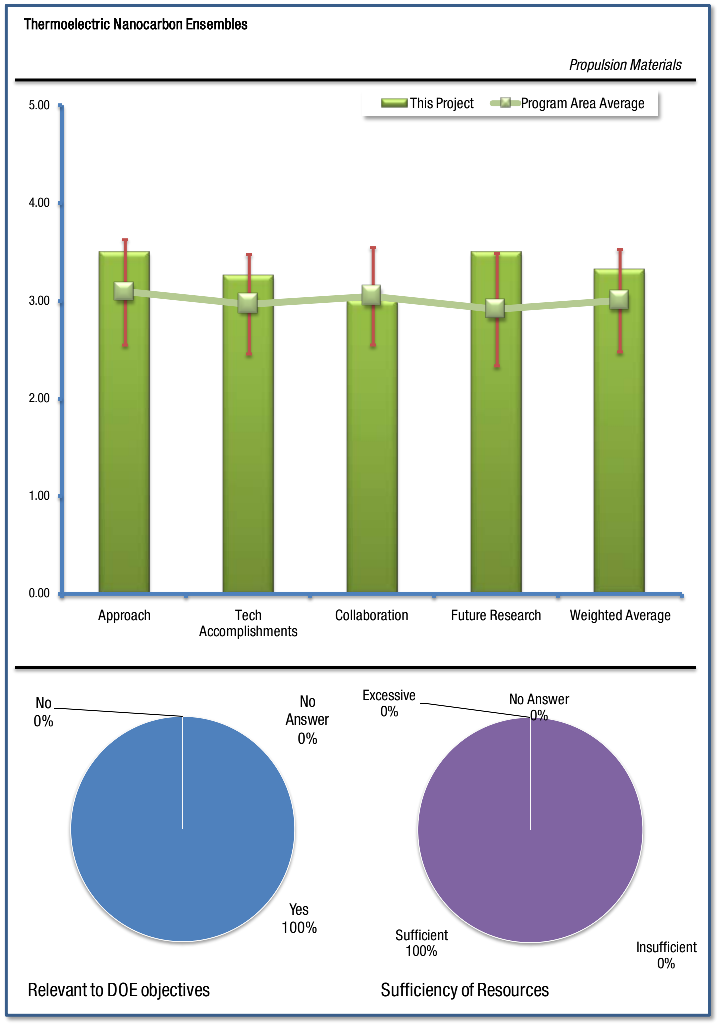
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer noted how both oxides, chalcogenides and antimonides will be examined in the theortical calculations. The reviewer also suggested the PI should consider, if possible, presenting results in terms of ZT. If k is the problem, perhaps he can find a way to measure or predict it (difficult as this may be). Also, the T dependence of ZT would be very good to predict, again if possible. Another reviewer notes how the project appears to have similar trends to the unexpected finding of ceramic superconductors which was unexpected. Does any of that work apply in a conceptual fashion to the thermoelectrics? A reviewer noted how the project studied alternate oxide compositions, Tellurium free analogues of telluride thermoelectrics, and Zintl phases.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer commented that resources are adequate. Another noted that FY 2009 funding has arrived.

Thermoelectric Nanocarbon Ensembles: D.M. Gruen (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

The reviewers approached this technology positively. One remarked the development of novel TE materials is very important for waste heat recovery applications with an expected improvement in efficiency. The hope is to increase efficiency by 3% to 10% that could also be applicable to solar applications. Another reviewer commented the thermo electric effect belongs to the top three potential energy recovery methods in cars and trucks in the future. Energy recovery will lead to improved overall fuel efficiency. An efficient in bulk produced thermo electric material would lead to a significant contribution to the overall DOE objective.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Some of the reviewers had a positive assessment of the approach. For instance, one reviewer remarked the approach taken here is to develop high ZT materials through high electrical transport (as contrasted to the more conventional low k). The concept is to attempt to work independently with the parameters that factor into the ZT formula. The materials targeted are nanocrystalline, in particular nanocarbon doped with boron. Both Seebeck and electrical conductivity are measured in what seem to be very precise devices. This reviewer also remarked, the theoretical computations which are density functional theory provide interesting insights into the reasons why the electrical properties behave as they are found from the experimental measurements.

Another reviewer had insight on the barriers, commenting the report clearly describes the barriers–a focused approach is provided to overcome these barriers. Focusing on nano carbon material opens the opportunity for a bulk producible TE material with low impact on material resources. It is taken into account that there are still a great many uncertainties inevitably coupled to innovative projects.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers recognized the project has proven significant improvements. For instance, a reviewer remarked how results based on density functional theory were provided, which provide interesting insights into the reasons why the electrical properties behave as they are found from the experimental measurement. The data on power factor show a strong monotonic increase with T. The effects of annealing appear to be strong. In the past year the PI appears to have shown a significant improvement of the power factor. Another reviewer concurs, noting that a significant improvement in power factor is proven in past period, but that little information is provided on the efforts to decrease the thermal conductivity. In itself this is a critical parameter towards overall success. It would be good to compare the results with the performance of the existing traditional TE materials.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer noted that collaborators include BES, CNRS and the Naval Surface Weapons Center. However, the precise roles of these partners were a bit unclear. Another felt that a broad consortium is formed with other institutions also outside the U.S. The activities are performed at different locations. The results are promising so industrial interest should become reflected in the consortium. This would also underlines the promising future for this material.

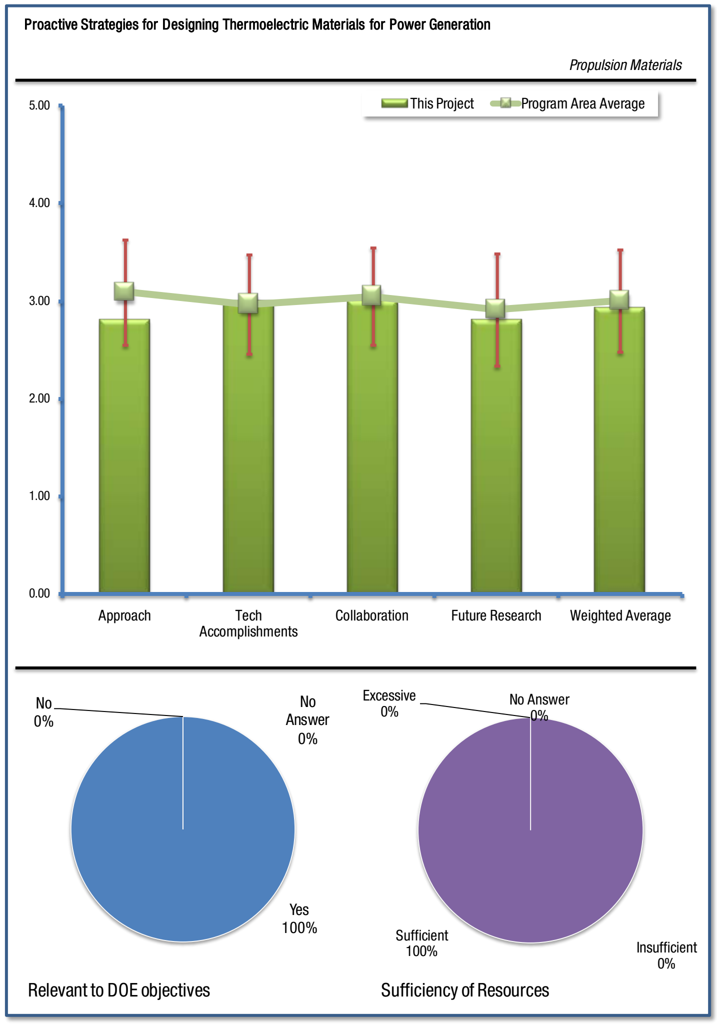
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers perceived that activities are promising. For instance, according to one reviewer, the plan to focus on increasing the Seebeck coefficient through nano-ensemble composition (as by annealing) and to decrease thermal conductivity (by density and porosity structuring) is interesting. Hopefully, the PI will be able to accomplish this since the prior art has shown some challenges in this regard. Another noted how the proposed future work focuses on the four critical barriers. The activities are in line with past results.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer felt the funding was adequate. Another commented that reported results are in line with the provided budget, but it would be good to have a Gantt chart of the project comparing achieved milestones with the original project planning. Another opined that this project is beginning to show promise. Increased funding should be considered after FY 2009.

Proactive Strategies for Designing Thermoelectric Materials for Power Generation: Terry Hendricks (Pacific Northwest National Laboratory (PNNL))



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers saw possibility for petroleum displacement. For instance, one reviewer commented that developing TE materials has significant promise for efficiency gains in waste heat recovery. Another reviewer recognized that this project aims to increase 10% fuel economy of heavy-duty engines over 2010, to improve light-duty vehicle fuel efficiency up to 10%, and to improve Cost-Effectiveness and Performance of Exhaust Heat Recovery. A reviewer opines that waste heat recovery is applicable across the board to light- and HD engines of all conventional and advanced types. Another reviewer had a similar viewpoint, commenting that the project focused on bringing TE materials to the market. TE materials potentially lead to recovery of waste heat improving the overall fuel efficiency of vehicles.

Another reviewer identified possibility for a little displacement, remarking that scavenging waste heat will help overall efficiency a little. As new engine technologies (or fuel cells) pull more energy directly from the fuel, the exhaust temperatures are tending to lower temperatures. The thermoelectrics contribution would be expected to decrease with the more modern engines with lower-temperature exhaust.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Among positive reviews, one reviewer answered yes, this project will systematically investigate Dual-& Tri-Rattler Skutterudites, refine n-type Materials, Characterize at Higher Temperatures & Transition to TE Couple, systematically Develop p-type Materials with Performance Similar to n-type Levels, conduct TE Property Measurements at OSU Laboratories, and conduct structural / Thermal Property Measurements at PNNL. Another commented that Skutterudites will be examined with a target ZT of 1.6 as the goal. The university measures Seebeck coefficient, thermal conductivity, expansion coefficient, and electrical conductivity; PNNL will measure mechanical properties. PNNL itself will also fabricate the materials. A similarly positive response was offered by one reviewer, who commented the project builds on the outcome of various other projects. To link the material research results to overall TE system performance helps to introduce this technology in the market place.

Another reviewer showed concern for cost, commenting that the fascinating science of thermoelectrics is being approached in this work without apparent concern for the extreme costs of some of the elements involved. The emphasis is "to be on Rh" was stated. Rhodium is a very expensive choice. Rh certainly is used in automotive applications, but only in catalytic quantities.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer identified significant progress, commenting that investigators measured Material Strengths at Room Temperature, determined Elastic Material Properties Over Elevated Temperatures, modified existing Quasar RI-2000 Resonant Ultra-Sound system, and developed structural testing plans and identified test equipment. Another held a similar perspective, remarking on how the most promising materials are identified and test plans are developed. In addition, the structural characterization is addressed in this project. However, based on the provided information it is difficult to assess what is accomplished in this project and what is the result of previous projects. Another reviewer commented on how the PI has developed a high T furnace for high T measurements of electrical and structural properties. The PI has measured strength properties at room temperature and elastic properties at elevated temperatures. Seebeck coefficient and electrical resistivity measurements were also measured as a function of doping level. Power factors as a function of T which showed a peak at about 450K (without Rattlers). Another reviewer noted there are thermoelectric property results for more materials being provided in this work. Some of these seem to be nearing physical property targets for thermoelectric performance for gasoline engine exhaust temperatures, such as InCeCoSb. Cost is a concern.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

For the most part, reviewers identified collaborators and felt the collaborations were worthwhile. For instance, one reviewer noted that there is a very good division of responsibilities among collaborators. Another reviewer noted that the collaborators include a university with whom the PI interacts. However, there did not seem to be a TE manufacturer (e.g., BSST was mentioned but does not appear to be formally part of the program). A reviewer mentioned collaborations with Oregon State University, Corvallis and ONAMI. While a reviewer recognized that a well balanced consortium is formed and activities are coordinated, it is not clear if there is a role for end user from automotive. This was the case in the previous project but no cooperation was indicated in the provided material.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

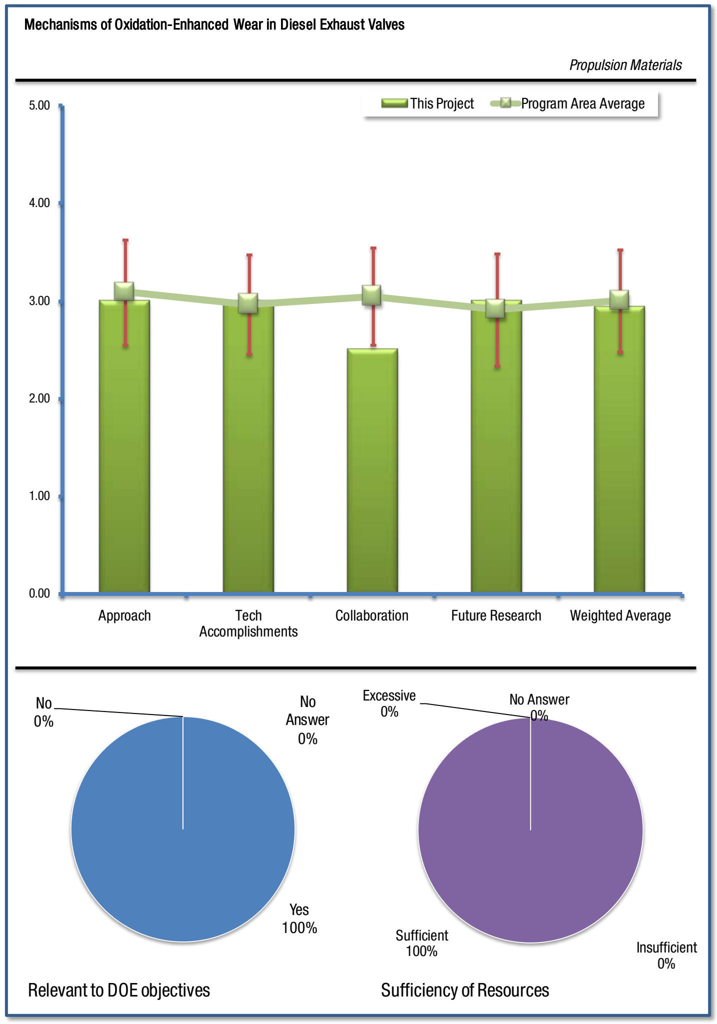
Several reviewers responded positively. One reviewer felt that future research is in line with the outcome of the first months of the project. The proposed activities are in line with the relative short remainder of the project. Another reviewer concurred, commenting that logical follow-on work is planned. Another reviewer remarked yes, and explained that future work includes Optimize Synthesis Procedures for n-type $(In,R)Co_4Sb_{12}$ Compositions, Introduce Single & Multiple "Rattlers" (In, Rare Earth) in $Co_{0.6}Rh_{0.4}SbO_3$, Characterize TE Properties & Validate with Third Party Testing, Structural Property Measurements, and Transition to TE Couples & Measure Performance.

A more mixed review expressed concerns over cost. Specifically, the reviewer remarked the cost is a concern for bulk application of material with large proportion of Rh. The associated cost will be extreme. Some estimates of this raw material cost should be considered in a device design. Another reviewer remarked the PI wants to optimize the synthesis of the n-type materials for future work. The structural properties will be measured at PNNL and OSU will be evaluating the TE properties. The challenge of quality control in manufacturing will also be a topic for continuing work. The PI should consider cost issues for large scale production, especially at x=0.6 for rhodium.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers responded that the budget is adequate. One reviewer noted that this project is funded for one year, and the budget is in place. Another felt that results are in line with the provided budget. A reviewer also said that this project appears to be producing good value for the money invested, and future funding might be increased with good effect.

Mechanisms of Oxidation-Enhanced Wear in Diesel Exhaust Valves: Peter Blau (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer responded that this project supports informed selection of exhaust valve alloys to improve fuel efficiency, and notes that it is to reduce wear around valve seat to improve fuel efficiency. Another reviewer commented that this project is attempting to elucidate materials behaviors that directly influence the efficiency of heavy-duty engines by the most basic mechanism, i.e., retention of cylinder pressure during the compression and power strokes.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer noted that the project used customer-designed high temperature repetitive impact system to study the effect of oxidation with seat alloys, and also developed model to understand the wear-oxidation effect.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer responded positively, commenting that differentiation of alloy behaviors under high-temperature, oxidizing conditions and the interplay between mechanical stress/deformation and surface chemical chemistry is particularly interesting. Another noted that the project selected 4 alloys for study and conducted baseline oxidation rate studies, conducted oxide scale healing experiments, and developed a customer-designed high temperature repetitive impact system to study the effect of oxidation with seat alloys.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

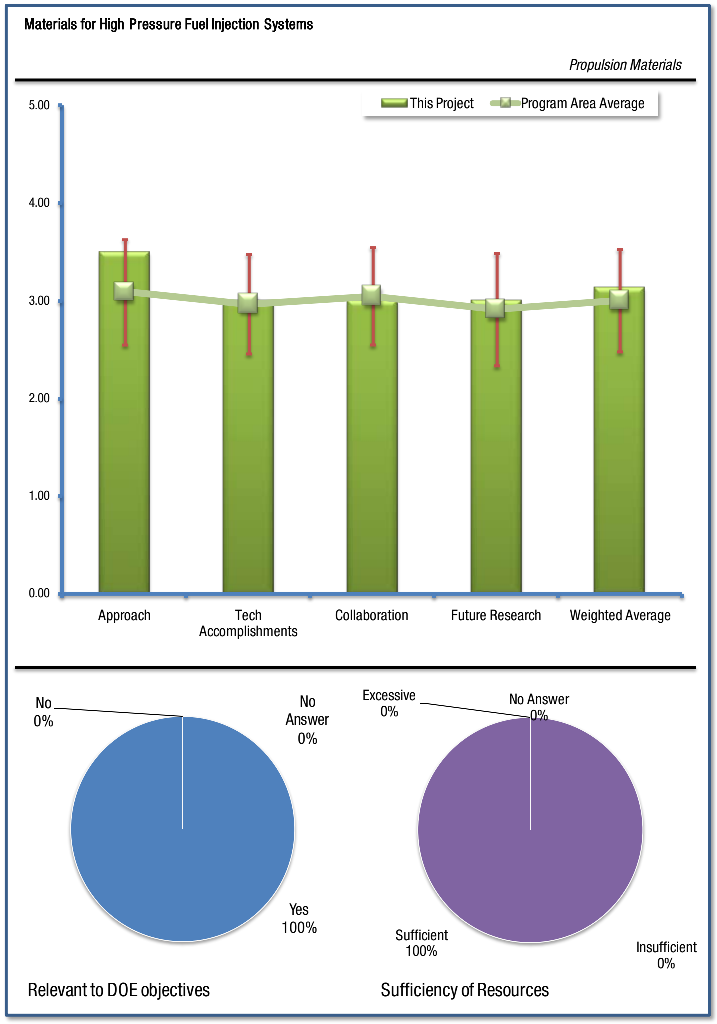
The reviewers did not see much collaboration. One reviewer noted that this project doesn't appear to rely on collaboration with other institutions, having only a single industry partner, but its results will be of use to the entire heavy-duty engine industry. Another reviewer noted informal collaboration with Caterpillar to share results and to provide valves for testing.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer commented that it appears this project will end in the next FY and that its results will then be available to industry to use. It's not clear that any direct follow-on work is planned at ORNL. The above rating of "Good" is therefore conditioned on the assumption that industry will find the work helpful and carry it on. Another reviewer noted the project's model development and its final report.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer noted that the project is 80% complete and will be completed in Sept. 2009.

Materials for High Pressure Fuel Injection Systems: Peter Blau (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Many of the reviewers commented on the practical nature of the project. For instance, one reviewer commented that the success of this work will aid in improvements to practical diesel combustion and in the efficiency of diesel engines using the technology, over and above the advantageous utilization of petroleum within the category of diesel-fueled engines. Another reviewer commented this is very basic work designed to answer fundamental and practical questions of manufacturability and durability of engine hardware essential to achieve goals (elevated injection pressures, enhanced mixture formation and improved combustion) that have been long established as key to engine efficiency.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer commented on the efficacy of the project. The reviewer remarked the project is a multiple-task characterization project. The project appears to be well-positioned to identify which are the better materials choices for high pressure diesel that promise to provide improved combustion and efficiency.

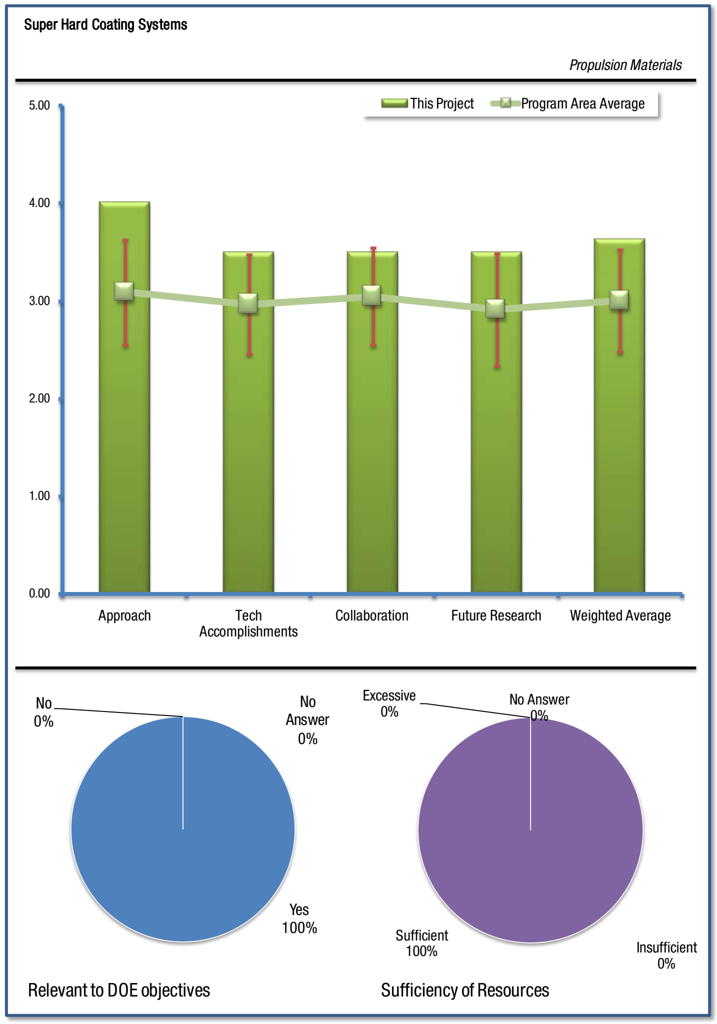
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Some of the reviewers identified that the work is just starting, but is on the right track. Specifically, one reviewer remarked the work is at an early stage, and that characterization techniques for nozzle hole roughness have been established is a marker of good progress. Another reviewer noted that some of the geometric and stress measurement techniques initially identified have proved unequal to the task. This is useful information in and of itself, and the investigators appear to know what to try next.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers remarked on the CRADA. One reviewer felt that CRADA provides linkage, and another reviewer noted that the CRADA is with a major industry actor.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
There were no responses to this prompt.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer noted that the resources appear adequate with industry time-share.

Super Hard Coating Systems: Ali Erdemir (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers recognized petroleum displacement opportunities. One reviewer commented on how coatings that reduce the friction coefficient lead to improved efficiency of the engine. These hard coatings will have the highest impact on fuel efficiency in difficult to lubricate location (example; piston ring cylinder wall contact). Another reviewer noted how reduction of fmep is one of the most basic (and last) areas in which to search for incremental gains in engine efficiency and low-friction coatings for internal engine components is a logical area to explore. Wear-resistant coatings will extend engine life and TBO, making it easier to recoup the additional cost of such surface treatments.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer opined that the chosen approach is very well suited to introduce these coatings in engine application. First build up thorough understanding of the materials and have it proven in a fired engine.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer felt that the presentation included proof that a further reduction of the friction coefficient was realized. One of the advantages of these coatings is the potential to reduce further the viscosity of the engine oil leading to further reduction of parasitic losses. The reviewer felt this was not mentioned in the report.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

The reviewers positively evaluated collaboration. One reviewer felt a good cooperation with industry is present in this project, but that a wider cooperation with other institutes would be beneficial. Another reviewer felt that industry interest in licensing and commercializing technologies is compelling evidence of successful collaboration.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer thought the next steps indicated show a clear path towards commercialization of the outcome of the project. Critical will be the outcome of the engine tests.

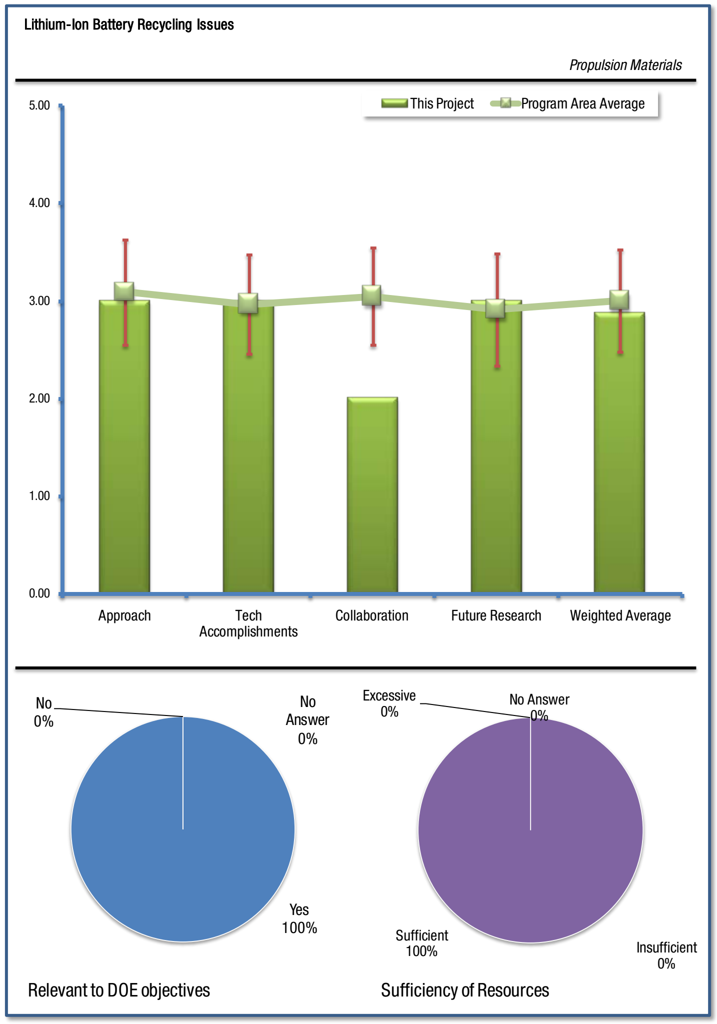
Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer saw that results are in line with the provided budget.

Lithium-Ion Battery Recycling Issues: Linda Gaines (Argonne National Laboratory (ANL)) - POSTER

Reviewer Sample Size

This project had a total of 1 reviewer.



Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer commented on how EVs, HEVs and PHEVs are probably the most important mid-term technologies to minimize the petroleum demand of the highway transportation sector. However, according to the reviewer they will present unique resource challenges of their own, among which will be the demands imposed by the large aggregate electrical energy storage capacity they will impose.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer felt the relative importance and market shares Argonne assigns to passenger cars and light trucks might merit reexamination in light of recent trends.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

There were no comments on this question.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer commented that the project appears to be solely the work of ANL. Collaboration and coordination with other institutions may not be a relevant metric.

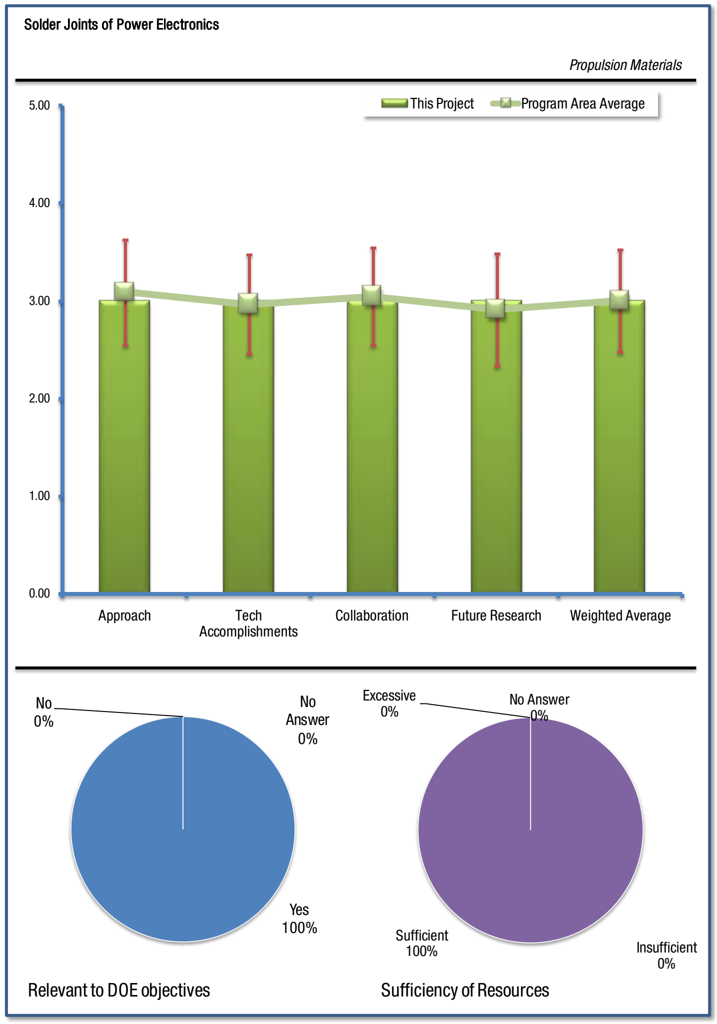
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

There were no comments on this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

There were no comments on this question.

Solder Joints of Power Electronics: Burak Ozpineci (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer commented that EVs, HEVs and PHEVs are straightforward means to displace petroleum in the highway transportation sector. Reliable power electronics are key enabling technologies or all such vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer expressed concerns about one element of the approach, commenting that the selection of -65 C for the lower limit of thermal cycling testing seems severe, at least for the contiguous 48 states.

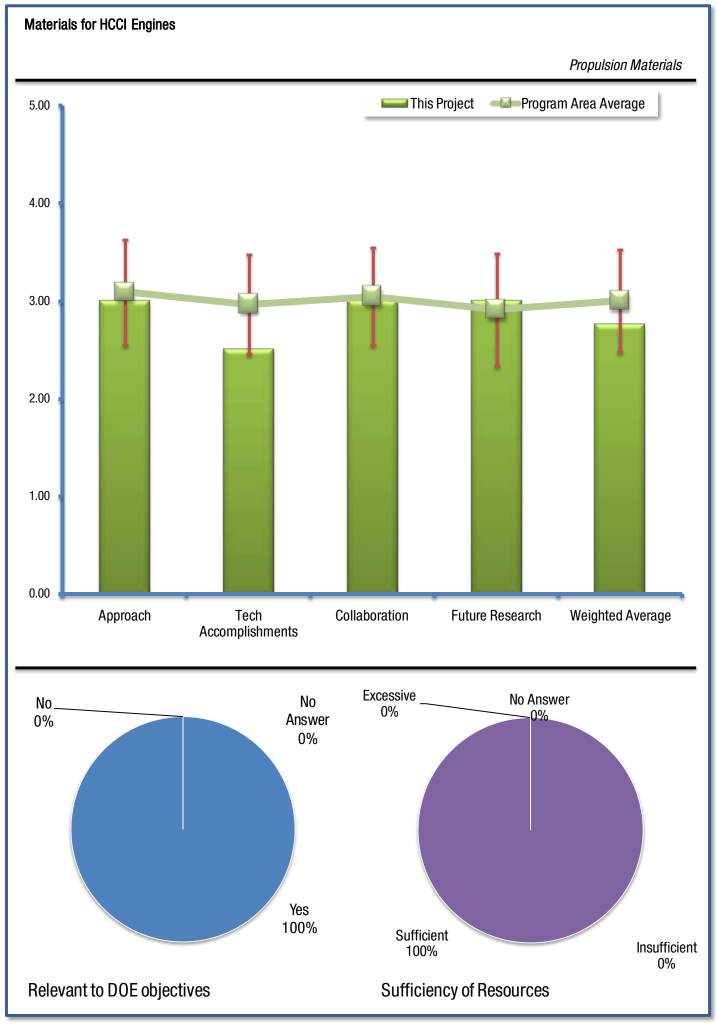
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
There were no comments on technical accomplishments.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer felt the initiation of contact with major U.S. auto manufacturing is appropriate and timely.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
There were no comments.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer commented positively on the funding, noting if this work can be brought to a satisfactory conclusion on the funding delineated in the poster, it could represent a bargain. Is it contemplated that there will be future cost share (other than in-kind) from auto manufacturing and current industry partners?

Materials for HCCI Engines: Bruce Bunting (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer felt the project does support DOE objectives, commenting that higher combustion temperatures/pressures, although they stress engine components and can shorten their service life, are apt to result from efforts to increase engine efficiency and specific output, which can reduce petroleum consumption.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

While a reviewer felt the approach is very good, the reviewer noted that HCCI combustion tends to be cooler than that of conventional CIDI engines, causing this reviewer to wonder if the principal application of this work is, in fact, to HCCI engines.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer felt the rate of progress in this early phase of the project is unavoidably slow. But, progress is likely to accelerate once the initial correlations of alloy microstructure with mechanical properties of interest are established.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer commented on how selection of collaborators - component manufacturing and materials supplier - is well-considered.

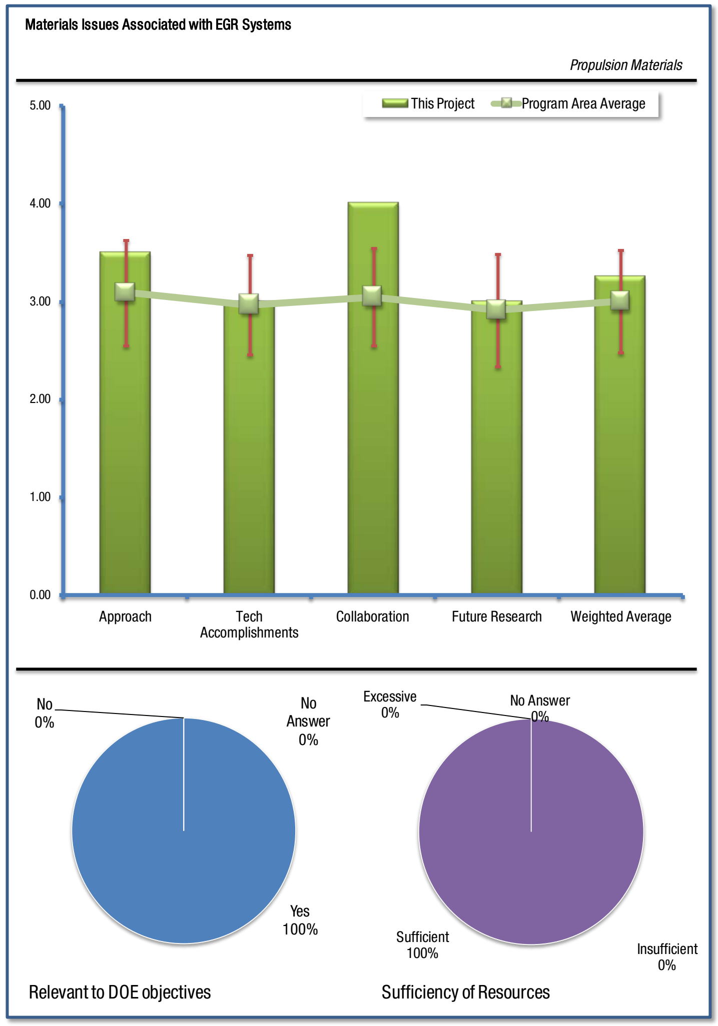
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

There were no comments.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer saw that funding levels for FY '08 and '09 suggest a lean program.

Materials Issues Associated with EGR Systems: Michael Lance (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer offered an enthusiastic evaluation, commenting the success of this project will help the effort to widen the market for modern, highly fuel efficient, low-emission diesels. Diesel is recognized as a highly efficient means of converting chemical energy to mechanical energy. However, some of the ideas for further improvement of efficiency are creating new concerns to be addressed, as is the case here. Another reviewer commented CIDI engines must remain viable and economical in operation to contribute to petroleum conservation in highway sector. Current and pending emissions regulations will compromise CI engine performance, especially economy of operation, making it imperative that the deleterious effects of exhaust gas aftertreatment be minimized.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers offered positive feedback. One reviewer noted this project is "sharply focused" on critical issues identified by a multi-company industry team that is guiding the work. The insights from project investigator having a materials background is helping to guide which deposit properties to look for in this study. Another noted that the project had an excellent approach, and should result in highly detailed description of EGR deposits.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers recognized the accomplishments. One reviewer identified that techniques have been developed for sampling the EGR cooler deposits for a variety of thermophysical property measurements. Work has been reported recently at a major automotive meeting (SAE). Another reviewer felt it was too early in project to rate accomplishments fairly, but based on approach, collaborators, etc. significant accomplishments can reasonably be expected.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers noted the depth of collaboration. One reviewer commented on how the project's multi-company involvement reinforces the high interest in the solution of the EGR-cooler-deposits concern. Another reviewer agreed, commenting collaboration with and selection of industry partners to date could hardly be improved upon.

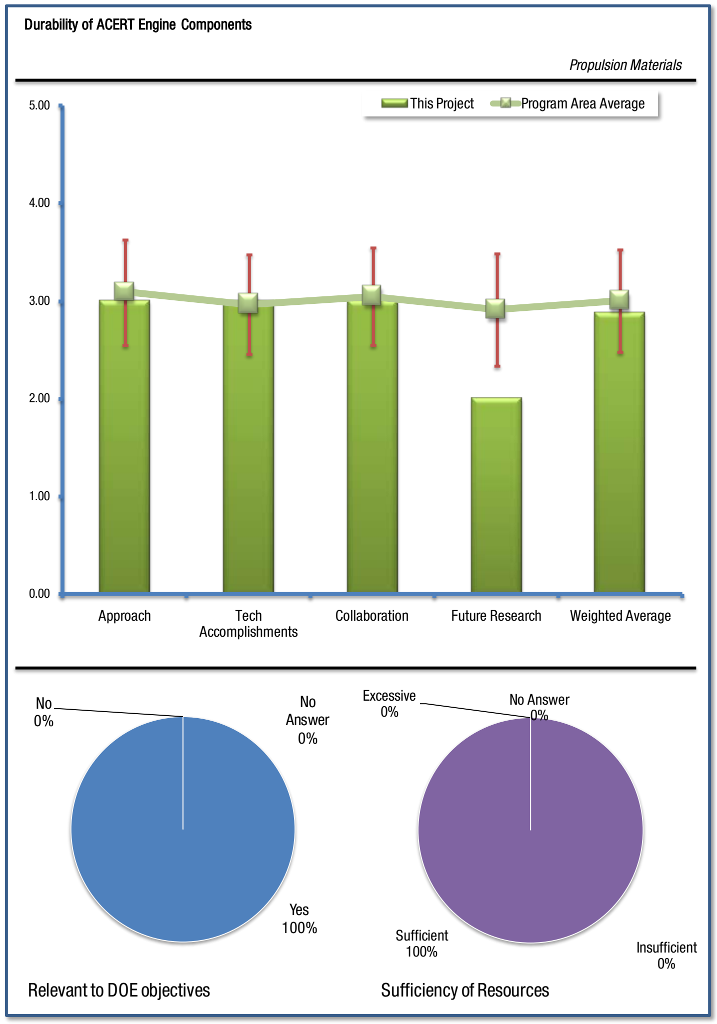
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer noted how the proposed work is responsive to the occlusion conditions found in real engines.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

There were no comments on resources.

Durability of ACERT Engine Components: H.-T. Lin (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer commented that within the project materials are those evaluated that enable lightweight solutions for structural components. This will contribute to the goal of 55% efficiency in 2012. Another reviewer commented that achieving HDD engine efficiencies >50% will directly reduce petroleum consumption. Materials offering greater durability in the high temperature ranges that will characterize such engine will be needed to enable long-term operation.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer's assessment was that the chosen approach to evaluate materials in real engine conditions will help to overcome the barriers more quickly. The approach will not provide answers to the contribution of the improving the fuel efficiency from 42% to 55%. It is recognized that the two chosen materials are likely candidates. No supportive documentation was provided to support this choice.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Reviewers commented on the potential for the program to progress. One reviewer expects significant progress, given expertise and experience of project collaborators, but progress to date had been modest. Another reviewer noted how there is good progress being made, but felt that the only setback is the failure of the valve retainers in the engine test. It would also be good to evaluate the current material in the same manner as the new materials. This would give more insight in the progress made so far.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers saw cooperation, but with some reservations. One reviewer perceived the cooperation between partners is good. However, there is little collaboration with other institutes. Still missing is the cooperation with a valve manufacturer. Their expertise on manufacturing of valves and assemblies could be beneficial. Another reviewer sees the CRADA with Caterpillar as a good vehicle for collaboration. However, Cat has announced its withdrawal from the on-highway engine market. This project is apt to result in materials and techniques for their application that will be relevant to all CIDI engine market sectors, but does Cat's exit from the highway truck engine market compromise the value of this project to that key sector?

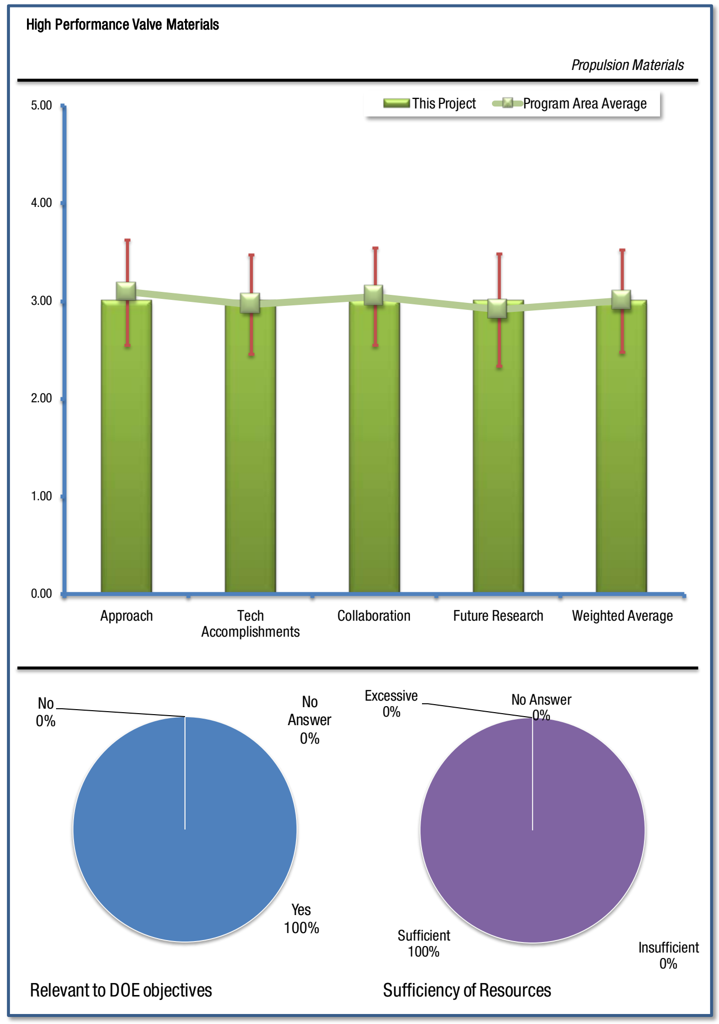
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer commented that the sheet provided was the same as in PM 06 09 by Kass. The information provided was not applicable to this project.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer felt the project's results are in line with the provided budget.

High Performance Valve Materials: Philip Maziasz (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer felt that higher CIDI engine efficiencies directly reduce petroleum consumption, but demand higher operating temperatures/pressures, which in turn demand higher-performance materials.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
No comments provided on this question.

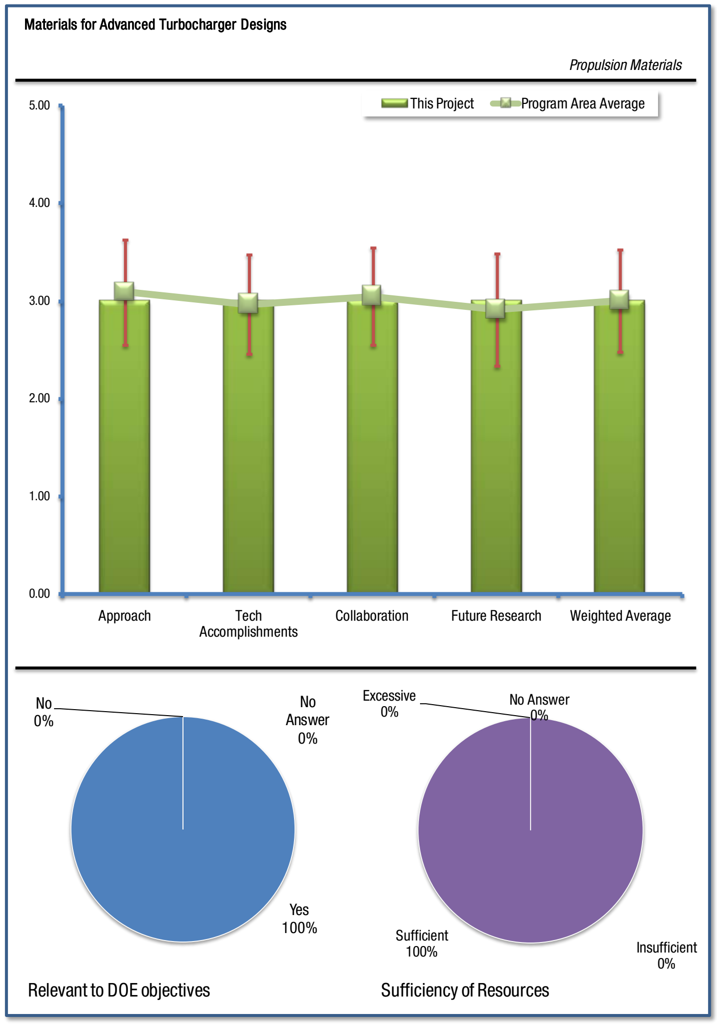
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer felt the early "instant success" speaks to significant technical accomplishments.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer felt the choice of collaborators was excellent and logical.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
To a reviewer, the twelve-month project extension appears justified based on early success and expectation of further progress.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no comments on this question.

Materials for Advanced Turbocharger Designs: Philip Maziasz (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

For a reviewer, the relevance of the project is obvious - higher operating temperatures are needed for additional efficiency, but stress engine components past current physical (and economic) limits. Turbochargers are universally applied to current and future CIDI engines.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

To a reviewer, the description of planned approach seems logical.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer felt it is too early to assess any accomplishments beyond selection of collaborating companies, but that and research plan appear to have been done well.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer commented on how Honeywell is largest turbocharger manufacturer and supplier to CIDI engine industry and thus obvious choice for project partner.

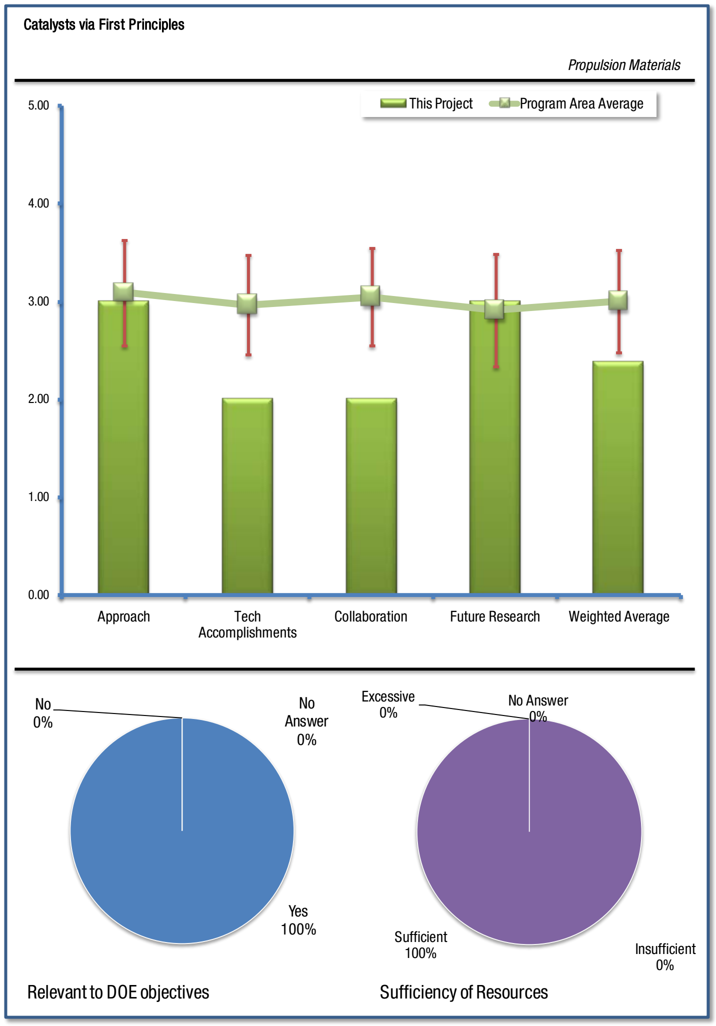
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

There were no comments on this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer felt funding is clearly sufficient and 50% industry cost share is appropriate.

Catalysts via First Principles: C.K. Narula (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer commented that more rational and rapid catalyst design methods would make it possible to more economically tailor exhaust aftertreatment catalysts (which are universally acknowledged to be indispensable to meeting current and future exhaust emissions standards) and improve their performance. This could indirectly allow improved engine efficiency (and thus reduced petroleum fuel consumption) by permitting efficiency-optimized engine calibrations.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
There were no comments on this question.

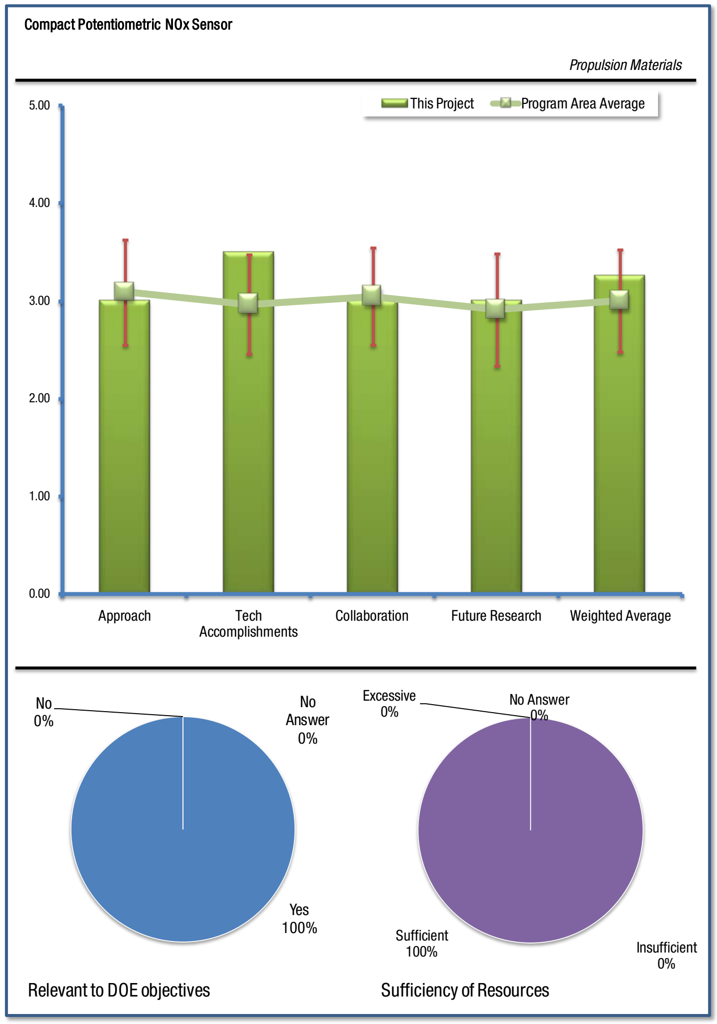
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
There were no comments on this question.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer felt the active participation of one or more catalyst manufacturers would be desirable.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
There were no comments on this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer asked whether this work duplicates current efforts of catalyst manufacturer(s), or has that been determined? Closer collaboration with a major catalyst manufacturer could help optimize cost-effectiveness of this project.

Compact Potentiometric NOx Sensor: Dileep Singh (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers saw potential for displacement. A reviewer noted how this project develops high temperature sensors to monitor combustion gases (NOx, O_2, CO, CO_2) for an internal combustion engine to optimize the combustion process (maximize fuel efficiency) and minimize pollutants. Another reviewer felt that practical exhaust gas species sensors could facilitate combustion optimization for the best balance of engine efficiency, emissions.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer suggested that the project should develop a high temp O_2 sensor and then modify it to sense NOx in combustion environments, develop high temperature plastic joining technology to join the YSZ sensor components to produce a leak–proof package, and conduct extensive tests to validate the performance of the sensor.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer saw an excellent program made in the project, and noted how the project developed a basic sensor package design, developed and demonstrated an O_2 sensor with an internal reference, made progress in the development of a novel high temperature ceramic electrode material (LSAM), and demonstrated joining of LSAM to YSZ ceramic.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer noted that work on gas sensors must be ongoing at any number of companies, given the importance engine and vehicle manufacturers attach to the subject. This reviewer asked, does the approach employed in this project mirror the approach(es) employed by others, or does it represent an altogether different approach to this important problem? Another reviewer noted the work with Marathon Sensors, McDaniel Ceramics, and Integrated Fuel Technology to develop the sensor, and recommends work with end-users such as automotive manufacturers or diesel engine manufacturers to further put the senor to test on the real engines and vehicles.

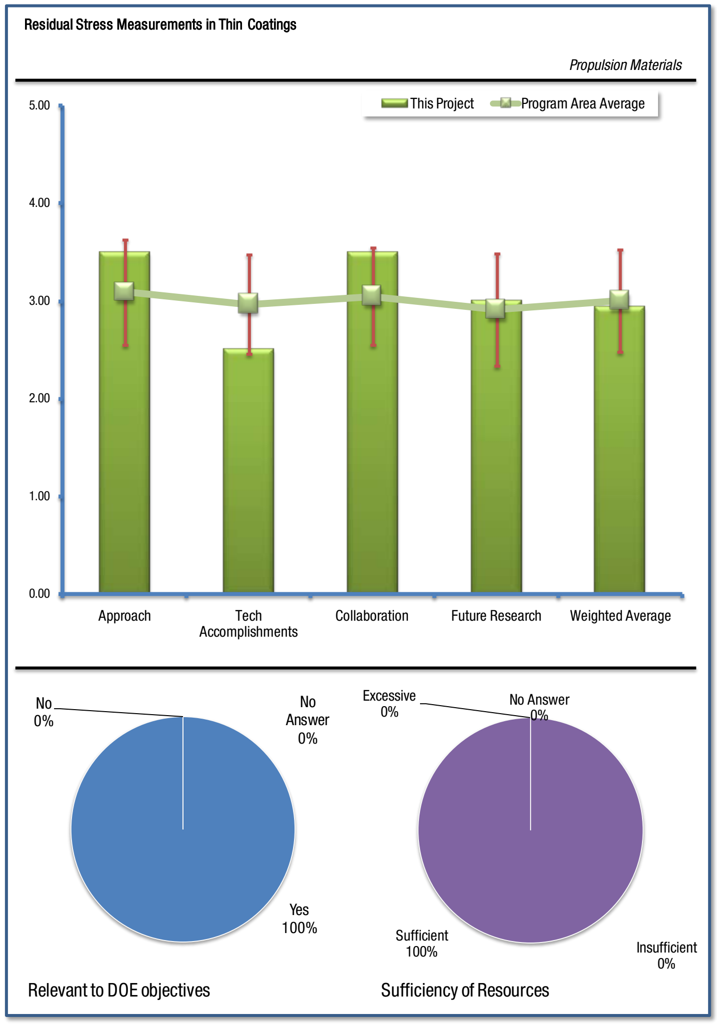
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer felt the aim of ultimate commercialization is laudable. Another reviewer commented that the project should continue to develop the sensor packaging, further develop the NOx sensor, fabricate the NOx sensor and characterize sensor performance, establish durability of the sensors, and should work with OEM to initiate discussions with OEMs for technology demonstration and eventual transfer.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer felt the funding level seems relatively modest, given the ambitiousness of the project goals. However, if this work duplicates R&D ongoing elsewhere (in the private sector), modest funding may not represent such a bargain. Another reviewer commented the funding for FY 2009 has been distributed and work with partners on the development work.

Residual Stress Measurements in Thin Coatings: Dileep Singh (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Reviewers saw potential for petroleum reduction. One reviewer commented the use of coatings have a history of aiding engine performance. Advanced diesels are looking at higher cylinder pressures and pushing the limits of existing materials. The knowledge of residual stresses will help give a physical understanding of how to obtain reliable coatings choices. Once a coating's reliability is proven for use in advanced diesels, broader acceptance and wider petroleum savings can be obtained by use of that coating. Another reviewer commented, understanding the mechanics of thin coatings will tend to make them more widely applicable and practical. Thin coatings include low-friction and anti-wear treatments for internal engine components which reduce FMEP (thus increasing efficiency) and extend engine life (thus reducing the life-cycle costs of advanced engines, accelerating their market penetration). Both those factors tend to reduce petroleum demand.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer saw that this is a coatings characterization project using a variety of simple (scratch and indentation) and complex (X-ray determined stress versus depth) methods.

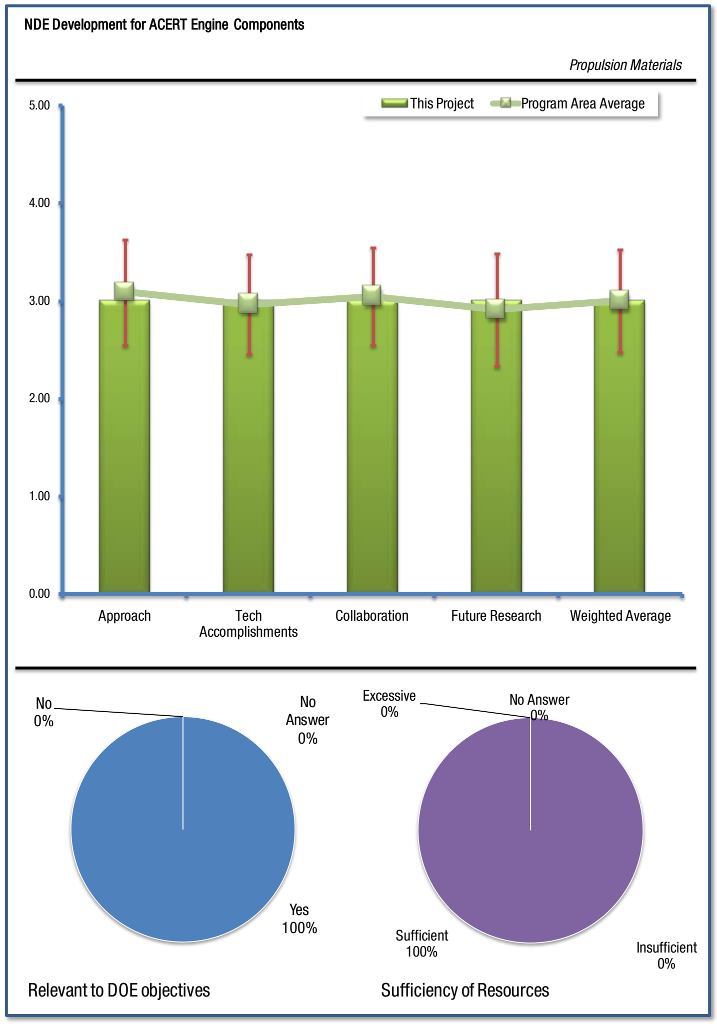
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer recognized how the researchers have gained a physical understanding of the limitations of the indentation method, and they are now proceeding with setting up for scratch testing.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
According to a reviewer, this work appears to be tightly integrated with the coatings' synthesis efforts.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
For a reviewer, the choice of scratch testing appears to be appropriate for the specific adhesion character of the coatings of interest to the larger project team.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no comments on this question.

NDE Development for ACERT Engine Components: J.G. Sun (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers saw the project as aiming to provide the means for petroleum reduction. A reviewer felt that achieving CI engine thermal efficiencies as high as 55% (which will self-evidently help to reduce petroleum consumption) will be difficult, requiring stringent management of thermal energy and the development of materials and components capable of tolerating long-term (1 million mile) exposure to very high temperatures. Rapid and reliable means to qualify and confirm the characteristics of such materials and components will be required if they are to be practical in mass production. This project aims to provide those means. Another reviewer saw that to reach the 55% efficiency in the field it is necessary that the engine components used are reliable. For this, it is necessary to have technologies available to check the components integrity before assembly.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer thought the approach to first scan various methods and select one to optimize more thoroughly is a good approach. Furthermore, the team also considered experience from other industries into their evaluation.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer commented on how in its first year, the project resulted in a clear direction for solving the NDE challenge for TBC.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers saw evidence of collaboration. A reviewer was cognizant of collaboration with other institutes and industry. There is exchange with other institutes, like Imperial College. Another reviewer saw collaboration, but had concerns. Specifically, collaboration with Cat is valuable, but will that restrict the application of any NDE techniques developed to that one engine manufacturer? The extent of collaboration with ORNL was not well-defined in poster presentation.

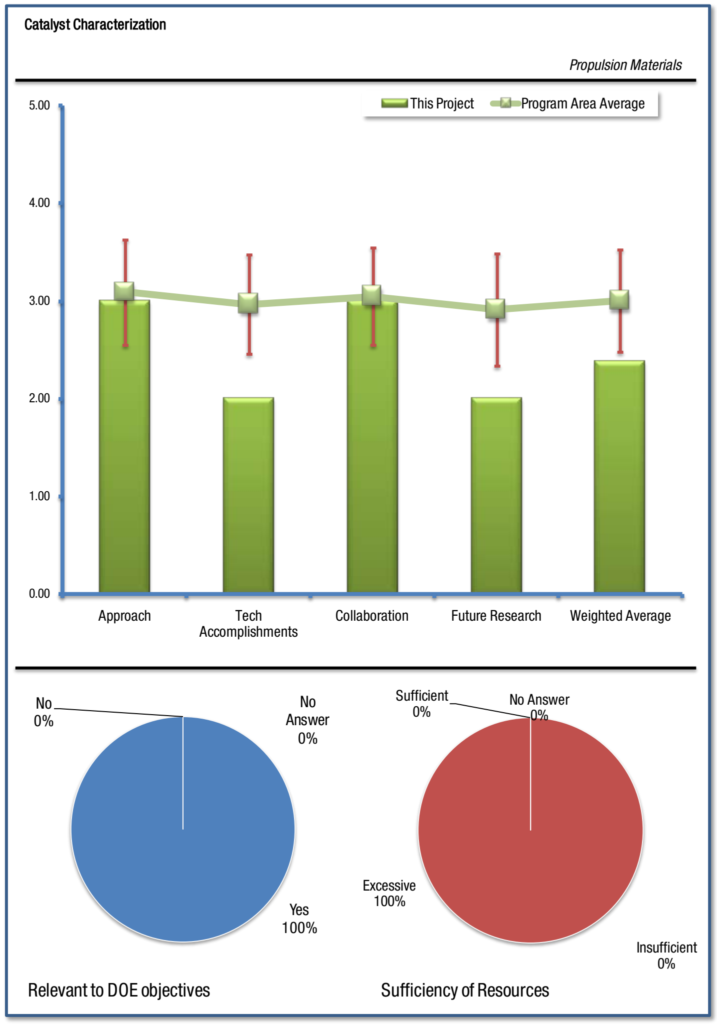
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer commented that the proposed work is a clear follow-up of the accomplishments so far.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer perceived that accomplishments are in line with the provided budget. Another reviewer felt funding appeared to be weighted fairly heavily toward the last two years of the project. Is this by design, and what, if any, will be the co-funding level provided by the project partners?

Catalyst Characterization: Thomas Watkins (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size

This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer recognizes the project's importance. Specifically, the reviewer commented SCR exhaust gas aftertreatment will be one of the principal routes to compliance with the 2010 HDD engine standards. SCR offers the possibility of calibrating the HDD engine for maximum fuel economy - which will help reduce petroleum consumption - despite the concomitant tendency to increased engine-out NOx. But SCR catalysts must be able to provide reliable NOx control over an extended time/mileage. Understanding the mechanisms that degrade SCR catalysts is the first step in learning to control them, and is therefore of key importance.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

There were no comments on this question.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer commented on the project's immediate milestones, noting that the milestone cited for '08 ["continued evaluation of commercial zeolite urea SCR catalyst"] is not, strictly speaking, a milestone. It is not clear, from the posters provided, that a 3-yr. extension of this project reflects encouraging progress or the slowness of progress to date and the need for additional time/work.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer saw project collaborators as both good and logical choices.

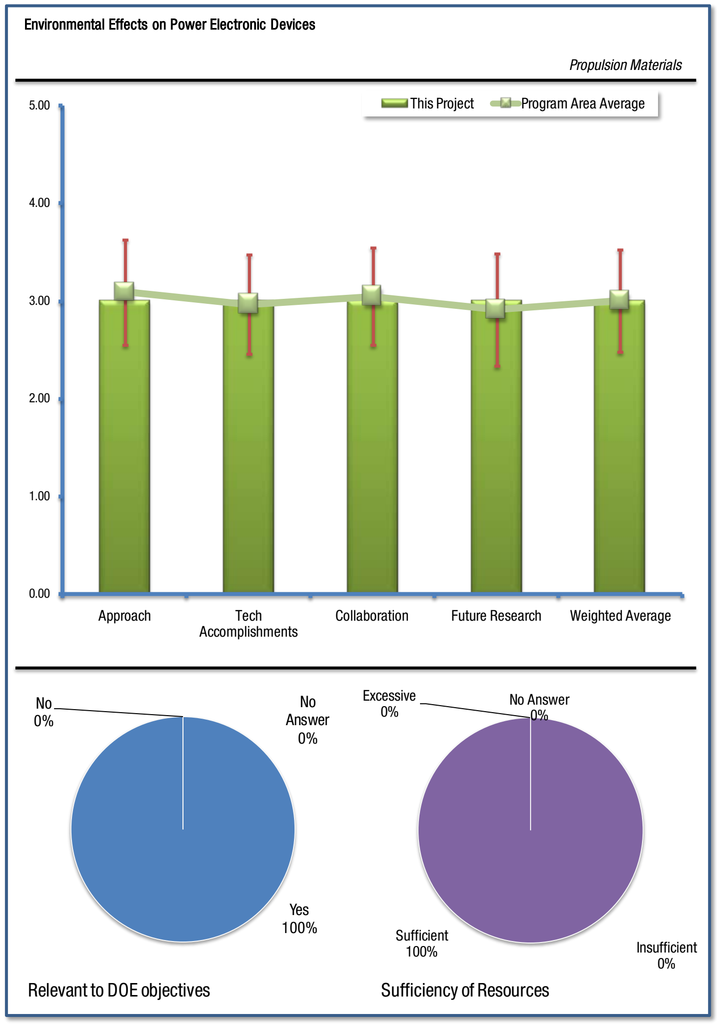
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

There were no comments on this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

There were no comments on this question.

Environmental Effects on Power Electronic Devices: A.A. Wereszczak (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer commented that electrically driven vehicles (all types) offer a direct means of reducing transportation-sector petroleum consumption. Power electronic components for these vehicles must be capable of performing reliably for times/mileages comparable to those of current ICE vehicles if EVs are to be commercially successful. This work directly addresses that requirement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
There were no comments on this question.

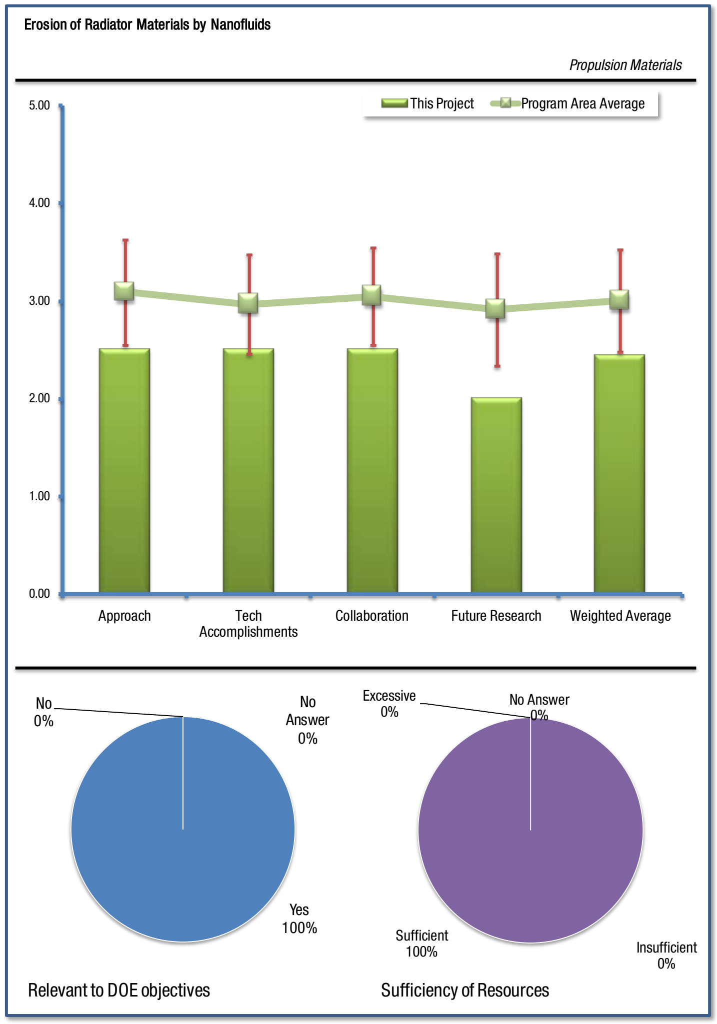
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
There were no comments on this question.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
There were no comments on this question.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
There were no comments on this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no comments on this question.

Erosion of Radiator Materials by Nanofluids: Dileep Singh (Argonne National Laboratory (ANL)) - POSTER



Reviewer Sample Size

This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

A reviewer offered a positive evaluation, commenting that nanofluid engine coolants, if otherwise acceptable (cost, environmental impacts, etc.) for long-term use, could enable a reduction of radiator size/frontal area. This could translate to a reduction of vehicle weight and aero drag, both of which could enable a reduction of petroleum consumption in the heavy truck sector. Another reviewer saw a limited expected improvement in petroleum displacement, seeing perhaps a distant second order effect.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer definitely would determine thermal stability, etc. before erosion testing. Another reviewer asks, "Has any consideration has been given to the environmental safety of these nanofluids and their ultimate disposal? Their materials costs and the costs of their preparation?" Also, the presentation seems to draw a parallel between galvanic pitting corrosion rate and the rate of uniform corrosion. As a practical matter, the two are not equivalent and do not predict equivalent equipment life.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

There were no comments on this question.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers see potential for additional collaboration. One reviewer commented that other nanofluids should be tested. Also, does the nanofluid remain in suspension or does it eventually "plate" out or coagulate and thereby lose the effectiveness? Another reviewer feels the addition of a heat exchanger manufacturer might be desirable.

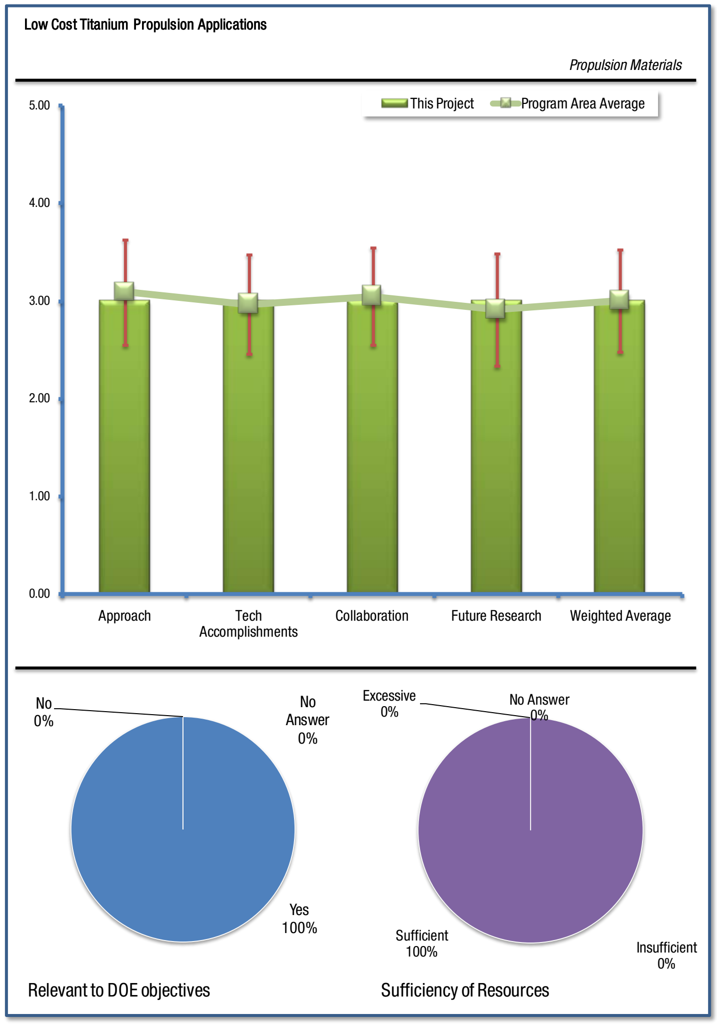
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Reviewers see potential for other development pathways. For instance, according to a reviewer, erosion of cooling system components may not be the most significant barrier to widespread use on nanofluid coolants. Could other coolants (non-nanoparticle-based) offer comparable (ca. 5%) reductions in radiator size without the possible complications of nanofluids? Another reviewer suggests including some aging studies to determine stability and effectiveness of the fluids.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

There were no comments on this question.

Low Cost Titanium Propulsion Applications: Curt Lavender (Pacific Northwest National Laboratory (PNNL)) - POSTER



Reviewer Sample Size
This project had a total of 1 reviewer.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A reviewer sees potential for this technology, commenting that the relevance of this project to the primary DOE goal is not obvious on its face. However, this project seeks to explore and hopefully, to confirm the relevance of an emerging technology to this goal. If the anticipated cost and performance targets can be achieved, there seems to be little doubt that the lighter, stronger engine components the technology would enable would in turn contribute directly to DOE's objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
There were no comments on this question.

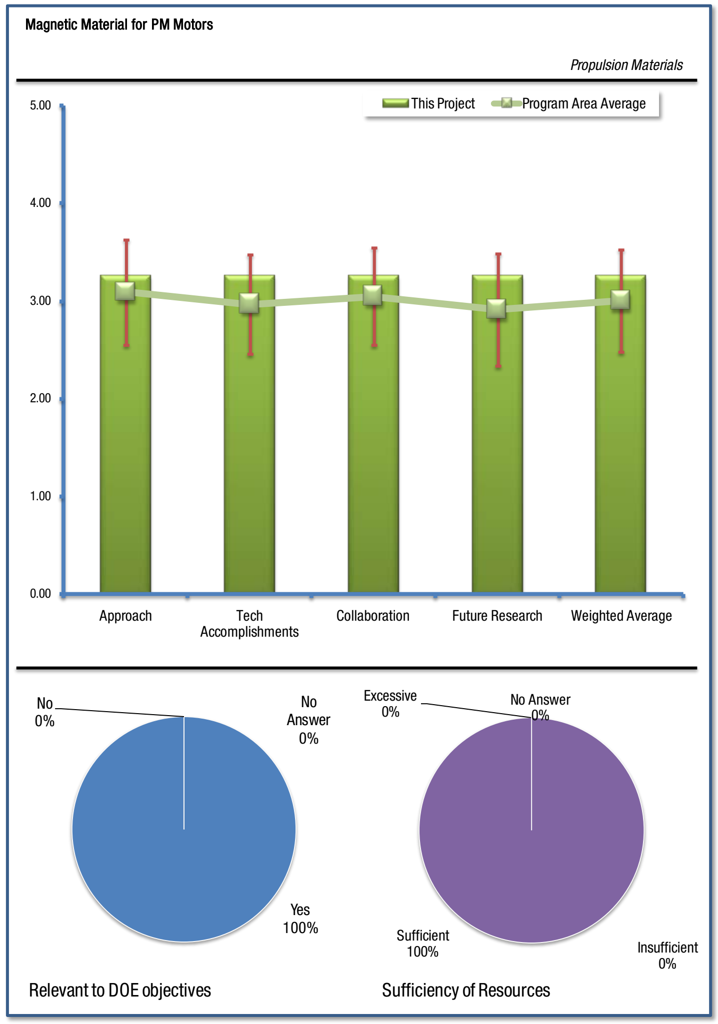
Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
A reviewer saw the project as not being far enough advanced at this time to permit a fair assessment of its technical accomplishments. The "good" rating is based more on the reasonableness of the approach to future work and the likelihood that it will yield definitive answers.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
A reviewer found the eclectic mix of industry partners an appeal aspect. However, selection of an "expert in engine efficiency analysis" [see slide 10, for example] shouldn't be delayed. This is a key part of the overall analysis and it would seem to be a straightforward step to find such a collaborator (perhaps within the Cummins organization?) and get him/her to work promptly.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
There were no comments on this question.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer opined that funding level of this project makes it appear to be highly cost-effective if its goals can be realized.

Magnetic Material for PM Motors: Iver Anderson (NASA Ames) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Several reviewers saw the technology as key to meeting petroleum displacement objectives. One reviewer saw the development of low cost high temperature magnets as important to the future of electric motors needed for hybrids and electric vehicles. Another reviewer perceived that high-temperature magnets are an enabler for the higher coolant inlet temperature and the high power density motor. A third reviewer found common ground, commenting high-power, compact electric motors are a key to the commercial acceptance of electric vehicles and the ability of such motors to tolerate high operating temperatures will minimize he need for motor cooling with its attendant parasitic losses. Electric and hybrid electric vehicles are a straightforward means to minimize the petroleum consumption of the transportation sector. Another reviewer commented permanent magnet motors are of interest as components within electrical machines for use in hybrid-electric vehicles and all-electric vehicles, to make large gains in petroleum fuel reduction (or elimination). The magnets may also provide incremental energy efficiency gains in the many small motors used on conventional vehicles.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Among positive reviews, one saw the importance of this work is to develop high temperature low cost rare earth magnets. There is no such product commercially available now. The approach is innovative and builds upon past work and successes. The PI is looking at new processes that could become commercial is a few years. Another reviewer commented on how the work uses advanced metals processing to gain performance-enhancing anisotropy in a way that can be molded to align the microstructure to the most favorable directions within an electrical machine.

One reviewer would like to see a more focused approach, stating the approach is good but it seems that the project is pursuing many directions (an isotropic sintered, an isotropic bonded, and rare earth free magnets) and more focus on a few of them will be more beneficial

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Several reviewers saw progress being made. To wit, a reviewer noted that technical accomplishments may rate higher than indicated, and noted that the results are encouraging. According to another reviewer, benefits of anisotropic particles and a sintering aid (aluminum) are showing magnetic property gains. These gains are interpreted from a physical understanding of the microstructures that are developed. Another reviewer notes that excellent progress is being made in improving the temperature range, however this has been done by adding dysprosium, which is a very rare and high cost metal. Ultimately, the value of this work may depend on the world market price for Nd, which has been rising over the years due to the monopoly held by China. If the cost of Nd makes it impractical for PM materials in electric motors, then companies will seek other solutions.

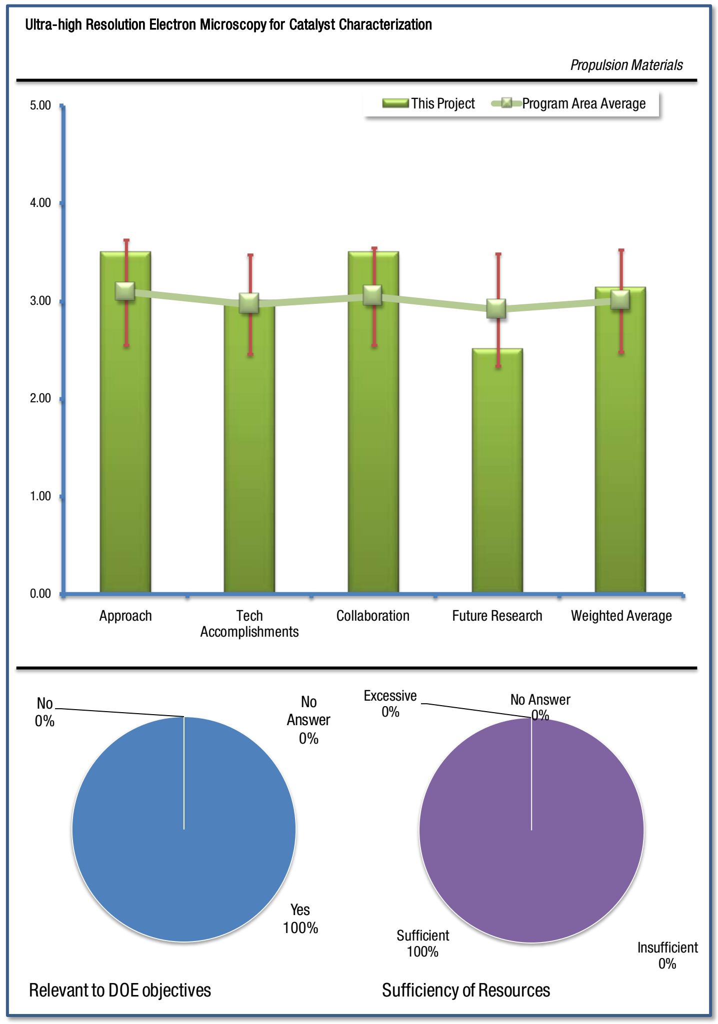
Similarly, another reviewer states that there are good accomplishments, but not enough testing has been done to support the analysis. More coupons need to be produced to verify the energy product at higher temperatures. To this reviewer, the predicted energy products at higher temperatures are still low compared to SmCo, for example. A cost comparison with today's SmCo that can go to very high temperatures will be useful.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Reviewers saw evidence of good collaboration with external partners, and collaboration well integrated with potential manufacturers. Another reviewer states that the PI is working with the top experts in the field.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Among positive reviews, one thought the PI has very clear plans for the work product in the future. Another reviewer is concerned about the cost of materials. According to this reviewer, for the anisotropic-particle lanthanide materials, processing modifications are likely to provide improvements in properties. The stretch-goal of finding a non-"rare-earth" permanent magnet chemistry is to be encouraged, but in a way that makes clear that the high risk associated with the quest. A third reviewer sees that the work is so diverse, more focus and actual testing is needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
Reviewers believe resources are sufficient, with one reviewer commenting the project has sufficient people and labs to create the desired materials.

Ultra-high Resolution Electron Microscopy for Catalyst Characterization: L.F. Allard (Oak Ridge National Laboratory (ORNL)) - POSTER



Reviewer Sample Size
This project had a total of 2 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
A positive review saw that fundamental, atomic-level understanding of heterogeneous catalytic processes will likely enhance the performance of practical bulk catalysts. Since these are indispensable both to vehicle exhaust gas aftertreatment and to fuel refining, they can be expected to contribute, ultimately, to petroleum conservation. Another reviewer commented that after examining the evolution of fuel efficiency over recent years, it becomes clear that progress is slow. The reason is in the introduction of exhaust gas regulations. Measurement of fulfill these requirements hamper fuel efficiency improvement. With this in mind, this project aims at more efficient exhaust gas treatment giving room to engine internal measures to improve fuel efficiency.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer found the project to have a clear approach on how to improve the insight in catalyst reactions. The development of in situ capabilities will be very beneficial. Another reviewer stated that investigators make a good case for the integration of their work with that of others. To this reviewer, the second barrier slide (slide #2) appears to be a goal of the project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer found that the reported progress is good, and sufficient proof was provided. Because this project is in its final phase, some results should be available concerning the reduction of aftertreatment cost.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Evidence of well-coordinated cooperation with partners was apparent. A reviewer noted how a large number of collaborations with other institutions is mentioned.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
While a reviewer saw plans built on past progress, no plan is provided on how to reduce cost of catalytic materials.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
While one reviewer saw results in line with the budget provided, another reviewer asked whether $860,000 in total funding over a 6-year project is sufficient to accomplish all project goals.

8. Educational Activities and Technology Integration Activities

Introduction

The Technology Integration subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles, including fuel cell vehicles, to help meet national energy and environmental goals and accelerate dissemination of advanced vehicle technologies through demonstrations and education. This subprogram's efforts logically follow successful research by industry and government and help to accelerate the commercialization and/or widespread adoption of technologies that are developed in other VT program areas. Deployment activities linked to R&D also provide early market feedback to emerging R&D.

Subprogram functions include both regulatory and voluntary components. The regulatory elements include legislative, rulemaking, and compliance activities associated with alternative fuel requirements identified within the Energy Policy Acts of 1992 and 2005 (EPACT 1992 and EPACT 2005). Voluntary efforts include demonstration of advanced technology vehicles to verify market readiness and public information, education, outreach and technical assistance efforts.

Education aids in overcoming institutional barriers to widespread use of advanced vehicle technologies and alternative fuels. Activities such as the Advanced Vehicle Competitions and GATE encourage the interest of university student engineers and engage their participation in advanced technology development.

EcoCAR: The NeXt Challenge: EcoCAR is a three-year engineering competition sponsored by the Vehicle Technologies Program and General Motors (GM). EcoCAR, started in 2008 and ending in 2011, challenges students to reengineer a 2009 Saturn Vue. The Challenge is to engineer a system that reduces fuel consumption and lower emissions by using advanced vehicle technologies. This is state-of-the-art training and allows students to mirror the real-world development process used by GM and other auto manufacturers from around the world.

Automotive X Prize: DOE has partnered with Automotive X Prize to develop an educational outreach program aimed at engaging students (kindergarten-12) and the public in learning about advanced, energy-efficient vehicles. DOE is providing $3.5 million over 3 years for the outreach effort. The Automotive X Prize (AXP) is an open competition with the goal of inspiring a new generation of super-efficient vehicles that dramatically reduce oil dependence and greenhouse gas emissions.

Graduate Automotive Technology Education (GATE): The DOE established the GATE Program in 1998 to train a future workforce of automotive engineering professionals knowledgeable about, and experienced in, developing and commercializing advanced automotive technologies to help overcome technology barriers preventing the development and production of cost-effective, high-efficiency vehicles for the U.S. market. To that end, DOE established 10 GATE Centers of Excellence at nine U.S. universities that addressed fuel cells, hybrid electric vehicle drivetrains and control systems, lightweight materials, direct-injection engines, and advanced energy storage.

EPAct Transportation Regulatory Activities: The U.S. Department of Energy's (DOE) Vehicle Technologies Program manages several transportation-related regulatory activities established by the Energy Policy Act of 1992 (EPAct), as amended by the Energy Conservation Reauthorization Act of 1998, EPAct 2005, and the Energy Independence and Security Act of 2007 (EISA). These activities seek to reduce U.S. dependence on imported oil through the use of alternative fuels and alternative fuel vehicles (AFVs), as well as through the use of other petroleum-displacement methods. EPAct 1992 defined certain fuels as alternative fuels and directed DOE to undertake regulatory activities that focus on building an inventory of fleet AFVs in Metropolitan Statistical Areas/Consolidated Metropolitan Statistical Areas, which were selected to serve as launching pads for alternative fuels and advanced vehicle technologies.

Clean Cities Program: Clean Cities strives to advance the nation's economic, environmental, and energy security by supporting local decisions to adopt practices that contribute to the reduction of petroleum consumption. Clean Cities has a network of approximately 90 volunteer coalitions, which develop public/private partnerships to promote alternative fuels and advanced vehicles, fuel blends, fuel economy, hybrid vehicles, and idle reduction.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Penn State DOE Graduate Automotive Technology Education (GATE) Program for In-Vehicle, High-Power Energy Storage Systems	Joel Anstrom (Pennsylvania State University)	8-10	3.00	3.20	3.00	3.00	3.10
UC Davis Fuel Cell, Hydrogen, and Hybrid Vehicle (FCH2V) GATE Center of Excellence	Paul Erickson (University of California - Davis)	8-13	3.25	3.00	2.50	2.50	2.94
GATE Center for Advanced Automotive Propulsion	Yann Guezennec (Ohio State University)	8-16	3.50	3.75	4.00	3.25	3.66
The University of Tennessee's GATE Center for Hybrid Systems	David Irick (University of Tennessee)	8-18	2.50	2.25	2.50	2.50	2.38
University of Illinois at Urbana-Champaign's GATE Center for Advanced Automotive Bio-Fuel Combustion Engines	Chia-fon Lee (University of Illinois at Urbana-Champaign)	8-20	3.60	3.40	3.60	3.20	3.45
Center for Lightweighting Automotive Materials and Processing	P.K. Mallick (University of Michigan - Dearborn)	8-22	2.83	3.00	2.83	2.83	2.92
Clean Cities Tool Development and Demonstrations	Margo Melendez (NREL/ORNL)	8-25	3.67	4.00	3.33	3.33	3.75
GATE Center for Automotive Fuel Cell Systems at Virginia Tech	Doug Nelson (Virginia Tech)	8-27	3.17	3.33	3.17	3.17	3.25
Clean Cities Regional Support & Petroleum Displacement Awards	Michael Scarpino (National Energy Technology Laboratory (NETL))	8-30	3.00	3.25	3.25	3.50	3.22
GATE Center of Excellence at UAB in Lightweight Materials for Automotive Applications	Uday Vaidya (The University of Alabama at Birmingham)	8-33	3.00	3.20	3.00	3.00	3.10
EcoCAR the Next Challenge	Mike Wahlstrom (Argonne National Laboratory (ANL))	8-36	3.25	3.25	3.75	3.75	3.38
Automotive X PRIZE Education Program	Mark German (X PRIZE Foundation)	8-38	3.40	3.40	3.60	3.25	3.41
Merit Review: EPAct State and Alternative Fuel Provider Fleets	Dana O'Hara (U.S. Department of Energy)	8-41	3.33	3.67	3.00	3.33	3.46

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
OVERALL AVERAGE FOR EDUCATION-TECHNOLOGY INTEGRATION			3.17	3.26	3.19	3.11	3.21

NOTE: Italics denote poster presentations.

The reviewers viewing the projects dealing with hydrogen education were asked a slightly different set of questions provided by the Hydrogen Program: a summary of the results from these reviews is provided below.

Presentation Title	Principal Investigator and Organization	Page Number	Relevance	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Hydrogen Safety: First Responder Education	Marylynn Placet, Pacific Northwest National Laboratory (PNNL)	8-43	3.80	3.60	2.80	3.40	3.80	3.32
Hydrogen Education for Code Officials	Melanie Caton, National Renewable Energy Laboratory (NREL)	8-45	4.00	3.50	3.25	3.50	3.25	3.48
Hydrogen and Fuel Cell Education at California State University, Los Angeles	David Blekhman, Cal State LA University Auxiliary Services, Inc.	8-47	3.00	3.20	3.00	3.60	3.00	3.10
Hydrogen Energy in Engineering Education (H2E3)	Peter Lehman, Humboldt State University Sponsored Programs Foundation	8-49	3.40	3.40	2.80	2.80	3.20	3.08
Hydrogen Education Curriculum Path at Michigan Technological University	Jason Keith, Michigan Technological University	8-51	3.00	3.40	3.20	2.60	3.20	3.14
Bachelor of Science Engineering Technology Hydrogen and Fuel Cell Education Program Concentration	A.K. Sleiti, University of Central Florida	8-53	2.80	3.00	2.60	2.00	2.25	2.63
Development of a Renewable Hydrogen Production and Fuel Cell Education Program	Michael Mann, University of North Dakota	8-55	3.20	3.20	2.20	2.80	2.80	2.72
Dedicated to the Continued Education, Training and Demonstration of PEM Fuel Cell Powered Lift Trucks In Real-World Applications	Tom Dever, Carolina Tractor & Equipment Co. Inc.	8-57	3.60	3.20	3.20	3.20	3.00	3.26

Presentation Title	Principal Investigator and Organization	Page Number	Relevance	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Hydrogen Education in Texas	David Hitchcock, Houston Advanced Research Center	8-60	3.40	2.60	2.40	2.60	2.40	2.66
Development of Hydrogen Education Programs for Government Officials	Shannon Baxter-Clemmons, The South Carolina Hydrogen and Fuel Cell Alliance	8-63	3.20	2.60	2.40	3.80	2.80	2.78
VA-MD-DC Hydrogen Education for Decision Makers	Chelsea Jenkins, Commonwealth of Virginia	8-66	3.25	3.75	3.50	3.50	3.25	3.48
2009 DOE Hydrogen Program Review Presentation	Joel Rinebold, Connecticut Center for Advanced Technology, Inc.	8-68	3.60	3.40	3.60	3.40	3.20	3.50
Raising H2 and Fuel Cell Awareness in Ohio	Pat Valente, Ohio Fuel Cell Coalition	8-70	3.40	3.40	2.75	2.60	3.00	3.02
H2L3: Hydrogen Learning for Local Leaders	Patrick Serfass, Technology Transition Corporation	8-72	3.80	3.60	3.60	3.40	3.80	3.64
Hydrogen Education State Partnership Program	Charles Kubert, Clean Energy States Alliance	8-74	3.40	3.20	3.00	3.20	3.20	3.16
Hydrogen Knowledge and Opinions Assessment	*Rick Schmoyer, Oak Ridge National Laboratory (ORNL)*	*8-76*	*3.75*	*3.75*	*3.50*	*3.50*	*3.50*	*3.60*
OVERALL AVERAGE FOR HYDROGEN EDUCATION			**3.40**	**3.29**	**2.97**	**3.10**	**3.11**	**3.15**

NOTE: Italics denote poster presentations.

Overview of Clean Cities and Top Accomplishments: Dennis Smith, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated it was a good overview of the Clean Cities Program and role of National Laboratories. Tracking and measurement of petroleum displacement is a key metric of the success of the program. DOE should continue to use and document this metric. The programs do a good job of leveraging additional funding through cost sharing. AFDC and FuelEconomy.gov provides an excellent resource of information for researchers, consumers, fleet managers. Development of interactive online tools is a new feature that has received recent focus. These tools make it more exciting for consumers and the public to get involved with fuel efficient technologies. Nice tools for tracking fuel economy, locating fueling stations. Another reviewer noted the presentation was very well delivered and coherently covered all of the critical areas of the Clean Cities program. The organization and effectiveness of the Clean Cities program have greatly improved from its early days. While the current level of petroleum displacement is well below the 2020 target it is growing at an ever increasing rate. Given the new administration and renewed focus on energy security issues, they are hopeful that the Clean Cities program will achieve greater prominence and effectiveness. One reviewer commented all program areas were identified and introduced. The presentation focused on Clean Cities and its mission and strategies were clearly discussed. Clean Cities accomplishments to date are impressive with about 100 coalitions and nearly 6,000 stakeholders resulting with 2 billion GGE displaced since 1993 and 375 million GGE in 2008. Good work with National Parks and in the development of alternative fuel corridors. There is a strong educational component. GATE, challenges, and other areas were clearly discussed. Comments from another reviewer noted Dennis clearly covered the sub-program and identified issues and challenges. He clearly presented a comparison of this year to the previous year(s). Another reviewer mentioned the Sub-program overview provided a complete overview of the program strategy, important issues and challenges. Progress towards the goals was demonstrated. One reviewer brought up the area of technology integration was covered thoroughly. Progress was clearly shown with many important accomplishments: displacement of petroleum, educating the public, and providing a new generation of engineers. Overall sub-program issues were not presented, but individual presentations addressed their issues. Another reviewer answered yes then said the Sub-program was adequately covered and issues and challenges were identified. A comparison of progress made by the Clean Cities program from the prior year was also given.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated the programs do a good job of covering the focus areas of outreach/education, infrastructure development, and coordination with EPAct fleets. Education programs like EcoCAR and GATE are very strong components and have had great success as evidenced by the number of graduates that have taken jobs at DOE, automotive manufacturers, and other companies involved with efficient transportation. They do not see apparent gaps in the programs and projects that are funded. Another reviewer commented future actions that were detailed in the presentation appeared to be correctly focused to both address the challenges of the program and to capitalize on new web based outreach tools that are becoming available. They could not identify any significant gaps in the program. One reviewer mentioned it does not appear that there are gaps in the project portfolio and DOE has clearly identified a number of plans to address continuing challenges to increasing the use of alternative fuels, alternative fuel vehicles, hybrids, plug-in hybrids, and ways to get current drivers to drive smarter. Comments from another reviewer noted they have good plans to address the challenges within their budget constraints while another reviewer stated overall sub-program issues were not presented, but individual presentations addressed their issues. Another reviewer mentioned very little was presented regarding issues, challenges, and gaps. Not much was said regarding interactions with industry technology providers to promote their products. One reviewer answered yes; there are plans in place to improve Clean Cities.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

A reviewer stated the sub-program consists of a broad range of activities and appears to be well managed. Clean Cities appears to be well focused and effective. It appears that Clean Cities would be an excellent mechanism to help identify gaps in technology development and accelerate technology demonstration and deployment; however, nothing was presented regarding this potential coordination with the Vehicle Technologies R&D effort. Coordination with the R&D program is one area that could be better explained and/or promoted. Another reviewer commented a well rounded approach was taken and it seems to be effective, although, more R&D for vehicle technologies is always needed to reduce petroleum usage. One reviewer mentioned this program is well managed and focused on those challenges within their budget scope. Comments from one reviewer noted this is not so much a R&D program as a program assistance, coordination, and outreach program. As such it appears to be effective and appropriately focused and managed. Three reviewers answered yes, with one saying the program is well focused and addresses the national goals and needs to increase fuel efficiency, displace petroleum fuels and increase deployment of alternative fuels, and advanced technologies. The program focus is broad but seems to be well covered. Another reviewer who answered yes also wrote the Sub-program does appear to be focused, well-managed and effective in addressing the DOE Vehicle Technologies Program R&D needs.

4. Other comments:

A reviewer stated it was unbiased, technically reliable data. The programs do a good job at providing unbiased information. There is a need to make Clean Cities Coordinators aware of the tools that are available and making Clean Cities University a requirement for coordinators is a good idea for trying to address this problem. Another reviewer mentioned they like to see HQ staff take the lead in local Coalition activities.

Overview of Hydrogen Education: Christy Cooper, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated accomplishments for 2008 were well-outlined in the opening presentation. Education efforts cover the major audiences well (students, safety/code officials, end users, governments). Concrete goals and objectives were presented, as well as the target audiences. The program's focus on making technology information easily understood by the lay person is very important, as they will ultimately need to be comfortable with the technology to purchase it in the future. Another reviewer commented the presentation was an efficient summary of a wide variety of education activities throughout the DOE Hydrogen Program. Challenges were clearly identified and progress was shown. One reviewer noted the issues and challenges were clearly delineated. Projects were listed according to area of focus. Comments from another reviewer stated good coverage of the topic. Progress was highlighted and challenges were discussed. Another reviewer stated this was an exceptional sub-program overview. The Technology Manager provided an in-depth overview of all aspects of the sub-program, including highlights of current projects, training activities by target audiences and numbers that have been reached to date. The same depth of information was also provided for codes & standards activities. The current and past budgets were addressed, as well as organizational changes. One reviewer noted the sub-program was well covered and important issues identified, with another reviewer commenting the overview was concise and clear. Three reviewers all answered yes; with one adding that the importance of education in furthering the hydrogen economy was detailed.

A reviewer stated the subprogram seemed to be covered rather well. They think the education area is one that still could stand some further work. In the areas of first responders training and codes training, they estimate that progress has clearly been made, but it is still lagging need. There is a need to come up with ways to better deliver this information to potential adopters of the technologies. In the state and regional awareness activities, the fall 2008 awards make it difficult to assess progress to date. Another reviewer commented they believe that a robust educational and outreach effort is critical to support the advancement of breakthrough technologies. Fuel cells generally do not have the benefit of robust outreach efforts from the industry to build public awareness of the products and their benefits, therefore it is justified for the public sector to coordinate a national effort, and the use of "clusters" to support the national effort is prudent. The use of "clusters" in the form of selecting programs in several key states is financially prudent. This reviewer thinks the program has selected the right states and the right principals within these states. They also believe the principals with a scope beyond the state level are also good selections. This reviewer urges the program to proceed with a coordinated effort to communicate jointly and frequently with these groups and, where financially justified, to support the outreach efforts of these principals at key events by sending DOE representatives to these events.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated issues and challenges were identified, but the plans to address them were not explicitly outlined (but are implicit in the summaries of projects that were done over the year). Another reviewer noted that challenges were identified; current and future approaches to overcome the challenges and ways to improve the sub-program were discussed. One reviewer commented well-organized program, with very specific products for a variety of audiences. Challenges for the variety of audiences are well-understood and appropriate tools are being used and developed. Given the wide ranging needs, this is an important aspect of the education program. Comments from another reviewer stated the plans are adequately identified - no apparent gaps with another reviewer agreeing that there were no obvious gaps detected in the portfolio. Another reviewer stated the issues and challenges were identified and addressed, with another reviewer adding plans for dealing with challenges were identified but having the key person (Ms. Cooper) on another assignment is a weakness. Two reviewers both answered yes to the question, with one reviewer adding for each of the target audiences, projects have been identified. The key target audiences in addition to the general public are identified showing a comprehensive approach to addressing education needs.

A reviewer stated the portfolio for education spans the U.S. There are efforts that have been awarded for South Carolina, Texas, Ohio, Florida, Michigan, a greater U.S. effort and coordination has occurred among those entities. Another reviewer noted they think there is opportunity to 'synthesize' material being developed in the regional and state projects. Ensure the basic materials are consistent, adequate, and clear, while placing the state and regional details on top of that 'core'. One reviewer commented that no funding next year will greatly hinder the program's portfolio. Comments from another reviewer stated they would urge the portfolio to consider state-level regulatory actions, especially renewable portfolio standards that recognize fuel cells without fuel source restrictions. Only a few states have this and most of the states that have adopted RPS impose fuel source restrictions on fuel cells. Another reviewer noted the plans were not very specific nor was there any mention of possible effects of the priorities and budget requests of the new Secretary.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

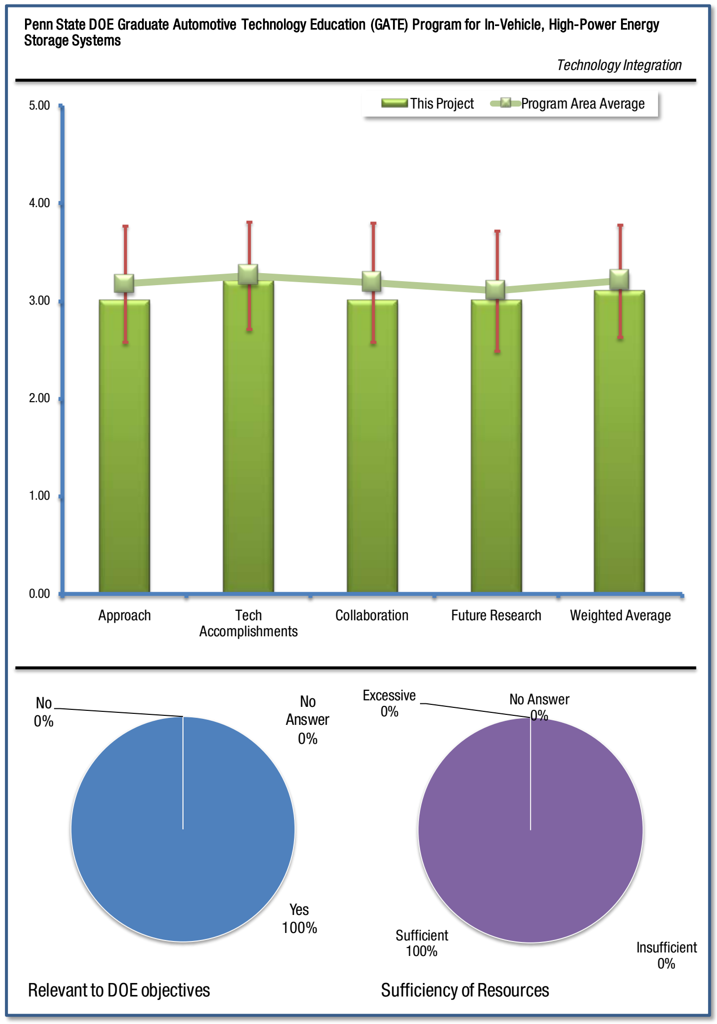
A reviewer stated the additional staff resources from Vehicle Technologies are welcomed. The program is logically structured by target audiences, and reasons to reach out to each audience are well-outlined. Outreach efforts appear to be effective: the upcoming opinion survey will confirm this. It will be critical to ensure that the various programs that seem to be addressing different subsets of the same major audience groups be coordinated to the maximum extent possible: this would seem to be of benefit to DOE from a cost standpoint. Another reviewer noted the Hydrogen Education sub-program is very well managed. In addition to addressing education needs, the sub-program includes projects that increase market transformation. One reviewer commented the program has many audiences, and specific sets of tools are designed to target one or more of those audiences. The program team has done a great job of tackling the challenges of putting together age- and audience-appropriate materials. Another reviewer stated the theme of providing technically accurate information in an understandable manner to a non-technical audience is outstanding. That is exactly what needs to be done in order to promote key points about hydrogen and fuel cells and to counter much of the inaccurate information that is out there. One reviewer stated it appears to have done quite a bit on a limited budget. Comments from another reviewer mentioned the sub-program has been well coordinated and managed as activities have transferred from the HFCIT program to vehicles. One other reviewer noted the sub-program does appear to be focused and generally effective. There is no way to know from the presentations whether or not it is well managed. Five of the reviewers answered yes with one adding they think there is still a great opportunity to leverage ongoing work of federal and private sector entities to provide better content and delivery.

A reviewer stated the Sub-program appears to be well-managed but might be stronger if all of the teams within a focus area were organized as a unit. It seems like a waste of dollars to have each group (for instance in the education of local leaders) developing educational material. If each team were responsible for one piece, the majority of the time could be used to get the info out to those being targeted. Another reviewer commented management of the program suffers from having the key person assigned to another task.

4. Other comments:

A reviewer stated it seems that the program has done a lot of education with a small (and unsteady) budget. MySpace page is an interesting addition that will reach the most important future technology purchasers. Another reviewer noted it is important to sustain the education effort through the lean years of 2010 so as not to send the message that hydrogen and fuel cells are no longer a future clean technology that will help citizens and businesses in multiple ways. If at all possible, as strong an effort in messaging from DOE headquarters to these grass roots entities needs to be maintained, and if possible, expanded. One reviewer commented getting the baseline knowledge survey is crucial to future work and if anything it could be done more often. They applaud the DOE for taking modern approaches to education such as using tools like MySpace and other social networking tools. This should be continued since a multi-media approach is the only way to reach some audiences. An increased focus on using video is encouraged. The creation of short, education and informative videos can lead to viral sharing and therefore multiply the effectiveness of outreach. Comments from another reviewer mentioned education is a fundamental way to keep the hydrogen program alive. The more people who understand and support hydrogen and fuel cells, the more likely they are to be vocal, thus ensuring that Congress continues to appropriate the necessary funds. This is a vital program and a good portfolio. Another reviewer talked about Christy Cooper as an excellent manager. They are glad DOE finally has some money to spend on education and outreach. We also need to learn from the Europeans. One reviewer stated this subprogram is an important component of the overall program. It should continue to receive funding in the future. Another reviewer said thanks for the opportunity to assess the projects. An additional reviewer noted they urge the program to use frequent and joint communications activities with these principals, such as webinars and conference calls, to make sure that the principals are fully informed of important events and activities. One other reviewer mentioned the speaker was personable but not too effective as a speaker with another reviewer saying the program deserves a full time manager.

Penn State DOE Graduate Automotive Technology Education (GATE) Program for In-Vehicle, High-Power Energy Storage Systems: Joel Anstrom (Pennsylvania State University)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Several reviewers saw that the Penn State GATE program's focus on high power in-vehicle energy storage devices serves to enhance the development of key facilitating technologies for electric and hybrid electric vehicles. As such this research focus is directly relevant to the DOE goals of Petroleum displacement. One reviewer stated the project facilitates education of engineers in critical technologies for advanced efficient vehicles. Another reviewer thought the project is highly relevant to petroleum displacement through the development of trained engineers in the area of energy storage, which is a key component to developing viable hybrid and electric vehicles. A reviewer is of the opinion that educated students and advancement in energy storage is needed for significant increases in fuel economy, while another reviewer cites energy storage as one of the keys to EV vehicle performance.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Several reviewers positively evaluated the program's approach. A positive review noted how the program appropriately leverages DOE funds with an approximate 25% university match. Curriculum and instructors appear to adequately cover the breadth of energy storage technologies that are the focus of this program. Another reviewer commented the overall approach is sound, and the program appears to be nicely integrated into existing engineering programs. The process for recruiting and involving students appears good by allowing multiple pathways for students to be involved in the program. The focused vehicle approach appears to be a solid way to involve students at various levels. Another reviewer focused on faculty involvement, commenting that the number of faculty members in the energy storage area will make the program successful, and that the program does not overload a single faculty member. This reviewer also noted how the program has developed and employed a very good plan of developing courses, recruiting, and developing GATE projects.

A mixed review stated that while barriers focused on attracting students and industry funding, it would have been beneficial to identify specific technical barriers. Although the center is for energy storage, it has expanded to include power electronics, combustion, and hardware in the loop. Integrating these elements will provide opportunities to investigate the at performance target optimization of components in a systems integration context. On the other hand, it does diffuse the effort from energy storage. Other universities are focused on hybrid systems.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

According to reviewers, the program is on schedule, has developed a strong curriculum, and has the majority of key elements in place. According to one reviewer, because the focus is for graduate student education, the goals have been exceeded from the amount of funded students, classes offered, and the listed publications. Another reviewer thought the coordination between GATE and AVTC was good.

A reviewer noted that the new emphasis on HIL is good, as is how the HEV lab permits students a great opportunity to compete in major challenges. Fifty-five total students have participated as GATE fellows but they are behind in planned student semesters due to prior shortfall of students. Recent progress has been made in recruiting more students into the program. The placement of students in auto industry is strong. However, this reviewer mentions that industrial sponsorship continues to be less than optimum and should be a focus of improvement.

A reviewer thought tie-in of the program with undergraduate DOE AVTC student design vehicles provides a good way to transition undergraduates to continue on in the program, and an opportunity for the grad students to develop a broader perspective of the issues and challenges of integrating such emerging technologies into the vehicle environment. However, this reviewer did not think the presenter indicated whether the lack of properly prepared domestic students was limiting the number of GATE fellowships or whether it was the lack of sponsorship funds. Furthermore, while the number of students participating seems adequate, given the instructional infrastructure put in place, it would seem that the program could handle greater student through-put. A potentially troubling aspect was that most of the research papers were from 2006 and none more recent than 2007. The comment that it is hard to get masters students to publish doesn't fully explain away the lack of more recent papers.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers noted the strong collaborative relationships with many organizations. A reviewer felt the program did not have partners in the GATE but strong coordination with AVTC and other agencies, including NSF, DARPA, DOT, NASA, etc. The reviewer recognized sponsorship (in-kind, and contract) from industry and national labs, and saw a good networking event linking to PSU solar home.

Another reviewer thought the coordinated outreach with NSF appears to have reached a large number of K-12 students. Furthermore, two large grants from the PA DEP on hydrogen production seemed to drift from primary focus on batteries, capacitors, and flywheels. Workshops and the 3-day EV HEV expo are good outreach programs but the number of outreach events seemed to have slowed since 2007. A reviewer made note of the many industry and academic projects completed, and that an interesting HIL project is upcoming. Another reviewer commented that while the presentation lists no other direct "partners" it appears that non-DOE and university entities are funding some GATE student work (not clear from the presentation exactly how much). It also appears that there is a fairly good degree of research and academic relationships (including international) established at this program.

Some reviewers thought collaboration with industry is less than optimal. For instance, a reviewer thought most collaborative efforts were with Penn State-related functions, and commented that no industry partners were mentioned except for ones where students were placed after the fact - with the exception of A123. However, the reviewer was unsure of the extent of that involvement.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

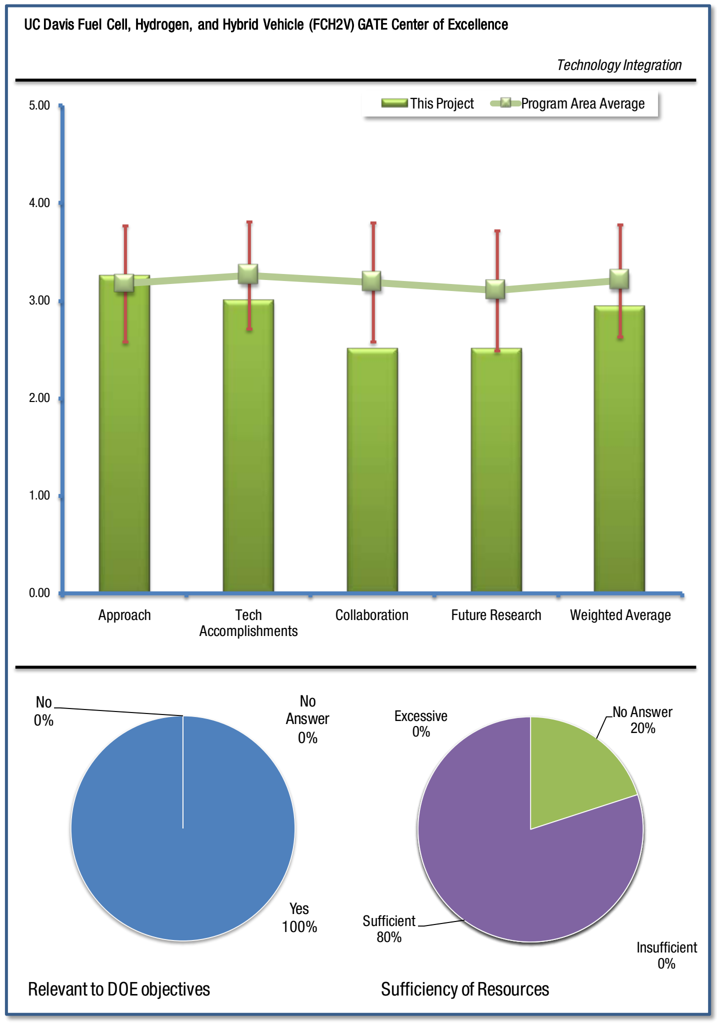
Among positive reviews, one thought the program appears to be pretty well established and is now focused on continuous improvement, though nothing of major significance was suggested for the final two years of the project. Another reviewer thought the program has a great plan to implement energy storage throughout their engineering program.

A reviewer thought the program seems to be working pretty well, and future work detailed in the presentation addresses key areas where growth is desired or needed. However, (not as a criticism of this program) it will be very difficult to add industry partnerships and funding in this current economic environment. Another reviewer thought that the presentation did not offer enough detail on future activities to describe how the program will improve.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewers saw project funding as sufficient, or doing a lot with current funding levels. Another reviewer commented that the program appears adequately funded and supported, and as a result is on schedule. A reviewer noted how the center seems to have morphed from one focused on energy storage to hybrid systems.

UC Davis Fuel Cell, Hydrogen, and Hybrid Vehicle (FCH2V) GATE Center of Excellence: Paul Erickson (University of California - Davis)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Many of the reviewers thought the project is highly relevant to petroleum displacement. One reviewer thought this is due to the development of trained engineers in the area of fuel cells and hybrid vehicles, which are key components to enabling a reduction in the use of petroleum. Another reviewer noted that the program is centered on hydrogen and hybrid electric vehicles. A third reviewer opined that the merging of the two existing UC Davis GATE programs into the current version results in a broad focus of fuel cell and hybrid electric technologies that are directly relevant to the DOE objective of petroleum displacement.

Another reviewer noted how the project addresses educating future engineers-- "people who can navigate" in technical areas of fuel cell technology for transportation and hybrid-electric vehicles, and that the project is cross-training to enable the engineers to make the decisions that need to be made. This reviewer also noted a transition from a focus on FCV to HEVs and PHEVs.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Many of the reviewers saw the project as having a sound approach. One reviewer echoed this, and noted how the program combined two existing centers to form the current FCH2V program. The program nicely leverages existing partners. The student recruitment process is rigorous and appears to be highly effective in selecting the best graduates for fellowships. The transition from hydrogen to hybrid topics for fellowships is a good response to current market forces. Another reviewer thought, while not specifically stated in the presentation, it appeared the program (given the program's performance) appropriately leverages DOE funds. Furthermore, to this reviewer curriculum appears to adequately cover the breadth of fuel cell and hybrid electric technologies that are the focus of this program. This reviewer perceives the broad program focus and emphasis on developing the knowledge for the students to be able to see the big picture as an advantage.

A reviewer made note of how two previous GATE centers, one in Fuel Cell and one in HEV, were combined into one. This reviewer also noted the synergistic focus areas: fuel cell and hybrid component level, vehicle and energy systems research, and fuel pathway analysis. The curriculum is well-organized and laboratories support the three core focus areas. There is an interdisciplinary approach, and engineering and economic side courses. Have had to address the issue of prerequisites for courses as a result of the cross-cutting curriculum but seem to have an approach to manage this issue. Another reviewer did not feel barriers were stated in the slides, and the subsequent rating is an assumption.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Among positive reviews, one thought the program has developed strong interdisciplinary curriculum on both engineering and economic issues, has good student participation and currently has three graduate fellowship students. The program appears to have made some initial steps in transitioning from a fuel cell and hydrogen program to hybrid vehicles, and has successfully placed graduates with many major automotive companies. Another reviewer saw the program as being largely on-schedule and with the majority of key elements in place. According to this reviewer, the competitive nature of the program probably limits the number of students participating (quality vs. quantity). However, that said, the number of students appears to be fairly modest. Given the instructional infrastructure put in place, it would seem that the program could handle greater student through-put without sacrificing quality. However, tie-in of the program with the DOE AVTC student design vehicles provides a good way to transition undergraduates to continue on in the program as well as an opportunity for the graduate students to develop a broader perspective of the issues and challenges of integrating such emerging technologies into the vehicle environment. Hopefully, this can be used to increase both the quality and quantity of the students in this program. The quantity and diversity of recent publications by students and faculty seems to be pretty good.

Another reviewer made note of how the main focus is funding GATE fellows. The application process targets the top students. Applicants must submit a research plan. The project has had good success in recruiting and granting 3 GATE fellows. Students are undertaking highly relevant projects, and the project has admirable placement of students within the industry.

A mixed evaluation was that a reviewer did not feel technical accomplishments were stated in the slides, and the subsequent rating is an assumption.

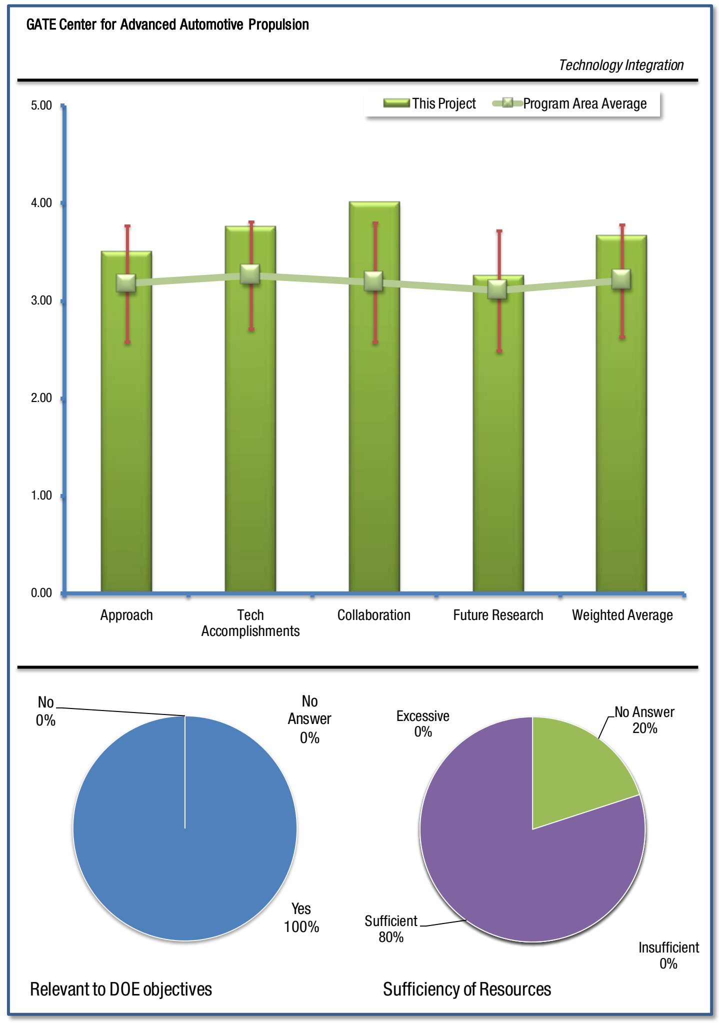
Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
Several reviewers thought more external collaboration with other institutions and partners would be helpful and should be a focus. Specifically, a reviewer commented that while the programs and partnerships listed no doubt add to the program, there appears to be little direct industry sponsorship in place. The program seems to be "California Centered" with weak to non-existent relationships with national labs, non-California industry, or other universities (both in and out of the United States). If these relationships exist, they were not highlighted in the presentation. Another reviewer thought collaboration with the existing programs, and with the research and training facilities at UC Davis, was very good.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Many reviewers noted the lack of information describing future plans. A reviewer commented that, all in all, the program seems to be working pretty well, but the presentation did not detail specific future activities or areas where growth is desired or needed. Another reviewer stated that it was difficult to rate because barriers were not stated. A reviewer also noted how the transition to a hybrid program needs continued development.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
A reviewer thought the program leverages existing programs and partners to provide extra support. The program has funded the fourth year of the GATE Program with only three years of funding from DOE through successful leveraging. The PI addressed the funding difficulties with the award process as an issue that needs to be addressed in the future with DOE. Another reviewer commented the resources appear to be sufficient. Funding issues were the focus of another reviewer. This reviewer commented that funding issues delayed the launch of this year's program

(application deadline slipped from April to May 09). Problem is probably not level of funding but timing and delivery. Hopefully, funding issues will not adversely impact the program.

GATE Center for Advanced Automotive Propulsion: Yann Guezennec (Ohio State University)



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Responding reviewers see the program as highly and/or directly relevant to petroleum displacement. One reviewer saw this objective as being completed through the training of engineers in modeling, control, and system integration for advance propulsion systems. Another reviewer commented that the program addresses issues related to improving current propulsion systems and future ones. One reviewer took a broader view, stating that GATE students provide knowledgeable employees to the industry, and system integration is of vital importance as hybrid technology (lowering fuel consumption) becomes increasingly implemented. Another reviewer made similar comments, noting that the Ohio State GATE program focuses on a broad range of energy and emission technologies with an emphasis on the integration of these technologies into on the highway vehicle environment.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Among positive reviews, one perceived that Ohio State GATE has developed a sound strategy focusing on training students' ability to integrate a variety of advanced automotive systems. The program has strong links to vehicle competitions and is highly leveraged, and offers a good number of courses covering a wide variety of topics. A second reviewer concurred, stating that the program has very well rounded deployment/approach: multiple projects, multi-disciplinary, and many different courses. Another reviewer noted how currently, there are four DOE funded GATE fellows and eight University or Industry funded GATE fellows as well as international visiting scholars that are not funded by GATE but work with the GATE program. As a result, the DOE funds appear to be well-leveraged. Curriculum and course offerings appear to cover adequately the breadth of advanced combustion, energy storage, fuel cell, sensing and actuation, and hybrid electric technologies that are the focus of this program. The emphasis on the integration of such technologies and systems is a strong point of this program.

A mixed review felt barriers were not addressed except the level of funding and what will become of the program after the GATE funding ends.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
There were several positive comments, many of which focused on the curriculum and technical accomplishments. For instance, one reviewer thought the program was very successful, and noted how multiple projects (not GATE) have developed due to the GATE program. Another positive review opined that the program has developed and now offers a good number of courses covering a wide variety of topics. Short courses on specialized topics have been developed

and offered. The program currently has four DOE and eight industry supported fellows, seems to have attracted a lot of industry funding to leverage the DOE funds, has developed a highly successful International Visiting Scholar program, and has placed high in several challenges. The research has resulted in four to five patents plus other invention disclosures. The program is involved in several applications competing for funding under the American Recovery and Reinvestment Act.

Another reviewer noted how the program appears to have caught up with respect to schedule. Additionally, compared to other programs, the number of DOE funded students appears to be the same (~4 per year). However, the non DOE funded students seemed to drop significantly (~16 per year to ~8 per year). This could be due to funding problems and uncertainties as well as the tight economy. Given the instructional infrastructure put in place, it would seem that the program could handle greater student throughput. However, tie in of the program with the DOE AVTC student design vehicles, as well as other "hands on" vehicle projects, provides a good way to transition undergraduates to continue on in the program as well as an opportunity for the graduate students to develop a broader perspective of the issues and challenges of integrating such emerging technologies into the vehicle environment. Hopefully, this can be used to increase both the quality and quantity of the students in this program. Quantity and diversity of technical accomplishments, publications, and patents by students and faculty seems to be pretty good (above average for programs evaluated).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Several positive comments on how the program has done a good job of developing collaboration, including with many industry partners. One reviewer thought the program has attracted significant industry funding for fellowships and research. The thriving international program with visiting scholars supports diversity in the GATE program. The program is working with other GATE universities and industry to compete for stimulus funding. A reviewer made note of the many visiting scholars, multiple proposals with other university, and industry programs with GATE students. Another reviewer commented that the program seems to excel at developing strong partnerships and relationships with industry and other academic institutions both here and abroad.

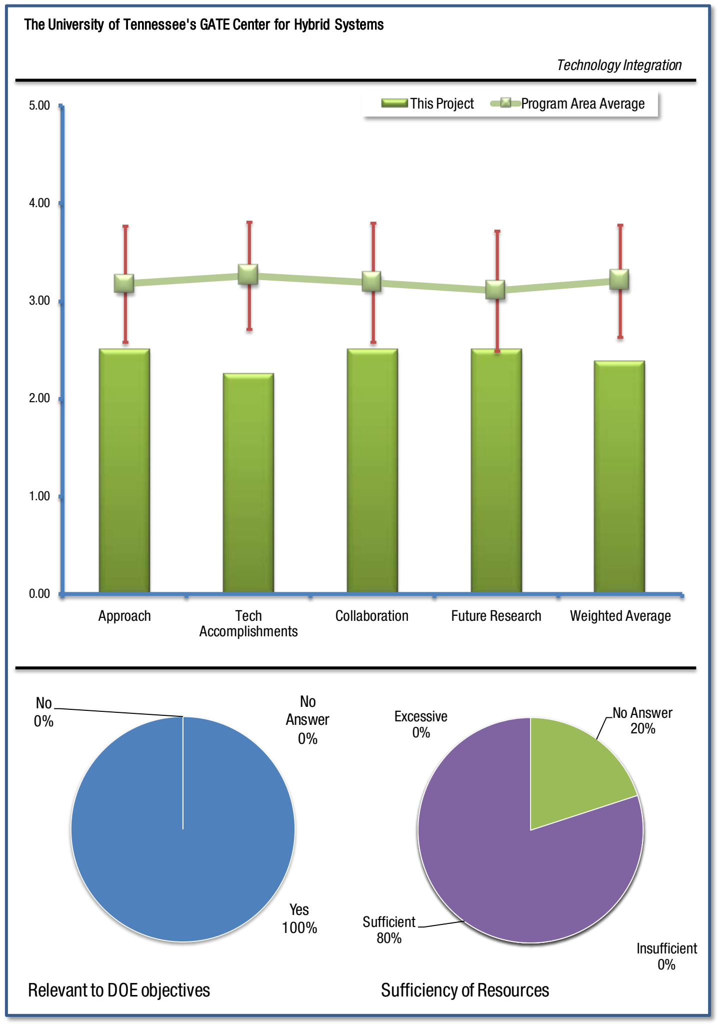
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Many of the responding reviewers commented on how OSU has done very well with the GATE program. A reviewer commented that the program has plans for continuous improvement with existing efforts and the development of two additional courses in advanced battery and system integration. Another reviewer noted how OSU has many proposals planned or submitted which are a direct spinoff of the GATE program. A reviewer also noted how the program seems to have recovered well from past funding issues. Furthermore, future work detailed in the presentation appears to be a logical extension of the current programs strengths. However, through no fault of this program, the current economic difficulties may hamper near term progress.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer commented that OSU is doing many good things with the current funding level. A second reviewer noted that although DOE funding is a little behind, the program appears to have sufficient resources with significant contributions from industry. For a third reviewer, while past funding issues seem to have been mostly resolved, the presenters make a good point that it is very important to have steady funding sources because students are loath to commit to a program which may not be able to fully support them throughout their project.

The University of Tennessee's GATE Center for Hybrid Systems: David Irick (University of Tennessee)



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Responding reviewers thought the program's focus on hybrid systems addresses DOE's petroleum reduction objectives. One reviewer commented that the program's goals are to overcome technology barriers, train engineers to enter the workforce in the areas of HEV and transportation efficiency, with a focus on advanced hybrid propulsion and control systems. Hence, this project does support the objective of petroleum reduction.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Among positive responses, a reviewer thought the overall structure of the program is sound, with multiple faculty members from three departments. Another reviewer commented that relevant courses have been developed and are being taught at undergraduate, master's and Ph.D. graduate levels. Advanced vehicle competition is used as a platform for the GATE program. A reviewer noted how the program appears to be appropriately leveraging DOE funds with the University providing $250K in cost matching.

One reviewer felt that progress seems to be slow on challenges addressed last year. Based on the presentation materials it appears that there are currently only three GATE courses offered, with two more planned for the immediate future. Compared to the course offerings for the other GATE programs, this seems to be a weak area of this program.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer noted how the program has resulted in 14 GATE fellows and nine GATE research assistants. Moreover, the program has good placement of GATE graduates within the industry. Several students have transitioned from GATE fellowship to sponsorship on funded research projects. This is a good model for leveraging the GATE program to acquire other funded research projects and place students onto those research programs.

Another reviewer feels the program appears to be just recovering from the lab fire in 2006. As described in the presentation materials, it appears that there are only a couple of students have completed their MS or Ph.D's. There was no indication of the number of students currently enrolled in the program. This also appears to a significant weak area in this program. However, tie in of the program with the DOE AVTC student design vehicles provides a good way to transition undergraduates to continue on in the program as well as an opportunity for the graduate students to develop a broader perspective of the issues and challenges of integrating such emerging technologies into the vehicle environment. Hopefully, this can be used to increase both the quality and quantity of the students in this program. This reviewer felt that the quantity and diversity of technical accomplishments, publications, and patents by students and faculty is underwhelming (below average for programs evaluated).

According to another reviewer, the program seems to have fallen off a bit. Currently only three courses are offered. It appears that facilities availability issues have hindered progress of program. Two recent students have graduated and are employed at ORNL but no mention was made of remaining students in the program or on the recruitment of new students. The program realized strong placement in Challenge X 2008. Aside from Challenge X 2008, outreach programs are somewhat limited. The current hydrogen fueled vehicle demonstration project is a bit adrift of primary focus area of hybrids. Another reviewer feels progress seems to be slow on challenges addressed last year.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Among positive reviews, one saw extensive partnerships. Another saw a focus on collaborative research and adjunct appointments with ORNL and ANL. GATE has been used to leverage $2 million in grants and contracts. The program has strong government and industry interaction, and good collaboration with Clean Cities on outreach. The program is involving ORNL in curriculum development and course offerings.

Another reviewer felt that past strong interaction with industry was noted but not much was detailed in regard to current industry participation. It was indicated that the recent poor economy has delayed collaboration with potential industry partners. Another reviewer perceived that the program currently (as detailed in the presentation) does not have the extensive collaborative relationships in place that the other programs do. While proximity to Oak Ridge is a plus, it is not obvious whether this proximity has been fully exploited. There is no evidence of international or other academic program partnering. Industry partnering also appears to be underwhelming and will likely not improve in this current economic climate.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer felt that continuing course development was evident, and the program will roll out several new courses in the upcoming academic year. Web site content is continued to be updated. A proposal in the works from major partnership with industry partner was affected by the downturn in the economy but they are continuing to explore the collaboration.

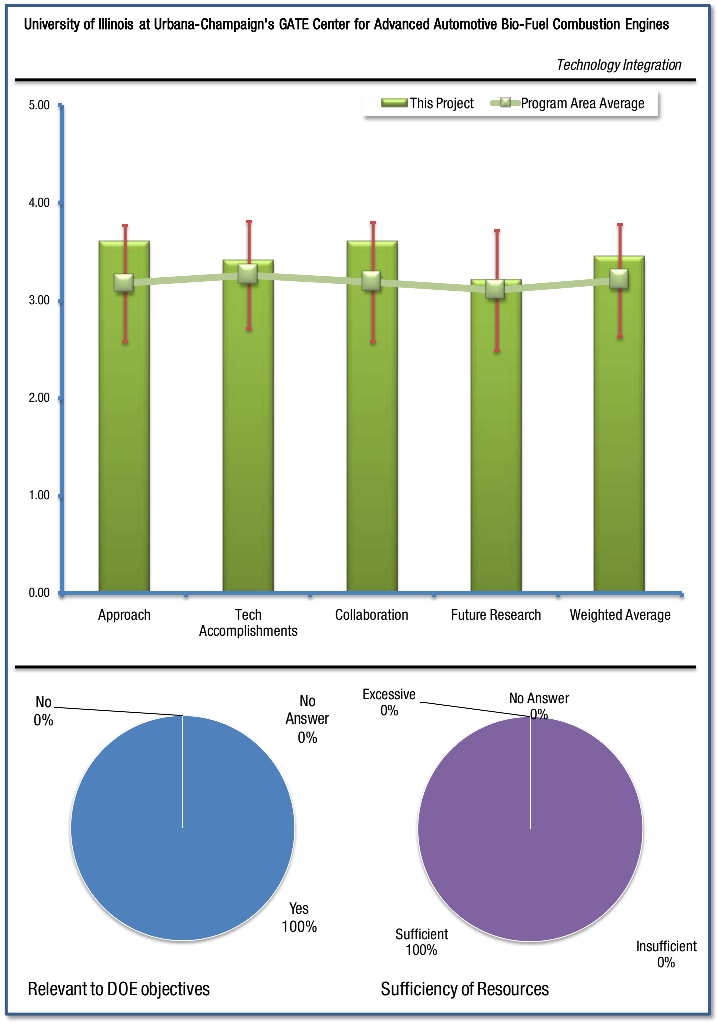
Another reviewer thought that plans to bring labs back on line soon should be a significant help to the program. Plans for the development of an additional course and the updating of another are good. Outreach and student recruitment need to be addressed. For another reviewer, while progress seems to be desired, plans stated do not seem too positive. A reviewer felt that all-in-all program seems to be struggling. Not sure if planned future activities/improvements will be able to be realized in this difficult economic environment.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Among positive reviews, one reviewer thought that resources are sufficient and leveraged to generate addition funding through externally funded research. Another reviewer commented that DOE funds are behind a bit but don't appear to be a limiting factor in the program. Industry support appears to be an issue.

For another reviewer, the presentation did not highlight any funding issues. However, this reviewer was floored when the presenter could not answer the most basic questions about program funding, which lowered the reviewer's confidence in this program even further.

University of Illinois at Urbana-Champaign's GATE Center for Advanced Automotive Bio-Fuel Combustion Engines: Chia-fon Lee (University of Illinois at Urbana-Champaign)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Because the focus of the program is on biofuels, several responding reviewers commented that the program supports or is directly relevant to DOE's objective of petroleum displacement. One reviewer noted that educating students in this area is highly important. Another reviewer commented that the University of Illinois GATE program focus on advanced automotive bio-fuel combustion engines fills a needed niche by providing students trained and research aimed at understanding the properties of bio-fuels and how these properties influence combustion and engine design/optimization. As such this research focus is directly relevant to the DOE goals of petroleum displacement.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Among several positive reviews, one saw the program possessing great focus on the barriers, including linking researchers focusing on biofuels to those focused on vehicle engineering - technology and operations. Another saw the program as having a solid approach, noting how the program involves 2 departments to develop an interdisciplinary curriculum integrating biological and mechanical aspects of biofuel technology. The program seeks to develop core competencies in the areas of auto technology, combustion, and environment. Another reviewer also commented on the multi-disciplinary approach, making note of the many research projects and papers related to the GATE program area of bio-fuel combustion engines. For a reviewer, the plan was very extensive, while another reviewer summarized how currently there are seven Ph.D. students supported by GATE scholarships as well as ~19 other students participating in the program. The University has cost matched approximately 30%, the list of partners includes a good cross section of academic and industry organizations both domestic and international, and curriculum and course offerings appear to adequately cover the breadth of advanced combustion and bio-sciences that are the focus of this program.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Several responding reviewers remarked how the program is making good progress. One reviewer noted that the number of students and publications were outstanding. Another reviewer commented that student participation is good with seven PhD students supported by GATE scholarships. They have started Phase II of the program and are on schedule. Research is broad-based with developing biodiesel fuel properties, in-cylinder combustion, engine performance testing with diesel and biodiesel, low-temp combustion, and electrostatically assisted atomization. The program is looking at evaluating novel fuels. Lots of tools seem to be available to the students. A certification process for students is due to be approved.

While a reviewer noted how the program is integral to all aspects of these efforts, it does not appear that as much progress is being made on the research side. More detail on the research progress would be helpful. Another reviewer felt though the program had a good interdisciplinary curriculum, and many detailed research projects, the reviewer was not sure whether GATE students were involved or just the GATE faculty.

A reviewer stated that the program appears largely on-schedule and has the majority of key elements in place, but it seems that the program could handle greater student through-put. One element the program seems to lack is a tie in with a "hands-on" design/integration project, such as the undergraduate DOE AVTC student design series, which would provide a good way to interest undergraduates in this area and to encourage them to continue on in the program. Such student competitions provide a valuable opportunity for the graduate students to develop a broader perspective of the issues and challenges of integrating such emerging technologies into the vehicle environment. Quantity and diversity of technical accomplishments, publications, and patents by students and faculty appears to be above average.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Many reviewers noted how the program has several good partnerships. One reviewer specifically mentioned partnerships with Cummins, Caterpillar, John Deere, BP, and Volkswagen and unique international connections with two European universities. Moreover, internships have been established with Caterpillar. Another reviewer felt the list of partners includes a good cross section of academic and industry organizations (both domestic and international).

While another reviewer saw lots of good partnerships, slides on all published papers are not necessary but instead more detail on the anticipated activities around partnerships. A reviewer saw limited collaboration and interaction with industry and universities, but this is planned in the future. More industry related projects are needed.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

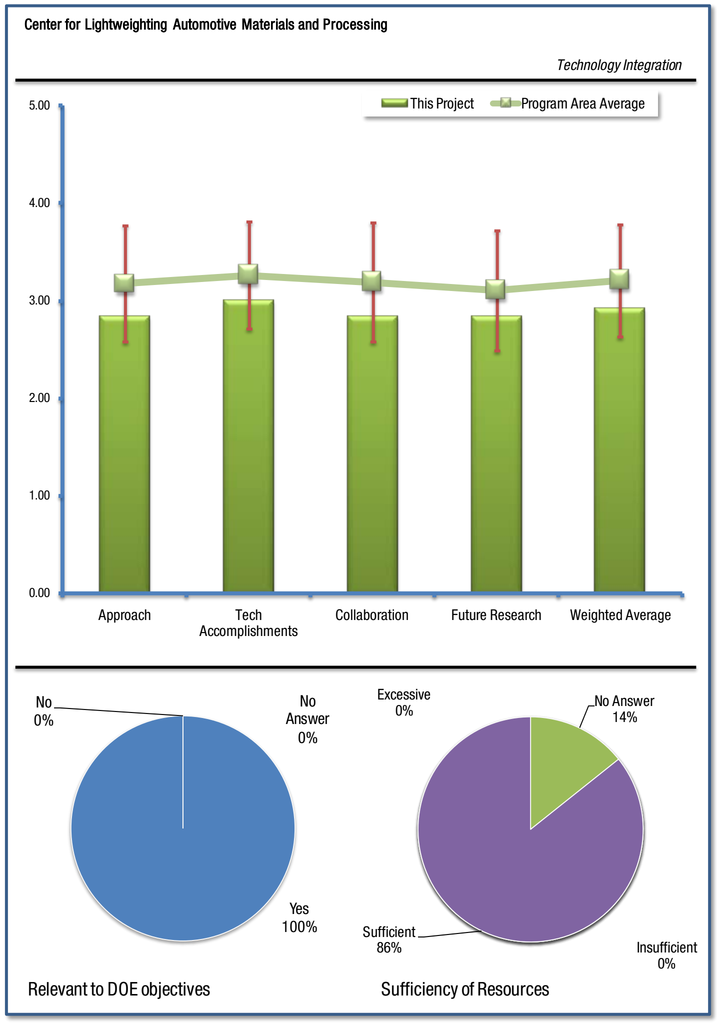
Positive reviews thought the program has good plans for the future. One reviewer noted how industry and academic collaboration is planned, more research in biofuels will be done, and how the program is integrating the GATE curriculum. Another reviewer thought, all in all, the program seems to be working pretty well. The future work detailed in the presentation addresses the key areas where growth is desired or needed.

More mixed evaluations included one reviewer who felt that information on future activities and how partnerships are included was lacking. Another reviewer felt that the program is looking to strengthen collaborative efforts with industry and further develop international collaboration. The program is looking to further develop student/faculty exchanges and integration of GATE curricula and certification. However, not much was mentioned on outreach to students through on-campus events. This could be an area of improvement.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Responding reviewers felt that the program appears adequately funded and supported and as a result appears to be on schedule. A reviewer felt that very little was presented on resources but there appears to adequate university, DOE, and industry support.

Center for Lightweighting Automotive Materials and Processing: P.K. Mallick (University of Michigan - Dearborn)



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers thought the focus of the program, lightweighting, is relevant to petroleum displacement. One reviewer felt the project uses materials science applications for the automotive industry. These lightweight, advanced materials have applications for the transportation vehicles and can reduce petroleum due to associated fuel savings or fuel cell technologies which do not rely on petroleum. Another reviewer commented that the program's focus on automotive materials and processing may not be the most glamorous, but since it directly contributes to vehicle manufacturer's ability to remove weight and hence increase fuel efficiency (regardless of powertrain/fuel technology), it is an essential element supporting the DOE's petroleum displacement goals. Another reviewer concurred that lightweighting vehicle materials is relevant to improving efficiency, and commented that the project is highly relevant to DOE vehicle technology goals. Few university programs across country address materials program focused on automotive applications. This makes this particular GATE center unique.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer thought that considering the number of students, good effective deployment was evident, and noted the peer reviewed publications, joint research activities with industry, and conferences supported. Another reviewer saw a well-defined strategy and goals for the center. The program's focus is to create university/industry government collaboration for education and research on automotive materials and processing for lightweight vehicles. The program emphasizes graduate education and research. The program addresses a barrier that many university curricula do not address, which is advanced materials for automotive use. Objectives include developing course on crashworthiness, upgrading materials labs, collaboration with industry on research. A reviewer noted how currently there are 10 graduate students in CLAMP research as well as ~65 other students participating in materials classes. The amount of University cost matching was not disclosed; however, the program does appear to have attracted significant industry research funding. Curriculum and course offerings appear to adequately cover the breadth of material sciences and processing.

A reviewer also thought the project is well-designed, although the technical barriers could be articulated more clearly. While a reviewer thought the approach to GATE is reasonable by establishing a materials concentration in the existing automotive systems engineering, not much detail was presented on student recruitment. Interdisciplinary collaboration with other university programs could be targeted as an area for expanding student outreach. Another suggestion for improving student involvement would be to offer a GATE certification for program participants.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer noted that the program appears to be largely on schedule and has the majority of key elements in place. Number of students supported (grad and under-grad) seems adequate. However, given the instructional infrastructure put in place, it would seem that the program could handle greater student through put without sacrificing quality. One strong point for this program is its tie with the 21st Century Model T project. Such projects provide a good way to transition undergraduates to continue on in the program as well as an opportunity for the graduate students to develop a broader perspective of the issues and challenges of integrating advanced materials and manufacturing processes into the vehicle environment. Quantity and diversity of recent publications by students and faculty seems to be pretty good.

Another reviewer thought the program had developed a solid curriculum with six courses now being available covering a reasonable range of topics. The addition of a course in crash worthiness is good. They have initiated an upgrade of the mechanical testing laboratory. There seems to be good student participation in the program with 10 graduate students participating in CLAMP research. Ten research projects have been conducted (5 have been industry funded) including three metals projects with Ford. The 21st Century Model T program appears to be very successful as a teaching platform (nine students participated). They are developing a materials database but showed little evidence of progress. This could be emphasized. A reviewer noted the third-year progress included a new course on vehicle crashworthiness, and upgrading materials laboratory. This reviewer noted how the program has produced 10 graduated students, 10 research projects being conducted, 5 industry funded programs, and the program shows evidence of leveraging, total of 6 graduate courses being offered, and has a good array of research projects. A reviewer noted that the presentation listed all the research projects, but no discussion on results. The team should list where the publications can be downloaded, or if they are industry sensitive, there should be some write-up to provide some indication on scope.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Among positive reviews, one thought the program has developed good collaboration with Ford in several research efforts and the 21st Century Model T program. They are working on developing additional collaboration with two companies on lightweight seats and extrusion process development for magnesium. Another reviewer thought that while the presentation does not list any direct “partners” it appears that the program has obtained significant industry research project funding and collaboration. A reviewer who saw industry collaboration cited collaboration with Ford, Auto/Steel Partnership, USAMP and Asian-Pacific Fuel Cell Technologies. Additionally, this reviewer thought that five industry-funded programs show evidence of leveraging, and suggests investigating collaboration with the University of Alabama GATE Center, which also focuses on lightweight automotive materials.

A reviewer thought collaboration with other organizations was mentioned and included the automakers, but it would be helpful to see more examples, rationale, and outcomes of such partnerships. Another reviewer thought collaborations seem to be centered on Ford and a few others, but it would be good to expand the number. A reviewer thought more detail should be provided on collaboration to get an idea of scope and schedule on these collaborations.

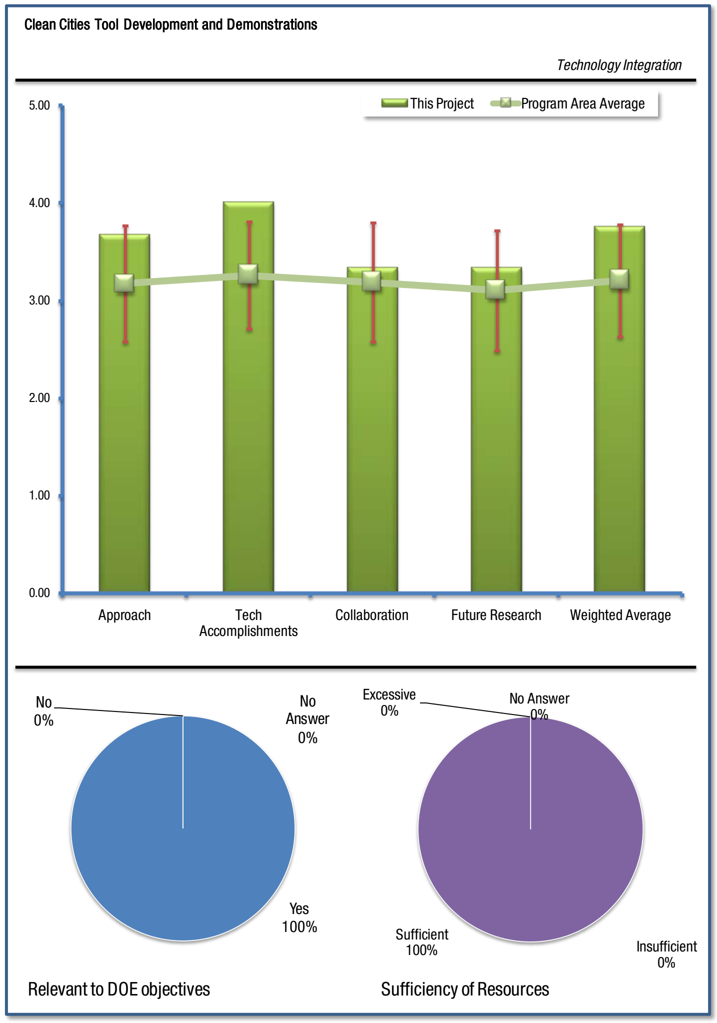
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

A reviewer perceived that, all-in-all, the program seems to be working pretty well. The future work detailed in the presentation addresses the key areas where growth is desired or needed. Another noted how the program is offering a new graduate course on Forming Process Modeling and optimization, offers two previously developed GATE courses, has performed laboratory upgrades to the Mechanical Testing Laboratory and the Metals Forming Laboratory, is increasing collaborative research, and recruiting more full-time graduate students. Another reviewer thought the program provided pretty solid plans for the upcoming period, including upgrading laboratory facilities, development of a new course, hosting of two symposia, recruitment of more students, and expansion of industry collaborations. A reviewer was unclear what the next steps are for the demonstration vehicle.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Some reviewers commented that resources appear to be adequate. A reviewer noted that nothing was directly mentioned regarding resources but there appears to be sufficient resources. A reviewer suggested that if the university intends to evaluate crashworthiness, involvement with DOT (specifically NHTSA) is critical. This is currently missing from the program's scope.

Clean Cities Tool Development and Demonstrations: Margo Melendez (NREL/ORNL)



Reviewer Sample Size
This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Responding reviewers saw value in the project, and thought it was aligned with DOE objectives. One reviewer commented this project is designed to provide consumers with valuable information on the AFDC website and fueleconomy.gov that relates to fueling stations, benefits of efficient vehicles, comparison of vehicle types and pushes information out to the public that is technically correct and unbiased. Based on the presentation, DOE is listening to consumers and updating the sites accordingly, as well as taking advantage of new and exciting mobile communication tools. Another reviewer definitely thought the project supports DOE's objective, and commented that it is a valuable tool for all sectors; public and private. A reviewer thought these are great tools for stakeholders to use. The programs, (AFDC, Fuel Economy.gov) have improved so much in the last few years that they are now very valuable resources for all stakeholders. This reviewer was very glad to hear that there are plans in place to reach out to stakeholders, especially the Clean Cities Coordinators, and educate them so that they can go out reach/teach others.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer thought the website was well-developed, and the Google maps were well-designed. Other reviewers commented on integrating this project with Clean Cities efforts. Specifically, a reviewer noted that a question was raised concerning whether the Clean Cities coordinators are aware of these resources and it was acknowledged that it is somewhat of a challenge to get information to them about all the valuable info on the websites. Another reviewer commented that in the past, the National Clean Cities program has relied heavily on the local Clean Cities Coordinators to reach stakeholders including fleet managers and the general public. This reviewer liked that the national program is now taking on this role and would like to see more direction from the national program. More guidance, more training and more "here is what you do" instead of the local Coalitions taking the lead. These tools are so good you could create events around them.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
One reviewer offered enthusiastic praise, commenting that NREL has made incredible strides and vast improvements in the advancement of these tools. This reviewer has been involved with Clean Cities since the beginning and felt it is nice to see how a "vision" over ten years ago has turned into a "reality" of tools all designed to help stakeholders.

Another reviewer stated over time, the sites continue to be updated in a timely way. A reviewer noted the new mapping tool, but wondered how often it is updated. This reviewer felt the University was a good concept.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer commented that the collaboration and coordination is invaluable. Another reviewer noted how a lot of the work on the AFDC and fueleconomy.gov is done through the national labs (Oak Ridge and NREL). It appears that they reach out to key stakeholders for up-to-date information for inclusion on the site and use these stakeholders to help spread the message about info on the site. A reviewer felt the project has gotten better and will continue to get better as NREL staffs up. This reviewer would like to see a quarterly meeting of industry partners to discuss opportunities for coordination (similar to the Coalition Regional Meetings.)

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

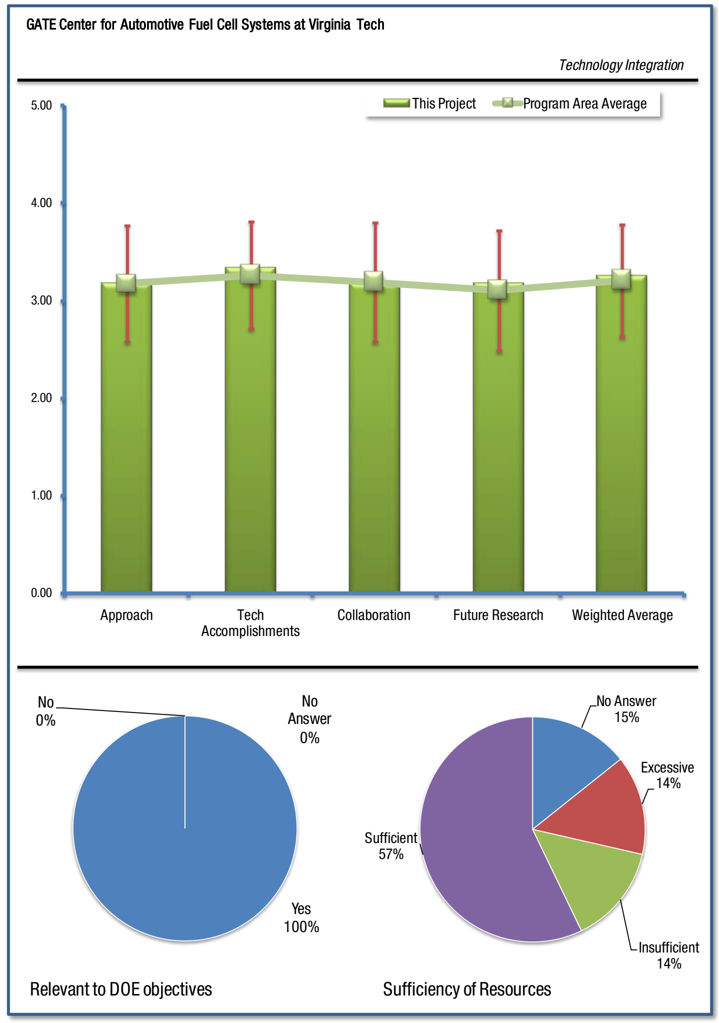
A reviewer felt that they have a plan for conducting future activities to take advantage of new mobile devices, updated fueling sites, and new regulatory and legislative actions. Another made note of the emissions map, and suggested expanding emission comparisons; wondered if there are links to affiliated groups, thought the desktop access was good, and saw help in analysis.

A reviewer described how many, many years ago the reviewer evaluated and saw a Clean Cities Road Map. The idea was this document would become a living document that would change on a regular basis. This reviewer has never seen an update of the Road Map, perhaps because they don't know where to look, but a plan needs to be in place and available for all to see and comment on. This reviewer is sure that NREL has a plan in place but would just like to see it.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Among comments, a reviewer felt that AFDC and fueleconomy.gov are being appropriated at approximately $1 million/year. Hopefully with the FY 09 proposed funding increases, they can obtain additional funds for future work. A reviewer commented that NREL and Clean Cities finally have the resources they need to make a substantial difference. Another reviewer felt that there are never enough funds for this type of program, and wondered, How many hits, and from where?

GATE Center for Automotive Fuel Cell Systems at Virginia Tech: Doug Nelson (Virginia Tech)



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Some responding reviewers felt the focus on the development of new science and technology to help overcome technical barriers for hydrogen and fuel cell vehicles is directly relevant to the DOE goals of petroleum displacement. A reviewer concurred with this assessment, and added that the program's focus on fuel cells is more of a long-term solution. Another reviewer also concurred, but added that DOE does not feel fuel cells for transportation are worth funding.

A reviewer noted that the project's focus is on coursework for graduate students. Building the next generation of researchers focused on technologies to reduce petroleum is necessary to achieve any measurable progress, although this is an indirect relevance. Eco Car challenge study compared hydrogen, plug-in hybrids (electricity), and E-85 and findings were not entirely new. Another commented fuels cells have some issues relating to petroleum displacement. Virginia Tech showed some research leaning more towards vehicle systems and integration.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer thought the Virginia Tech GATE program appears to appropriately leverage DOE funds with an approximate 33% university match. Based on the presentation materials it appears that there are currently only four GATE courses offered (without course descriptions). Given the overall strength of this program, these courses are probably well structured and integrated with other non-GATE prerequisite courses. However, it is hard to rate this aspect without more detail. A reviewer commented that the project showed good deployment, and involved multiple academic departments, and engaged students in some interesting research projects. A reviewer noted that there was a list of tasks around the Fuel Cell Program. The speaker mentioned barriers existed but did not go into detail. This reviewer felt it would have been nice to see the barriers identified, both research barriers and university program collaboration.

A reviewer noted how VT's approach crosscuts three departments, giving exposure to a large number of students. The approach focuses on engaging students in research. Not much was mentioned on available curriculum but it appears that only four courses are available. GATE certification for participating students was not mentioned. Laboratory facilities were not well described. Another reviewer commented that more mentoring is needed of the students who received gate support.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer commented the program has pretty good student participation with three current PhD students. Three recent graduates have been placed with GM. They have conducted research on durability of membranes and water transport and series PHEV. It seems like the program is migrating away from the fuel cell focus with work on hybrid vehicles. This is not necessarily a bad thing if approved by the DOE. The vehicle inertia study is interesting.

Another reviewer noted how the program presented results at National Fuel Cell Conference on fuel cell technologies. The primary study showed energy comparison of ethanol, electricity and fuel cells but results were not necessarily new based on other available research. This reviewer would have liked to see how this provided new insight. Other studies looked at hypermilers and the potential for improving fuel economy and shorter machicolation time at lower speed range. Then the program looked at HEVs and noted that you can do this for HEVs as well as conventional vehicles. This was very interesting although as was noted not very practical.

Another reviewer saw many interesting research projects on durability, water transport, etc. A reviewer noted how because their measure of success is the number of students graduated to support the vehicle companies and their suppliers, they made progress but only graduated three that were hired. The program should include sponsored internships with EPA labs, National Labs supporting the OEM's, and other organizations to broaden the students experience and base of knowledge. These institutions also have extensive interactions and partnerships with Honda, Toyota, and Daimler, which will provide more opportunities.

Another reviewer also focused on the number of graduated students. This reviewer commented that six graduate students (four Ph.D. and two MS) have received GATE support and nine other students that have completed GATE courses and/or conducted research in the GATE center facilities. While the number of students participating seems adequate, given the instructional infrastructure put in place, it would seem that the program could handle greater student through put. One element the program did not present is the degree of integration this program has with the VT undergraduate DOE AVTC student design series, which would provide a good way to interest undergraduates in this area and to encourage them to continue on in the program. Such student competitions provide a valuable opportunity for the graduate students to develop a broader perspective of the issues and challenges of integrating fuel cell technologies into the vehicle environment. This reviewer was not sure how well such potential synergies are being exploited. Quantity and diversity of technical accomplishments, publications, and patents by students and faculty appears to be above average.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Some responding reviewers saw great progress on published papers. One reviewer thought it was good to note 23 journal presentations since the last review. Another reviewer thought the presentation provided an excellent list of summary materials and the industry interactions. Furthermore, a reviewer thought the list of partners includes a good cross section of hydrogen and fuel cell focused industry organizations.

A reviewer thought the presentation mentioned interdepartmental collaboration but did not provide examples. Another reviewer thought the program has a good working relationship with GM, and that undergraduates have been able to obtain NSF research experience. However, further expansion of industry collaboration would benefit the program. A reviewer recognized that industry forums were attended, and saw evidence of some interactions with industry from the projects and professional development, but more interactions with other universities could be added, such as collaborative research projects. Another reviewer felt the program needs to interact with more labs performing similar research.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

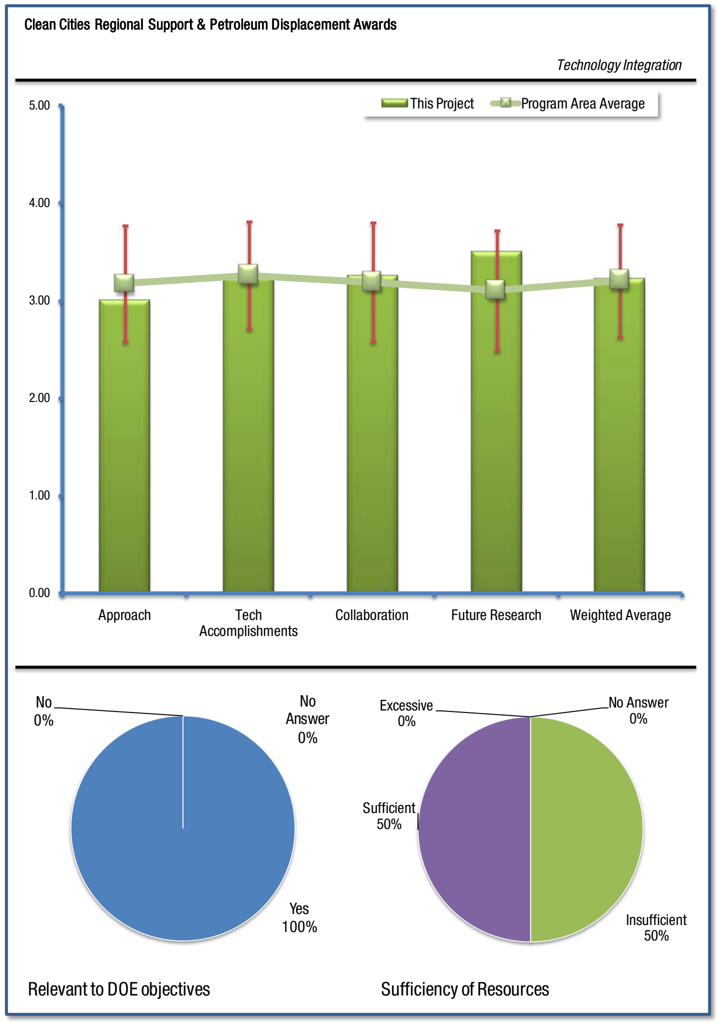
A reviewer thought a good summary slide on the upcoming activities for the curriculum and research program was presented. Another reviewer noted how the program's further plans include adding more courses, students, and industry collaboration.

A reviewer commented that nothing major is planned for the upcoming period. VT is looking to develop new Ph.D. course and recruit one or more students for GATE fellowships. They are targeting continuous improvement in the courses being offered. Curriculum expansion should be a focus. Another reviewer suggests developing an internship program with DOE labs, and foster work study at OEM's. A reviewer commented that all-in-all the program seems to be working pretty well. The future work detailed in the presentation addresses the key areas where growth is desired or needed.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Some responding reviewers commented that resources appear to be sufficient. Another reviewer felt that this is a good project that could be made even better with more interaction and collaboration. Have students work at Volpe, Sandia, ORNL on their engine stands or crash testing and EPA on their emissions modeling. Provide more opportunity to gain real life experience and make the students more valuable to a potential company. For one reviewer, because fuel cells are not being in future of transportation technology, why would grad students want to participate in a field that has no future in relative terms?

Clean Cities Regional Support & Petroleum Displacement Awards: Michael Scarpino (National Energy Technology Laboratory (NETL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer was of the opinion the project does support DOE's objective, commenting that this project funds the Clean Cities coordinators to conduct data collection and overall Coalition activities, as well as specific grants for key infrastructure-related projects. Through the work, 198 stations have been constructed and over 10 million gallons of gasoline displaced. Furthermore, it is providing additional training resources for Clean Cities coordinators and other resources to assist them in their work. Another reviewer commented that the program provides the mechanism for community and outreach, and deployment through Clean Cities Coalitions and Solicitations. A reviewer thought the program does support DOE's objective, but it could be expanded in supporting some other activities such as R&D. This is the only fuel and vehicle deployment program in DOE.

Another reviewer explained how, ten years ago the "grass roots" concept of the local Clean Cities Coordinators made a lot of sense. Alternative fuels was a dirty word and it wasn't getting much mainstream attention so we had to work behind the scenes in order to get things done. Now, alternative fuels are trendy and the new administration is making a big push. Perhaps we need to change how Clean Cities is run. "Instead of the tail wagging the dog perhaps the head should lead?" This reviewer would like to see the national headquarters staff (HQ) develop better guidelines for regional and local implementation of all of the great programs that have been developed.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

One reviewer thought it appears that setting up contracts with the Clean Cities coordinators has been helpful both in acquiring annual vehicle data and also providing them additional funding for training, workshops, and other options that they want to undertake with the additional monies.

Other reviewers had suggestions on expanded outreach. For instance, a reviewer thought the Q&A following NREL's presentation suggests AFDC and FuelEconomy.gov, although successful in obtaining hits, may not be effectively used by Clean Cities Coalitions. To improve communication, outreach, and coordination, the reviewer suggests hosting regional meetings in the CC region, including ADFC and FE.gov, perhaps at the National Lab in the region if appropriate. Strengthen link between R&D and Deployment activities. Another reviewer felt the program has extensive outreach, but it could be expanded significantly. Some coordinators appear to favor one fuel over another, and efforts should be encouraged to promote all types of fuels. This reviewer was unsure about the coordination between workshop participants and follow up.

A reviewer expressed the concern that the local Coordinators are planning events, performing education & outreach and deployment activities without a Road Map from HQ. Years ago there was a Clean Cities Road Map that was supposed to be a dynamic document that would be changed annually and provide guidance to the local Coordinators. This reviewer hasn't seen any revisions to this document since the original. This reviewer would like to see HQ lead the effort and provide guidance for activities, education and outreach and deployment initiatives to the local Clean Cities Coordinators.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Among positive responses, one reviewer thought progress is outstanding for the limited funds that are available for this program, and outreach is excellent. Another reviewer made note of how four specific projects were mentioned: the I-65 biofuels coordinator project; the Colorado project to increase biofuels; Kum and Go E85 retailer and the National Biodiesel Board's terminal blending. A reviewer thought accomplishments in terms of deploying alternative fuels station are significant and would be selected as Outstanding but for being localized. Additional resources would mitigate this shortcoming.

Although HQ has developed a very impressive array of tools and programs for the Coordinators to use, one reviewer was not sure all of them are taking advantage of them. Additionally, some of the Coordinators have not made many strides in adding vehicles while others are leading the way. The regional peer exchange meetings are an excellent way of comparing what works and what doesn't work and this reviewer applauded HQ's efforts in organizing these.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

A reviewer commented that outreach is outstanding, and Program direction and Coordinators are receptive to new ideas. A reviewer also noted how this entire project is dependent on working with Clean Cities coordinators throughout the country as well as key industry stakeholders to ensure that projects are undertaken in a successful manner. Another reviewer suggests, in order to improve communication, outreach, and coordination, hosting regional meetings in the CC region, including ADFC and FE.gov, perhaps at the National Lab in the region if appropriate. Clean Cities should strengthen the link between R&D and deployment activities.

A reviewer expressed concern that although HQ always strives for fuel neutrality local Coordinators often do not. Some have developed a "pay to play" philosophy in which a fuel needs to sponsor before they can speak. Because all Coordinators are now paid, although not enough, HQ can stipulate that all fuels are represented at local meetings regardless of sponsorship.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

Among responding reviewers, some thought that effective plans and goals were presented. For instance, one reviewer saw rational plans for addressing near-term opportunities provided by ARRA and for growth in FY09 and future budgets. Another reviewer thought the presentation addressed the FY09 Clean Cities program solicitation and how future funds will be allocated based on stimulus funding. Noted some future work plans for Clean Cities coordinators.

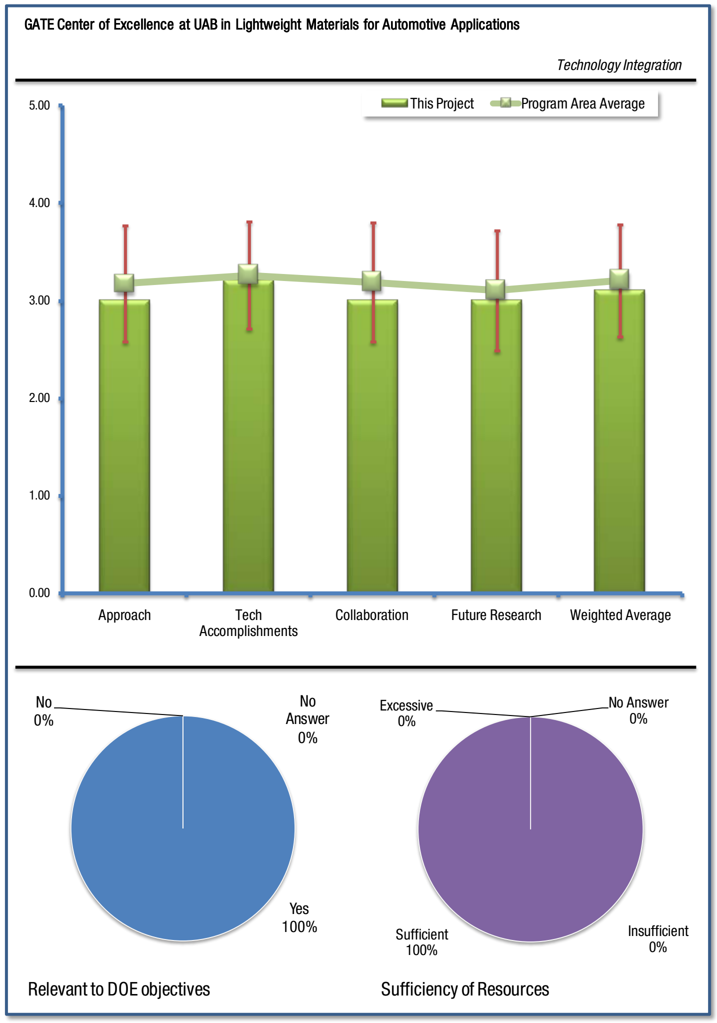
A reviewer expressed concern that the government appears to have different names for the program, and this tends to be confusing especially when researching funding levels. Another reviewer likes the additional tasks that are now required of each Coalition. This is a step in the right direction. Perhaps a national point person for the Coalitions could be identified and this person would be responsible for notifying partners of events, assuring fuel neutrality and resolving any issues that may arise. Some of the Coalition events are never even on our radar as they only reach out to certain fuel groups.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A responding reviewer has never felt that $12,500 or $20,000 is sufficient funding to support the activities of the Clean Cities coordinators. Significantly more money is required if the country is truly interested in furthering the use of alternative fuels/advanced vehicle technologies and infrastructure. Along these lines, another reviewer commented that the doubling of budget in FY09 should provide sufficient resources to execute plan. A reviewer feels the program should be encouraged to support vehicle R&D and demonstration activities, and to reference comments the reviewer made #1 and #5.

To another reviewer, current funding levels are where they have always needed to be. The reviewer noticed in the presentations that previous awards have been either CNG or Biodiesel based and fuel neutrality has not been maintained. This reviewer hoped the new level of funding will allow for an equal piece of the pie for all of the fuel groups.

GATE Center of Excellence at UAB in Lightweight Materials for Automotive Applications: Uday Vaidya (The University of Alabama at Birmingham)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Several responding reviewers commented that the focus on light-weight materials is directly related to DOE's petroleum displacement objectives. A reviewer commented that the University of Alabama GATE program's focus on lightweight materials for automotive applications may not be the most glamorous, but since it directly contributes to vehicle manufacturer's ability to remove weight and hence increase fuel efficiency (regardless of powertrain/fuel technology), it directly supports the attainment of DOE's petroleum displacement goals. Another reviewer commented that the project has a lightweighting focus in support of vehicle fuel efficiency; plastics, composites and metals. Also addresses recyclability. Focus is to train graduates in lightweight automotive materials technology and develop engineering curricula to produce specialists in the automotive materials area. Goals are aligned with national goals as well as GATE goals.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer thought the curriculum and course offerings appear to adequately cover the breadth of material sciences and processing. Additionally, while not specifically stated in the presentation it appears (given the overall performance of the program) to appropriately leverage DOE funds. Another reviewer thought the program is well-designed, and elaborated that the program involves four engineering departments in which graduate and undergraduate students can obtain GATE certificates with the completion of the requisite courses. The program appears to expose students to multiple learning experiences with hands-on labs, virtual classrooms, industry tours and workshops.

A reviewer found the program's strategy to be sound and aligned with GATE goals. It might be nice to show how focus on crashworthy materials relates back to DOE goals. While it was noted that there was automotive partnerships, it was not clear if the carbon fiber, aluminum and other parts are being deployed. The program's strategy is to recruit GATE students and enable interdisciplinary research projects. Program engages high school, community and undergraduate students, and addresses some off vehicle technologies like safety barriers. Plans are to support three graduate students per year with research projects focused on automotive applications. Also supports four undergraduates each year in automotive related research. The program is planning to develop and offer six new automotive related courses having the potential to impact 20-30 students per year. Extend impact to undergraduate, high school and minority students through hands-on workshops.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.
Responding reviewers felt the program is meeting or exceeding goals. For instance, one reviewer commented that the program is meeting or exceeding goals for the number of students participating in GATE courses and the number of courses offered. A sixth course on composites (long fiber thermoplastics) will soon be deployed and new class is being developed for designs for improved protection. Course diversity is good but a course on systems integration might prove useful. Research is focused on long fiber composites and seems to provide students with good hands on experience. The carbon fiber research appears to be producing good results. The program has added laboratory units (plasticator and press) to upgrade facilities. The "virtual classroom" is a good concept. Another reviewer saw a nice focus on integrated product and process development for students so there is real-world application in the research. Also good that the student project on banana fiber, which sounds innovative, is award winning.

A reviewer felt the program appears to be largely on schedule and has the majority of key elements in place. Number of student supported (grad and under-grad) seems adequate. However, given the instructional infrastructure put in place, it would seem that the program could handle greater student through put without sacrificing quality.

One strong point for this program is its tie with the Honda entry into the One Lap of America competition. Such projects provide a good way to stimulate undergraduate interest to continue on in the program as well as an opportunity for the graduate students to develop a broader perspective of the issues and challenges of integrating advanced materials and manufacturing processes into the vehicle environment. Quantity and diversity of recent publications by students and faculty seems to be pretty good.

Another reviewer noted that the program supported three graduate students, and four undergraduates. The program has offered 6 courses over history of program, and influenced more than 30 students. Research projects are aligned well with the focus of the GATE Center.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?
One reviewer thought collaboration and training seem to be focused on applied research. The bus industry example is great. It would be good to know if the company asked for this work or how the partnership was originated - i.e., by UAB or by the transit agency. Also, it would be good to see what the potential energy or petroleum savings are for the buses. Finally, it would be good to know quantitatively if the UAB online courses are being used. Another reviewer felt the UAB GATE program has good collaboration with industry through work with the DOT on school buses, ORNL on multiple projects, and Honda on One Lap of America. UAB has held several workshops and a conference on structural composites with 300 attendees. The program has good outreach to high schools.

One reviewer thought while the programs and partnerships listed no doubt add to the program, there appears to be little direct OEM vehicle manufacturer relationships (other than the one lap across America project with Honda). One of the big challenges with lightweight materials is how to incorporate them into a high production volume vehicle manufacturing process. As such, any collaboration with such OEM manufacturers would be a real bonus to the program. Another reviewer saw good industry collaboration through projects, and suggests interaction with national labs and community colleges, and exploring more collaboration with other universities, particularly the other GATE university working in the lightweighting/automotive materials areas.

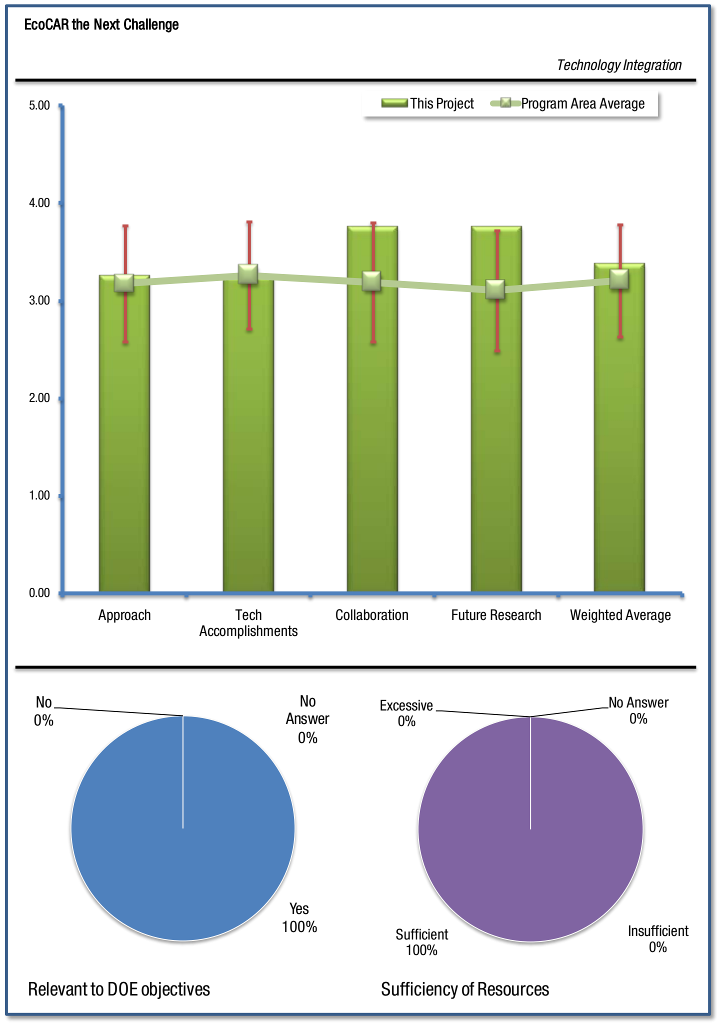
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?
Among positive responses, one thought that the program is working pretty well, and that future work detailed in the presentation addresses the key areas where growth is desired or needed. Another reviewer thought that a sound plan for the next fiscal year was presented. A reviewer praised the level of detail on partnerships with other universities and what projects these might generate in terms of new research efforts, and suggests more on barriers and how they might be overcome and that sufficient detail on forthcoming activities would be helpful.

A reviewer notes that UAB plans focus on building the current program without any significant additions. They plan to expand on various technical areas including carbon fiber thermoplastic impregnation, nanostructured biocomposites, and biomechanical aspects and crashworthiness of lightweight materials.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Many reviewers commented that the program appears to be adequately funded. One reviewer also notes that because of funding and support, it appears to be on schedule. Another reviewer commented good ability to leverage funds and good efforts to attract student. Great that they work with historically black colleagues and local community colleagues.

EcoCAR the Next Challenge: Mike Wahlstrom (Argonne National Laboratory (ANL))



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

Reviewers felt the program supports DOE's objective of petroleum displacement. A reviewer commented that the EcoCAR Challenge is very relevant to petroleum displacement by providing students an opportunity to use a variety of approaches to develop technologies for improving vehicle efficiency and a real world environment.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

According to one reviewer, the program appears to have improved some of its processes over previous competitions with increased requirements for safety and practicality of design and definitization of stage deadlines. Development of all event rules early on in the program instead of on a year-by-year basis would have been beneficial to the teams. The addition of hardware in the loop systems significantly improves educational value. Another reviewer thought the strategy was very well articulated, but it would have been good to hear more about how barriers have been overcome related to design. A reviewer thought these student projects have matured over many iterations to the point where they have anticipated and addressed virtually all of the key barriers to success. That said, these are exceptionally difficult economic times for some of the program sponsors.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

A reviewer noted how the program started in June 2008, and appears to be on schedule with the vehicle design phase being nearly completed. The program has provided rapid control prototyping systems and control interfaces to the participants. Another reviewer commented: When I was an engineering student, I participated in the SAE Baja and Formula vehicle design competitions (model for latter DOE student competitions). As such, I know firsthand the level of enthusiasm and the rapid learning that the undergraduate students obtain. In fact this was the reason that I pursued a career in the automotive industry. The same elements that fired me up as a student exist in these student competitions and results are borne out by the impressive number of them that continue on in this field (both as graduate researcher or in industry).

A reviewer felt the project is still in early stages. Another reviewer felt it would have been good to hear more about the past vehicles.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers cited an extensive list of partnering organizations. One reviewer noted how this list provides impressive leverage (bang-for-the-buck) for DOE funds. A reviewer commented that the program has very strong collaboration with a great multitude of governmental and industry organizations participating. Another reviewer felt that it's good that other funds are leveraged but would be good to hear more about the types of vehicles that have been developed.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

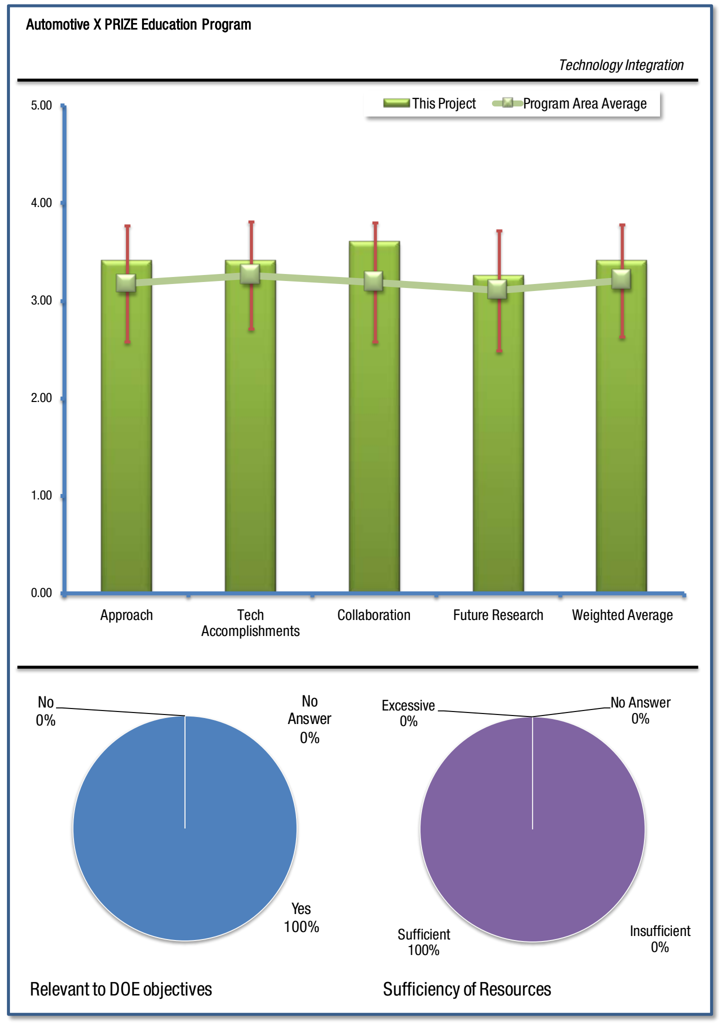
Several responding reviewers felt that progress is well-defined, and/or that the plan clearly addresses barriers and steps to solve challenges. One reviewer also commented that speakers did a good job focusing on future activities. A reviewer commented that future plans appear to be sound in getting vehicles to students, determination of drive cycles, 2-mode and fuel cell software testing, completion of the design of all events, and finalization of year two rules.

While a reviewer recognized that the program is designed as a multi-year program with each year's activities planned out completely before it starts, an area of concern is what if anything the current economy will do to the funding and company in-kind support.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

A reviewer commented that the program is highly leveraged and has sufficient resources.

Automotive X PRIZE Education Program: Mark German (X PRIZE Foundation)



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?
Some reviewers did not address this question with comments explaining a yes or no answer, but many identified positive long-term impacts. According to one reviewer, educating our children is the best way to ensure long-term change in fueling vehicles and making a difference in what vehicles and what fuels they choose to purchase. Another reviewer thought this project is designed to educate students about advanced technology vehicles, the importance of efficiency, and to encourage them to consider careers in the transportation sector. The project includes a number of partners, including Discovery Education, Widmeyer Communications, St Louis Science Center, and C Fox Communications. A reviewer thought that students gain with Applied Education activities. A reviewer commented that this project is aimed at raising the awareness and interest of the nation's youth about vehicle energy efficiency as well as stimulating this interest through a national high school design contest. A reviewer commented that educating our children is the best way to ensure long-term change in fueling vehicles and making a difference in what vehicles and what fuels they choose to purchase.

A reviewer notes how the program addresses the outreach and education aspect of the DOE programs, and addresses the fact that there is a lack of awareness among general the public and students. Particularly for K-12, there is a lack of specific criteria for school programs and lack of age appropriate curriculum. The goal is to inspire students to pursue education and careers in efficient transportation. The reviewer saw good use of the X Prize competition for an educational effort. It gives K-12 educators and students to follow the competition and learn about efficient transportation technologies. There was nice use of projects like the smart dashboard. A strong focus on youths is apparent, particularly the high school level.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A positive review stated that the project is well thought out, and has elements that will engage the general public, students, teachers, industry stakeholders and others in a creative and engaging way through competitions, national events, a creative website, design competitions, a Dashboard 2.0 design, etc. Another reviewer likes working with partners like Discovery Education and wonders if it would it be possible to get alternative fuels into the national science curriculums of elementary, middle and high schools. (The reviewer wasn't sure from Mr. German's presentation if that is in fact what they are trying to do.) A reviewer felt the program identified the barriers to educating and outreach, particularly the lack of curriculum and specifications for K-12 programs, and uses the

Automotive X-prize competition as a cornerstone for involving and educating K-12 student on fuel efficiency, vehicle design, and transportation sustainability. The reviewer saw good use of hands-on projects. However, might consider how the K-12 curriculum elements can be extended to outlive the X-Prize competition itself.

A reviewer scored the program as 'fair'; however, the reviewer is hopeful this is wrong. The reviewer elaborated, explaining that the program and design competitions just don't seem exciting enough, especially when they are competing against U.S. first and other robot competitions. Also, the high school student is very difficult to capture since school time is dominated by "no-child left behind" activities and the after school activities are dominated by sports and other programs as well as greater homework loads (my own elementary school kids have far more homework than I did in high school).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

One reviewer thought the project had a very aggressive timetable and it appears that it was met and exceeded. Another reviewer thought progress to date seems to match the program plan. A reviewer focused on the program's partnership, explaining that by using the partners, they've looked at other curriculum resources and highlighted good content already available and aggregated it in a meaningful way. To get curriculum adopted in the schools, they looked at the national and state standards. They also reviewed existing contests that are out there and then focused this one on the high school level. They are engaging out of school time partners since high school students have limited time during school hours to work on this. In terms of measures of success, they've had 16,000 site page views. Earned media figures show great interest but need to know how this will be adopted and used in the classroom.

A reviewer noted how the launch of the Fuel our Future.com web site was a focus in this year, and how there was a launch at NSTA to introduce the K-12 curriculum, which was attended by about 40 teachers. The reviewer saw good age-appropriate projects, and that the contest focuses on High School Level. Key challenges will be use of the program within schools considering the competition from other program. Promoting this program as out of school activity will be a challenge.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Reviewers saw a great deal of collaboration on this project, and strong partners. A reviewer commented that there is good collaboration with partners for education providers, science centers in K-12 - for example Discovery Education. There is also good organization of roles of partners. The program could explore more coordination with universities. While another reviewer felt the degree of collaboration and coordination appears appropriate, the reviewer is not sure how much funding leverage is in place. Presentation listed $3,504,686 as the DOE share but did not indicate how much partner funds and in-kind contributions they would be providing.

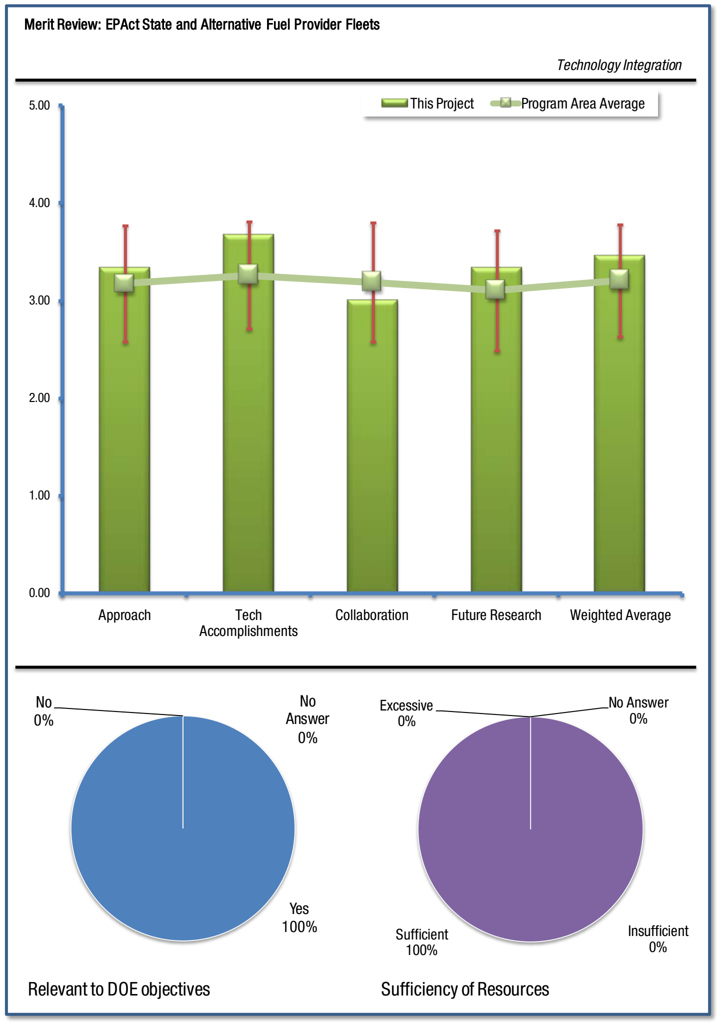
Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

In comments, most reviewers felt the project is on track with milestones and deliverables. Specifically, a reviewer commented that they are well positioned for future grant deliverables, including competition host city education events. Another reviewer thought the layout of planned future activities is appropriate and well thought through. A reviewer saw a well-organized plan going forward. Another reviewer thought the future work with the NSTA should be a great starting point for this curriculum to become accepted into science classes nationwide.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Among responding reviewers, one thought resources appeared sufficient. Another reviewer commented it appears that they have been able to leverage the $3.5 million in Clean Cities funding in such a way as to make this a successful project. A reviewer saw no indication that the program is underfunded - however, the DOE funding level of 3.5 million is a lot. The reviewer really hopes this program pans out. One thing that the reviewer noticed in the presentation was any follow-up success metrics (e.g., measures of impact/participation that are expected) that should be tracked throughout and following the program.

Merit Review: EPAct State and Alternative Fuel Provider Fleets: Dana O'Hara (U.S. Department of Energy)



Reviewer Sample Size

This project had a total of 3 reviewers.

Question 1: Does this project support the overall DOE objective of petroleum displacement? Why or why not?

One reviewer commented that the program is legislatively driven to specifically target reducing petroleum usage in automotive fleets through the use of alternative fuels and alternative fuel vehicles. Another reviewer saw that DOE displaces petroleum by having fleets comply with requirements for alternative fuel vehicles. A reviewer commented that this is a regulatory program to encourage adoption of alternative fuels. This is a vehicle acquisition program.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewers focused on how the program works to overcome barriers. A reviewer saw that most barriers are associated with regulatory restrictions, legal issues, and fuel availability. These barriers can be difficult to overcome. Barriers are often managed through exemptions and exclusions. Another reviewer perceived that most barriers are associated with regulatory restrictions, legal issues and fuel availability. Furthermore, the program has good knowledge of their barriers, and has developed a well-rounded program. A reviewer commented that the program has developed a strong approach to maximize compliance including the development of alternative compliance methods and direct interaction with stakeholders.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals.

Several reviewers noted the high level of compliance in the program. One reviewer noted that the program appears to be quite active and has achieved a very high level of compliance in meeting legislative requirements. The program appears to be highly flexible in compliance approaches. The trend for compliance has been more and more weighted toward E85 flex fuel vehicles.

Another reviewer recognized the high level of compliance, and noted that the program dealt with many different types of policies. A reviewer also commented that the program is meeting 95%-plus compliance within affected fleets.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions?

Many reviewers cited collaboration with NREL and Clean Cities. A reviewer cited this, and that good outreach and educational tools have been developed, including workshops and online toolkits. Another reviewer recognizes that the program is not really a project that can have collaboration, but they work with their stakeholders.

Question 5: Has the project effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology, and, when sensible, mitigating risk by providing alternate development pathways?

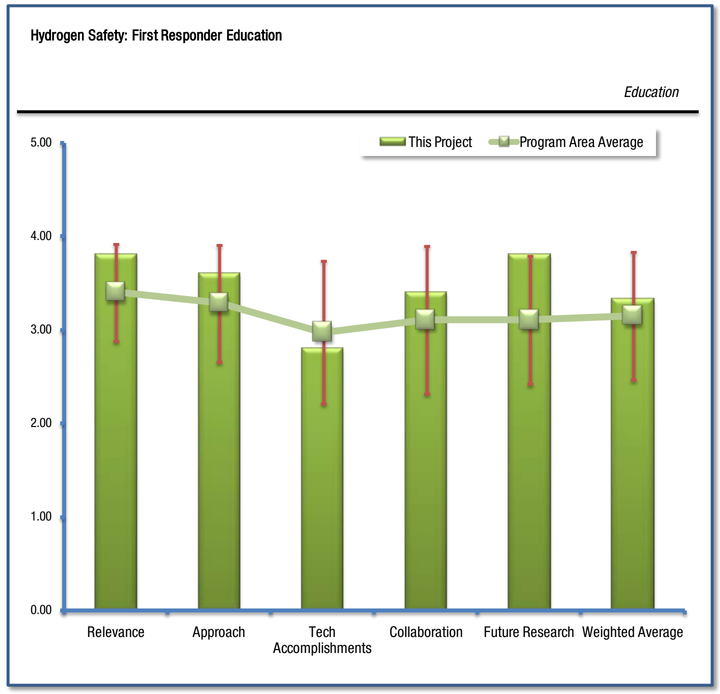
Some reviewers commented on the program's documentation. For instance, one reviewer thought the program seems to be well-organized and successful, and that documentation was mentioned as something that needs to be done for the project.

Another reviewer suggests that better documentation of the program should be pursued. While data is collected, this reviewer wonders if this data is made available to public and the alternative fuels, industry and research communities. A reviewer also thought that future plans appear to expand the resources available to fleets and to continue the refinement of program activities and reporting. The program will be analyzing other fleets to increase coverage. The program has a sound plan for going forward.

Question 6: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

All reviewers commented that resources appear to be sufficient to meet milestones.

Hydrogen Safety: First Responder Education: Marylynn Placet, Pacific Northwest National Laboratory (PNNL)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Review comments were generally positive here. A reviewer cited the wide effort to disseminate H_2 information. Another stated that a focus on first responders is necessary. Hydrogen safety and first responder training is essential for the introduction of the technology. Experience has shown there is a fire professional education and awareness hurdle that must be overcome in almost every demonstration project. A third reviewer believed that a robust educational and outreach effort is critical to support the advancement of breakthrough technologies. Fuel cells generally do not have the benefit of robust outreach efforts from the industry, in this reviewer's opinion, to build public awareness of the products and their benefits, so public sector participation in coordinating a national effort is justified. The final reviewer stated that this sort of work is essential to the program. Proper first responder training and code enforcement official knowledge and confidence are enhanced by such training and familiarity. The course deals with stationary and vehicle incidents, which this reviewer saw as a strength.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer saw this work as having a creative approach to address important barriers, and combining the use of the prop and online tools is great. This reviewer suggested taking the prop to other locations to reduce travel costs for the attendees and bring the course to others who might not take the time to travel. By obtaining feedback from technical experts and first responders, the project was improved, in another reviewer's view. Brainstorming in the classes (student centered learning) is an excellent approach and is also a strength of the program. Having a web based course, with a certificate, is an excellent way to encourage participation, and represents a third program strength.

A third reviewer said the approach appears solid, although there is a lot of funding being placed against this effort. Previous comments made about HAMMER site being hard to get to is still germane to some extent. This reviewer did say there was an excellent steering committee. The final reviewer was unsure if the scope was limited to the vehicle side of the training, but seems that this type of training must cover the infrastructure side of the equation...especially indoor refueling for forklifts. The team will probably need to revisit this given the focus on market transformation activities.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer offered the positive comments that 300- 500 unique visits per month to the website is outstanding. This reviewer noted that courses still continue to be given, and the project team reacted to steering committee input and made changes as appropriate. This reviewer felt the hydrogen versus propane flame work is a good project.

On the other hand, a reviewer said that the May schedule date was not met and was slipped to June, while one program was canceled. This is a weakness in this reviewer's mind. Another expected the hydrogen suppliers to have been more involved in the development of the program. It is good that they were invited to a workshop, but this reviewer offered that they could have contributed much more if given a steering committee role, and the progress may have been better. A reviewer was unsure how the percent completions were derived. Was this based on work breakdown structure level measurement, or just gut feel? The final reviewer saw the project moving ahead on schedule, with its only weakness being in getting more people to take the course. Traveling with the course outside of Washington may solve that.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Comments on collaboration were fairly brief. One noted that collaboration with CaFCP and steering committee are both good, but there was not a lot of discussion on other collaboration partners. Another reviewer saw collaborations as good, but potential exists to bring in many of the federal agencies who have some demonstration projects underway (DOD, USPS, FAA, etc.) A reviewer said that coordination with other organizations has been comprehensive and extensive. To another, coordination efforts with fire departments and with NASA were strengths.

Question 5: Has the project effectively planned its future work in a logical?

A reviewer stated that it appears this is already fully funded. If not, they should continue their program through completion. Another offered that the plan moving forward is on target, but the team must look to relevant conferences to get the word out...potentially add NHA and FCSE to the list of events at which to present. The final reviewer said that the plan to continue the web based course and to give periodic training sessions in various locations is an excellent approach. These are both strengths.

What are the project's strengths?

A number of strengths were listed, including relevancy to early markets and facilitating market introduction, good industry representation other than hydrogen supply, coverage of vehicles, fueling stations and stationary installations, and coordination with fire departments and other experts including NASA. Further strengths involved the creative approach with the prop and online tools to reach safety officials, the intensive interaction with small to medium groups, the peer reviews of the curriculum and approach, the use of brainstorming and student centered learning, the provision of a certificate for the web based course, and the continued use of the web based program and periodic exercises around the country.

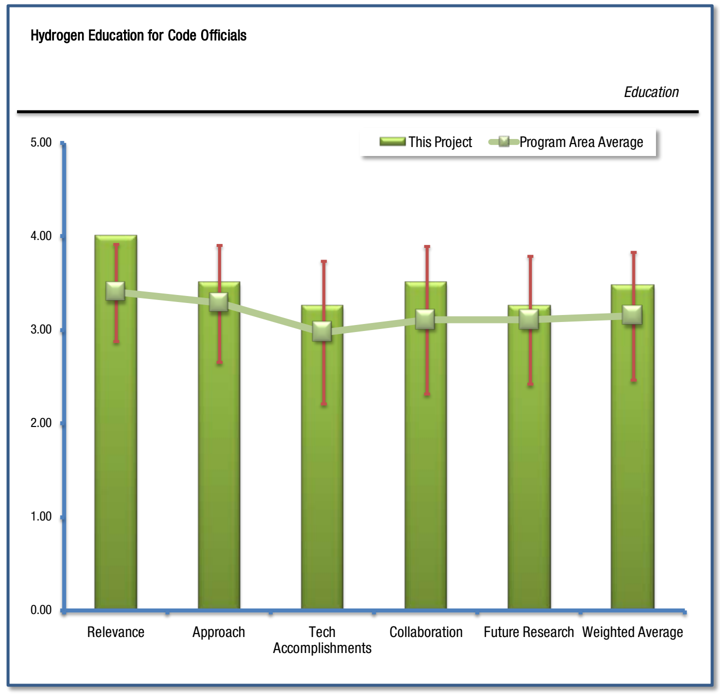
What are the project's weaknesses?

Weaknesses listed were few: the team canceled one class for 2009, and the project is limited in its current structure to reach large numbers of people (but that is fixable). Finally, a reviewer noted that per the presentation, this project seems to be focused on the FCV side: please consider other applications and in place infrastructure.

Do you have any recommendations for additions or deletions to the project scope?

Recommendations included consideration of expanding the scope to include other applications a little more specifically (since they are near market opportunities) along with infrastructure. Another suggestion was to take the prop to other locations to reduce travel costs for the attendees and bring the course to others who might not take the time to travel. The final suggestion was that more project classes with props would be an improvement.

Hydrogen Education for Code Officials: Melanie Caton, National Renewable Energy Laboratory (NREL)



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Comments received for this question included the statement that educating AHJ about codes and standards is absolutely essential for market transition activity. From personal experience, this is potentially the current limiting factor for broader H_2 introduction. Also noted was that training code officials will help to make permitting easier.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first reviewer liked the e-learning method for delivery, but it often will require some personal engagement in the near term because some of the codes are under development and change. This reviewer also liked the fact we are ensuring symmetry with the awareness training from PNNL. A second reviewer noted this was an excellent step to coordinate with the national and state level organizations. Their support should greatly help facilitate the outreach to the first responders, as well as the delivery of training materials. Also, coordination with PNNL is a good step. A second reviewer said the program was well designed to begin with, and was modified according to feedback provided at the beginning. The third commenter offered extensive discussion of the approach, stating that taking feedback from the code officials helped to make the project more relevant: this is a strength. Giving a certificate helps to encourage participation. Covering both fueling stations and stationary fuel cells is a strength, but not covering parking facilities and repair facilities is a weakness. Linking the project to the permitting web site to ensure current information is used is a strength. Not having links to each individual jurisdiction's particular code and depending on the user to pick the proper source code and make the appropriate changes for his or her jurisdiction is a potential weakness. For instance, is the New York code set appropriately represented?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Progress toward goals is the main commenting subject here. A reviewer said that progress is being made, although initial fielding was delayed from May to June of 2009. Second, a reviewer stated that so far progress has been good. This reviewer looked forward to seeing how the training is used and rolled out once it becomes public. The final reviewer said that the project appears to be on schedule, which is a strength.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer said that the current level of collaboration appears good. This reviewer sensed that a stronger tie to NFPA may be desirable (they were mentioned as 'other'). Additionally, it might be worthwhile to include some federal officials in the collaboration area. A second reviewer said that collaboration on the course was extensive and comprehensive, while a third said that coordination with applicable AHJs is a strength. Finally, a reviewer noted that coordinating with the national and state level organizations was an excellent step. Their support should greatly help facilitate the outreach to the first responders, as well as the delivery of training materials.

Question 5: Has the project effectively planned its future work in a logical?

To the first reviewer, the proposed future work is good, but could be improved if the scope is expanded to include parking garages and indoor fueling for applications such as lift trucks. The plan for moving ahead is sound and well planned, offered the second reviewer, who suggested planning for the update and building out of some of the materials in the modules. The final review comment was that consolidation of resources will be helpful: this is a strength.

What are the project's strengths?

A strength was the program's relevance to the market transformation activities. Educating and delivering technical content to the AHJ is absolutely essential for demonstration projects and future fielding of the technology. Another strength was that this project addresses a key education need with a very important target audience. From what this reviewer has seen of the course, it is very well done. Another comment was that taking feedback from the code officials helped to make the project more relevant. Other stated strengths were the project's coverage of both fueling stations and stationary fuel cells, the linking of the project to the permitting web site to ensure current information, and the consolidation of resources to be done.

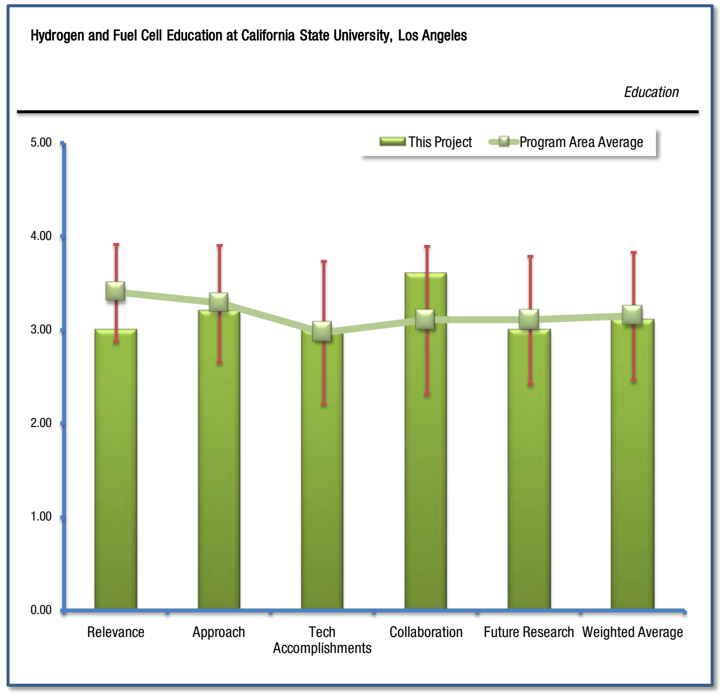
What are the project's weaknesses?

Project weaknesses were that current coverage is primarily outdoor infrastructure, and that the project does not cover parking facilities and repair facilities. The statement was made that automatic updating is good, but this reviewer anticipated issues when new code sections are added to address systems not previously addressed. There might also be confusion when sections are moved and combined, which often happens with new codes. Another comment was that not having links to each individual jurisdiction's particular code and depending on the user to pick the proper source code and make the appropriate changes for his or her jurisdiction is a potential weakness.

Do you have any recommendations for additions or deletions to the project scope?

Recommendations were that the team should consider broadening of the module 3 content to include indoor refueling, parking, and repair facilities (most applicable to near market opportunities): another suggested adding parking garages and repair facilities. Similar comments were that the proposed future work is good, but could be improved if the scope is expanded to include parking garages and indoor fueling for applications such as lift trucks. The final recommendation was for indoor refueling for forklifts, given the delay that DLS experienced at their Susquehanna facility.

Hydrogen and Fuel Cell Education at California State University, Los Angeles: David Blekhman, Cal State LA University Auxiliary Services, Inc.



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
A reviewer felt that the goals and objectives of this project support the aims of the Education Subprogram: a similar comment from another reviewer was that the program supports the objectives. The project was clearly relevant based on stated DOE objectives. A reviewer commented that development of college-level curricula related to hydrogen and fuel cells is critical to the development of a future hydrogen/fuel cell workforce. Similarly, curriculum development is essential to bringing well trained technical people into the industry. This could include researchers, engineers, designers, scientists and technicians. Having well trained technical professionals is essential to a growing and advancing industry.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer felt the approach appears to be reasonable and consistent with the development of new, relevant courses and labs; however this reviewer said it was difficult to tell which courses are new and which already exist. Good supporting activities were shown in hydrogen and fuel cell technologies. Another commented that the curriculum is on track to set up curriculum/lab and expands on typical classroom courses by incorporating research, demonstrations and outside integration of existing hydrogen stations and cars in area. Multiple tasks are planned or underway, stated another reviewer who also noted the aggressive plan, especially considering the relatively low level of funding. This reviewer highlighted the use of other funding to supplement this effort. Good efforts in course developments, lab developments, demonstrations, and student projects, and an overall impressive effort, in a third reviewer's opinion. The final reviewer suggested that having several courses in several schools may help to get more people familiar with the technology, but having more courses in one school might help to build a higher level of expertise in a particular field of study. This is a recommendation for future work.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
Progress seems reasonable, to a reviewer. Accomplishments have been as good or better than would be expected in every area. Another said that most tasks are works in progress but seem on course to completion: the hydrogen laboratory with solar electrolysis capabilities will provide crucial data. A number of courses have been developed and are being delivered, noted the third reviewer, who added that outreach activities have involved diverse audiences. Finally, a reviewer commented that the course work has already started and further development is progressing well.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
Good collaborations and also good outreach activities was the opinion of a reviewer. Another highlighted the collaboration with CaFCP, GM and Honda as strengths. Similar comments were that there were key partnerships with

CaFCP and local companies, and important work is ongoing with California government and utility companies. A reviewer noted that this is an interdisciplinary program with multiple funding sources and participating companies and organizations. Collaborations were characterized as very impressive, and a strength regarding the extensive partnerships was identified. Finally, a reviewer said that both conference participation and coordination with junior colleges were strengths.

Question 5: Has the project effectively planned its future work in a logical?

Future plans to complete the project were satisfactory to one reviewer's eyes. Another said that the project seems to be on track for completion, and the zero-emission fuel cell lab will be an important addition to research world. A reviewer stated that there was a good plan to expand course availability and variety. Most future work will concentrate on continuing both hardware and course/lab developments as previously planned, stated another. The final comment was that having several courses in several schools may help to get more people familiar with the technology, but having more courses in one school might help to build a higher level of expertise in a particular field of study. This is a recommendation for future work.

What are the project's strengths?

Several project strengths were highlighted by reviewers: availability of hydrogen fueling station based on renewable energy sources is an asset, noted one. Another felt a strength was the good outreach and education around project, and the participation at local shows and venues; this reviewer said the project should be able to continue on its own without DOE funding once that ends. Another spoke of the involvement of multiple participants and departments at the University. A reviewer stated there were excellent simultaneous efforts in many phases, along with good participation at Cal State and excellent collaborations. A reviewer listed conference participation, coordination with junior colleges, collaboration with CaFCP, GM and Honda, and extensive partnerships as strengths.

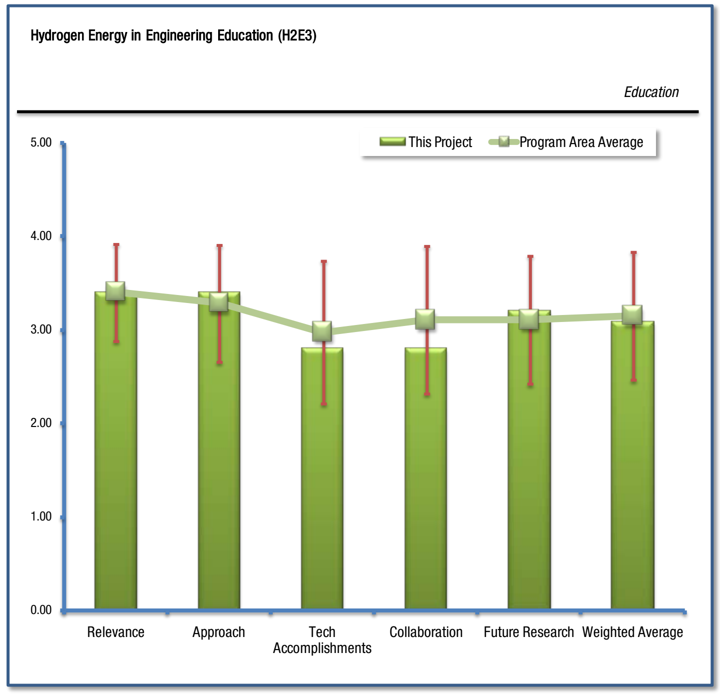
What are the project's weaknesses?

Outside feedback has not been solicited on the technical content of the courses was one stated weakness. Another said that it was not clear the Industrial Technology is the best home for the efforts. Finally, a reviewer offered that having several courses in several schools may help to get more people familiar with the technology, but having more courses in one school might help to build a higher level of expertise in a particular field of study. This is a recommendation for future work.

Do you have any recommendations for additions or deletions to the project scope?

Three recommendations were provided by reviewers: lower level courses should be developed for first or seconnd year students; continue the work as planned; and adding curriculum to Electrical Engineering.

Hydrogen Energy in Engineering Education (H2E3): Peter Lehman, Humboldt State University Sponsored Programs Foundation



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer noted that the project is structured to be consistent with the subprogram goals and objectives. Another felt there was good relevance for the DOE-stated education objectives. A reviewer further stated that the project supports program objectives with hands-on fuel cell and hydrogen experience for students. A reviewer highlighted the long history of effective educational tool development and continued by saying the project is addressing long-standing concerns about hydrogen and fuel cell education gaps. The final reviewer said that the development of educated trainers is necessary for training future industry professionals. These curricula may be replicated at other universities to maximize benefits.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer highlighted the broad-based approach including course development, labs and demonstration kit development. A reviewer said this offered good use of existing infrastructure and groundwork at the university. A reviewer made specific mention of modifying existing courses and developing suitable modules with an emphasis on undergraduate engineering students, as well as making use of the presence of hydrogen refueling stations in California to enhance the student experience. A reviewer noted several strengths in the approach, including developing curriculum for all levels of university students (lower division, upper division and senior level), using the California hydrogen fueling stations as part of the curriculum experience, replacing existing curricula with curricula that covers fuel cells, and building educational kits and test stations to be consistent with the curriculum. The final reviewer contrasted with these other opinions by noting that while the approach intent looks good, it is not clear that there is sufficient internal support. Chemical Engineering should also be involved.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Progress was judged to be reasonable - project will be completed on schedule. This was echoed by another reviewer who also said the project appears to be on schedule. A reviewer emphasized that the electrolyzer had been completed and the team is making multiple kits. The reviewer also stated the team built own fuel cell stack to save money, and felt the project was on track. A reviewer said there was good progress on developing and testing curricula, test kits and fuel cell test stations. The final reviewer disagreed with the progress assessment, saying that many phases of the work seem to be well behind schedule.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Collaboration assessments were mixed. One said there was a good set of project participants, and similar views were offered by another who felt there was good collaboration with other schools. Planned collaborations look excellent to another reviewer, but this person was not clear how much is actually taking place thus far. A reviewer noted the varied partnerships with fuel cell companies - different fuel cell sizes/products/markets and locations. The final reviewer was less positive in saying that some collaborations are in place, but rather limited at present.

Question 5: Has the project effectively planned its future work in a logical?

Assessments here included that there were good future plans that build on past progress and represent logical steps to move forward. A reviewer said the team was on course to complete major tasks by end of 2009. Plans for 2010 are promising, but some seem contingent on DOE and U.S. support for hydrogen (stations, infrastructure). A reviewer stated that replication to other campuses is a good goal for future work: passing this curriculum to other universities will be a big milestone, according to a similar comment. The final comment was that the team expected to continue with planned efforts.

What are the project's strengths?

Strengths related to experience were noted by several: one said this project builds on a long history of hydrogen education at the college level, while two other reviewers offered the opinion that the school has a long history of work in this area. Internships with fuel cell companies were strengths of the work, as was the ability for on-site hydrogen fueling station to provide actual operating data to students. A reviewer spoke of the project taking advantage of California's commitment to hydrogen and fuel cell development (but this was also judged a weakness - see below). Other strengths were in developing curriculum for all levels of university students (lower division, upper division and senior level); using the California hydrogen fueling stations as part of the curriculum experience; replacing existing curricula with curricula that covers fuel cells; building educational kits to be consistent with the curriculum; and building test stations to be consistent with the curriculum.

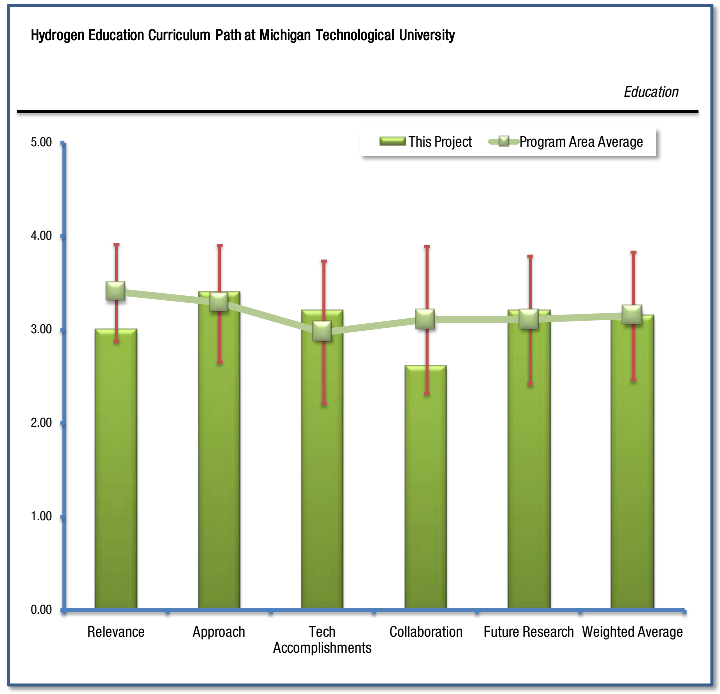
What are the project's weaknesses?

One reviewer said that no project weaknesses were identified. Others disagreed, speaking of the limited range of the program (California) and how to spread the work to other regions/areas to help boost hydrogen education in places without as many stations or support. To a third reviewer, it appears that thus far they have not put in as much effort as would have been expected.

Do you have any recommendations for additions or deletions to the project scope?

Recommendations for the work included educating other regions, universities and groups in other states or university clusters as to how to do similar programs in their area. Expanding potential collaborations to include other engineering disciplines was also suggested, as was adding graduate courses for Masters and Ph.D. work. The final comment was that the team should continue as planned if there are indications that needed efforts will be exerted.

Hydrogen Education Curriculum Path at Michigan Technological University: Jason Keith, Michigan Technological University



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Comments included that the project supports goals and objectives of the subprogram by developing courses and labs in hydrogen and fuel cell technologies. Another comment was that there was good relevance based on DOE education objectives. A reviewer said the effort is designed to develop course materials and student projects, and to disseminate the materials to other institutions. The final comment was that the project is still in its infant stages but the plan seems to coincide with Hydrogen Program goals and objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer was positive in offering the opinion that there was a comprehensive approach to the barriers addressed. This reviewer liked the incorporation of addressing the texts commonly used and hoped this work can be incorporated into future editions of those texts. A reviewer saw a good approach and plan to disseminate the curriculum nationwide. The ease of integration of these modules and courses by other institutions is nicely done. The design of the products to allow easy integration of modules into existing courses/curricula is very good. A reviewer was specifically speaking of work to incorporate fuel cells and hydrogen into existing courses and new course material and noting a hydrogen minor proposal was approved. Other comments (less positive) were that the approach is typical and seems to address the proposed approach, and that the approach was very good but could be a little better with more involvement outside academia.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Some disagreement was seen on the progress of this work. Progress appears to be rather slow in one stated opinion, with project really just getting started. The other reviewers were more positive, stating that the team had made very good progress and that materials have been developed and are being tested. Similar comments included that the team has accomplished much in a relatively short time and had excellent accomplishments with all phases apparently meeting or ahead of schedule. The final statement was that the proposed courses were approved, adding hydrogen to existing fuel cell courses, and the team had been working to find the places in a packed curriculum to add fuel cell/hydrogen problems and tasks.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer stated that the team is collaborating well with other universities across the country, presenting results and work at pertinent conferences and reaching out to industry and government to get feedback. Another stated that collaboration with universities was excellent, but collaboration with industry needs improvement to make sure that the information presented will actually help prepare students for a career in the hydrogen and fuel cell field by addressing the technology in a practical way--not just scientific. A reviewer highlighted the good cross-discipline participation and the expansion of collaborations to include industry. To another reviewer, collaborations appear to be primarily internal to Michigan Tech; although reference was made to sharing project result with several other universities. Similarly, a reviewer offered that collaborations were excellent with other departments at MTU and other institutions. Some industrial involvement could make it better.

Question 5: Has the project effectively planned its future work in a logical?

Future plans were judged to be good. Future plans for completing the project appear to be adequate. The team is effectively building on progress and will be advancing fuel cell and hydrogen courses that were accepted and developed. Another reviewer said that there was an aggressive plan to disseminate information. Establishing contacts with publishers of standard textbooks is a good step in the effort to institutionalize this material. The final comment was that the proposed continuation work is appropriate per original plans.

What are the project's strengths?

Strengths listed for this project included its national scope/focus - putting their module/plan into other states/schools, and the flexibility and accessibility of the materials as a key feature of this work. Further, the project appears well-managed by an enthusiastic and capable P.I, and the project is moving ahead very efficiently in the short time since the project was started--impressive.

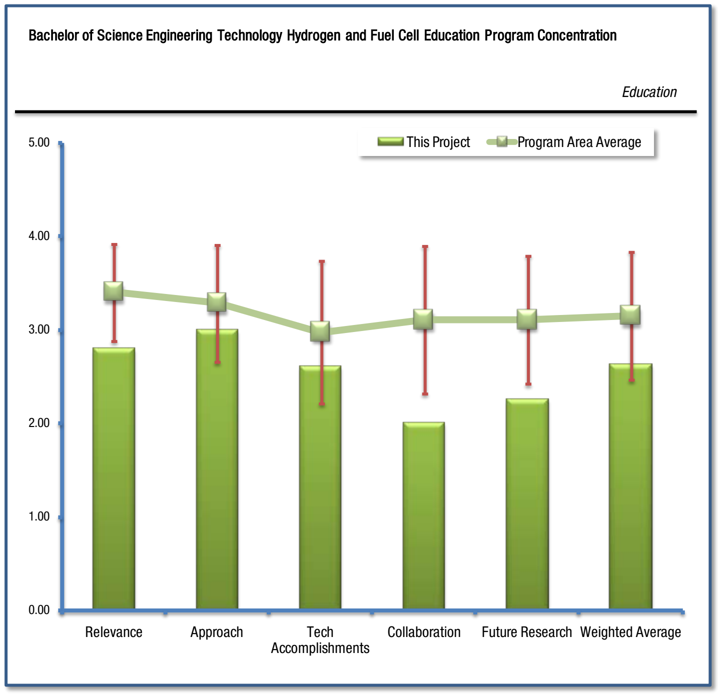
What are the project's weaknesses?

Several weaknesses were offered. Collaboration with industry needs improvement to make sure that the information presented will actually help prepare students for a career in the hydrogen and fuel cell field by addressing the technology in a practical way--not just scientific. This reviewer would suggest industrial review of course content to ensure credibility. Another suggested contacting industry associations like USFCC or NHA to find industry reviewers of project deliverables. The final comment was that slow progress needs to be accelerated in order to complete the project in a timely fashion.

Do you have any recommendations for additions or deletions to the project scope?

Two comments were made here: one suggested the project continue as planned, and the other suggested reviewing the weaknesses for scope additions.

Bachelor of Science Engineering Technology Hydrogen and Fuel Cell Education Program Concentration: A.K. Sleiti, University of Central Florida



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer stated that the project has a specific task that supports overall objective for DOE. Other positive comments were that the program appears relevant and is addressing education objectives for hands-on workforce. This project is relevant to the goals and objectives of the Education Subprogram. However it is rather limited in its educational depth since it is focused on developing a bachelor-level degree program and does not address the broader intent of the Education Subprogram. The barriers that this project will address were not adequately discussed (apparently the speaker thought this meant actual barriers to successfully completing the project). A final reviewer offered that the presentation slides say that no technical barriers were addressed, but this reviewer thought that's probably not true.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The approach was judged as appearing valid, seeming to be reasonable, and being based on the extensive fuel cell and hydrogen experience at CFU/FSEC. The program seems to be on track, stated another comment. A review comment noted that the team is developing course work for training of technologists. Recruiting students from community colleges is an effective approach. Offering the courses online is a good addition. The last comment was that it seems the project has been planned out well, but the presentation was very hard to follow because it moved so slowly through the slides.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Some difficulty in judging progress was stated by the reviewers. A reviewer said that it was hard to tell if the pace of this project is slow or on schedule. There is no way to know based on the presentation, according to another reviewer who noted that the speaker never got this far. Progress appears to be adequate, but it was noted that most milestones identified were timed at, or near, the end of the project. This makes it difficult to track progress in the earlier stages of the project. A reviewer did comment that the program is on track for completion. A final statement was that the team has developed some of the proposed courses, and approval for a number of the courses is pending. This process is time-consuming for most institutions.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

On the one hand, a reviewer noted that the team is collaborating with Florida Solar Energy Center - an expert institution in this field. Outreach to community colleges is key for education but also to recruit transfer students. Similarly a reviewer highlighted the team's work with hydrogen experts in Florida.

On the other hand, collaboration appears to be limited to internal participants, according to one reviewer. It was stated that industrial support was expected but details were not given in the presentation. Another said that collaborations were never mentioned by the speaker as he did not get this far. The final review comment was that no evidence of collaboration with others outside of the university was seen.

Question 5: Has the project effectively planned its future work in a logical?

A reviewer commented that future plans were not discussed during the presentation since the speaker exceeded the time allowed: this time limitation was also noted by another reviewer. A reviewer said further that the presenter was ineffective in being able to clearly explain this project. In addition, because so much time was taken on the first slides, the other slides were not covered. Looking at the slides now, it looks like much has been done, but since the presenter conveyed the opposite (work, but not a lot of clearly defined progress), it's very difficult to give many comments on this one.

Other comments were that the project ends in 2009. It needs to be sustainable on its own, which it seems that it will be. The university has experience with on-line courses so that is an option in future for non-lab classes, possible module for lab courses. The final comment was that completion of development and approval process is critical for the success of the curriculum.

What are the project's strengths?

Collaborations were noted as strengths, with two reviewers noting the Florida Solar Energy Center connection and one also noting the UCF College of Engineering, both excellent organizations to these reviewers. Extensive hydrogen and fuel cell experience was also a strength. Good outreach activities were also a strength, with outreach beyond scope of this program to get teachers/students interested in UCF and fuel cell/hydrogen work as a further strength. The final comment was that the program needs to sustain itself after funding/set up is done and the program seems on track to do so.

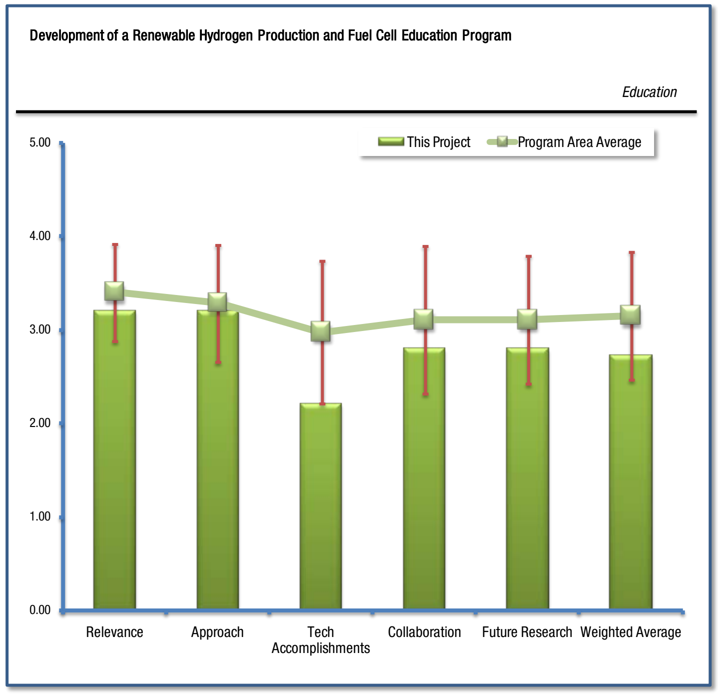
What are the project's weaknesses?

The program would probably have been better served to be associated with an engineering program instead of engineering technology.

Do you have any recommendations for additions or deletions to the project scope?

The only comment here was "appears marginal."

Development of a Renewable Hydrogen Production and Fuel Cell Education Program: Michael Mann, University of North Dakota



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Relevance was judged positively for this project. A reviewer stated that this project is relevant to DOE goals and objectives. Another observed that this project appears to be relevant to the goals and objectives of the Education Subprogram. A reviewer was more specific in saying that the course content and applicability to advancing hydrogen and fuel cell education seems relevant. The final reviewer commented that the program is well-designed to be relevant. Only the small size of the school and the small number of students that will be reached limits the relevance.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer felt the proposed approach is sound and includes several educational components - course development, off-site participation, internships, seminar series, etc. Another reviewer liked the incorporation of case studies and seminar series which presents exposure opportunities to a wider audience. A reviewer said there seems to be a well-balanced approach targeting students at all levels - giving general exposure to everyone, then more focused to interested/advanced students as they progress through program. The internship program is a great opportunity for students to work in a real world setting and gain valuable experience for themselves but also university. A reviewer noted that the combination of different level courses, lab experiments, teaching experiences, internships, midddle school "modules", and seminar series is a very comprehensive approach. Finally, the three level approach to reach large numbers of students with basic information and smaller numbers with more detailed information is admirable. Interactive teaching and case study use is also very good. This reviewer said it may be hard to update case studies as they age. Seminary series is good to integrate industry representatives, but it's unclear whether that will happen in practice given the low involvement by industry to date.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Most reviewers noted that the project was just beginning, so progress was difficult to judge. A reviewer said the project seems to be just starting in terms of the development of the coursework. Similarly, a reviewer observed that the project is just beginning so not much progress to review (10% complete so far.) The project has 2 more years to go, and course development is progressing nicely. Another comment was that accomplishments have been very good although most parts of the plan are not yet complete. To another reviewer, progress has been extremely slow: it was reported that the project was only 10% complete. The team provided no convincing argument that the schedule would be accelerated. The final reviewer said it was too early to judge significant progress. Case studies should be complete and they are behind schedule. There were not enough details provided on the other tasks to fully assess project status and ability to hit scheduled milestones (several past due).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Collaborations were reviewed relatively positively. Several good collaborations were mentioned including review of developed course materials. A reviewer said the current work with partners appears sufficient, but appears there should be a wider audience for potential partners. A reviewer commented that there were not many partners but good ones. Another comment was that the project included partnerships with industry and NREL, but no other educational institution involvement is apparent. A reviewer offered that there was good collaboration between partners, but outside industry collaboration could be improved, especially regarding the case studies. This reviewer recognized that the case studies are largely focused on basic engineering topics, but some real applications would probably be very useful to show how the science translates to technology in use today.

Question 5: Has the project effectively planned its future work in a logical?

A reviewer commented that future plans are adequate if the schedule can be accelerated in a timely fashion. Another said that much of the work is in the future- once completed, it will be very valuable. A reviewer stated that the future work is appropriate based on original plan. Finally, plans to complete work in FY 2009 and 2010 appear to be there, but not enough work breakdown structure to fully assess status and adequacy in planning.

What are the project's strengths?

The introduction within the ChE and EE programs provide the widest possible exposure within those programs, noted the first reviewer. The program targets all levels of students, and provides real world experience via internships. There is good outreach to students both in and out of program via seminars and workshops - helps educate non-engineers about importance of technologies. The team is developing materials to middle schools. A reviewer stated the program was well-planned and there was good UND institutional involvement and support. The final comment was that the program addresses the need to prepare researchers for future careers in a systematic way.

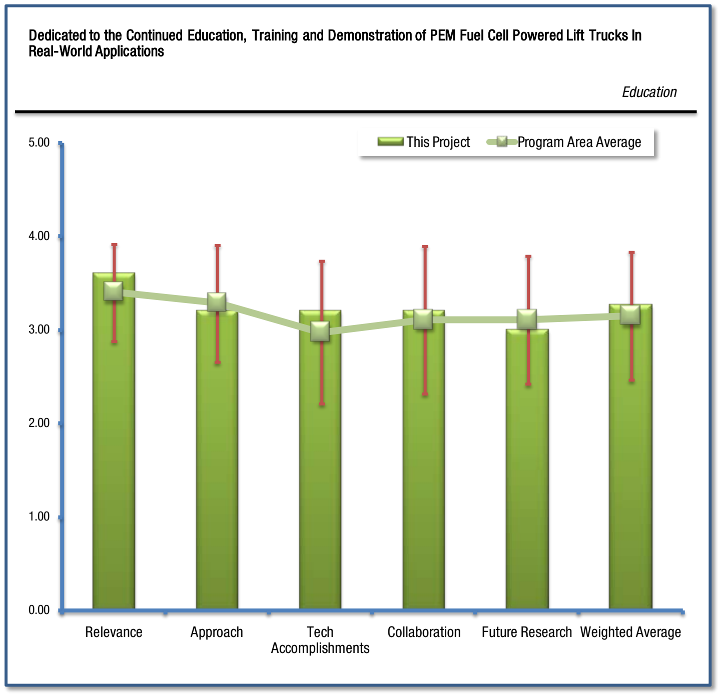
What are the project's weaknesses?

A weakness identified by a reviewer was that this is a very small program which probably will not reach many people. Similarly, a reviewer said that the current size of the ChE and EE programs at UND provide somewhat limited audience. The team might consider expansion to include the ME program as well. It has made a slow start due to outside forces. Evaluation of the results of this project includes more than just the numbers of students participating but rather include evaluation of the "quality" of the material presented. This project could use more tie-ins with industry and today's applications. This field is changing so fast, without some connection to the technologies that are making it into the marketplace, I don't think this project can realize its full potential.

Do you have any recommendations for additions or deletions to the project scope?

A reviewer recommended that the team might consider expansion to include ME program as well with the course material (especially the fuel cell applications/case studies). The other comment received was that the project should continue as planned.

Dedicated to the Continued Education, Training and Demonstration of PEM Fuel Cell Powered Lift Trucks In Real-World Applications: Tom Dever, Carolina Tractor & Equipment Co. Inc.



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer stated that the project offers real time efforts at expanding the fuel cell and hydrogen markets. This technology has commercial viability in some scenarios today and this will help form the basis of developing the message and the business case surrounding broader introduction. Given recent reductions, this is an effort which must be leveraged to continue supply chain viability. The opinion of a second reviewer was that education to potential end users and customers is vital to industry, and deployment of actual units is crucial as well. A reviewer offered that the work appears to support the overall program goal of gaining experience with fuel cells in real-world deployment projects to show relevance of fuel cells to other potential near-term audiences. Work directly supports the barrier of lack of technical information (through data collection and analysis) and the barrier of mixed messages (dissemination of real-world information). The final reviewer stated that this demonstration project includes training and addresses lift trucks, one of the early markets

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer commented that this is a viable approach which seeks to 'introduce' the technology to potential users. The approach is limited due to duration at each site, the use of one fuel cell manufacturer and one type of lift truck. Another comment was that deployment of units for demonstration is key for commercialization of fuel cells. This reviewer also highlighted the team's work in reaching out to community colleges and other lift truck operators. A reviewer said that the approach combines education of lift truck users with strategic deployments of fuel cell lift trucks. This work builds on previous successful experience LiftOne has had with lift truck demonstrations. This addresses a key early market for fuel cells, as outlined in previous analysis documents. The final comment was that the seminars conducted at LiftOne branches are intended to educate a broad group of stakeholders. This reviewer noted the month-long deployments at UTi, Michelin Tire, Stanley Tool, Bausch and Lomb, Lowe's and Electrolux does introduce technology and infrastructure (AirProducts Siting mobile fueler at deployment facility; working with site personnel and local officials).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer stated that the accomplishments to date seem on track, but it was rather early to gauge the impact of the demonstrations and how they will increase awareness and opportunities. A second reviewer said that the program was just starting but has already accomplished a lot. A demonstration at the NHA conference is a great way to promote technology. The team is working out kinks and potential problems that future customers will deal with – this will help avoid these problems when real sales start happening. A reviewer stated that considering the project has only been running for 6 months, progress is reasonable. They have identified some large companies for demonstrations and education that will hopefully have favorable experiences with fuel cells that can be passed on to others. Hydrogen seminar (as described) appears to cover the appropriate bases. It would have been helpful to see samples of the 180 slides to get a feel for the content and presentation to better judge the potential success of the seminars. A reviewer observed that data analysis of equipment performance is being conducted to determine business case (number of lift trucks needed, amount of fuel used, hours of operation, etc.); this is necessary with every demonstration program. It is likely that this project will increase future sales. The final reviewer said that there was no information on data analysis provided.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer stated that his project team partners with numerous industry entities. This approach will encourage early market transformation. Another emphasized that the team is working with real customers and potential end users about fuel cell forklifts and hydrogen. A reviewer stated the team is working with commercial entities and Hydrogenics and Air Products, but an opportunity exists to broaden the application and the collaboration network (DLA, Army, USPS, etc). The project team is only working with two community colleges relative to collaborating with educational institutions. The final commenter stated that collaborations are good with the fuel cell manufacturer. If the companies to receive fuel cells in the deployment efforts can be defined as "collaborators" the project team has done a very good job of identifying large successful companies whose positive experiences will be very beneficial (e.g., Michelin, Stanley Tool, Bausch & Lomb, Lowes).

Question 5: Has the project effectively planned its future work in a logical?

Comments were mixed on the future work. One reviewer said that the future work plan to continue the deployment and education efforts is sensible and should be successful, but the description of how the program would be publicized beyond the fleet operators taking part in the education seminars (a key part of an educational effort) should be more clearly defined. For the activity laid out through December 2009, the future work appears on track to delivery on meeting objectives, in another’s view. The question would be what follows those demonstrations. The measure of the program success should be some indicator of the elements and conditions that should exist for conversion of lift fleets to H2/FC. A reviewer suggested several items, including broadening the scope with drivers and local colleges and conducting more deployments. The team will need to share demonstration experience with others: make information public to encourage other companies to participate in demos or testing of fuel cell-forklifts. A reviewer’s opinion on the future work was dependent on where the team is at the end of 2009. If they've done all the deployments, there is no point in finding hard-to-get funds. Could data analysis be done by a lab later? Would DOE own the data? The final reviewer indicated that next steps like outreach to decision makers to purchase FC lift trucks were not discussed. Is there a metric to determine the impact on market transformation (number of FC lift trucks sold)? Is the metric only number of individuals trained? What happens to the equipment after the project ends?

What are the project’s strengths?

The strengths are the applicability to near market opportunities, and the great list of companies who will participate in the demonstration: major corporations with highly recognizable names. Comprehensive seminars were done to provide technical information to attendees: demonstration of the lift truck as part of the seminar is an important addition. A reviewer felt that having real users at real sites helps tremendously with education to public.

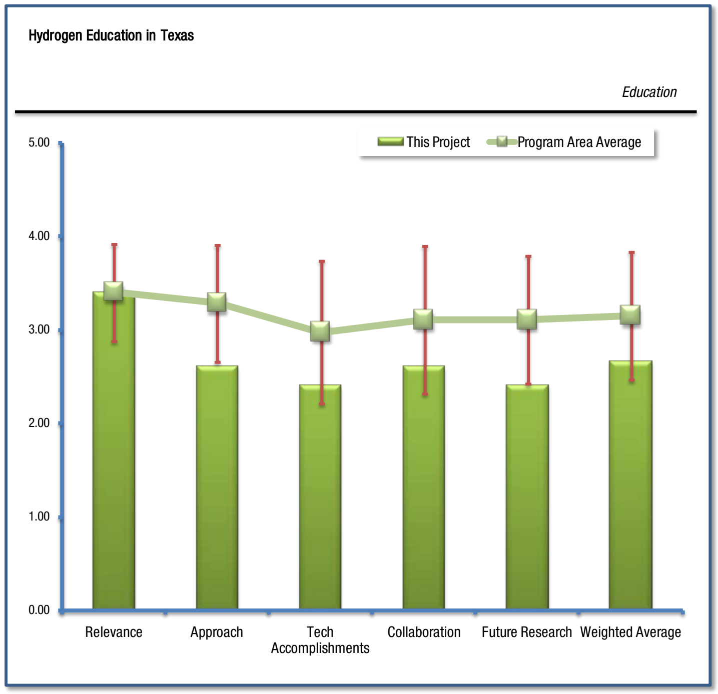
What are the project’s weaknesses?

Several weaknesses were identified. One was that a reviewer was not sure what happens from January 2010 to August 2011 (it was hard to see the schedule layout. A reviewer stated that the future work to publicize the results of the program is not made clear. Another stated that the current limitations of one fuel cell provider and one make of lift has its limitations. The program does not fully demonstrate the 'drop in' battery replacement nature that may be necessary to accelerate fielding. It does not appear to aggregate the results of the several sites to come up with the generic 'conditions' that should exist for cost effective consideration of lift fleet conversion. The team might consider broadening the collaborators on the project. The final reviewer suggested that as deployments end in 6-9 months, it would be extremely useful to continue in concert with education portion of project.

Do you have any recommendations for additions or deletions to the project scope?

The only recommendation was to require a 'final business case' that aggregates the results, or require collaboration with other entities which may be trying to define a business case (DOE, DOD, USPS, etc.)

Hydrogen Education in Texas: David Hitchcock, Houston Advanced Research Center



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer said that the project does support the barriers of information dissemination and addresses regional differences in hydrogen education within Texas. State leaders are an important audience for education to ensure these stakeholders are engaged in any future initiatives. Similarly, a comment was received that education of state and local leaders is relevant, especially in a state with major hydrogen producers. The attribute of accomplishing regional outreach is laudable in another reviewer's opinion, but risks development of different content and approaches to delivery of information in different states/regions. The final statement from reviewers was that the goal/intent of the project to create a statewide plan is excellent and would support the Hydrogen Program goals and objectives.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

On the positive side, a reviewer said the team had very clear understanding and outlining of the target audience. Target audience is very important to success of hydrogen initiatives, and can ensure that these projects will happen. Use of existing materials ensures consistency and cost-effectiveness. Cooperation with the Clean Cities Program (another DOE initiative) will supplement their success. Another said that the webinars and workshops are good, using material already developed by others is very good. With the amount of SPAM everyone gets in their email, doubtful that many will read one more unsolicited email. A reviewer offered that the method for outlining the needs and developing course content is adequate. A reviewer did note that the team learned that the initial approach wouldn't work, and they needed to shorten up the training times.

A reviewer did offer some dissenting opinions, stating that it is not clear what the PI is actually doing. The initial strategy to develop and deliver 5 hr sessions with 100 participants changed to including information in conjunction with meetings held by other entities. Existing educational materials are being used. Partners are relied upon to identify participants. New partners include Clean Cities Coalitions, a good asset and approach. Other audiences should also be recruited. The project intends to start workshops by asking the audience what their current level of knowledge is. It would be helpful to understand the audience and their needs prior to developing the materials. Government staff is the target. This audience is already the most informed according to the Hydrogen Survey project. It is not clear what this project will accomplish. One of the barriers this project is designed to address is, "Lack of readily available, objective and technically accurate information", yet existing educational materials already developed by DOE are being used. It is not clear how this project addresses the barrier.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

The relatively short time since the project started was the subject of several comments. A reviewer said that the progress seems to be commensurate with time since the beginning of the project, while another felt it was too soon to tell about progress. A reviewer stated that the project was relatively early in the life cycle, and hard due dates and measures of success still need some development. Considering the project is only a quarter of the way through its time period, the accomplishments are appropriate, noted another reviewer. Contact with Clean Cities Coordinators is good, and will provide a receptive audience to their message. Adjustment of the project plans based on DOE education workshop will help ensure success. The final reviewer observed that they've only had one conference booth, meetings with Clean Cities and the State Legislature. To this reviewer, that is not much outreach and communication since last August.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Several positive collaboration comments were received. One comment was that collaboration with the state energy office is important: communication should be maintained. Clean Cities provides vital regional contacts. The participation of the Texas H2 Coalition is also good. Another stated that the right groups seem to be involved, i.e., Texas H2 Coalition, State Energy Conservation Office and Clean Cities. It would be even better if some of the hydrogen related industries were collaborating. Third, it is good to collaborate with Clean Cities, Texas H2 Coalition, and the State legislature, but the collaboration doesn't seem very regular to this reviewer. It appeared to a reviewer that there ought to be great opportunity to collaborate with some of the other state and regional awardees under the DOE program. The final comment was that HARC is partnering with SECO and the Clean Cities coalitions. Clean Cities coalitions were not initially involved, but as the project progress coalitions were found to be invaluable in assisting with workshops. Entities outside of Texas are not involved.

Question 5: Has the project effectively planned its future work in a logical?

Future planning is good, given the current scope. This reviewer said that more indicators of due dates and measures of success would be useful. Another comment was that the proposed future work plan is appropriate. The workshops will cover the major Texas metropolitan areas. A reviewer suggested that an assessment method needs to be created and in place before starting, and a method to take a successful statewide program and replicate that success in other states should be addressed. The final comment was that the team has only received 25% of funding so far. As this is not an expensive project it will be best to see it through if 2009 funds can handle it. On the other hand, Texas is not an early market and does not have a lot of alternative energy initiatives outside of wind.

What are the project’s strengths?

Strengths listed included the well-organized presentation that makes reviewing much easier, the good connection with Clean Cities to build regional connections, the good coverage of state population centers, and the important activities to reach the state decision makers. Another offered that a strength is the use of materials developed by others rather than "reinventing the wheel." One reviewer did say that no strengths were particularly noted.

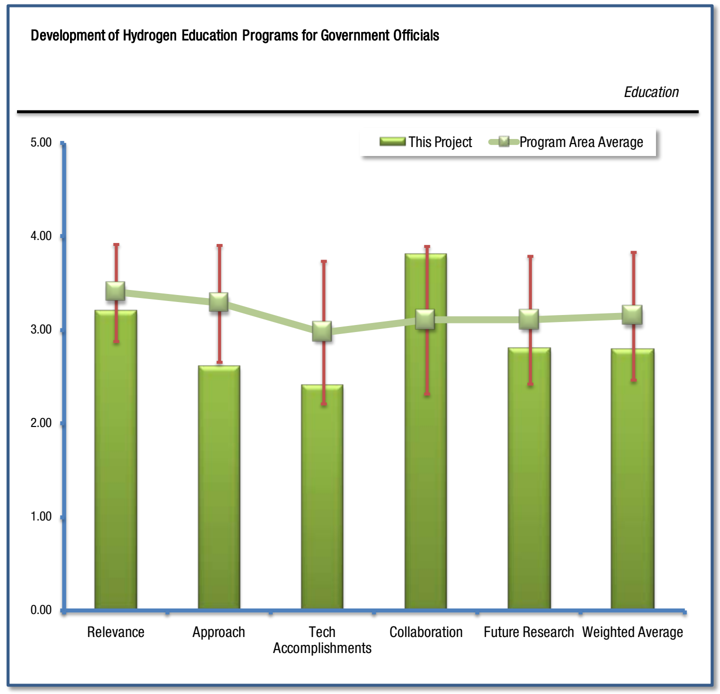
What are the project’s weaknesses?

One weakness was a lack of definitive measures of success. Another was the targeting of the Texas legislature--if they only meet every two years, it doesn't seem like there would be much impact to be gained. This reviewer also highlighted success measures: there should be some kind of metric to judge the project's success. Is putting on x number of workshops a measure of success if only three people attend? The final reviewer said that no weaknesses were identified at present: will have to wait for the website and the completed meeting educational materials to determine if any weaknesses are present here.

Do you have any recommendations for additions or deletions to the project scope?

A recommendation offered was to develop measures of success (personnel contacted, projects begun, etc.) for use in gauging value from the project. Another suggestion was that DOE should look at bringing the state and regional coalitions together (if not already done) to develop a solid and consistent content which then has the regional specifics overlaid. The way it is structured now, it would appear that we might have several different packages in use around the country. A comment was received that the general public has a huge desire to know more about hydrogen. Maybe a few public service announcements promoting the webinars and workshops so that the general public could participate would be a bonus.

Development of Hydrogen Education Programs for Government Officials: Shannon Baxter-Clemmons, The South Carolina Hydrogen and Fuel Cell Alliance



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Relevance opinions were generally positive. A reviewer observed that South Carolina is a leading state for getting onboard the H2 economy. Another commented that education and outreach will need to be a focused effort in the years to come, and we must build support at the state/local level. A reviewer stated that this project addresses the need for accurate information to state and local governments, and meets DOE objectives to build hydrogen economy in the state. This project is relevant because it proposes Hydrogen 101 for state and local governments. The final reviewer noted that this effort takes the approach to provide information on hydrogen and fuel cells to trusted community members and government officials. For those that show interest, this effort will provide more information and encourage these potential advocates to learn more. Eventually a set of advocates, early adopters and opinion leaders will be developed.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The first comment was that the approach was not very specific. Another commented that the approach for developing content is valid and straightforward, but not much detail was provided to currently gauge the progress. The approach shows good understanding of the concerns of the target audience: educational materials should be designed to meet these concerns. Special mention was made of learning the audience's terms of art, ensuring that the message will be clearly understood and giving the audience assurance that the educators have taken time to educate themselves before presenting information to the audience. Evaluation component is important to gauge success: provides feedback to improve the materials and processes. A reviewer offered that broad-based information sharing is expected to result in a set of interested community leaders and government officials. By continuing to give them supportive information, it is expected that they could become advocates, opinion leaders and early adopters.

This project includes some good approaches, but overall it is unclear exactly what the project focus is. Presentations will continue and the team will "work with partners" but specifics were not provided. Presentations at NHA and other hydrogen meetings will reach audiences already interested in the technologies. Other meetings/approaches/strategies need to be identified. Using the battery/fuel cell comparison experiment during the training is on target. This is an image that will stay with participants long after the training has ended. It is also an experience that will be shared with co-workers, friends, family and children. This expands the reach of the training beyond the targeted audience and plants a seed that may motivate the expanded audience to further investigate these technologies. "Learning the lingo" of the various target groups, for example, planners and economic development organizations, is an excellent approach to ensure that the information is understood by that group.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Both positive and negative comments were received here. One noted that the team has presented (or plans to present) at several venues, including the Municipal Association of South Carolina. It would have been interesting to hear more about the evaluation procedures: this could be beneficial for several of the projects in this program area. Another reviewer said that although it is difficult to gauge success on this kind of project, the proof of success shows up late in the process and persists long after the project is complete. It may be too early to expect success, but success will come with blooming projects brought on by advocates and early adopters educated by the effort.

On the other hand, a reviewer said there was nothing in the slides except progress from others or the HFC program in general. Similarly, a reviewer said that the degree of technical accomplishments and progress is impossible to score. The PI misinterpreted the request for information. The PI addressed accomplishments in the development and deployment of the technologies; not project accomplishments. Finally, a commenter said that it was hard to gauge current accomplishments at this stage. Some engagement was seen during NHA, but the most important of engagements is yet to be accomplished.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Collaborations and partners were judged to be very good. One reviewer said that this was probably the most robust of the 'teams' in any of the projects this reviewer addressed. The team has government, academic and industry represented, which is a true strength. Once again, however, there might be some advantage from sharing lessons from the different states/regions performing this outreach and education. Excellent partnerships include working with the SC State Fire Marshal, SC SEO, Municipal Association of SC and SC Chapter of the American Planners Association, Primary Partners: Green Energy and SCHFCA members. Another said that the team includes the organizations most connected to local decision makers (the Municipal Association, planning associations) as well as the state energy office. The project team is co-located with the state energy office. Inclusion of an experienced team member (Greenway Energy) on hydrogen issues should provide benefits for accurate information dissemination. The next reviewer saw that there was good membership and good effort to identify community leaders and government officials. The final comment was that the team has many collaboration partners and they are influential in their own right.

Question 5: Has the project effectively planned its future work in a logical?

One commenter noted that the project plan is as solid as any of the regional plans. Another stated that work with the fire marshal's office is a unique aspect of this project: it will be interesting to see how that pans out. The concept of providing the economic case for fuel cells to help local decision makers get projects together should be beneficial. A reviewer spoke of continuing efforts with additional effort to define a project pathway.

To another reviewer it was hard to determine if they've been fully funded or not. But with a new station in SC and the Governor's PAC critiquing the state legislature on HFC investments, the education effort needs to continue. Also, if this is a 3 year proposal, this reviewer was not sure what happens in the outyears: just more of same? The final reviewer was concerned that the information provided was very general. This is a concern for a project in its first year. Specific approaches, plans, and schedules should be stated.

What are the project's strengths?

The team itself was a strength to one reviewer: the collaboration was evident in the project. Another offered strengths of the feedback loop to increase effectiveness of the educational materials, the focus on "talking the audience's language", and the inclusion of financial and business case calculations to push projects forward on a business basis. Another also noted the good membership, and also highlighted the good method of seeking new advocates and the fact that this is a focused effort that is not distracted by other technologies.

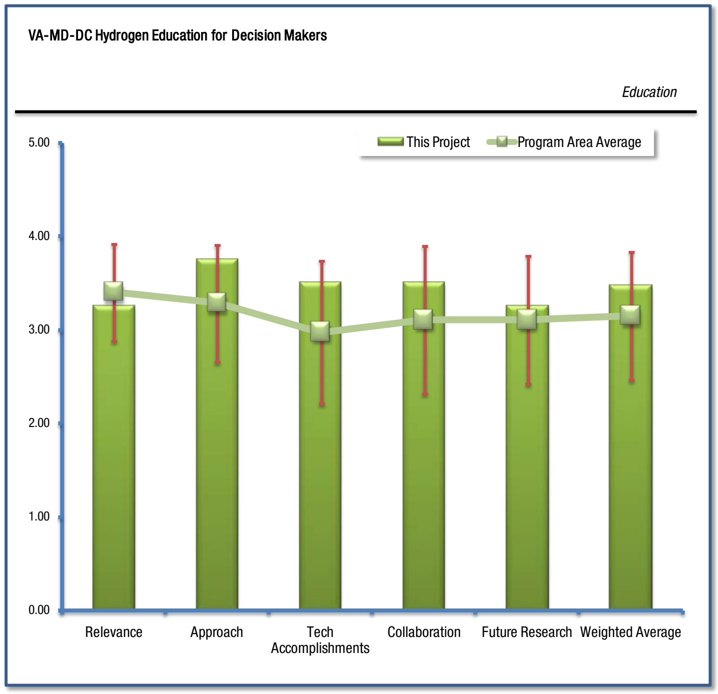
What are the project's weaknesses?

Weaknesses were that the program had a lack of measures of success, and that it was difficult to quantify early benefits.

Do you have any recommendations for additions or deletions to the project scope?

Several recommendations were offered, including the suggestion that the team develop measures of success (personnel contacted, projects begun, etc.) for use in gauging value from the project. Another suggestion was that DOE should look at bringing the state and regional coalitions together (if not already done) to develop a solid and consistent content which then has the regional specifics overlaid. The way it is structured now, it would appear that we might have several different packages in use around the country. Similarly, a reviewer said the team should ensure this project is coordinated with the Texas project approaching a similar target audience (state and local leaders).

VA-MD-DC Hydrogen Education for Decision Makers: Chelsea Jenkins, Commonwealth of Virginia



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer said that the project team's work directly addresses goals of the program to build knowledge of hydrogen technology to ensure continued deployment of the technology. Another said that this project directly and efficiently addresses the goals and objectives of the MYRD&D plan and barriers listed, and the project exceeds expectations. A third reviewer observed this is another regional program which is focused on the mid-Atlantic area that will help educate and inform which is very relevant to the DOE program. The final reviewer said it was good to have an education program focused on the National Capitol Region.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The approach was very well received. A reviewer said the team had a very good approach and detailed milestone schedule. Another stated that there was a solid planning approach and existence of a work breakdown structure for monitoring purposes. Several 'layers' of development is a little unique among the state/regional players that this commenter reviewed.

A reviewer said that the project will reach decision makers in a key area for early market deployment. Use of MotorWeek to produce video segments to educate the audience is a unique aspect that could benefit many of the educational efforts. The agreement by MotorWeek to broadcast portions of these segments on their weekly show will reach a wide audience as a side benefit of the work. Hardware demonstrations are a very good addition: it is unfortunate that demonstration hardware is hard to come by. Could DOE help in this regard?

The PI identified concrete, measurable deliverables including 12 workshops, magazine articles, a website, video resources, ride-n-drives, webinars, Twitter and other social networking technologies, and two 8-minute informational segments on MotorWeek. MotorWeek reaches a national audience. This is an outstanding, well thought out and thoroughly planned project with tangible deliverables. Impressive speakers have been secured for workshops. Measurable tasks are identified. The tools can be used after the period of performance ends. This is a model project that should be used to design other projects.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer said that the project is on schedule in spite of original partners who have not participated as stated. Another said that the accomplishments since September are very impressive (several seminars, production of year 1 Motorweek segments, two magazine articles, website). The team should keep working on its collaboration with DC, as this will be an important audience to reach. A reviewer observed that the web site is up, two articles have been written, four seminars conducted, and a video shoot completed. This reviewer noted that no demonstrations have been done as the team is apparently having problem getting demo's. Have they contacted Christy Cooper? The final reviewer said that some progress is being made...a little behind on schedule, but it is relatively early in the project.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Collaborations were also good: a reviewer said there was a good list of partners that combines some academic and government entities. Motorweek offers opportunity to hit a much larger audience. Similar comments were that the project is led by the Virginia Division of Energy: includes local universities and Clean Cities. Inclusion of Motorweek is a unique aspect. Another said that the partnerships include a remarkable and broad array of collaborators that is telling of the PI's ability to bring groups with a shared goal together. Universities, public television, fleet and public stakeholders, respected educational entities, and Clean Cities Coalitions from two states and DC are included. The last comment was that the team is following up on surveys, but is having trouble with partners in DC and Maryland.

Question 5: Has the project effectively planned its future work in a logical?

A reviewer observed that the team has done a lot with only $21K of DOE funds so far (out of $282K). That progress warrants more 2009 funding. Also, a lot of things are in progress (video shoot) and additional funding will allow them to follow through on that. Another comment was that there was aggressive content for future work with the number of seminars and the articles and segments to be developed. This reviewer liked the indication of follow-up surveys as one measure of success. Seems that future success is being linked to demonstration tools for use during seminars...may want to see how webinars can deliver that content. A reviewer further offered that the future work keeps up the good output of this team. The team appears to be doing more seminars than other teams had planned. Evaluation learnings will be critical to gauge success (some of this has already been done). The final commenter said that this project has been planned at the utmost professional level. Specific, tangible deliverables are scheduled and will no doubt be completed on or ahead of schedule.

What are the project's strengths?

Motorweek was one of the project strengths: one reviewer noted the use of Motorweek for video segments could have broad appeal and utilization, while another commented on the Motorweek exposure and TV-quality video materials. Other strengths include the ambitious schedule of seminars that should cover the bases well, and the activities conducted to prove the increases in knowledge.

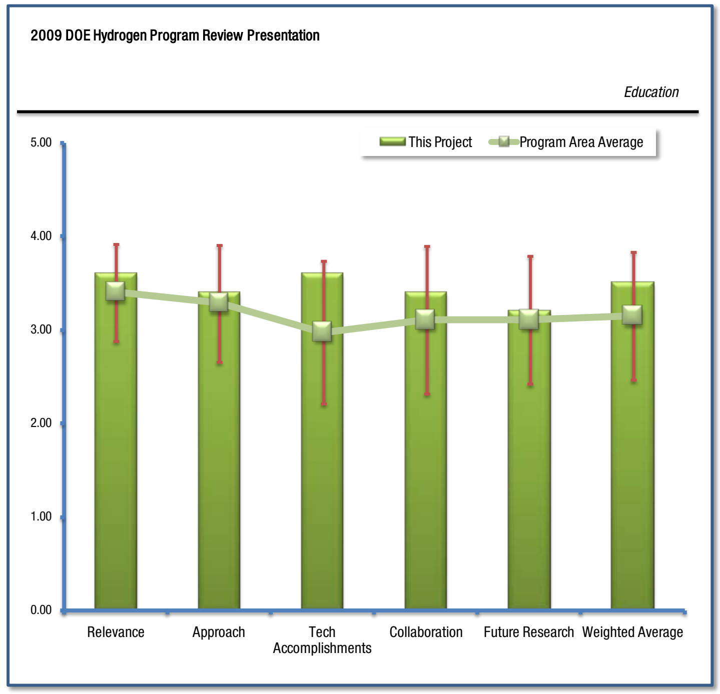
What are the project's weaknesses?

One weakness identified was a lack of measures of success to know when we have achieved what we need to. Another weakness was the need to involve the decision makers in DC: the team should keep working on that.

Do you have any recommendations for additions or deletions to the project scope?

A recommendation from a reviewer was to develop measures of success (personnel contacted, projects begun, etc.) for use in gauging value from the project. Another recommendation was that DOE should look at bringing the state and regional coalitions together (if not already done) to develop a solid and consistent content which then has the regional specifics overlaid. The way it is structured now, it would appear that we might have several different packages in use around the country. The final statement was that this project should be coordinated with the others tackling the local decision maker audience: perhaps the sharing of information can improve results for all?

2009 DOE Hydrogen Program Review Presentation: Joel Rinebold, Connecticut Center for Advanced Technology, Inc.



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer said that this project is very relevant to approaching hydrogen projects in any state and offers a methodic approach. Another positive comment was that this project is realistic and well managed. They have asked all the right questions and taken the time to listen for the right answer. A reviewer stated that this project meets DOE objectives of educating local government decision makers, and supports early market deployment for fuel cells. It has a comprehensive outreach strategy at all levels of government. This is an outstanding project that fully supports the goals and objectives of the MY RD&D Plan. The project includes integrating state and local energy plans with federal objectives. This project could be used as a model for other states. A reviewer did comment that education of key stakeholders is important but wondered how the partnerships are being strengthened.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Positive comments were that the approach includes a major component to map the state to locate telecommunications infrastructure, state and local government facilities, and other locations that could be ideal for early market deployment of fuel cells. The team has also developed criteria for assessing potential stationary power and transportation fuel cell applications. Approach is very practical and analysis-driven. Another comment was that this excellent approach includes partnering with stakeholders, developing resources, tools and models for the specific audience, educating local and state officials, identifying funding opportunities for projects, and posting project results on the PI's website. A reviewer highlighted the grassroots deployment of hydrogen fuel cell technology with a good implementation strategy. The project is limited to Connecticut but this model could be used for other states. Component 2 is a good example for other states to approach the same deployment model. A reviewer noted the focus on both stationary and transportation opportunities. The final reviewer did say the program seems to lack concrete goals. The team has identified potential sites for stationary power and transportation applications, but how is this educating someone?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer noted that stakeholders have been identified, the website has been launched, and criteria for sites have been developed. A commenter said that stakeholders have been identified, analysis tools for potential deployment sites have been developed (good use of mapping tools), and education levels have been identified among the stakeholders. These are significant accomplishments given the time frame since the project start. Connection with local energy plans and Federal objectives is important.

A reviewer said that the team has developed an excellent data base of existing resources for all potential sites. They have keep a good perspective on the realism of their project. This reviewer liked the way the PI has digitized the outcomes and kept them relevant to project developers and educators. There was a good analysis of survey results. All five components are well thought out and comprehensive. Good website results with 20,000 hits per year.

A reviewer observed that the deployment based modeling is at a high level of sophistication in terms of identifying potential customers and needs for electricity and thermal power. A model of job creation potential has been presented to DOE HFCIT program management and federal agency management. Financial models and emissions benefits models have been reviewed by NREL for potential incorporation into NREL models.

A reviewer stated that defining some performance indicators would make it easier to judge progress.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer observed that this project brings together local, state, regional, federal, and utility partners that are key to the success of this project. Working sessions are planned with partners identify opportunities. Another noted that the utilities provide a good sense of realism. The project team has knocked on every door in the state. This is a very comprehensive approach. The notion of holding workshops for State and local interaction is a great idea. A reviewer further added that the partners appear to be appropriate for the target audience to be reached. Utility partners will be a good addition. A reviewer noted that the team makes full use of strong industry presence within state and is conducting strong outreach to municipalities in terms of development clean energy plans through workshops. A reviewer suggested that if local partners are Mayors, First Selectmen and Public Works Officials and these are key project participants, the PI should specify "mayors from the x largest cities have met with PI and..." Otherwise, the collaboration statement is too vague.

Question 5: Has the project effectively planned its future work in a logical?

A reviewer said that not a lot of information about the future work plans, but they appear to be appropriate. Another observed that a general schedule for future activity was presented, but specific information and tasks would be useful. A reviewer asked how the decision makers and key stakeholders are going to be educated.

What are the project's strengths?

Strengths listed for this project included the good management: the team used surveys and good investigation techniques. Another set of strengths included the extensive analysis-driven planning for identifying appropriate sites for fuel cell demonstrations and the practical educational focus areas (return on investment, energy and environmental value provided for dollars expended). A reviewer believes that this model could be used by other states.

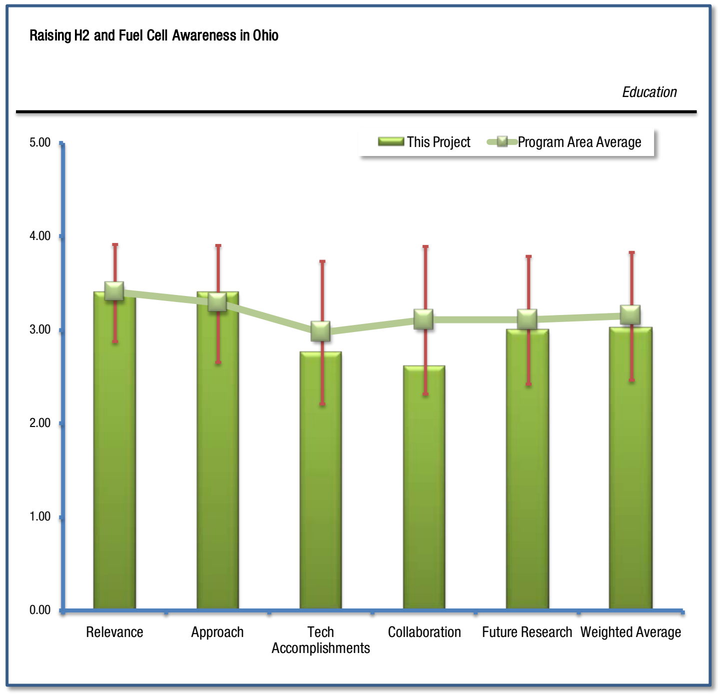
What are the project's weaknesses?

The only weakness identified was that goals, definitions, etc. were not clearly spelled out.

Do you have any recommendations for additions or deletions to the project scope?

A reviewer recommended that the PI coordinate with other projects that are addressing similar decision maker audiences. The other suggestion was that the CT program be a model for other state outreach programs.

Raising H2 and Fuel Cell Awareness in Ohio: Pat Valente, Ohio Fuel Cell Coalition



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

The first reviewer believed this project does address DOE objectives of reaching local decision makers. A reviewer offered that Ohio investment in fuel cell industry should provide a good story in terms of jobs impact, which should be a key message in a depressed state. A reviewer said this work addresses important issues. The final reviewer said that the proposed project intends to increase the awareness of hydrogen and fuel cell technologies if state and local officials. Specific metrics are stated.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer stated that the project had well-defined objectives with measurable goals. Another felt that addressing the employment issue (retaining or increasing employment) will be important for the Ohio audience. Target audience drivers have been clearly identified. Measurement of improvements in education levels will be critical. A reviewer said that the approach is correct, but this reviewer would like to think that the awareness goal is conservative. While the public awareness level of hydrogen and fuel cells is low at this time, the success of early market products, like forklifts, should provide opportunities for increasing public awareness levels above the goals shown by this project. A reviewer noted that the team plans to hold forums around the state in different regions, and provide fuel cell 101 training and education for state and local officials. This reviewer believed the team is putting “a lot of eggs in the annual Ohio Fuel Cell Symposium basket.”

A final reviewer stated that the approach is unusual; rather than provide information and training on the hydrogen and fuel cell technologies, the training will provide "information about fuel cell companies, research entities and community colleges concerning fuel cell activities and give examples of early market deployment and manufacturing operations." This novel approach for the nine forums could reach more of the intended audience than more traditional approaches. The team has full understanding of the barriers to be addressed. The bi-annual newsletter is good way to continue raising awareness.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

The fact that the project had just begun was noted by several reviewers. One stated that there were not many accomplishments, but the project has just started (March). It will be easier to judge this next year. Another noted this was a new project that had barely begun, while a third said progress was not yet applicable because the project started in March. A reviewer offered the opinion that it took too long to launch the effort, but, now launched, it should be able to make good progress. The final reviewer highlighted the nice package they will give out during the forum, and observed that the target audience includes elected officials.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer observed that the stakeholders include: Ohio Dept of Development, Edison Materials Technology Center (EMTEC), but wondered if they have approached other collaborators. They have good technical support-- why can't they get them as collaborators? A second reviewer said the partner list could be stronger: can some of the Ohio-located fuel cell related companies (Rolls-Royce, Battelle, others) be included? A reviewer said that the team has named specific partners and are reviewing and compiling educational materials with these partners. A reviewer commented that it is not clear which of the two partners are responsible for which tasks. Additional partners are not identified.

Question 5: Has the project effectively planned its future work in a logical?

Future work appears appropriate to one reviewer to achieve the objectives of the project. Another stated it was well planned with solid dates for conducting forums. It is a good plan for a newsletter to use as follow up. A reviewer said the plan seems robust now that launch has been achieved. However, this reviewer thought the awareness goal should be higher. A commenter noted the project will draw audience to annual Ohio Fuel Cell Symposium, matchmaking, and deployment of fuel cells. The final reviewer stated that a date and location for the first forum is provided. No information was provided regarding the locations, dates, estimated participants, etc.

What are the project's strengths?

The forums were a strength to one reviewer. Another reviewer felt the strength was in the focus on economic development and jobs growth in a depressed state. However, given Ohio has already invested $79 million on fuel cell economic development, this reviewer urged the project to better develop its jobs growth message. There should be a good story to tell, given the level of investment. Ohio and CT should be models for jobs growth; however, Ohio doesn't seem to have developed as good a story as CT has done in terms of jobs. A reviewer highlighted the publication of a newsletter that will keep the hydrogen message in front of the target audience and the clear identification of target audiences and approach to address their main drivers for adopting fuel cell technology. The final reviewer said the project was well thought out and well defined, and it was easy to measure the success.

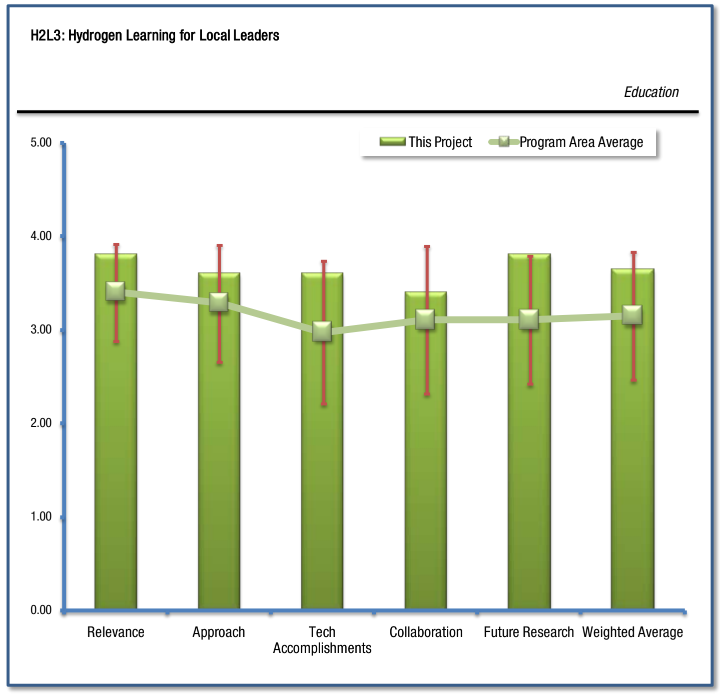
What are the project's weaknesses?

Partnerships with other agencies (state energy offices, associations of counties, other forums) could be stronger, stated one reviewer. Weaknesses in reliance on "ad hoc" collaborators and in having little emphasis on web-based information dissemination were also identified. A reviewer stated that the team needs to polish and better define the jobs messaging -- this should be a strength, as indicated above.

Do you have any recommendations for additions or deletions to the project scope?

A reviewer suggested that the team should coordinate with other projects to reach state and local governments. Connecticut should be able to help Ohio in terms of developing a jobs story.

H2L3: Hydrogen Learning for Local Leaders: Patrick Serfass, Technology Transition Corporation



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer said this was well aligned with the goals of DOE. NASEO is a great organization to utilize. A reviewer observed that relevance to DOE objectives was clearly stated: project addresses curriculum development, pathways to disseminate information, and conducting of national-level educational workshops. This project directly addresses DOE objectives of increasing hydrogen education levels. A reviewer said this is an outstanding project designed to work with the national associations of state and local officials to educate state and local officials.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The approach was generally felt to be good. A reviewer stated that the team is working with the appropriate national-level organizations to reach state and local officials. It is Important to reach out to key stakeholders like NASEO, but this reviewer would like to see more outreach to more groups, like NCSL and CSG, as effort develops. A reviewer said that "working with" instead of "talking at" state and local officials is a good plan that should increase success. A reviewer stated that there is good practical outreach through workshops. Core curriculum was used based on an existing curriculum. A final comment was that the approach is effective because the PI works with NASEO and PTI, not only to identify participants, but to obtain guidance on the type of information that best suits the needs of state and local officials. Peer presenters are included to present case studies, excellent approach. The PI uses established communcation networks to increase their reach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

In a short period of time, since October 2008, a significant number of tasks have been completed, according to the first reviewer. These tasks include curriculum development, advisory committees have been assembled, peers have presented to audiences, and two Hydrogen 101 workshops have been held. Another stated that the team has completed the basic curriculum, forged partnerships with NASEO, and conducted the first of the Hydrogen 101 workshops. Progress is good considering the relatively short time since the project start. The third reviewer observed that a curriculum was developed using an advisory committee that includes local and state officials--excellent approach. The last reviewer liked how the team piggybacked on the NASEO annual meeting and trained officials using the Hydrogen 101 Workshop.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Collaborations were also strong for this project. Collaborations appear reasonable to one reviewer: NASEO is the correct organization to be a partner for this work. TTC is connected to several major hydrogen associations.

Curriculum developer is technically capable. The PI and team are working in close collaboration with NASEO. Schatz Energy Research Center is a good partner. A reviewer felt that the most important collaboration is with the local and state officials but the team members also have some strong partners. The final reviewer strongly suggested interaction and coordination with the state groups.

Question 5: Has the project effectively planned its future work in a logical?

The "train-the-trainer" aspect was highlighted by several reviewers: one observed that the train-the-trainer effort will improve the reach of this educational effort. Another said that train-the-trainer workshops are planned. This approach will expand the number of trainers throughout the nation, and has the potential to greatly increase the number of individuals that receive training. The third reviewer said the future work was well defined with a good approach in the train-the-trainer workshops. The final reviewer stated that webinars are a good way to go.

What are the project's strengths?

Strengths listed were: using cutting edge reach out techniques like webinars; having realistic expectations; having connection with national-level organizations (NHA, NASEO); having a national-level focus for education; and creating a good organization with goals that will be easy to measure for success.

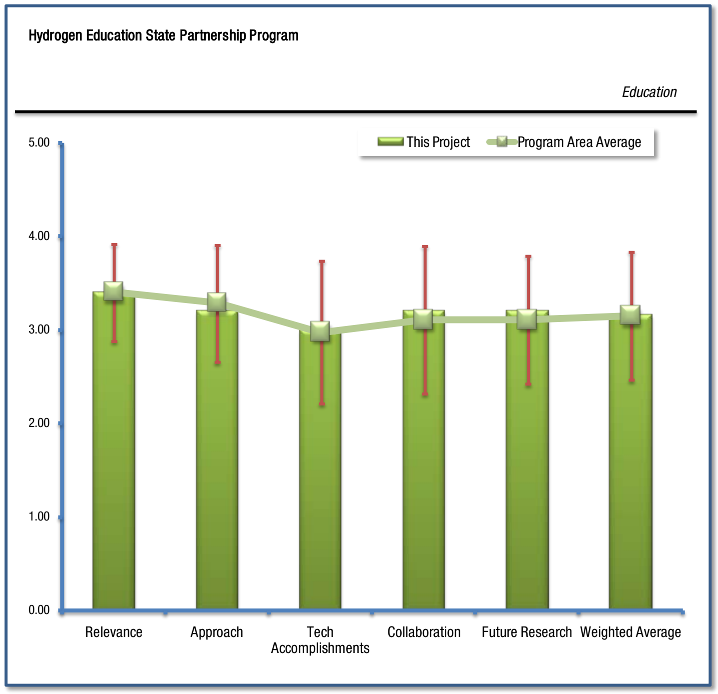
What are the project's weaknesses?

No weaknesses were identified.

Do you have any recommendations for additions or deletions to the project scope?

As with the other decision-maker focused projects, coordination among the projects is important. This project could provide guidance from the top level to the other state-level projects. Similarly, a reviewer offered that the team should work with other projects funded in this program to increase their chances of success.

Hydrogen Education State Partnership Program: Charles Kubert, Clean Energy States Alliance



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
The project will educate state-level officials, and fits well with DOE objectives, in the opinions of two reviewers. Another stated that the project addresses need for education among state-level officials and meets DOE goals for educational efforts. The final comment was that this is an excellent project that supports the goals and objectives of the Hydrogen Program by collecting and assessing state hydrogen programs, providing target specific tools and working with the National Conference of State Legislators.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer said that preparing and providing technical overviews for policy makers is a valuable approach. A reviewer observed that the focus on state-level activities is unique among these projects. Identification of best practices will be useful to many of these programs. Building state partnerships will be important. A second reviewer also noted the approach to identify state hydrogen program best practices and policies, provide information and technical assistance to state policy leaders and state renewable energy programs to foster the development of effective hydrogen fuel cell programs, and promote strategic opportunities for states and DOE to advance hydrogen technology deployment through partnerships, collaboration, and targeted activities. A reviewer stated that the team will need a lot of reinforcement at state level in order to compete with solar and wind interests. This reviewer was not certain that adequate resources exist in many key states. Also, this reviewer believed this group should expand its focus beyond systems benefits charges and look to overall state level policies that can help the development of the fuel cells. Policy areas to consider are renewable portfolio standards, grid interconnectivity standards, and net metering. In terms of RPS, only six states include fuel cells without fuel source restrictions -- and two of these states (Minnesota and NY) are considering revisions that would impose fuel source restrictions. A final reviewer observed that the approach is multi layered. It focuses on the specific barriers that need to be addressed by state officials. The approach also includes tools, resources and workshops the audience can use to overcome the barriers. The approach is effective in building partnerships.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
Some reviewers felt the program accomplishments were appropriate for the time spent. One said that accomplishments are good given the short time since the project inception. Limited response to the state fuel cell survey was disappointing: the team needs to examine ways to improve response to their inquiries. Technical overview documents will be useful for many of these educational programs. Another said that much has been accomplished in a short period of time. Since November 2008 the project team has conducted a survey of state hydrogen programs, launched a state hydrogen website, conducted on-going state and regional calls, held workshops and started technical research. Similarly, a reviewer said that the project is relatively new but have completed a survey and launched a

website. A reviewer said the potential to collaborate with NHA, DOE and TTC is great: this reviewer hoped there will be good coordination. The final reviewer simply stated that it seems like the project has taken a long time to launch.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer said that the team includes the National Conference of State Legislators. This organization has a built-in means of communicating the target audience. Additionally, the bi-monthly calls are held in partnership with NHA. The steering committee is comprised of state energy offices, hydrogen organizations, and hydrogen grant awardees. The breadth of partnerships is more than adequate for this project. Another highlighted the collaboration monthly calls with DOE and NHA that are good: this reviewer said it is essential to work with NASEO. Another encouraged the potential to work with NHA and the state groups. A reviewer stated the opinion that collaborations were not clearly shown, but appear to be acceptable (NHA is involved, and project is led by a coalition of state clean energy programs). The final reviewer questioned what NCSL's role was in the team. Is the organization just available for dispensing the information to policy makers or do they have an actual role on the team?

Question 5: Has the project effectively planned its future work in a logical?

A reviewer said that the future work was not as well defined as some other projects: no metrics were given to determine success of project. Similar observations were that a general overview of upcoming work is provided. This work will assist DOE in meeting the goals and objectives. Additional details on the upcoming work would be helpful. A reviewer said that future plans appear to be appropriate for the work to be accomplished. Participation in NCSL annual meeting will be useful. Good ideas contained in the future work were the webinars with NCSL and the publishing of articles. The final reviewer strongly recommended the group address regulatory barriers, as highlighted above.

What are the project’s strengths?

The tight focus on state-level requirements and the development of technical resources for hydrogen education that can benefit many educational programs were highlighted as strengths. Another reviewer observed that bi-monthly conference calls with DOE and NHA should improve project focus. The final reviewer said the project’s strength was that it realizes the potential opportunity.

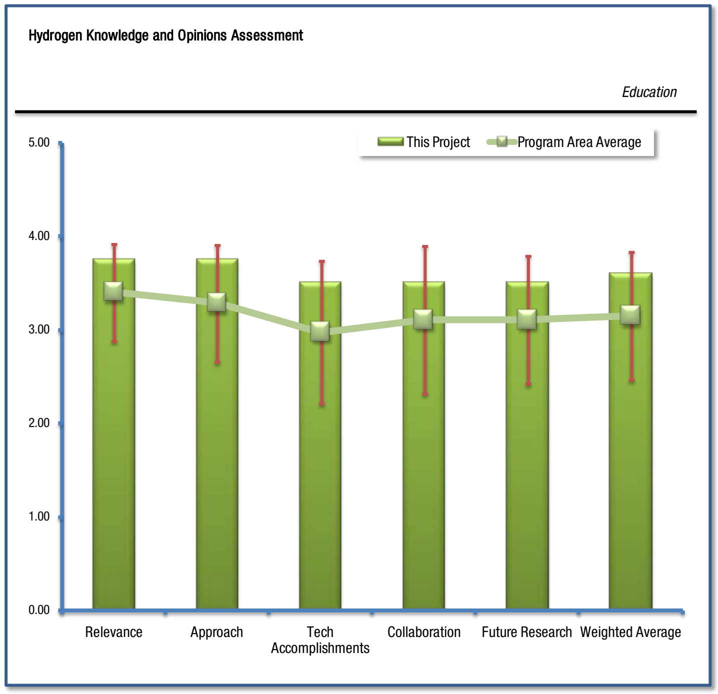
What are the project’s weaknesses?

The only weakness was that a reviewer was not sure if, given the resources, this effort can compete effectively with the generally well funded efforts by other renewable technologies. This reviewer believed the scope of messaging should increase to include important state-level regulatory actions, especially RPS.

Do you have any recommendations for additions or deletions to the project scope?

Several recommendations were offered. This needs to be coordinated with the other education projects, especially the TTC (Serfass) project working with state officials. The team should seek out potential partners, such as CHP and other DG-focused groups, to leverage message. This reviewer believed the scope of messaging should increase to include important state-level regulatory actions, especially RPS. The team should identify key states for a more robust effort. Perhaps taking on a small number of states with a lot of effort is better than spreading the resources over a larger number of states.

Hydrogen Knowledge and Opinions Assessment: Rick Schmoyer, Oak Ridge National Laboratory (ORNL) - POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer characterized this as an essential project. Another disagreed, stating this is a useful, although not critical, activity. To be most useful, plans must be developed to impact results. In support of the first reviewer, a third reviewer said it is critical to utilize some type of survey instrument/quiz to gage the effectiveness of training, education and outreach programs. The thought process of measuring success in several of the ED programs was lacking the statistical rigor contained in this effort. A final comment was that this is a key project that measures the general public's, and specific target audiences', knowledge of hydrogen and fuel cell technologies over almost a decade. The survey findings assist in determining training needs: the survey is one means to measuring the impact of the sub-program's efforts.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer characterized this work as having a good and well thought out plan, with barriers that are acknowledged and addressed. Another stated that by all appearances, the methods and approach to the work is statistically sound and measures progress over time. The challenge comes in the addition of populations or details as the work progresses. A third opinion was that it is vitally important to have these data on general opinions to show what people think about these new technologies. Approach should be continued exactly as planned and executed so far. The final reviewer stated that this is a well designed approach other than reliance on phone interviews. The PI reports that telephone survey response rates are low and that this may be due to the fact that many households use a cell phone as their only phone. These individuals may be more technology forward. Without their input the data may be skewed. Additional survey approaches were not offered.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A commenter said that the data appears to be of good quality and well analyzed. Another noted that the team completed the very detailed 2008 data collection, analyzed the data and reported their findings. The third reviewer observed that technically speaking it is sound and relevant in the results and progress shown to date. The delays on surveying the codes and standards officials are all that is currently lacking on the project. The final reviewer offered that we could use this information more often and that the procedure to get this information is onerous due to bureaucracy. If there was a way to hold these surveys more often, it should be done.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer observed a good collaboration, but feels there is more opportunity to collaborate with some early adopters and demonstrators to form a more specific idea of learning and growth and general awareness. Another offered that the team has collaborated extensively with industry and other experts. Going forward, this reviewer felt it is important to continue to collaborate with communications professionals who know the right wording to use--not engineers. A last comment was that the team partners with an array of national and international organizations to clarify data, hydrogen and fuel cell associations, and the Opinion Research Corporation.

Question 5: Has the project effectively planned its future work in a logical?

A reviewer said the work is sharply focused but more future work could be done to get more data more often from the surveys. The planned work for the completion of the project is described, according to a reviewer. The final product will provide DOE with a detailed examination of how the Education sub-program has increased the nation's awareness of hydrogen and fuel cell technologies. A reviewer offered that the approach makes sense to test again in 4 years. The final comment was that given current status, the proposed plan is good, as funding and resourcing is a little unknown at this point.

What are the project's strengths?

Strengths were in the well thought out plan and good slate of questions that address the issues. Another strength was in the statistical rigor and demonstration for changes from 2004 to 2008. A reviewer noted that the team has comparable data year to year: no one else is doing this. The final strength was that the survey approach is technically sound and OMB approved. The project spans almost a decade providing a means to determine the impact of the sub-program's efforts.

What are the project's weaknesses?

A reviewer observed that the weaknesses are the same as those addressed by the report, such as non-response bias. Another comment was that a reviewer did not note any relationship to this knowledge and opinions research and any of the current ED programs underway. A reviewer said that audiences should be surveyed more often. A final reviewer said that for other than government agencies, response rates from key target audiences are less than 30%. Challenges with telephone interviews are stated. Other survey approaches could be employed to improve response rates. In FY09 safe and codes officials are added as an additional target audience. It is unclear why this important audience, one that needs training before other audiences, was not included in the initial survey.

Do you have any recommendations for additions or deletions to the project scope?

A reviewer suggested that the team look for opportunities to link the state/regional/national level ED programs to providing input to this dataset maintained at ORNL. For instance, DOD/DLA is looking to survey the workforce at one of the distribution centers before and after training and initial operations. The team should look to feed that information into the ORNL body of work and see if it helps inform and redirect focus. Another suggestion was to conduct surveys more often. The final reviewer noted that households served only by cell phones are not surveyed. These residents may be more likely to be early users of new technologies. They may also be more knowledgeable about new technologies. Again, perhaps other survey approaches, for example, web-based surveys would improve response rates.

9. Technology Validation

Introduction

In addition to the technical challenges being addressed through research, design, and development, there are obstacles to successful implementation of fuel cells and the corresponding hydrogen infrastructure that can be addressed only by integrating the components into complete systems. After a technology achieves its technical targets in the laboratory, the next step is to show that it can work as designed within complete systems (i.e., fuel cell vehicles and hydrogen refueling infrastructure).

Technology validation confirms that component technologies can be incorporated into a complete system solution and that system performance and operation are met under anticipated operating scenarios. DOE is developing and testing complete system solutions that address all elements of infrastructure and vehicle technology, validating integrated hydrogen and fuel cell technologies for transportation, infrastructure, and electric generation in a systems context under real-world operating conditions. Data will be collected to determine whether targets have been met under realistic operating conditions, to provide feedback on progress, and to efficiently manage the research elements of the program while providing redirection as needed.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Relevance	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Controlled Hydrogen Fleet & Infrastructure Analysis	Keith Wipke, National Renewable Energy Laboratory (NREL)	9-6	4.00	3.75	3.75	3.75	3.50	3.78
Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project	Dan Casey, Chevron	9-8	4.00	3.80	3.60	3.60	3.20	3.68
Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project	Mike Veenstra, Ford Motor Company	9-10	3.67	3.67	3.33	3.17	3.17	3.43
Hydrogen to the Highways	Ronald Grasman, Daimler	9-12	4.00	3.60	3.60	3.40	3.20	3.62
Hydrogen Vehicle and Infrastructure Demonstration and Validation	Rosalind Sell, General Motors Corporation	9-14	3.83	3.83	3.67	3.33	3.00	3.63
Validation of an Integrated Hydrogen Energy Station	Edward Heydorn, Air Products	9-16	3.80	3.80	3.40	3.40	3.60	3.58
California Hydrogen Infrastructure Project	Edward Heydorn, Air Products	9-18	3.60	3.40	3.20	3.60	3.40	3.38
Technology Validation: Fuel Cell Bus Evaluations	Leslie Eudy, National Renewable Energy Laboratory (NREL)	9-20	3.40	3.60	3.40	3.60	3.20	3.44
Hawaii Hydrogen Energy Park	Richard Rocheleau, Hawaii Natural Energy Institute	9-22	3.75	3.75	3.00	4.00	3.75	3.48

Presentation Title	Principal Investigator and Organization	Page Number	Relevance	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Detroit Commuter Hydrogen Project	*Jody Egelton, Southeast Michigan Council of Governments (SEMCOG)*	*9-24*	*2.80*	*3.00*	*2.40*	*3.20*	*2.40*	*2.68*
Tanadgusix (TDX) Foundation Hydrogen Project	*Katherine Keith, Tanadgusix Foundation*	*9-26*	*2.20*	*2.20*	*2.25*	*2.20*	*2.20*	*2.22*
Texas Hydrogen Highway - Fuel Cell Hybrid Bus and Fueling Infrastructure Technology Showcase	*David Hitchcock, Texas Hydrogen Highway*	*9-28*	*2.60*	*2.40*	*1.75*	*2.40*	*2.40*	*2.18*
Florida Hydrogen Initiative	*Pam Portwood, Florida Hydrogen Initiative*	*9-30*	*1.83*	*1.83*	*2.17*	*2.50*	*1.83*	*2.03*
OVERALL AVERAGE FOR TECHNOLOGY VALIDATION			**3.31**	**3.26**	**3.06**	**3.21**	**2.96**	**3.16**

NOTE: Italics denote poster presentations.

Overview of Technology Validation: John Garbak, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

A reviewer stated the challenges and focus of work were clearly identified. Total progress was well-outlined (total miles traveled, fuel dispensed), and over a million miles of travel is a significant accomplishment. Progress on durability also appears good (60,000 miles). Comparison to 2008 was not presented in the overview, but may not be as relevant to this program of vehicle demonstration as the total accomplishments will be. Progress in the data collection aspect since 2008 is very good. Another reviewer commented that a detailed overview of Technology Validation efforts was provided. Goals, objectives and key targets were addressed. The current number of fuel cell vehicles and stations were provided. Future projects, including the project at the Volcano National Park were discussed. One reviewer noted they wanted to hear more about the DOE's plans for the future and progress from the previous year. For example, what about the distance of H_2 vehicles, start up time, performance and life cycle of the PEM in vehicles? What about the stationary power generation? Is DOE testing different sizes and getting results? Comments from another reviewer mentioned the sub program overview was adequately presented. The program has been in existence for four years and has made a lot of progress. Several demonstrations and large data base development is underway which provide good information on vehicles, infrastructure, safety, etc. This is invaluable for making the case for fuel cell vehicles and hydrogen refueling infrastructure. Program is on target to meet 2009 goals, including 2000 hr durability by 2010. Recent results include 1.9 million miles traveled using 140 vehicles, 85,000 vehicle miles, 6 stations, refueling at 700 bar, and climate effects analysis. Good data on Gen 1 vehicles has been collected; Gen 2 vehicles are now on the road and being evaluated. The challenge continues to be fuel cell durability.

Another reviewer stated they didn't attend the previous year, but from what they saw this year, it appeared to be adequately covered. Challenges of hydrogen infrastructure were discussed in detail. The change in strategy of the new Administration was covered briefly during the plenary session. It was a difficult topic because this area receives zero funding in the 2010 President's Budget Request. One reviewer commented the Sub-program area was adequately covered as it fully explained the scope of the program and requirements. Important issues and challenges were fully identified as one would hope for in a program important for the long-term energy security of the nation. Comments from one reviewer said they believe the presentations and the progress are excellent while another reviewer noted this sub-program is based largely on vehicle learning demos and was adequately covered and justified. Another reviewer mentioned the presentation covered the tech validation program well and the 2009 progress was clearly shown, but there was not an obvious comparison with 2008. This was a very brief presentation. Three reviewers answered yes to this question, with one adding the targets are being met with impressive numbers of vehicles/stations; the cost is dropping substantially on fuel cell stack and hydrogen cost.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

A reviewer stated a budget request of zero for 2010 will be a problem for this program. Is there a plan for addressing this issue should this be part of the final 2010 appropriation? Are there other DOE partners (vehicle systems, Clean Cities, other) that could help? Other challenges (data on refueling events, real-world operation of vehicles in variety of climates, etc.) are well-outlined and addressed by the program. There do not appear to be any significant gaps in the program. Another reviewer noted that challenges, including a $0 budget for next year, were addressed including plans to work closely with industry partners. One reviewer mentioned there do not appear to be gaps in the project portfolio. There are many challenges in deploying hydrogen fuel cell vehicles and the accompanying infrastructure, but it appears that funding from DOE in this area will be scarce in the near-term to address them. Comments from another reviewer said the zero request for FY2010 is the major issue. If this holds, the sub-program will cease to exist. If not, continuing to get data on the Gen 2 vehicles to address durability will be the major objective and challenge. Another reviewer stated that apart from new funding, there are no gaps in the project portfolio and all issues and challenges appear to be soberly presented. As for the funding shortfall, not much can be done unless national leadership changes its will. One reviewer commented they are fortunate to have been part of Ford's effort to unveil a fuel cell vehicle prototype publicly five years ago and also to have been a hands-on witness to the latest design levels of fuel cell vehicles in the past year. The progress by the auto companies in their fuel cell vehicle programs over the five years has been outstanding, if not awe inspiring. The DOE deserves a lot of credit for its contribution to this progress. Comments from one reviewer noted the performance of FC vehicles under real life conditions, and the documentation and analysis of same are very important activities while another reviewer mentioned they would like to see more on infrastructure of production and storage. Another reviewer stated the presentation was too brief to cover all the topic areas. One other reviewer noted that the future plans were identified but will they be able to be met without funding? Two reviewers agreed that the plans were identified and there were no apparent gaps.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

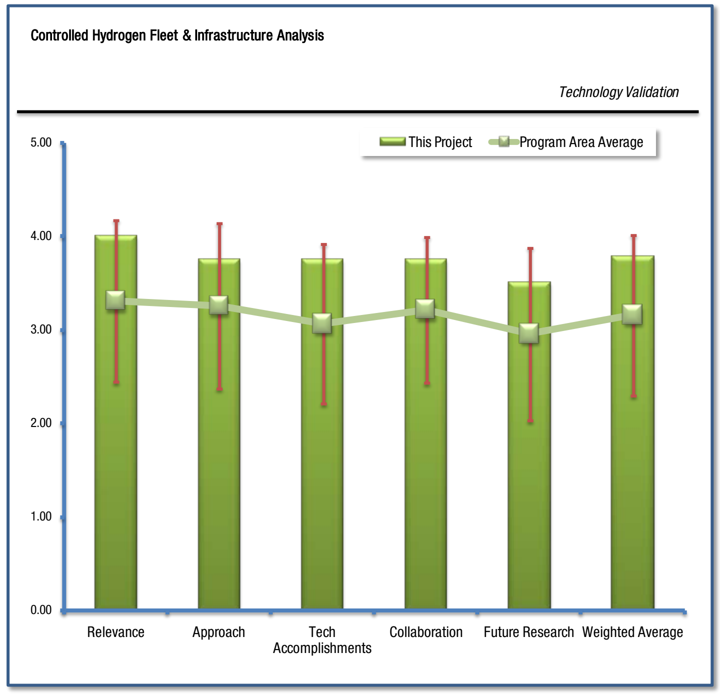
A reviewer stated this sub-program appears to be well-organized, and is effectively providing the vehicle, infrastructure, and fuel cell partners with useful real-world information on performance, reliability, and operation. It is addressing the needs that the Hydrogen Program has for data and experience. Data collection and analysis portion of the program is very carefully planned (special Matlab tools developed), and provides adequate safeguards against distribution of proprietary data while giving more than adequate information for the public to be used in the Hydrogen Program activity. Another reviewer mentioned this is a well-managed program that is working diligently to validate hydrogen and fuel cell technologies in real-world applications. The program also works to determine the current state of the technologies to assist the direction of future research. Comments from another reviewer said the Sub-program is well managed. Data collection and dissemination is an effective and transparent process. A well-designed data matrix was developed. The Sub-program is focused on transportation and FCVs. If the 2010 budget holds and hydrogen FCVs are eliminated it will not be effective in meeting program goals. Another reviewer noted the Sub-program is well-focused, well-managed, and effective in meeting Hydrogen Program R&D objectives. One reviewer stated it was hard to tell from this presentation and there is a need to explain the relationship with all DOE labs especially NREL. Comments from one reviewer said the subprogram is well focused, well managed and appears to be effective in supporting the DOE program and its goals. Six of the reviewers answered yes to all of the questions with one adding it seems all the targets are being met and providing crucial data to overcome technical issues. This reviewer went on to say they are not sure what will happen if the budget is not restored or at least supplemented by Congressional appropriations. One other reviewer who answered yes also said the DOE deserves a lot of credit for its contribution to the great amount of progress in the product development of fuel cell vehicles. The comments by the auto industry representatives gave this observer a confident belief that the key players can see the finish line in terms of being able to commercialize these products.

4. Other comments:

A reviewer stated it would be interesting to hear about the findings from the retired vehicles (overall condition of vehicles, did teardowns occur), but some of this may be proprietary. The public outreach products are very informative and extensive, giving diverse ways to examine the data produced by the project. Details of the operation of the vehicles should be very useful to manufacturers in improving the next generation of fuel cell vehicles. Analysis of the greenhouse gas emissions (W-T-W) is a very important addition to address objections, especially regarding hydrogen production via electrolysis (the electricity emissions issue). Another reviewer queried why is the cost target $2-3 per gge for 2015? That seems a bit vague, what is the reason? How will the reduction in funding levels affect the existing and continuing technology validation projects? Will there have to be drastic cuts or elimination in some projects?

A reviewer asked how the program can justify the cost of continuing data collection in the fleet vehicles and new construction at the Hawaiian power park at this time. One reviewer asked why there was a 50% decrease in funding from FY2008 to 2009. With the likely zero vehicular H2 budget for FY2010, there does not seem much hope for H2 in the foreseeable future which is a shame! Comments from another reviewer said the Sub-program is commendably well-run and advances clean and green reasonable alternatives to meet advanced transportation alternatives. Another reviewer asked if, given the decision by the DOE to discontinue vehicular hydrogen, this activity will continue in FY-2010. One reviewer noted it was also good to see progress in terms of hydrogen fueling infrastructure while another reviewer said this was a thorough and comprehensive presentation.

Controlled Hydrogen Fleet & Infrastructure Analysis: Keith Wipke, National Renewable Energy Laboratory (NREL)



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
One reviewer feels that the collection of vehicle and fueling data under realistic, real-life operating conditions is vitally important to assess the of the technology validation effort. They pointed out that the collected data provides critical information to both the hydrogen program participants and to the general public. Another reviewer said that the project is very relevant to DOE's objectives prior to phasing out hydrogen funds. They also feel that the project needs better marketing or promotion to let public and government officials know about the program, progress, etc.

Other reviewers also said that the data is enormously valuable in determining technology readiness and provides important information to the overall program by providing data collection which includes analysis on real world experience. They point out that a partnership with vehicle manufacturers important to success of program.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer feels that the approach taken is both comprehensive and complete. They also note that the project has been responsive to input from the program participants and the approach has been adjusted as the project progresses as appropriate. Another reviewer said that there is a very thorough analysis and progression from the beginning of this program (6 years ago) - addressing all issues - range, durability, maintenance, cold start, etc.

Yet another reviewer noted that the project has a very focused effort on collecting, analyzing and disseminating data, but at the same time industry sensitive information is protected (by using composite data). They recommend that dissemination of data could be improved by providing information (a) on how to obtain results, (b) updating results more often and (c) going beyond web site to disseminate the information.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
One of the reviewers noted that the excellent progress continues and the project manages to keep current as extensive data submission from the various participants has increased. This is a vital component of vehicle technical validation program. One reviewer would like to see key decision makers on how much progress is being made to show worth and value of program.

A different reviewer noted that there was software developed (Matlab) which has a great custom user interface and that is was very impressive comprehensive data collection and display of results.

A reviewer felt that the overall progress over the course of the program has been good; they point out specific accomplishments such as the good number of stations brought on line, the significant quantity of hydrogen produced and distributed, and the significant mileage accumulated on vehicles. They also say that new results appear to be limited to data analyses on fuel economy range and fuel cell performance characteristics. They feel it is not clear whether some of the other analyses presented were performed this year or were a continuation of previous studies.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Overall the reviewers noted that extensive collaboration has been ongoing and is absolutely essential to the success of this project. They commend the project for using different fuel cell vehicle manufacturers with different fuel providers, and point out that USFCC, CaFCP, and DLA connections are important partnerships. They also noted that there has been very good coordination and data sharing with other organizations involved in similar activities, some feedback from program areas has been used to supply specific analyses One reviewer says the project could enhance collaborations with other program areas of hydrogen program.

Question 5: Has the project effectively planned its future work in a logical manner?

Reviewers feel the plans for future activities are reasonable and appropriate, but wonder how to ensure funding and focus.

What are the project's strengths?

The reviewers note that the project has excellent data collection, data tracking, data analysis and information mining methodologies. They also point out that the project is addressing major technical issues facing fuel cell vehicles and making enormous strides. Furthermore they feel the project is responsive to input from participants and DOE.

One reviewer points out that the project has a good relationship between participants with great communication that gives the project the ability to handle proprietary data very well.

What are the project's weaknesses?

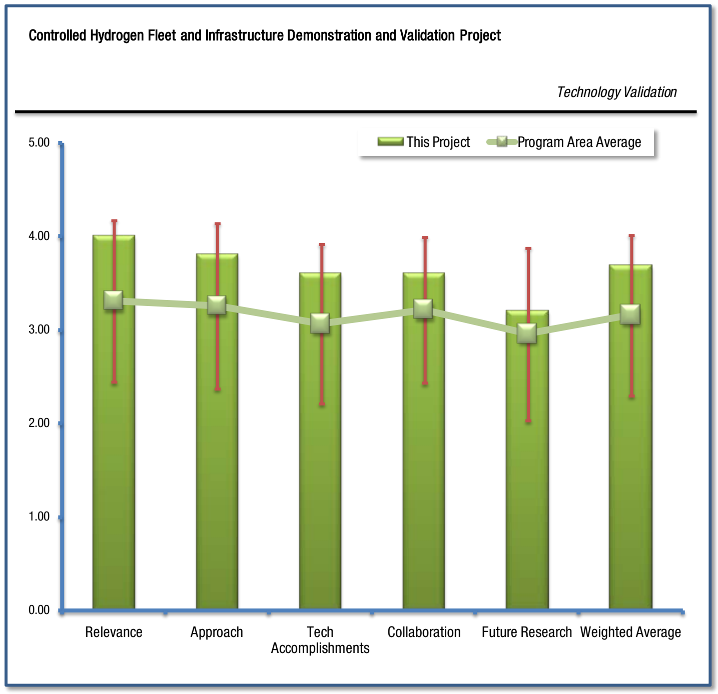
One reviewer points out that that there is not enough promotion or sharing of results - presenting results at fuel cell seminars and meetings is great, but need to do more to let public, media, policymakers and Congress know how much work is being done and the progress that is being made so people aren't so quick to write off fuel cells and hydrogen as a future technology with too many technical challenges - the challenges are being met yet not publicized very well so no one knows how much has been done. They say the project needs to present side by side with battery or plug-ins to show progress in vehicles but also quick hydrogen fills.

Do you have any recommendations for additions or deletions to the project scope?

One reviewer points out that vehicle and fuel cell system availability information would be useful. They also feel that inclusion of forklift, back-up power and stationary system operating data will be an important component of this project in the future as the program shifts emphasis to these areas.

Another reviewer feels that more education and publicity about data acquired in this project is needed and could help direct funding back to hydrogen if more people knew how much progress has been made in a few years. One reviewer feels that the project partners need to address the sulfur contamination in electrolysis. As mentioned in the project weakness comments above one reviewer feels that some of the results and analyses generated in this project should be disseminated in a format suitable for general-public consumption. They feel there has been much progress made in real world operating experience in terms of FC durability, vehicle range, miles driven, accident experience, etc. They think these results could go a long way toward getting public support and overcoming some misconceptions about the state of this technology.

Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project: Dan Casey, Chevron



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Overall the reviewers feel the project is very relevant. Another reviewer points out the project appeared comprehensive and complete and fully addresses the goals and objectives of the technology validation section of the multi-year R&D plan. The reviewer especially appreciated the complete answers Mr. Casey provided for the few questions he was asked.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewers feel the project is a complete project in that nothing seems to be missing. They feel it is everything one could want for a well-run FCV program and it advances the United States towards deploying FCVs for consumers. They note that the approach to address barriers is logical and straightforward, they note that the addition of data submissions from non-DOE funded vehicles are a useful supplement to the body of data being collected for the program. One reviewer does point out that training drivers to fuel for themselves is an important component.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

One reviewer pointed out that the work on cold-start and data transfer were relevant and needed technical progress. Overall the other reviewers felt that there has been outstanding technical progress in the areas of hydrogen dispensing, station operation, demonstration of cold starts, safety and first responder training. One reviewer notes that the goals are high but the Chevron team appears to have responsible plans to meet their goals. Another reviewer says that the vehicles appear to be meeting fuel cell durability and range requirements, and have demonstrated freeze capability; they also note that the vehicle tank temperature sensor analysis is a useful addition to the body of knowledge for fuel cell vehicle and refueling.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

One reviewer complements the project team for their vehicle operators like the government, Sea World, and the Orlando airport, all of which are high profile, well-known places. They feel this is crucial to education and outreach to have high profile demonstrations like this.

A reviewer also noted that Chevron assembled a well-rounded team and each team member appeared to have contributed as required. Similarly they feel that the University of Miami hydrogen modeling will also add to the body of knowledge, as well as the collaboration with DoD adds their perspective on vehicle operation.

Question 5: Has the project effectively planned its future work in a logical manner?

Overall the reviewers felt the future work outlined is appropriate and that the Chevron presenter seemed to represent the company well in that he knew where the company at least should be headed. The reviewers also feel that fuel cell bus deployment and technology development is key. One reviewer reminds the project team that reports must be publicized. One of the reviewers says that it would be great if there was another phase of this project, which would include next design iteration vehicles and fueling stations.

What are the project's strengths?

The reviewers feel that the project appeared like it was run by professionals through and through, noting 100% positive customer feedback and meeting of technical targets using varied hydrogen generation technologies across the country. They also commend the project for their work on the educational aspects, especially first responder training.

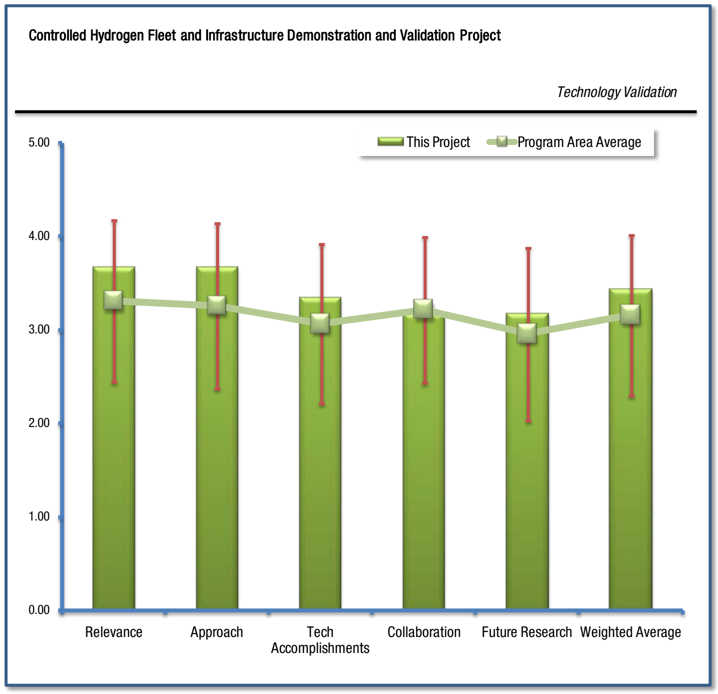
What are the project's weaknesses?

One reviewer did feel that the project needs to publicize accomplishments better - cold start, customer feedback, vehicle data - public and policymakers need to know technical challenges are being met and moving forward. Other reviewers commented that they could not identify any weaknesses.

Do you have any recommendations for additions or deletions to the project scope?

One reviewer feels that the project needs to promote the fuel cell bus by making data known, public needs to know more about buses. Another reviewer had the recommendation of integration of fueling with innovative renewable hydrogen sources, such as CHHP or biogas from waste streams. They also recommended the project consider the creation of clusters of hydrogen stations in targeted areas.

Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project: Mike Veenstra, Ford Motor Company



Reviewer Sample Size
This project had a total of 7 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
In general the reviewers felt that this project is very relevant to the goals and objectives of the Hydrogen and Fuel Cell Program in that it collects realistic operating data on vehicle and fueling performance. Another reviewer feels the Ford team project fully supports all aspects of DOE program requirements. They also note that all aspects of the project appeared solid and commendable and fully address the key technology validation targets.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
The reviewers feel that the approach is logical and reasonable by covering both current technology vehicles for operational use data collection and the development of technology demonstration vehicles to address critical development and design gaps. They also note that the data collection plan is good and thorough. The reviewers say the approach clearly demonstrates that Ford and its team focused on the task at hand in their presentation. The reviewers are impressed with Ford looking at various fuel cell designs in its demonstration fleet, including a PHEV hybrid. One reviewer does mention that the addition of a vehicle in Iceland provides an interesting data point, but is perhaps somewhat out of place in a US DOE-funded program.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
The reviewers stated that the progress in addressing some of the vehicle level performance goals is satisfactory with good investigation into total life of fuel cell technology. The reviewers also noted that the project made progress toward implementing more objective infrastructure at its demonstration sites. They feel the Ford team fully meets the expectations and goals one would expect for a team of their standing. They did well. One reviewer notes that it is unfortunate that financial issues have slowed or stopped progress on this technology development.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
The reviewers noted that the project assembled a solid team for the project to both gain and spread knowledge of fuel cell systems. Collaborations are adequate and include NREL for data collection. One reviewer said that the close, appropriate collaboration with its partners clearly rates as an outstanding aspect of the presentation.

One reviewer commented that the project featured limited collaborations with infrastructure site partners and did not incorporate partnerships with universities or laboratories. Similarly a different reviewer said that not a lot of information was provided about collaborative efforts. One reviewer did comment that the cooperation with the fuel cell manufacturer (Ballard) appears to be solid.

Question 5: Has the project effectively planned its future work in a logical manner?

The reviewers noted that the project is nearly complete but that Ford is clearly working to advance the future of its hydrogen program and the future plans appear satisfactory.

What are the project's strengths?

The reviewers generally agreed that the project assembled and utilized a good team by assembling a mix of fleet vehicles for mileage and use accumulation and technology demonstration vehicles to demonstrate progress in addressing critical barriers to introduction of purpose-built fuel cell vehicles. The reviewers commend the project team for solid technical work, tight focus on developing practical and functional vehicles, which were accomplished through a variety of design iterations that allowed the team to make significant progress as shown in startup times and stack life.

What are the project's weaknesses?

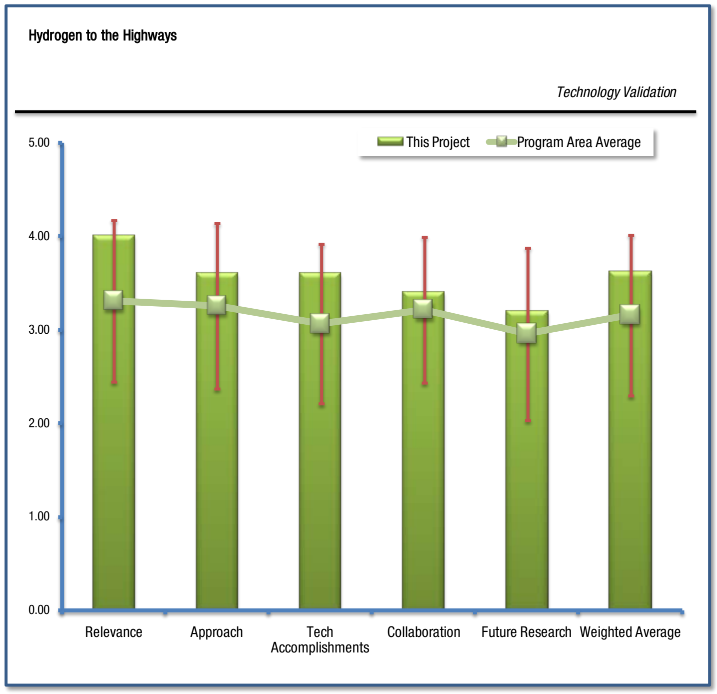
Some reviewers felt that there were no weaknesses but another commented that not much information was shown on project outreach, they reviewer assumed this is done mostly through NREL data collection efforts.

One reviewer did make the point that while not necessarily a weakness, the focus appears to be almost exclusively on vehicle design, as opposed to fueling station.

Do you have any recommendations for additions or deletions to the project scope?

One reviewer said they would like to see an effort at optimization of "transitional" design variations, such as a PHEV hybrid. None of the other reviewers had recommendations.

Hydrogen to the Highways: Ronald Grasman, Daimler



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

The reviewers agree that the project clearly meets all technology validation requirements necessary to advance DOE objectives and place FCVs throughout the consumer base in real-world applications.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?

Is the project well-designed, feasible, and integrated with other efforts?

Overall the reviewers feel that the project has a good approach – placing vehicles on the road, and opening stations to support vehicles and raise public awareness. The reviewers felt the project has completely addressed all elements of the requirements to advance deployment of fuel cell vehicles. A reviewer also points out that the work on codes and standards appears to be unique to this project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewers noted that the vehicle fleet is operating beyond the end date and performing above expectations. They also point out that Gen II vehicles will achieve the DOE target range. Overall the reviewers agree that the project has made outstanding progress towards objectives and the team seems determined to place these vehicles onto the roadway. They also commend the project for extensive progress and participation in the development of codes and standards. One reviewer does point out that the refueling station portion of this project appears to have had some problems (stations that have closed, obstacles in transferring stations from the project to other owners).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer felt this project fully met all expectations for assembling a comprehensive team to address requirements, including a strong partnership with fuel provider and other groups such SAE and other standards bodies on development if codes and standards. One reviewer felt that the collaborations are not very well-defined in this presentation.

Question 5: Has the project effectively planned its future work in a logical manner?

The reviewers generally agree that the future work appears logical to complete project and there is a good focus on education and infrastructure which is the key for success. Reviewers complemented the project team on a nice job of comparing past generations of vehicles to develop future FCV plans. They also mention that internal work is critical in case funding is not restored.

What are the project's strengths?

The reviewers feel that there is clearly a strong commitment to the technology and better, a strong commitment that Daimler will be moving forward with this technology. They also point out that the vehicles are surpassing expectations by showing fuel cell stacks lasting longer than goal.

They also point out that the outreach efforts have increased visibility of the project and the overall DOE initiative.

What are the project's weaknesses?

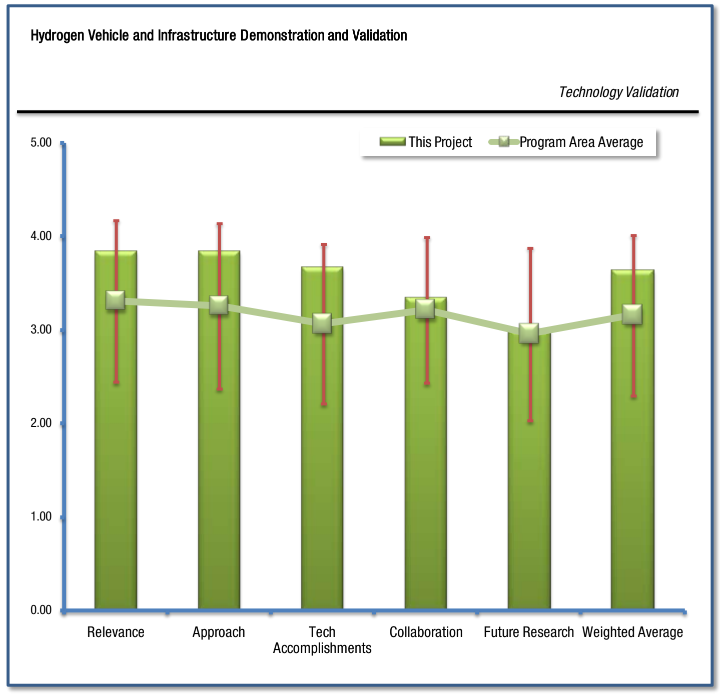
Reviewers question if stations will stay open and if Daimler will continue the introduction of vehicles in US if DOE terminates the hydrogen program? Another reviewer feels it is unclear how much of their infrastructure advancements cited in the project are the result of the project itself.

Other reviewers point out problems in getting stations completed and maintaining their access to FCV users (at least one station partly funded under the program has closed). They feel it is going to be a shame to see the fueling stations being decommissioned after a rather brief operating period.

Do you have any recommendations for additions or deletions to the project scope?

Most reviewers had no recommendations other than to not abandon this project, another reviewer is hopeful of "clusters" of hydrogen infrastructure in very targeted areas to allow the demonstration to progress to next gen vehicles and fueling.

Hydrogen Vehicle and Infrastructure Demonstration and Validation: Rosalind Sell, General Motors Corporation



Reviewer Sample Size

This project had a total of 7 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Reviewers agreed that the project involving realistic performance testing of hydrogen fuel vehicles and refueling stations is very relevant to the ultimate goals and objectives of the Hydrogen and Fuel Cell Program. They also noted that General Motors is making great progress to the commercialization of FCVs so they clearly exceed the goals and objectives of the technology validation section.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The reviewers commented that the project has an excellent approach, is sound and appropriate to execute vehicle demonstrations and hydrogen dispensing via various technologies. Reviewers also complement the project on training users, operators and the general public. They also said that GM appears to be making the transition from “science project” to early generation commercial project; thus they rate and deserve an outstanding grade for this area.

The reviewers also mentioned that the demonstration of some fuel cell vehicles in the hands of the public (Project Driveway) is a unique aspect of this project: it has received much good publicity (including MotorWeek discussion). The reviewers also felt that the identification of maintenance facilities for these vehicles was also unique to this project. GM's participation in codes and standards work with NextEnergy is important.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewers commented that the progress to date is satisfactory and consistent with the established schedule, and that the project is also meeting all DOE goals and targets. They also pointed out that the project has achieved improved power densities and performance. This project has resulted in an outstanding and comprehensive approach to exceeding the technology validation goals and overcoming technical barriers.

The reviewers also felt that the vehicles and project have made excellent progress in validating the technology and appear to be meeting or exceeding all customer expectations for operation, range, and utility. Reviewers also note that it is somewhat difficult to gain full appreciation of the technical accomplishments because of confidentiality issues, but this is understandable.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

In general the reviewers feel that appropriate collaborations to accomplish the goals and objectives of the project are in place. The reviewers commended the fact that GM has made key partnerships (the Project Driveway drivers) with high profile agencies - EPA, Postal Service, etc. This is key for visibility and future fleet purchases. Project Driveway gets vehicle in hands of general public which is crucial. Reviewers also mentioned the collaborations with NextEnergy on codes and standards efforts and other collaborations that include DoD and Quantum for maintenance facilities.

Question 5: Has the project effectively planned its future work in a logical manner?

Reviewer said that the future plans are good and will complete the project in a timely fashion and noted that GM is committed to fuel cell vehicles and infrastructure development. One reviewer also said: "With getting customer-drivers into their FCVs, it appears GM's future is now ... outstanding!"

What are the project's strengths?

Reviewers feel that the strengths of this project are the strengths and expertise of the project participants. They commend GM for having partnerships (the Project Driveway drivers) with entities like Disney, Virgin Atlantic and celebrity drivers. The reviewers see this as raising awareness and profile of FC vehicles.

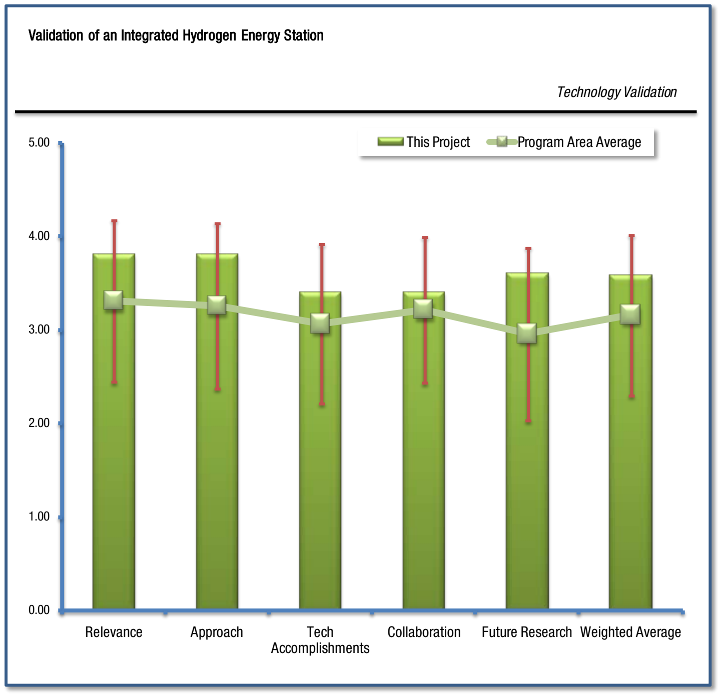
What are the project's weaknesses?

The reviewers felt that there was no real weakness apparent from this presentation.

Do you have any recommendations for additions or deletions to the project scope?

Reviewers recommend that in the future the project presentation should focus on technical aspects rather than contain so much promotional materials. Reviewers would also like the project to continue to be funded and for broader dissemination of results in the future.

Validation of an Integrated Hydrogen Energy Station: Edward Heydorn, Air Products



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
One reviewer said that renewable H_2 production is key to the hydrogen economy as it can take advantage of renewable portfolio standards and other state and federal incentives. They also said that looking at leveraging stationary fuel cell production to produce hydrogen is an excellent way to avoid stranded H_2 assets -- especially in the near term. They feel that validating of the economics of this type of effort will help expansion of this concept or point to better ways.

The reviewers noted that the co-production of power and hydrogen is an excellent way to go. The system under development can employ fuels derived of renewable sources.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer complemented the project team for getting the Orange County Sanitation District and Fuel Cell Energy onboard and for also going after CARB funding as it was wise in terms of realizing the vision of a working station using this renewable hydrogen. A different reviewer said the approach of coupling a molten carbonate fuel cell with a reforming operation is excellent. One reviewer felt that the project was presented in a logical and detailed manner. They also note that the DOE program 4 phases were employed and the presentation was detailed.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
One reviewer feels the project is making steady progress, but notes that the unit is still in Danbury, CT and it would be nice to see it in Fountain Valley soon. Another reviewer pointed out that this project is 85% complete, which may be problematic for Phase 4 operation, testing, and data collection.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
The reviewers felt that the brief and briefer showed good knowledge of all the major players required working with in order to maximize chances for success and they felt that project had good collaboration with California. One reviewer noted the limited partnerships, but this was still not inappropriate considering the stage of project development.

Question 5: Has the project effectively planned its future work in a logical manner?
One reviewer thought that it's important to see this project through as there are no other CHHP (Combined Heat, Hydrogen and Power) plants that are operational. They see that the data from this demonstration will help identify the value proposition and the key criteria for similar projects elsewhere. Furthermore they feel fully funding his project will also advance the Technology Readiness Level of Molten Carbonate Fuel Cell CHHP. The reviewer pointed out that the case can be made that where appropriate, CHHP from renewable sources (at least in part) can fill

in many hydrogen infrastructure gaps where stranded assets are considered too high a risk. CHHP can “dial back” on hydrogen production when necessary and produce renewable heat and power at high efficiencies. They also point out that the Self Generation Incentive Program (SGIP) in California, CHHP can become a very economical option that also serves to further hydrogen infrastructure when needed.

A different reviewer strongly encouraged the economic analysis of the hydrogen production potential of the Fountain Valley station. The reviewer feels the potential for hydrogen extraction should enhance the value of the CHP investment to the customer because it provides a potential low-cost source of hydrogen.

The reviewers feel that since the project is coming to a close in March 2010 and given the decision by the DOE to eliminate vehicular hydrogen, future activities should perhaps focus on other uses of hydrogen. They also say that this project is just beginning the operational and data collection phase, so it is still at an early stage. This makes it difficult to judge in terms of current progress and future activities.

What are the project’s strengths?

The reviewers feel that it is excellent teaming with a good host site and that there is great potential for scale up in hydrogen production. The reviewers also noted that the considerable expertise with hydrogen systems.

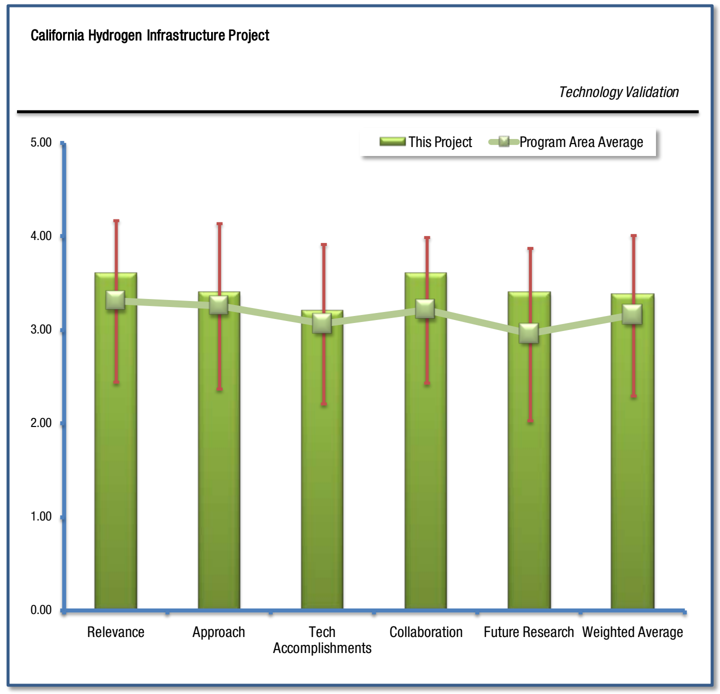
What are the project’s weaknesses?

No project weaknesses were identified by the reviewers.

Do you have any recommendations for additions or deletions to the project scope?

One reviewer strongly encourages the economic analysis of the hydrogen production potential of the Fountain Valley station. They point out that the potential for hydrogen extraction should enhance the value of the CHP investment to the customer because it provides a potential low-cost source of hydrogen. The value of the hydrogen sales revenue to the CHP customer could enhance the value of the CHP investment.

California Hydrogen Infrastructure Project: Edward Heydorn, Air Products



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
The reviewers feel that the project is very relevant as the need for low cost H_2 infrastructure in the early market (state of California) is critical. They point out that multiple hydrogen storage and dispensing technologies need to be employed at various sites in order to find the optimum mix. The reviewers also say that the metric of "cost of hydrogen delivered" is a solid technical target and that the project objectives address one aspect of hydrogen fuel cell deployment, that is, to gain experience on hydrogen refueling stations. A different reviewer pointed out that if successful, this statewide approach could be duplicated across the country.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
One reviewer feels that the project has a good approach is some areas (UC Irvine, Torrance, Fountain Valley) -- not so good in others (Long Beach, Northern California). After hearing the briefing the reviewer said the Lake Tahoe idea does not seem as farfetched as there would be an element of demand in this pristine area. Another reviewer complements the project for the station locations being chosen based on specific criteria and project partners. They noted this approach has been effective and that stations have been sited for 350 bar and 700 bar.

One reviewer has a different concern pointing out that the dependence of the project on short term deployments of fueling systems not necessarily a good approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
One reviewer says the work accomplished at the Torrance Pipeline station is essential to demonstrate low cost hydrogen fueling station. In general, the reviewers note outstanding progress on all the tasks under this project.

One reviewer commented that the project has done a great job in getting three potential permanent stations underway. They also feel that involving UC Irvine to provide objective data on this project is also important. The reviewer also pointed out that the Long Beach deployment did not turn out so good and saw very few refuelings. This reviewer also feels that the Torrance project should be a great data point for retail production of hydrogen from a pipeline source.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
One of the reviewers did not fully understand all the relationships with the collaborators such as SCAQMD, OEM's, UC Irvine, Energy Companies. They note that CARB was also mentioned but there was no clarification of their relationship.

Another reviewer says that the project has done very good networking to achieve success at Torrance -- where Honda and Toyota maintain a large corporate presence, and OCSD -- where renewable production of hydrogen closely aligned with demand will occur.

Question 5: Has the project effectively planned its future work in a logical manner?

One reviewer agrees with the projects future work suggestions and points out that the instillation and commission of 350 and 700 bar systems at the Fountain Valley Renewable Station seems like a very important area to continue. Another reviewer says that the future activities appear to be essentially working towards completion of some of the project objectives.

A different reviewer points out that the future work seems pedestrian with simple follow-up to existing pathways. Similarly another reviewer said that the project has expanded beyond expectations during development and future expansion is planned.

What are the project's strengths?

The reviewers feel that the variety and quality of technical work is outstanding and the project has demonstrated good, methodical and well-delivered site choices in the cases of Torrance, UC Irvine and OCSD Fountain Valley. They also point out that the UC Irvine partnership ensures transparency and objectivity in reporting results.

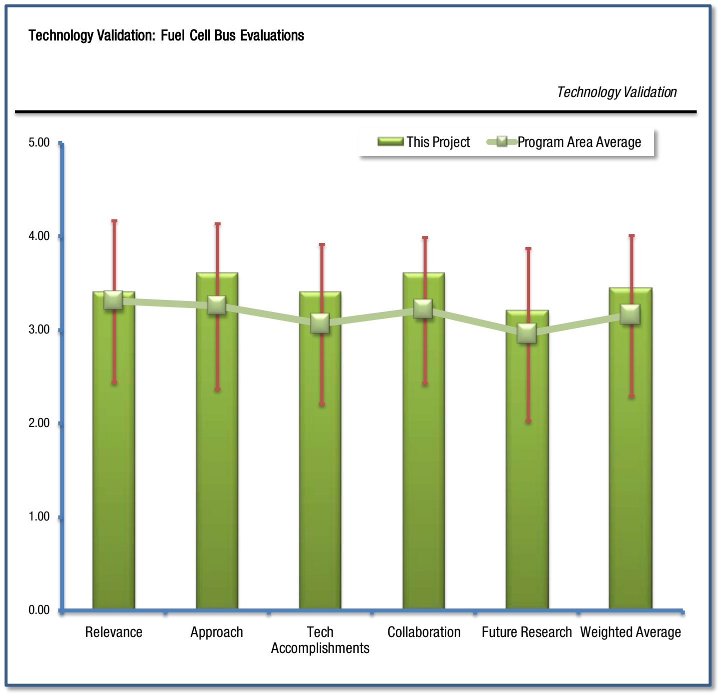
What are the project's weaknesses?

The only weaknesses mentioned by the reviewers are that the efforts in Northern California and Long Beach did not produce promising results for hydrogen infrastructure deployment in California.

Do you have any recommendations for additions or deletions to the project scope?

One reviewer asked if the project needs repetition of low pressure tube-trailer options (Placerville and Long Beach). They elaborate by asking what more can we learn from such systems within the same "geographies". Another reviewer feels the project should keep doing what it has been.

Technology Validation: Fuel Cell Bus Evaluations: Leslie Eudy, National Renewable Energy Laboratory (NREL)



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

The reviewers feel that this project meets the TV objectives as well as assists with market transformation by providing third party data collection and analysis by a third party. They point out that project consistently provides essential operational and technical data feedback for the program level validating critical technical targets.

A different reviewer says that this appears to be a "score keeping" exercise to develop a methodology for compiling performance data for these early market vehicles. The reviewer feels it would be helpful if the mission was stated more clearly.

A few of the reviewers commented that niche markets can be vital to the deployment of new technologies. They note that transit buses are especially important because they use significant amounts of petroleum and can be an important success story to be included in outreach efforts.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Most of the reviewers feel that the evaluation approach for costs and reliability is comprehensive and clear. They note that there are well defined milestones that guide the project and measure performance and in general the project is disseminated well. A different reviewer is concerned about the variability of the data among the survey group and says there appears to be differences in the inputs among the bus sites. One reviewer mentioned that it was a very thorough presentation that discusses all aspects of the project.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A few of the reviewers feel that project appears to be on schedule and gives a good evaluation of durability, availability, MBRC, and summary of costs. One reviewer points out that the data on infrastructure was clear and well developed. A different reviewer complements the project by saying that the data collection efforts and analysis are substantial, noting that the project would benefit from access to additional buses/fleets.

One reviewer does point out that the analysis is excellent, but the results would suggest that the fuel cell buses are not ready to compete effectively with alternative energy technologies at this time. They fear this could discourage bus fleet managers from purchasing fuel cell buses. However, a different reviewer felt that the fuel economy comparisons to natural gas and diesel fueled buses were impressive.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

The reviewers feel that there is very good participation from many collaborators, especially from bus lines. One of the reviewers feels that DOE needs more projects like this that develop technologies in the real world situation with tangible results and general public benefit and education. One reviewer points out that it is about time that FTA started to provide some funding for analysis of renewable transit bus systems.

Question 5: Has the project effectively planned its future work in a logical manner?

One of the reviewers said that DOE should piggyback on the FTA funding to evaluate the durability and other DOE technical targets. Another reviewer noted that it would be helpful to put in steps to share information with the fuel cell bus industry and make it part of the mission. Other reviewers feel that the project presented a good plan for continuing the data acquisition and analysis work and that the process and number of data points appear to be robust. One of the reviewers also feels that additional buses/fleets are needed.

What are the project's strengths?

Reviewers commented on the excellent management, data evaluation and participation from NREL staff. They also complemented the outstanding project partners (transit bus partners, H_2 suppliers, and fuel cell companies).

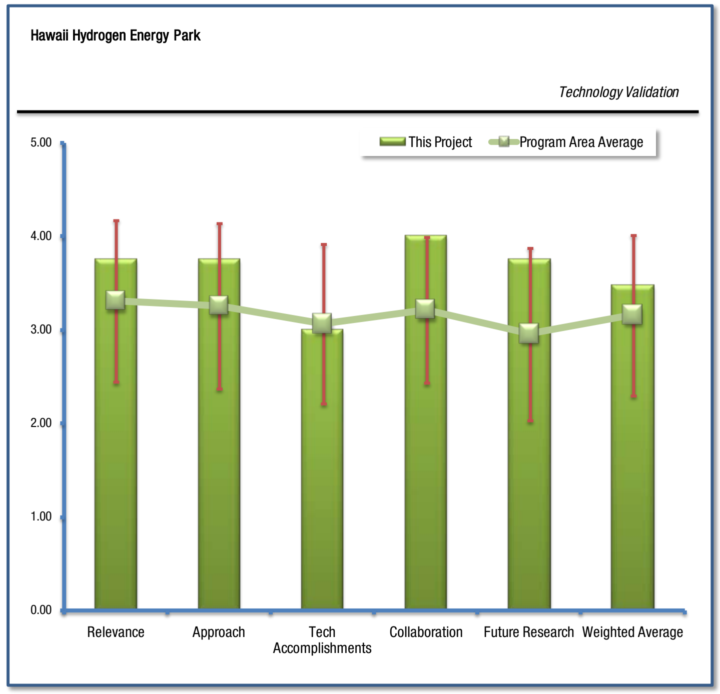
What are the project's weaknesses?

Most reviewers did not point out any weaknesses but one did mention the apparent variability of the data inputs from the bus fleets.

Do you have any recommendations for additions or deletions to the project scope?

Reviewers would like to see the continuation of data collection/analysis. One reviewer also mentions that workshops with industry to share performance data and help them improve technology would be good.

Hawaii Hydrogen Energy Park: Richard Rocheleau, Hawaii Natural Energy Institute



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
A reviewer notes that the relevance is outstanding. They point out that Hawaii has high electricity rates and if renewable hydrogen is going to work anywhere, it is here.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed?

Is the project well-designed, feasible, and integrated with other efforts?
One review said that the team has been working on this project since 2004 when they won the first hydrogen power park award. They note that the project has had many setbacks but this plan is tested and looks feasible economically, politically, socially and technically.

A different reviewer would like to better understand what is meant by "plug-in hybrid electric vehicle (PHEV) shuttle buses using hydrogen". They also want to know how many shuttle buses will be used.

One reviewer asked if the H_2 fueling station is the electrolyzer. The reviewer also queried that, if given the project's past experience with electrolysis, how hopeful the project team is that this equipment will be of value to overcome DOE's technical targets.

One reviewer said that the involvement of stationary and transportation demands as well as focusing on renewable hydrogen is excellent approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
A reviewer pointed out that the project team is taking advantage of the many lessons learned so far and have reached a high level of success, these results are helping DOE to achieve their technical targets.

Another reviewer mentioned that the project is making good but not outstanding progress. They see the H_2 speciation completion as an important step. The reviewer also liked the goal of 10-20 kg H_2 per day and bringing the cost of hydrogen down to $6/kg. They also liked that the DoD and NPS are two non-DOE agencies that can trumpet the successful results. The same reviewer also said that getting ONR involved recently on the FROG building is also a great addition. The reviewer has concerns that the Proterra bus may be a problem.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?
The reviewers felt the long and impressive list of diverse and complimentary partners speaks well for this project. They point out that each partnership is also a long term potential partner for even greater deployments of hydrogen

and fuel cells and other renewables. The reviewer also noted that the Hawaii Natural Energy Institute (HNEI) has gone beyond the original collaborating partners to now include the Office of Naval Research (ONR).

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer points out that the project plans are based on many lessons learned and practical input from their collaborators. This reviewer feels the future plan is achievable in the period and budget allocated.

One reviewer is concerned that the presenter mentioned that the installation of the fueling station might slip.

Reviewers also point out that there are a large number of visitors to both Hawaii Volcano National Park and the KMC military camp and if they ride the fuel cell bus or see the FROG building or any associated presentation material they will know that hydrogen and fuel cells are for real.

What are the project's strengths?

Reviewers point out many project strength such as; great collaboration, excellent management team, good use of resources, good public outreach, clear vision of how to complete the project and help DOE reach technical targets. Another reviewer points out that lessons learned will be made about getting a project like this going.

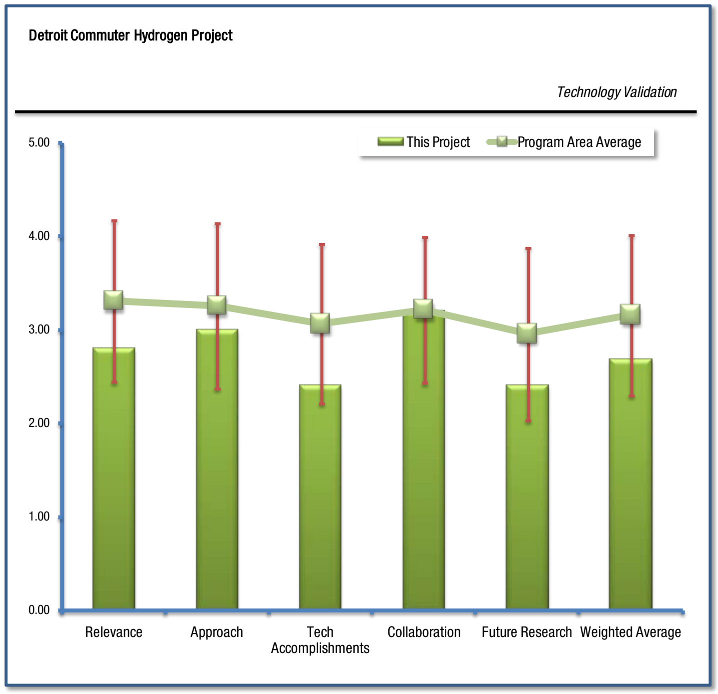
What are the project's weaknesses?

Reviewers point out few project weaknesses but mention that changing politics have affected the success of this project in the past (in the forms of permitting delays and funding issues).

Do you have any recommendations for additions or deletions to the project scope?

The only recommendation is to write up lessons learned (noise permitting).

Detroit Commuter Hydrogen Project: Jody Egelton, Southeast Michigan Council of Governments (SEMCOG) - POSTER



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Reviewers agree that the project relevance is good and addresses main objectives of DOE in Tech Validation efforts. They point out that H_2 ICE and hythane buses could be an early way to bring in hydrogen infrastructure and educate the public about hydrogen. One reviewer points out that Michigan houses the big three automakers and one would think the surrounding area would be early adopters of hydrogen technology.

Another reviewer points out that the technology evaluated could help increase use of hydrogen. But they feel it is unclear if H_2 ICE vehicles are on a path to commercialization and the project would need to see a committed OEM before continuing funding.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers feel that the project appears to be well designed as it attempts to break some of these barriers to acceptance by running regular bus routes that could be part of a larger mass transit system linking Detroit, Ann Arbor and the Detroit Airport. One reviewer says the since the project has only begun collecting data for the past few months, ultimate success will depend on detailed data collection - usage, maintenance (both preventative and repairs), fuel economy and cost of operation are all important criteria that should be monitored and reported. They also say a plan for data collection should be prepared and approved (if this hasn't already been done). One reviewer does feel that there is too much dependence on fuel supplier and "good will" of partners. A different reviewer said this project is a needed demonstration of a niche application, short haul buses within a regional public transportation system. They also feel the ICE approach will be very useful in comparison with the many FC validation activities being pursued in the DOE TV effort. One reviewer points out the fact that hythane as a fuel can be an educational precursor to hydrogen at a station. The comment on the bus route selected as it is a very busy one (airport runs) and would see a lot of customers. Reviewers also say that the comparison to a baseline (conventional) vehicle is good, but it would be nice to see a comparable gasoline vehicle instead of Propane.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewers understand that the project is just beginning and in the early stages, but the progress to date appears to be satisfactory. They recommend that the project could provide more details on the implementation of the project from fleet perspective: early experiences, challenges overcome, training accomplished. There was no suggestion as to what else might be an H_2 source. Also, no information on ridership is provided or any data for that matter other than it is running 8 hours daily. The reviewers have a lot of concerns and questions of the loss of the BP fueling station, this seems to be a serious problem.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

The reviewers feel that this project appears to have appropriate partners and benefits from good collaboration. There are serious concerns over the future ability to get fuel, and the reviewers feel the project should work quickly to identify other solutions to avoid further delays in schedule. Reviewers feel there will be a problem with the continued involvement of the hydrogen provider (BP). One reviewer did point out that the poster session did discuss outreach efforts to secure a replacement to the BP operation for hydrogen.

Reviewers agree that being associated with the SEMCOG (with 50% cost share) will encourage collaboration across municipalities as to how this project is going. One reviewer did not see anything specific about an outreach plan. Another reviewer points out that project is getting user input with onboard user feedback cards but again, no data on what the riders are saying was provided.

Question 5: Has the project effectively planned its future work in a logical manner?

The reviewers say that the future plans are adequate with the possible exception of fuel (hydrogen) availability and that is fuel is not available the buses should be transferred to somewhere useful before their lease is up. Reviewers also point out that operation during summer months (air conditioning requirements) and winter months (adverse weather conditions) will be especially important.

What are the project's strengths?

Reviewers feel there is a good project plan and good partners. One reviewer points out that according to poster session the project has the most ridership of any Ford Hydrogen ICE bus to date. Reviewers also commend the project for introducing hydrogen in metropolitan Detroit, MI. Reviewers feel that this project is a good application for demonstrating this technology in real world validation with good comparison to baseline technology.

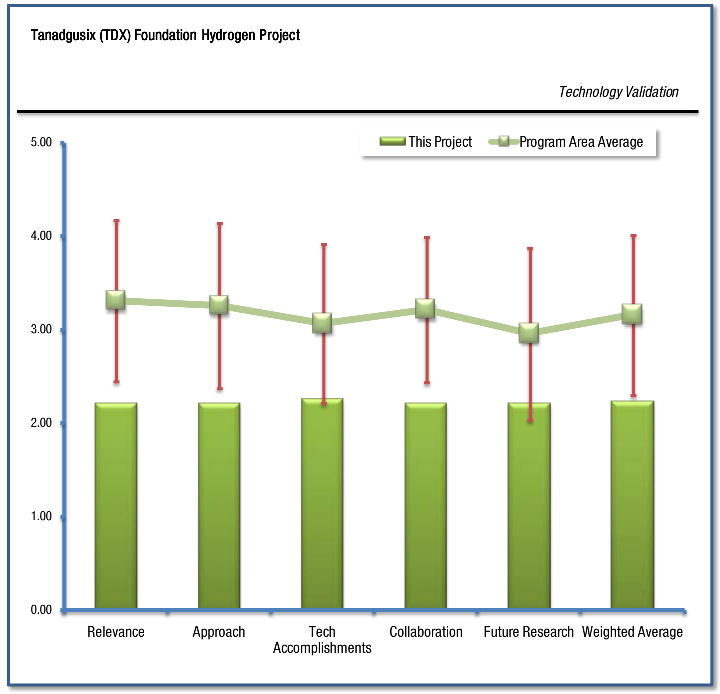
What are the project's weaknesses?

Almost every reviewer brought up concern with fuel availability. They feel the lack of hydrogen infrastructure and the lack of contingency planning with major partner (BP) hampered project and will shorten the project. Reviewers point out that not enough detail on data collection included in presentation and it appears the project does not share data with other groups.

Do you have any recommendations for additions or deletions to the project scope?

One reviewer recommends developing a detailed data collection plan. While another reviewer feels that the project could benefit from gasoline comparison vehicles in similar service. Reviewers also recommend that the project should discontinue if a reliable fuel supply cannot be secured resulting in inadequate data being collected.

Tanadgusix (TDX) Foundation Hydrogen Project: Katherine Keith, Tanadgusix Foundation - POSTER



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
Reviewers say that this is an interesting demonstration of renewable hydrogen used in a public transportation. However the unique setting (a small, sparsely populated island in the Bering Sea) severely limits the benefits of the projects as an example that could be replicated in other locations. Another reviewer said that this project only partially supports the DOE Hydrogen Program objectives, as only 1/4 of project is focused on hydrogen. As such another reviewer points out that this project helps analyze the wind to hydrogen technology pathway, which relates to many DOE targets for renewable hydrogen. One of the reviewers says that the PI reported that assuming a 20 year project life, the cost to run the leased H_2 hybrid ICE is $13 million. This is a high risk/low value project.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Reviewers feel that the approach is sound and reasonable, however the costs associated with the project may be unreasonably high due to the geographical location and the project team should have conducted a good economic analysis. They point out that this project illustrates the technical viability of wind/electrolysis production of hydrogen.

One reviewer says all the major steps are laid out, but details of the execution plan, analysis methodology and cost calculations could be clearer. One of the reviewers wondered if the H2A model was being used for cost estimations.

A different reviewer felt that this project appears to simply be using data on various fuels, vehicle types, approaches for the TDS Corporation to make a purchasing decision.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
Reviewers agree that it is very early in the project, but that the progress to date seems to be reasonable. One reviewer points out that the methodology for determining the assessment metrics and "scores" for the four transportation alternatives is not clear. A reviewer raised the issue that the VESTA Turbine works well but the project is not using electrolysis to make the hydrogen.

Other reviewers raise issues with the initial costs of the project by pointing out that motor gasoline costs $13 per gallon and four HICE Ford buses were purchased at a cost of approximately $250K each (this cost appears to be too much). A different reviewer points out that if the project is going to state the $13/mile H2ICE path cost, they should state the cost per mile from the other three technologies, which look like they would range from ~$1/mile to $6/mile (to keep things in perspective). Yet another reviewer said it is hard to imagine all three buses have same estimated maintenance cost of 55 cents/mile.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

One reviewer pointed out that there are local partners in this project - however a vehicle provider partner would strengthen the project as opposed to just leasing the hydrogen-fueled ICE shuttle buses. One reviewer pointed out that there was no mention of the nature of the collaborations.

Question 5: Has the project effectively planned its future work in a logical manner?

The reviewers say that the future plans appear to be reasonable and looks like it will yield answers to interesting and relevant questions.

What are the project's strengths?

The reviewers feel that there is good engagement by the collaborators and that they are overcoming weather related obstacles such as cold weather and the remote location. A different reviewer feels that for the low budget of this project, it could yield some interesting results to guide this and other future standalone wind to hydrogen projects.

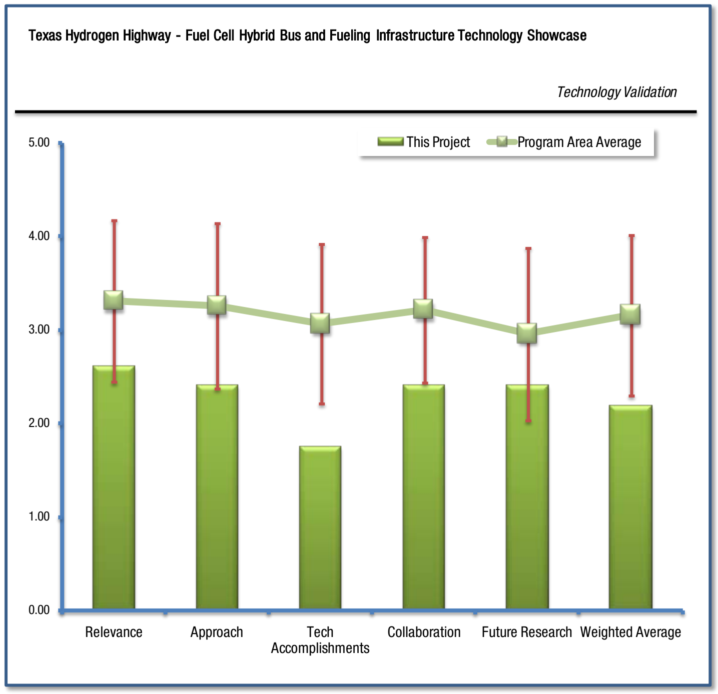
What are the project's weaknesses?

Reviewers point out that the extreme geographical location is a project weakness. They also feel that there is a need for stronger awareness and collaboration among other related wind-to-hydrogen projects that have already demonstrated working systems. One of the reviewers sees no depth of knowledge that can supplement the existing body of expertise. Further, the reviewer believes there is little potential to demonstrate the use of hydrogen via various product applications, as the sponsors appear to be totally focused on attracting hydrogen vehicles to this remote area of Alaska. The reviewers believe this will not happen.

Do you have any recommendations for additions or deletions to the project scope?

A reviewer says the project should ensure that detailed performance and cost data are collected and reported. Another reviewer feels the project should buy an electrolyzer and hook up to the wind turbines to generate hydrogen. They say that this will help DOE with their cost and technical production targets from renewable resources. One reviewer says that if this project was to continue (and they would not recommend continuance), the sponsors need to identify early market hydrogen-using products for the customers in this area. Another reviewer recommended that the project should have an outside review of results by project collaborators, particularly NREL.

Texas Hydrogen Highway - Fuel Cell Hybrid Bus and Fueling Infrastructure Technology Showcase: David Hitchcock, Texas Hydrogen Highway - POSTER



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

One reviewer stated that the project did not identify technical target goals. Another reviewer said the project contributes to data collection efforts within TV. One of the reviewers said that FC buses are one of the early markets for transportation fuel cells and it is good to have another bus being demonstrated and evaluated. The reviewer said that the project needs to flesh out the nature of the "performance evaluation" listed as one of the milestones; what data will be collected, how will it be compared on ongoing bus evaluations?

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Two reviewers say the approach appears to be logical and reasonable. They feel it will introduce hydrogen/fuel cell technologies in a location that traditionally has a petroleum-based economy. Another reviewer makes the point that the barriers to using hydrogen fuel cell buses in public have already been proven in many places already in the US. The reviewer questions why DOE would want to spend money to cover the same educational public awareness ground.

One reviewer mentioned the unique aspect of the project appears to be the inclusion of plug-in electric capability (which a very popular concept these days).

Two reviewers felt that the approach is a bit vague on details and could be more detailed, such as explaining how additional potential transit applications would be evaluated for the future based on results from this project (cost, public awareness, CO_2 reduction, etc.).

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Reviewers understood that the project just started and had been waiting for funding. One reviewer did note that the hydrogen fuel cell bus and refueling infrastructure have been procured (from non-DOE resources).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Reviewers did note the partners, but mentioned that no information is given regarding roles and responsibilities of partners. Again, a reviewer did note that the fuel cell bus and infrastructure have been funded by non-DOE sources. One reviewer recommended that the data should plan on feeding FC bus data to NREL for use in their overall evaluation of FC buses.

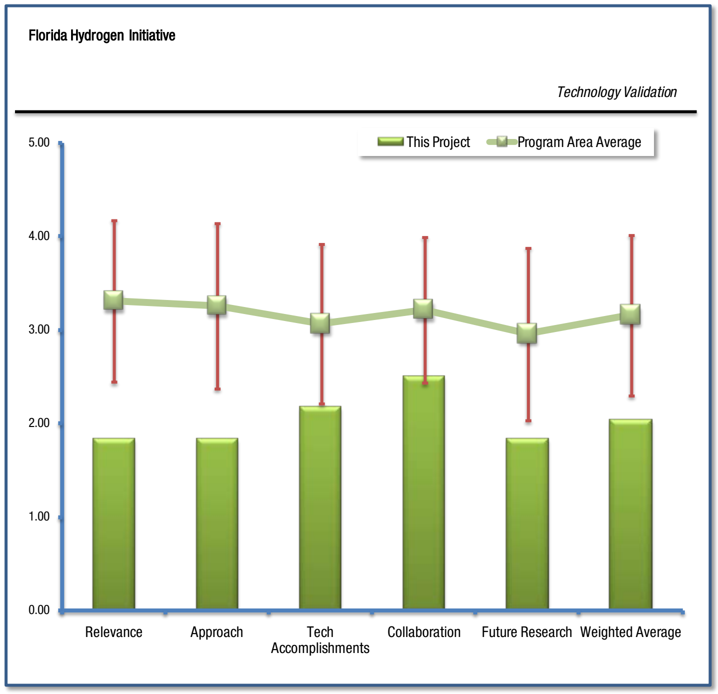
Question 5: Has the project effectively planned its future work in a logical manner?
Reviewers commented that the future plans and schedule appear to be adequate, logical and straightforward. One reviewer makes a statement that this project is unlikely to start, given the DOE decision to eliminate funding for hydrogen-powered vehicles.

What are the project's strengths?
Reviewers identified many project strengths such as; GTI is involved, bus being available, hydrogen source is available. Reviewers also note that the project contributes to the body of knowledge about fuel cell operation in a different vehicle application. Reviewers also note that the inclusion of PHEV aspect to the bus operation should increase interest in the project.

What are the project's weaknesses?
Multiple reviewers noted that while it is a fairly small project there is an overall lack of details such as no technical targets or outreach and education activities, except overcoming public awareness. Reviewers would like to have more details about how progress on this project will be measured and how it will be integrated into the overall DOE program and H_2 community. One reviewer would also like to have the roles of the partners clarified.

Do you have any recommendations for additions or deletions to the project scope?
Reviewers recommended that the project cater to educational institutions and should train bus and maintenance crew based on Palm Springs experience and readily available training manuals. One reviewer would like to see a detailed plan of how the bus performance will be measured, how it will be compared to some sort of baseline, and how the results could be used as a basis for future decision making about fuel cell bus deployment in similar applications.

Florida Hydrogen Initiative: Pam Portwood, Florida Hydrogen Initiative - POSTER



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Reviewers agree that there is moderate relevance to DOE Goals and note that two out of three of the areas do not validate technical targets. Reviewers felt that the projects are not coordinated. They point out that on-site reformation of diesel to hydrogen is not a high priority and the museum exhibit is educational, but suffered from lack of rotation among other museums. The HyTech Rest Area did not end up as planned.

Overall the reviewers feel that, while some aspects are interesting, the full impact of these projects may not be that significant and the technologies are unlikely to become a commercial product. Furthermore multiple reviewers point out that these projects do not actually support DOE's objectives in any meaningful way, issues were raised with diesel as a feedstock.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Reviewers point out that two out of three project areas are educational in nature and only the On-site Reformation of Diesel Fuel for Hydrogen Fueling Station has any technology validation relevance. They also point out that DOE does not have a technical target for producing hydrogen from citrus or methanol.

The reviewers do say that using a competitive process to solicit ideas is good, but the resulting projects seem arbitrary/unrelated. They note that teams formed around each project that appear to be sound in the beginning. To be successful the reviewers thought that there should be a roadmap/plan to increase hydrogen use in the state that meet goals for the state and align with DOE objectives.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer points out that the project has set out to do what it said in the most basic ways, but the project has had a number of changes in contractors (Orlando Science Center changed hands) and that caused a loss of interest in seeing the project through. Reviewers note major problems like the citrus waste is not working out and then more fuel cells are needed to power the rest area. They also point out that the exhibit never left the first museum yet they proposed that it would tour 18 museums.

In general the reviewers noted that there has been some success with the education and outreach attempts but in general the projects have had varying levels of progress. Project partners should consider if continuing is feasible since original objectives have changed. One reviewer points out that the first two projects that began in 2006 (citrus and H_2 assessment) are behind schedule. The diesel project is completed, but metrics including costs were not provided.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Reviewers said that the collaboration and coordination with project partners are good for all selected projects and are working well. The reviewers mention that partnerships outside of the project team were identified, but specific tasks completed by each partner were not. Furthermore reviewers point out (again) that collaboration with the other 17 museums did not occur as planned. One reviewer points out that it was explained at the poster session that the exhibit didn't travel because it is costly to do so and the museums charge fees to host exhibits. This should have been known up front and at least collaborating with museums in Central Florida could have been accomplished.

One reviewer stated that they could personally verify that the Orlando Science Center piece is in place. They commented that it seemed to be geared to young students 5th grade to 8th grade.

Question 5: Has the project effectively planned its future work in a logical manner?

Reviewers said that in some cases the project is over and doesn't need more funding (the museum exhibit, for example, only needs a future assessment). They point out that reforming diesel to produce hydrogen is not a high DOE priority nor is methanol fueled fuel cells. One reviewer does mention that during the Poster Session there appeared to be no interest in performing another education hydrogen project in the future. In fact, the new Contractor for the Orlando Science Center didn't know a lot of the required details.

Reviewers brought up that there should concentrate on fuel cell durability and that in general any follow-on activities should be weighed based on applicability to wide-spread use and potential for commercialization. However, a different reviewer noted that future work and these projects overall have little relevance toward eliminating barriers.

What are the project's strengths?

In generally the reviewers pointed out many project strengths such as Chevron demonstrating reforming of diesel at the bench scale, sulfur reduction reported in the on-site reformer, good partners and considerable cost share (from one project). One reviewer noted that the project was multi-dimensional and their approach worked state-wide.

What are the project's weaknesses?

Overall the reviewers found quite a few project weaknesses. Reviewers pointed out that besides having a lack of commitment from many stakeholders the project was also buying methanol from the Netherlands and importing to run through their fuel cell.

Reviewers felt that the projects could benefit from an overall plan to meet goals of increased H_2 use in state. They also point out that the project demonstration periods should be longer to allow adequate data collection for analysis. Similarly the reviewers thought that the lack of follow through in executing educational projects that could have reached large audiences was a project weakness.

One reviewer also pointed out that liability insurance was an issue for this program. They point out that the lack of an entity to take on this responsibility holds the project back.

One reviewer summed it up by saying; that by providing funding for another entity to provide funding had led to small, disparate projects that were not very compelling and did not assist DOE in meeting their goals. Reviewers also thought that the projects will not have much impact on the technical development of hydrogen-fueled vehicles.

Do you have any recommendations for additions or deletions to the project scope?

Reviewers realize that the projects are more or less complete and provided suggestions for moving forward. One reviewer recommends the scope of each project could be analyzed for ability to address DOE goals, and lead to potential commercial products. Reviewers also feel that any separate projects that are similar, can be integrated in the future, and benefit from shared lessons learned. They note that any funds that carry over into FY2010 should be directed to fuel cell activities.

One reviewer feels that the program should be eliminated or scaled back to only those areas that do not need liability insurance. The recommend that perhaps just public outreach should be done and note that the program is too diffuse and lacks effective leadership.

One reviewer felt that the project still needs to complete a final report. The reviewers also suggested getting funding from state to continue the maintenance of the kiosk at the Florida turnpike.

10. Safety, Codes, and Standards

Introduction

DOE is working to develop and implement practices and procedures that will ensure safety in operating, handling, and using hydrogen and hydrogen systems. In addition, DOE is working with domestic and international organizations to identify the current gaps in the standards development process; facilitate the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications; and provide technical resources to harmonize the development of international standards.

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses. In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Presentation Title	Principal Investigator and Organization	Page Number	Relevance	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
Hydrogen Codes and Standards and Permitting	Carl Rivkin, National Renewable Energy Laboratory	10-4	4.00	4.00	3.83	4.00	3.83	3.92
Hydrogen Safety Sensors	Robert Burgess, National Renewable Energy Laboratory	10-8	3.20	3.60	3.40	3.40	3.20	3.38
Materials Compatibility	Brian Somerday, Sandia National Laboratories	10-11	4.00	3.67	3.50	3.50	3.33	3.62
Hydrogen Safety Knowledge Tools	Linda Fassbender, Pacific Northwest National Laboratory	10-14	3.67	3.33	3.50	2.83	3.33	3.42
Hydrogen Fuel Quality-Focus: Analytical Methods Development & Hydrogen Fuel Quality Results	Tommy Rockward, Los Alamos National Laboratory	10-18	3.50	3.67	3.33	3.50	3.17	3.43
Hydrogen Release Behavior	Chris Moen, Sandia National Laboratories	10-20	3.80	4.00	3.60	3.60	3.60	3.72
Hydrogen Safety Panel	Steven Weiner, Pacific Northwest National Laboratory	10-23	3.60	3.80	3.60	3.60	3.40	3.62
Codes & Standards for the Hydrogen Economy	*Gary Nakarado, Regulatory Logic*	*10-25*	*3.67*	*3.67*	*2.33*	*3.33*	*3.00*	*3.03*
Safe Detector System for Hydrogen Leaks	*Robert Lieberman, Intelligent Optical*	*10-27*	*3.50*	*3.75*	*3.50*	*2.75*	*3.75*	*3.50*
OVERALL AVERAGE FOR SAFETY, CODES, & STANDARDS				**3.67**	**3.71**	**3.46**	**3.41**	**3.54**

NOTE: Italics denote poster presentations.

Overview of Safety, Codes, & Standards: Antonio Ruiz, U.S. Department of Energy

1. Was the Sub-program area adequately covered? Were important issues and challenges identified? Was progress clearly presented in comparison to the previous year?

Most reviewers felt that the sub-program area was adequately covered by the presentation. A reviewer stated that the sub-program area was adequately described with enough depth. Another noted that the subprogram was very well covered, the important issues were identified, and progress was shown. A third reviewer commented that Antonio gave a clear presentation that showed significant progress through the program that comprehensively addressed codes and standards needs. Challenges were clearly identified with the strategies to overcome them. To another, the sub-program area was covered completely, barriers and challenges have been identified, and progress has been made from the previous year. A statement was made that the subprogram was well covered and issues and challenges were identified, but a comparison to the previous year should have been presented.

A reviewer offered that progress was clearly presented and the sub-program was covered for what was able to be funded this year. The most important issue to this reviewer is the request for zero funding from the Secretary of Energy as progress was very clearly presented; the program has made significant progress to date, data were aligned and timed very well with codes and standards development, and coordination with national labs generates very valuable data which is incorporated into national standards. The program demonstrated how well they are working with national and international codes and standards organizations and coordinating them. On-line tools for permitting officials of hydrogen installations and the programs for emergency responders are a very valuable resource for progressing the technology.

A reviewer commented that the presentation did not cover all of the issues or barriers that have been identified by the California Fuel Cell Partnership or those who have tried to get projects built. Due to funding issues in the past, a more comprehensive discussion of accomplishments should have been presented.

2. Are plans identified for addressing issues and challenges? Are there gaps in the project portfolio?

Reviewers generally stated that plans were identified for addressing challenges, but that funding would be an issue for the future. A reviewer said that challenges were identified along with progress and accomplishments. However, issues beyond the control of the sub-program and management negate planning for addressing any issues or challenges. To another, there were plans for addressing issues; however, due to the recent budget cut, the presenter did not cover what will happen over the next several months. This reviewer asked how any of the needed goals would be achieved when the Program is in close-out mode. A reviewer felt that plans were not addressed, as there can be no further plans for addressing challenges per the zero funding request from the secretary; this needs to be reconciled.

Planning for addressing future challenges has been identified, according to a reviewer, who went on to note that whether there will be funding to address all the issues is a big question. This reviewer saw a minimal amount of gaps, but would like to see greater involvement from OEMs and energy producers in future work. How to develop the incentives to get their cooperation is a challenge.

A reviewer said that plans for addressing issues and challenges were adequately covered. There should be some discussion concerning potential issues in market transformation segments (telecommunications backup fuel cells, material handling equipment fuel cells) as these are viewed and the nearest term markets and products are being introduced. Another stated that there is a detailed plan and discussion of challenges. There was not much of a discussion regarding remaining gaps- just remaining work needing to be done. There should be however recognition of prioritization related to safety incidents: e.g., shifting or adding resources to cover immediate development (such as component issues at 70MPa APCI site).

Other comments received included that plans were identified for addressing issues and challenges. For gaps, the codes and standards program is comprehensively addressing most or all of the key codes and standards needs. However, additional work to increase international collaboration and the development of codes and standards that may aid the international installation of new systems could help increase the export of American hydrogen and fuel cell products. DOE's codes and standards program could increase its scope to make sure areas that can help increase these international installations are addressed to increase the use of hydrogen and fuel cell products overseas.

3. Does the Sub-program area appear to be focused, well-managed, and effective in addressing the DOE Vehicle Technologies Program R&D needs?

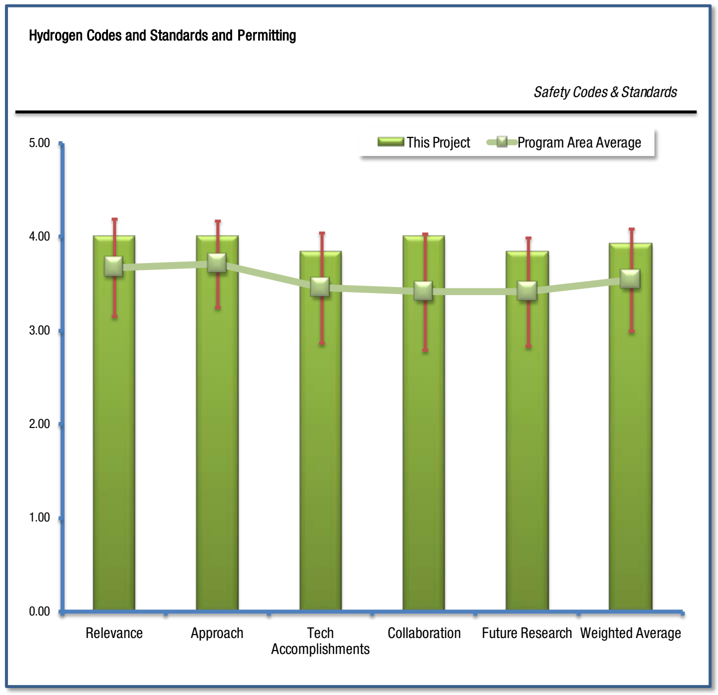
Responses to this prompt were generally positive, with one reviewer offering that overall the subprogram is achieving very good results. Another statement was that the sub-program area is very focused, well managed and effective for the DOE hydrogen program. Further comments were that the sub-program area is focused and has been managed well given the immense barriers and challenges that exist. Managing such diverse areas as the minutiae of fuel quality measurements and getting code officials up to speed on the technology has been well handled. A reviewer stated that the sub-program appears to be well focused and well managed. It addresses the needs of the underlying R&D needed for the development of effective codes and standards. It effectively communicates to a wide cross section of the emerging community of hydrogen users. To another, the sub-program has been very well-managed and focused to date, but this reviewer felt the sub-program cannot continue to address the DOE Hydrogen Program R&D needs if there is no funding made available. The Sub-program was well focused, to another reviewer, but the effectiveness could not be evaluated since many of the projects were just getting restarted.

A reviewer stated that the DOE codes and standards program has done an excellent job of making sure that the most important areas are addressed comprehensively and with significant collaboration. This systematic approach, in coordination with industry, has led to successes that support larger DOE program needs. Without these efforts, new applications would have difficulty entering the marketplace.

4. Other comments:

Other comments received about the sub-program included that this was an important program to leverage also for electric vehicles. A reviewer noted that the program management has done a very good job of managing a complicated set of tasks. This reviewer went on to say that cooperation among the national labs has been good, but necessary course corrections from industry to the projects that will result in usable data have been lacking. This is not the fault of the Sub-program management, but of the individual companies themselves. This reviewer felt that proprietary interests have overridden the need to advance the technology. A reviewer was unclear in general as to how the conclusions supporting the request for zero funding were determined when this well-managed program repeatedly demonstrates progress and meets its goals. The final reviewer asked that depending on the appropriation process, how is the Sub-program going to transition and keep some progress on its actions when it is no longer able to fund any activity? What strategy will managers use to keep information current from the respective demonstrations and studies that are still needed for state funded activities, such as Clean Cities and CA Fuel Cell partnership?

Hydrogen Codes and Standards and Permitting: Carl Rivkin, National Renewable Energy Laboratory



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer said that this program has indeed contributed very valuable information to the development of codes and standards surrounding hydrogen and vehicles and has promoted the progress of the technology, which aligns very well with industry. Another commented that this program is 'mission critical' for the implementation of a hydrogen fuel cell economy. The program is designed to meet the most needed development areas in codes and standards, in another's view.

The work supported by NREL has been critical to implementing the National Template/Roadmap. The test work supported to date has provided necessary data to support the standards development. Going forward, there are existing safety concerns that need to be addressed or investigated to provide validation of the proposed test method and data to support revisions to the standard. A reviewer said the project should move beyond hydrogen codes and standards with R&D for alternative fuels codes and standards.

A reviewer observed that the objectives are correctly identified as critical to the development of vehicle-based components, refueling infrastructure components and preparing the infrastructure for commerce. SDOs have used (and are still using) results of the testing programs outlined as a basis for verification of their performance-based code-writing process. Identification, through a national template, of organizations best suited to develop codes and standards went a long way to getting many disparate SDOs on board.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Positive comments were that the three tiered approach builds and compliments one another. A reviewer noted that again, the testing and data gathering made possible through NREL support is critical to the standards development process. The approach appears to be well vetted by the industry and government. It is an analytical, organized, and easy to understand plan which pulls the expertise of the industry with empirical testing to accomplish tasks. A reviewer said the approach shows a systematic approach to addressing codes and standards barriers, and recognizes the need for consensus and collaboration so that when new ideas get transferred into code changes, they have the highest chance of success. The approach is adequately focussed on technical gaps identified by participants from a variety of disciplines: test houses, OEMs, and Code-writing technical team members, stated another reviewer. Permitting workshops have been instrumental in getting the rank-and-file AHJs introduced to the use of hydrogen in the commercial world. Project work output by the national labs has enabled SDOs to address concerns regarding the technology.

A reviewer noted that going forward, there continue to be issues with the nozzle and PRD's that need to be resolved to provide data to support revisions to the standard and provide reliability information. There are existing safety concerns that need to be addressed as the industry moves forward. The final comment was that the barriers are significant, but the process to address them has been very well thought out and executed. It is imperative for this work to continue as new and different challenges arise.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer felt that the support for gathering data has been instrumental in obtaining data that facilitated development of performance standards focused on safety. NREL's use of existing businesses that have capabilities or with some investment in capital for the organization would be the preferred path. This makes dual use of the funds by preparing U.S. companies for commercialization of alternative fuel technologies. Another comment was that every technical accomplishment that was highlighted is integral to the safe use of hydrogen as a transportation fuel and source of alternative energy as the technology develops. There are many application areas for hydrogen and fuel cells, specifically, and all areas are in need of this kind of work.

A reviewer stated simply that the work covers a wide vista of issues from component testing to workshops. Another said that excellent progress was made, but a clear definition of areas needing more attention related to infrastructure/ vehicles if any would be beneficial.

Good progress has been made in key areas, according to another reviewer. Online materials are key and those activities should be encouraged to continue to maximize outreach of safety, codes and standards materials. This reviewer said that great progress was made on the fuel quality international standard, residential garage modeling, and support of NHFCCSCC and HIPOC plus participation on other key groups is key.

The final commenter said that 70MPa testing of vehicle storage systems and station components has allowed SDOs to base their work on performance data. This greatly enhances the acceptance of this new technology by the AHJs. Ongoing fuel quality testing at the national labs and academia is allowing NIST to prepare documentation opening the door to use of hydrogen as a vehicle fuel. These types of tests are very expensive and some quite could possibly have been conducted by the private sector. However, conduct by the national labs has achieved greater acceptance by constituents of the SDO technical committees.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

Collaboration comments were generally positive, with one noting the outstanding collaboration with industry, industry groups, SDOs and CDOs. Coordination with and support of groups like NHFCCSCC and HIPOC is key to provide resources to groups which are important but would be challenged to attract outside funding to support their operations. A reviewer highlighted the excellent coordination with the International Standards Organization, which again, is key to the progress of the technology and the move toward commercialization. This type of work brings uniformity to the technology and promotes a very positive leadership/collaborative role for the U.S. A reviewer felt that the national and international collaborations are being handled very well, but suggested that the team should host German/ US/ Japan collaborative meetings (together) to better communicate issues. A reviewer said that the team should continue collaborations nationally and internationally for continuity.

Performers have done a good job of ensuring cooperation between collaborators, commented another reviewer. Development of an international fuel quality standard could not have been achieved without the use of recognized expertise. The level of acceptance of results by SDO has been very good. As above, the permitting workshops, where test data and informational material has been shared, have been very helpful in educating AHJs. It is the acceptance by these AHJs that is going to make or break the new technology, in this reviewer's opinion.

The final reviewer thought NREL does a good job at collaboration with other institutions. This reviewer thought it would be helpful for the program to have NREL to invest more in establishing and building capabilities for other organizations (as opposed to building new facilities) that will help the transition/commercialization. Specifically, if an organization has the expertise to perform testing/evaluation, etc. using the DOE funds to expand/obtain necessary capital for the initial purpose of obtaining data/validating tests/etc would then transition to a commercial venture once the technology is implemented. This is another aspect of preparing society for the change. This reviewer also believed that priority should be given to U.S. companies.

Question 5: Has the project effectively planned its future work in a logical manner?

The first reviewer commented that the proposed future work programs build on past accomplishments. Another said similarly that future work proposals continue to build on past accomplishments with a new direction to support electric vehicle development. In a similar line, a reviewer said that the future work shows an important continuity with work performed so far. Especially with this subject area, where codes and standards are sometimes slow to develop, that continuity in funding and activity is crucial. Work with vehicles must continue, in this reviewer's opinion. In addition, the work on near-term applications, like sensor placement and any potential standard (if needed) for the storage of hydrogen forklifts during non-use should be addressed.

A reviewer noted that this work was very important to the progress of the technology overall; wide proposed future work has broad application to alternative fueled vehicles in general--presenter has a very good handle on the tasks at hand and understands the issues that need to be addressed. The final comment was that the focus of NREL's activities in supporting work that will address and resolve known barriers is important for providing necessary data to develop appropriate methods for evaluation. The data are necessary resources for codes and standards committees to develop and evaluate appropriate criteria. Research and support for codes and standards activities is key to successful commercialization of new technologies.

What are the project's strengths?

Strengths listed by the reviewers included that the project is broad-based in its collaboration, and that it is well-organized and very effective, with industry/interagency support. A reviewer said that the project provides necessary resources and support for the development of codes and standards that provide a path for transfer of new technology from the laboratory to commercialization. Another strength exists in managing codes and standards development through facilitation and direct participation in organizations responsible for the development of standards. The final reviewer said that great work was done in keeping different codes and standards developments on schedule and moving ahead while avoiding delays that cost much in terms of time. Significant progress was made towards addressing key areas where codes and standards can aid efficient installation of new systems.

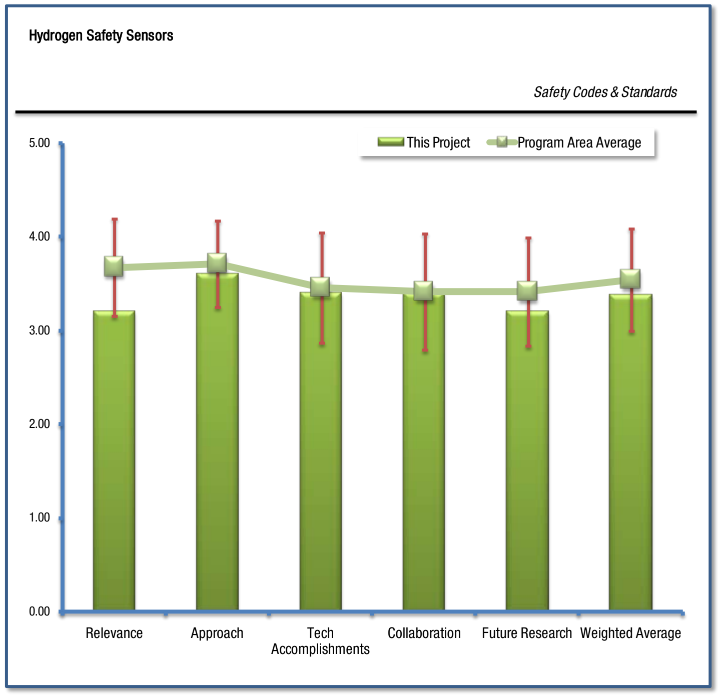
What are the project's weaknesses?

One reviewer did not notice any weaknesses, but others listed issues such as the length of time for processing requests for support for research projects and not utilizing existing business that have capabilities or with some investment in capital for the organization would be the preferred path. This makes dual use of the funds by preparing U.S. companies for commercialization of alternative fuel technologies. A reviewer asserted that the project may be trying to manage too many SDOs. Another listed weaknesses which included the lack of explanation for the hydrogen fueling effort at SAE, there was a need to further harmonize in hydrogen fueling but the GTR harmonization process update was not given, and the need for clarification regarding electric vehicle direction. The last reviewer stated that hydrogen sensor work should focus on refueling station applications, i.e. wide area sensing. This reviewer did not understand the last bullet on slide 15 re: "...special emphasis on electric vehicle standards."

Do you have any recommendations for additions or deletions to the project scope?

A reviewer recommended that DOE maintain and sustain the project. Other suggestions included that sulfur impurities on air side need to be evaluated (Hawaii and in laboratory), and that the team needs to add scope related to hydrogen sensor testing for a field trial once laboratory testing is complete. This reviewer recommended discussing this issue with CaFCP for future prospects. Another suggestion was to conduct additional work to increase international collaboration and the development of codes and standards that may aid the international installation of new systems can help increase the export of American hydrogen and fuel cell products. DOE's codes and standards program could increase scope to make sure areas that can help increase these international installations are addressed to increase the use of hydrogen and fuel cell products overseas.

Hydrogen Safety Sensors: Robert Burgess, National Renewable Energy Laboratory



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

Positive comments included that development of sensor performance is critical to infrastructure development both for commercial and residential refueling devices. Another comment was that the team has done excellent work with and contributing to the codes and standards development for a specific aspect of hydrogen safety and great work with industry; both are integral to progress. A reviewer highlighted that a need was identified and roadmap was developed for technology transfer to industry.

A reviewer commented that the project listed nearly every barrier in the codes and standards subprogram. At best, the project could help address barrier N: Insufficient Technical Data to Revise Standards. Another asked if the DOE objectives are 0.1 - 10%, why is the evaluation limited to 4%? What is the expertise of NREL to validate new sensor R&D as opposed to NIST? Why should NREL be established by DOE to be the sensor test laboratory? These issues were not discussed in the presentation.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Technical barriers were clearly identified, according to one reviewer who said that collaborating with device developers manufacturers is the right thing to do. Similarly, another commented that barriers were clearly identified with roles and responsibilities highlighted. A reviewer felt that there was a good understanding of technical requirements and constraints for performing hydrogen sensor characterization work. The fact that they balance data reporting for manufacturers while dealing with sensitive, proprietary information promotes understanding and develops competition in the market place, which in turn leads to jobs creation/security.

The interaction between manufacturers and NREL team was not clearly defined, according to the last reviewer. When a manufacturer requests UL certification, they have to pay UL for the tests and final certification. Is this task to replace the UL requirements, provide independent test data for accelerated certification, reduce the cost of certification for the manufacturers, or just provide information to companies who use hydrogen and must install sensors to meet the code? Are the test protocols accepted by NIST and other standards developers or are they still under development?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer offered that the team has a very deep understanding of the various, specific technology required for producing useful data and information for the manufacturers and/or end users. This is another key role in progressing the industry as a whole and very valid work. A reviewer said that there was a clear approach from identifying needs to benchmarking, technology transfer and codes and standards development. Gaps in current technologies were identified. A statement was made that reasonable progress has been made with respect to test apparatus and facilities.

Coordination with sensor standards efforts is good. Better outreach to and communication with sensor manufacturers could be beneficial, this reviewer suggested. Another suggestion was that evaluation of a wide variety of sensor types using a consistent set of criteria should result in the best device for a given application. The final reviewer noted that the lab was running, and asked several questions. How many sensor types have been tested? Do the manufacturers agree with the statistical results? How is the data published? Where is the data from the current round of tests?

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer noted that partners and collaborators were identified across academia and industry. Both of the existing and the new collaborations are valuable, according to another commenter. Additionally, the team is also actively seeking new collaborations/sources of data generation and has confirmed results with international testing agencies. This sort of collaboration is invaluable. The comprehensive set of collaborators should ensure agreement on devices, test protocols, and coherent international standards. A reviewer said that there is reasonable collaboration with other institutions and SDOs but increased industry input should be solicited. The final comment was that there was a good group of partners, but more discussion on roles and responsibilities would have been more helpful. Specifically on the testing with JRC, has there been validation testing between the facilities to verify protocols, data collection and analysis?

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer offered that the plans do build on past work. Another said that there was a clear and focused future work plan, building on prior work and geared to address gaps. A reviewer said that aspects of future work are reasonably defined but the sequencing and dependencies of the elements and decision points need to be better defined. It was noted that the project concentrates on stationary applications, but there may be a need for the same type of evaluation for on-vehicle gas sensors.

A final reviewer asked why the phase II was to be built to handle the wider range if it was not incorporated into the original design. What are the highest priorities for this work, especially if the funding is reduced? What does work towards improved codes mean? more specification? engineering? system testing? These issues were not clear to this reviewer.

What are the project's strengths?

A reviewer highlighted the good team, and a reasonable approach to test different technologies under similar conditions. Another stated that the project has a good handle on what is required to undertake the effort and is making progress. To another, there was a good base of collaborators with a wide variety of potential candidate devices. Finally, a very well rounded and encompassing process was demonstrated for acquiring the equipment to test. They have established good relationships with manufacturers and are able to provide unbiased information for all of the industry, allowing specific companies can acquire data from their own equipment. This program looks very valuable and useful in bringing the industry to the commercial phase.

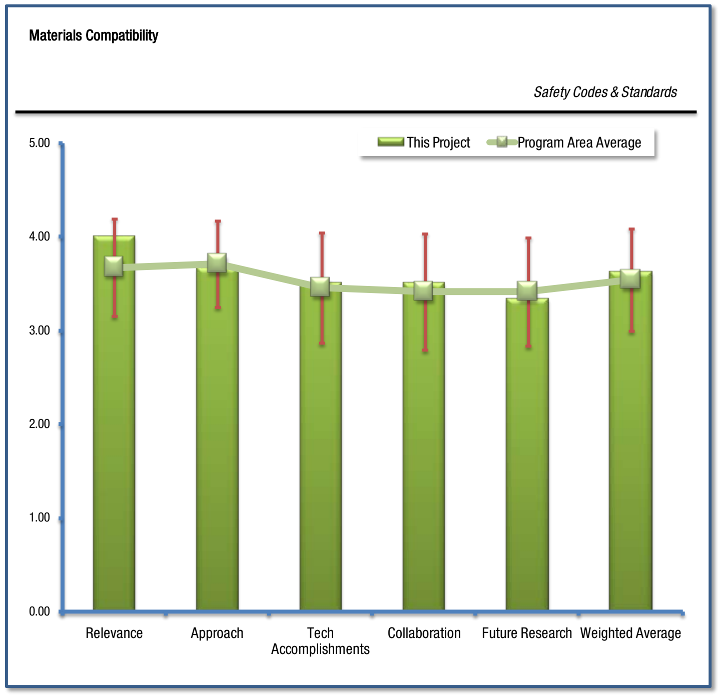
What are the project's weaknesses?

The project seems to address only a single barrier within the codes and standards subprogram though it is conceivable that barriers in other subprograms could be addressed to some degree by improvements in sensor technology. Another comment was that the presentation does not indicate clear winners for specific application (this reviewer was referring to refueling infrastructure uses). Are some performing better than others? The poorer performers should be weeded out and focus shifted to the more promising devices for commercial and residential refueling infrastructure use, according to this reviewer. The final reviewer listed weaknesses as roles and responsibilities, assumptions for the hardware design, and test protocols and validation of same.

Do you have any recommendations for additions or deletions to the project scope?

The only recommendation was that the effort is not examining wide area sensing technologies. It may be that such technologies, used in a number of areas for more generic flammable gas detection, may not be suitable for hydrogen-specific detection. At least an initial assessment is warranted.

Materials Compatibility: Brian Somerday, Sandia National Laboratories



Reviewer Sample Size
This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
A reviewer stated that the work performed on materials compatibility in a hydrogen environment has been critical to the progress in standards development. The data provided and the information on the web site is the leading reference in this area. Another felt this program had very specific relevance for hydrogen and fuel cell vehicles and was extremely important for overall safety. Commenters said that the project is vital to the commercialization of a hydrogen economy and is very relevant to the hydrogen economy.

The project provides essential data for compatibility of materials used primarily in stationary hydrogen storage applications and is critical for advancing knowledge of the suitability of these materials for such applications and the requirements for engineering design and safety margins needed in codes and standards for these applications. The work is critical for the progress and success of the Hydrogen Program and engages state-of-art science and engineering knowledge and expertise at Sandia National Laboratory.

The final reviewer said the work supports both vehicle component and pipeline material needs. Rather than provide a “catalog” of suitable materials, the project direction correctly pursues testing standards and investigation of hydrogen-assisted crack growth.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
A reviewer observed that the project appears to be focused on current technical barriers. The web site provides the information obtained and is available for use by anyone. It was this reviewer’s understanding that Sandia also adds to the materials list as information is requested from industry. That being the case, the work is focused on providing solutions for technical barriers. Another comment was that the overall approach is sound, but the focus on high pressure containment will lead to gaps in low pressure non-metallic materials. Such materials will be found in the low pressure side of FCV fuel delivery systems. A reviewer characterized the work as having an outstanding approach which leverages industry and government collaboration along with empirical data to accelerate the progress of hydrogen material compatibility.

To another reviewer, the project addresses voids in the existing materials compatibility database, and in-situ testing with high pressure hydrogen gas provides valuable data for both engineering design of high pressure containers and for design requirements in container standards. The work also includes evaluation of test methods and implications for design requirements.

The final commenter stated that the approach to developing test standards as opposed to providing a list of acceptable materials will allow for future development of acceptable materials.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

Good progress in meeting DOE goals, stated one reviewer. Another noted that technical accomplishments are being directly applied by industry partner. A commenter said that adding and updating chapters in the Technical Reference is valuable and completion of tests for selected pressure vessel steels show good progress, but some milestones are behind schedule. Updating of technical reference material for aluminum alloys is a positive accomplishment in another's view. Evaluations of cracking thresholds and crack growth measurements for commonly used materials beneficial to component developers. The final comment was that the work performed by Sandia and their involvement in codes and standards activities has provided a much needed resource in the area of materials when exposed to anticipated hydrogen environments. This involvement both on the research side and participation in the standards development is critical to moving standards forward in a manner that will facilitate commercialization of new technologies.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

One reviewer thought the collaboration is good and effective. Another noted that the broad collaboration (within DOE programs and internationally) was very important. A reviewer highlighted that data were being shared with industry partner, which was also noted by a reviewer who said that feeding material testing results back into ASME and components suppliers will yield long-term benefits. Similarly, providing technical input to and involvement with ASME is crucial and an essential part of the effort. The researcher and his team have been a very valuable asset to the DOE program through its direct involvement with the codes and standards development process. Involvement with the DOE Pipeline Working Group also adds value.

Question 5: Has the project effectively planned its future work in a logical manner?

One statement was that future work plans definitely build on past progress and are adequately focused. In contrast, a reviewer said that the future work seems limited in scope. According to the third reviewer, the project focuses its research efforts where industry indicates a need exists and where there is recognized need for future development to allow improvements in methods and technologies. The final comment was that continued interaction with industry, SDOs, and other labs is essential in addressing future work; more direct involvement with automotive OEMs and with component manufacturers and standard development organizations for components is encouraged.

What are the project's strengths?

One strength was that this project has provided a necessary source/reference for materials acceptable for use in hydrogen environments. Without this project, technology would not have progressed to the point it has today. Similarly, work on updating technical references in collaboration with vehicle/station component developers will be a big help. Measurement of fracture response of aluminum alloys may lead to reduction of weight targets for vehicle storage containers. Other general strengths were that the project was comprehensive, thorough, and relevant, and is critical for the expansion of the hydrogen economy. The project was also characterized as having an analytical and thorough plan to address potential materials compatibility concerns. The final reviewer felt this was an excellent application of laboratory expertise and test equipment to address critical needs of the Hydrogen Program, standards development organizations (especially ASME), and industry. The project is an excellent example of how technical expertise and state-of-art equipment at DOE national laboratories can be applied to address essential questions and obtain critical data needed to develop requirements in hydrogen codes and standards.

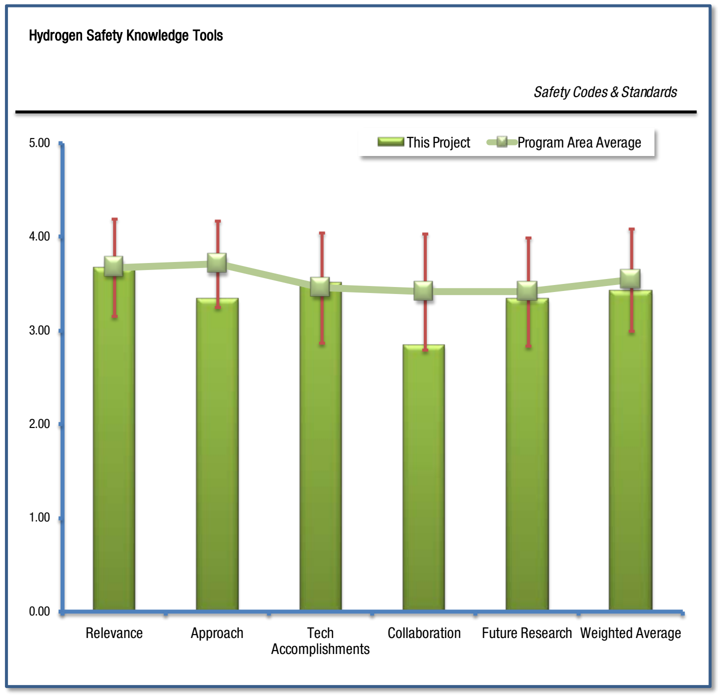
What are the project's weaknesses?

The project has no major weakness as it is well-designed and addresses critical needs of the Hydrogen Program, according to one reviewer. Another offered that this project needs to be expanded to encompass non-metallic materials at lower pressures. The only other weakness highlighted was the perceived relatively slow progress since 2003.

Do you have any recommendations for additions or deletions to the project scope?

A reviewer suggested that this project needs to be expanded to encompass non-metallic materials at lower pressures. The other recommendation was that if possible, the team should begin to apply materials science expertise to composite materials and expand Technical Reference to include chapters on these materials, particularly if a hydrogen storage tank standard for portable and vehicular use is a barrier and target (slide 2) that the project seeks to address.

Hydrogen Safety Knowledge Tools: Linda Fassbender, Pacific Northwest National Laboratory



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

The first comment was that this project provides an excellent source of materials relating to hydrogen safety, and the hydrogen incidents reporting is an excellent method for a neutral third party to gather and disseminate relevant data to hydrogen incidents. Dissemination of valid data for consumers and industry is critical to advancing the hydrogen technology. Another felt these tools were a helpful resource for those in the industry working with hydrogen: the team has made very good additions/improvements for ease of use, has added additional information, and made more resources available. To another reviewer, both the Best Practices and Incident Reporting databases and the associated activities are important in supporting DOE objectives for hydrogen safety. These tools are an excellent resource for the hydrogen safety community as well as the public. A reviewer said the work was very relevant to document incidents and experiences with hydrogen. Defining best practices for safely working with hydrogen is crucial to widespread acceptance. Incident reporting is also important in moving forward into a hydrogen economy. The final statement was that most activities address barriers. The ones that don't directly address barriers, however, are still relevant and important work.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer said that dissemination of valid data for consumers and industry is critical to advancing the hydrogen technology. Another offered that this was a great approach that could not be done better. Perhaps another example on site would be helpful. To another, the approach to developing the website seems logical and appears to be working well. This reviewer felt the suggestion to focus more on modern incidents instead of the older, potentially less relevant ones seems sound.

A reviewer suggested that vetting information to be posted on the H2 Incidents database with industry experts to ensure that it is useful and valid and meets the goals of the project is good and needed to keep extraneous/less useful information from populating the database. Another reviewer had suggestions on the Best Practices website: a more aggressive pursuit of commercial practices should be conducted. This reviewer understands that companies want to protect what they feel is their proprietary information, but safety should not be proprietary. This reviewer also had observations on the Incident Reporting database: DOE-funded projects should have incident reporting requirements already. Commercial installations should also be required to report incidents, even those that do not result in injuries.

Finally, a reviewer stated that the Best Practices website is well-designed, easy to use, and attractive. The Incidents website is not as attractive and the descriptions of incidents are sometimes sketchy (this reviewer thought this may be due to limits imposed by the facility being reported on). Both websites are well-integrated with other information sources. The Best Practices project is has good interactions with the Safety Panel, national labs, NASA, and IEA. The interaction with the Safety Panel and NASA for the Incident Reporting is essential. However, just linking the two databases is not be enough and, both projects could be improved by analysis, e.g., how incidents and lessons learned reflect on best practices.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

The first reviewer said the web site and project seems to be on track with adding materials needed and requested by industry. Another said the incidents alert seems useful, along with individuals sending information. Another positive comment was the statement that the project has been able to create two great websites. On the other hand, a reviewer stated it was hard to judge regarding technical accomplishments, but the document has progressed very well.

A reviewer said that there had been good progress in adding features and additional information to the Best Practices site, but some analysis on how effective the project has been in improving safety practices should be attempted. For the Incident Reporting database, this reviewer stated that just adding more records was not sufficient; more analysis on implications of lessons learned (perhaps for best practices) should be added.

For the Best Practices site, a reviewer said that using the peer review process to update the on-line manual is a big positive. Safety Panel observations resulting in additions to Lab Safety practices enhance the credibility of the on-line manual. Items that were added were useful in identifying/clarifying potential gaps in relevant Codes. This reviewer said that the Incident Reporting Database website is an excellent tool.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

The project has a good panel of experts that work directly with the project team, in one reviewer's view. Additional collaboration and cooperation with codes and standards developers would enhance the incidents reporting. Providing information on incidents to the appropriate SDO would facilitate prompt review by the appropriate industry technical group and promote revisions to documents in a more timely manner.

Another said there was a good link to Safety Panel, NASA, IEA, and national labs but perhaps the projects can be strengthened with more interaction with code and standards developing organizations and local code officials. More effort and analysis to assess needs for additional safety and codes and standards requirements in addressing causes of incidents would be helpful.

A reviewer suggested that there was a need to collaborate with other efforts at CaFCP & JHFC. Similarly, collaboration is good with the Hydrogen Safety Panel, but could be improved with audiences outside that group, especially non-engineers in groups who are considered to be the target audience, to make sure the sites communicate well to them.

For the Best Practices work, a reviewer would like to see more collaboration with commercial entities. This reviewer understands the proprietary nature of some of the installations, but, for the advancement of the hydrogen economy, more interaction with hydrogen suppliers and industrial process users of hydrogen would be beneficial. This reviewer suggested the team further engage commercial industry for the incident reporting database.

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer observed that the future work was not well defined, but understood that it is meant to document progress. A reviewer noted that the project has done an excellent job at meeting the need for information on incidents. The project is working to shorten the time between the incident and information being available on the web site, this is critical but it is understood there are many aspects involved that affect the timeline. Another said that the future work is outlined well and should be completed with an emphasis on making the sites more readable and attractive to non-engineers. If all those words are needed, this reviewer would suggest trying to find ways to replace words with graphics and photos, or links to explain more on another page. A reviewer felt that getting better exposure of the best practices site would be useful: there are currently links to the pages that go back and forth.

A reviewer offered that this was good future work in addressing key issues, e.g., chemical hydrides, nanomaterials. Expansion of work may overlap with other information sources (e.g., hydrogen properties) and care is needed to avoid too much overlap. Also, criteria for selection of best practice issues could be more carefully defined.

A reviewer offered that inclusion of industrial users of hydrogen in the Best Practices site should be included, and vehicle refueling operations should be included to identify best practices. This reviewer also suggested that the team increase vehicle refueling and station operation scrutiny for the Incident Reporting site. If there are not many incidents relative to the number of refuelings, this could be used as evidence of a safe refueling process.

What are the project's strengths?

A reviewer said that this work was an excellent source of information for industry and offered an excellent method of disseminating information both on hydrogen safety and incidents. A reviewer said that both websites provide important information in an accessible and searchable way and are valuable tools in making this information available to the hydrogen community and to the public. Both projects have incorporated the essential structure and information gathering tools and knowledge to become more valuable as the databases grow and are improved in clarity and purpose. Other strengths were the well thought out database that is valuable for those looking for lessons learned, and the fact that the safety panel certainly has the correct expertise to evaluate lab safety procedures/processes.

With the incidents database, the ability to address (or at least attempt to address) all the near-term incidents is impressive, according to the final reviewer. Perhaps more work could be done to explain/emphasize that all recent known recent incidents (or XX%) are covered.

What are the project's weaknesses?

A reviewer proposed that the team needs to have a defined mechanism for communicating incidents to relevant codes and standards area. Another suggested that more commercial inputs were needed. A third reviewer observed that the projects to date have focussed (as necessary) on gathering information. As the projects mature, there should be more effort on analyzing lessons learned from the Incidents database for implications for best practices and for including such analyses in the Best Practices database.

To the last reviewer, the best practices website needs a little more use of graphics. For example, can any graphics be used to replace the sea of text on the main page? This reviewer's comments are also applicable to the Incidents website. NASA's recommendation to make the site more accessible to non-engineers is good, but this reviewer questioned whether NASA is the best kind of advisor for this activity since it's one of the most engineering heavy organizations in the world. How about some communications experts or a group of people who might be considered to represent the target audience?

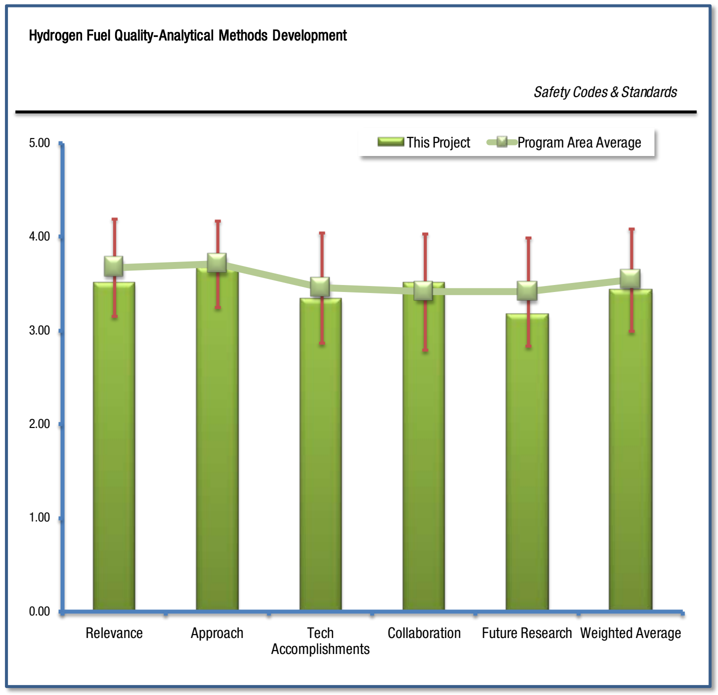
Do you have any recommendations for additions or deletions to the project scope?

Suggestions from the reviewers included adding a method/means to coordinate directly with SDO's on incident information to enable getting the information to the TAGs in a timely, efficient manner. This would promote dissemination of accurate information and implementation of potential codes/standards changes. Another suggestion was to identify which incidents were "taken care of" and which are "ongoing"; knowing this would be helpful.

The projects should proceed as planned by adding more to each database, stated another reviewer. The Safety Panel should do an in-depth evaluation of the databases and extract key lessons learned from the incidents and the degree to which the best practices database reflects state-of-art in industry and laboratory practice.

The final recommendation was that the team should emphasize the future work for best practices outlined in the presentation to include more photos and video (especially video). They need to be short, though, to ensure people watch them.

Hydrogen Fuel Quality-Focus: Analytical Methods Development & Hydrogen Fuel Quality Results: Tommy Rockward, Los Alamos National Laboratory



Reviewer Sample Size

This project had a total of 6 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

The project is providing necessary data to assist developers and modelers in determining the fuel quality limits that are acceptable, commented the first reviewer. A second said that understanding acceptable contaminant thresholds and fundamental mechanisms are important aspects necessary to form a technical basis for hydrogen quality specifications and standards for PEM fuel cells. Development of a fuel standard is critical to moving hydrogen into the commercial arena, according to the third reviewer. Selection of CO, H_2S, and NH_3 are the right fuel contaminants to check first. My only criticism is that this work has been going on since 2006 and three years later we are just starting to see data relevant to standards (SAE, ISO) contaminant tables. The final comment was that the project is primarily focused on fuel cell impacts related to impurities. Is the breath of the work sufficient if different MEA's, fuel cell type, and materials of construction are selected?

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Comments on the approach include that it appears technically robust and thorough, and that the project coordinates with industry and provides feedback to modelers to facilitate product development. A reviewer noted that in the case of hydrogen fuel contaminants, developing detection methodologies is key to repeatable experimental data. Testing contaminants in combination more closely represents what will be found in the real world. A reviewer highlighted the sound analytical approach with good repeatability. CO contamination and weight loss of catalyst was an issue with PT and ETEK; however, this work was not discussed in "future" work. This reviewer said the work needs to be broadened for more than PEM. The final suggestion was that more inputs from industry (OEMs) would provide valuable feedback to these efforts.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer observed that generally understanding fuel quality is critical to the progress of technology and bringing product to market, and both infrastructure and product developers require the information. Another noted that detection methods have been successfully developed and effects data generated: this information has been fed forward to modelers working on mechanistic predictive models. A commenter said that sound experimental design was exhibited in accomplishments to date. There are a few results that are still not adequately explained, according to this reviewer. Work involving the interaction of various contaminants seems to be at an early stage and could use better definition of the objectives as well as experimental design.

A reviewer felt there were very good results presented for CO, H_2S, and ammonia. This reviewer had several questions, however. Which data was provided by NIST and which by LANL? Were each data verified independently to eliminate procedural or equipment differences? What was the accuracy between labs? How does this get incorporated in the respective protocols or procedures? A similar comment from another reviewer observed the very good progress related to hydrogen quality testing with H_2S, CO, and ammonia: this reviewer offered that the team may want to discuss potential 'reversible effects'.

Combination testing of contaminants makes it more relevant to real world fuel applications, according to the last reviewer. Combinations to be tested should be verified by a variety of hydrogen production methods. Are these results being fed to ATSM for inclusion into their testing procedures? Those procedures will be used by NIST and California Division of Measurement Standards to enable a commercially available fuel.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer observed that LANL has worked with a wide selection of government agencies and academia in this effort. On the other hand, a reviewer countered by saying that while a large list of collaborators is presented, it is not clear (aside from round-robin testing) how most of them are participating in the effort. Further on the collaboration front, data exchange and discussion among the participants has been good. Has collaboration with the modelers been satisfactory?

A reviewer suggested that a roles and responsibilities table would have been nice. How do data collection and analysis differences between labs get resolved? What is the method for developing new approaches between labs, such as the sulfur permeation rates? The final suggestion was that a short slide on overall collaboration with other modeling effort would be beneficial to show connection to overall hydrogen quality test plan.

Question 5: Has the project effectively planned its future work in a logical manner?

The team has a good understanding of what is required to modify the experimental configurations to improve test results, according to one commenter. Other comments included that the presentation needs to be better laid out: the explanations of analytical methods run into actual contaminant testing, and the presentation was very hard to follow. A reviewer asked how the revised DOE budgets for hydrogen activities will affect future progress.

Since the work is only 45% complete, what is the expected outcome? A uniform set of fuel specifications for PEM MEA's, analytical methods to be incorporated in ASTM? A protocol for FC PEM manufacturers to follow for materials development? A broader objective and plan should have been presented, according to this last reviewer.

What are the project's strengths?

Strengths include the mixed contaminant testing, the rigorous methodology in use, the team members, the solid analytical presentation, and the analytical results to date. A reviewer said that the project is providing needed resources to advance industry. The project shows an excellent understanding of the technical requirements for executing the effort and delivering clean, sound results.

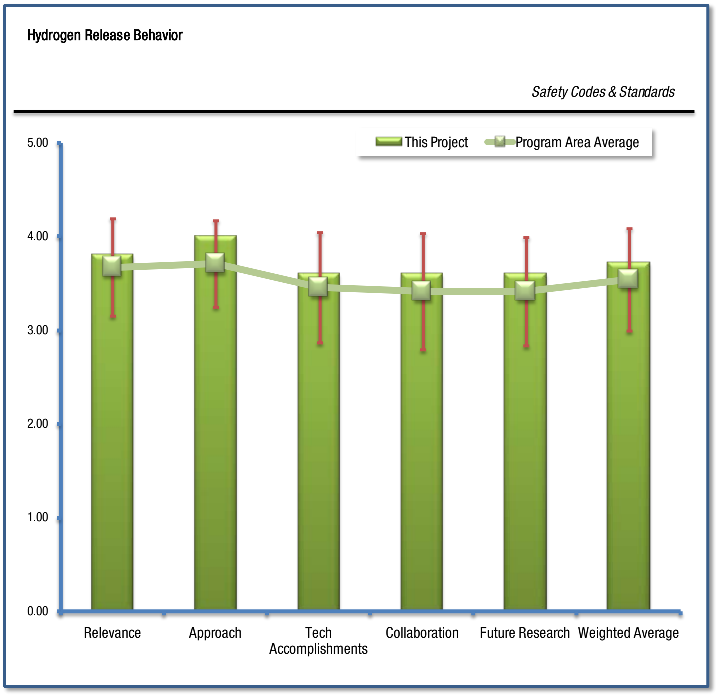
What are the project's weaknesses?

Weakness comments included that more clarity is needed regarding the scope of collaborators participation, and that the team needs to show repeatability in slides. A reviewer asked how the results will be incorporated into engineering, materials development or fuel specifications. The final reviewer observed that it takes a long time for results of testing to be peer-reviewed and published. Only after that can the data be used to update existing developing fuel standards. There must be a quicker way to get the data to the SDOs. Feedback from FC developers is critical. Developers can provide needed course corrections to ongoing research. OEMs should be pressed to provide timely feedback on testing and results.

Do you have any recommendations for additions or deletions to the project scope?

The only recommendation was that sulfur impurities on the air side need to be evaluated.

Hydrogen Release Behavior: Chris Moen, Sandia National Laboratories



Reviewer Sample Size
This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?
Hamilton, Jennifer (Primary):

A general comment was that this project is adequate in support of the development of codes and standards for hydrogen and fuel cell technologies. Interactions/involvement with many SDO's were very good, and included collaboration with other National Labs. A reviewer felt the work was very relevant for setback distances. A reviewer commented that the work is critical and essential to meeting DOE RD&D objectives. The RD&D on hydrogen behavior and quantitative risk assessment and the transfer of knowledge gained from this work to the codes and standards development process provide a model of how scientific knowledge and expertise at national laboratories can be applied to enable and strengthen the development of codes and standards based on technical data, modeling, and analysis. The final observation was that hydrogen codes and standards development and harmonization require a sound technical basis for separation requirements and this project is directly and positively affecting code development.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?
Several commented that the overall approach is technically sound, with one adding that it was thorough as well. One reviewer felt the approach was sound but that laser ignition is not a realistic ignition point.

A reviewer observed that studies on warehouses and parking structures are not mature--this area is very important and needs new and updated reports/data as the vehicles roll out and are used in "every day life" by the consumer. This project made very good use of resources and avoids reproducing data unnecessarily.

The approach is based on providing critical data, modeling, and analysis needed by standards developing organizations to establish a scientific and technical foundation for requirements incorporated in codes and standards. The development of a risk-informed decision process for codes and standards development is a major step forward and one that has been needed for many years. The incorporation of hydrogen behavior RD&D and quantitative risk assessment methodology in the development of separation distances for bulk hydrogen storage is the best example to date of how scientific information and analysis can be applied to the codes and standards development process.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.
The first reviewer simply said the accomplishments were good. Another suggested that tunnel studies are very important in the immediate time frame. The work to help reduce prohibitive standards is very good (separation distances)-this is important to infrastructure and minimizing the footprint of hydrogen installations, potentially saving costs on land acquisition, site prep, etc. Auto-ignition work very important to C&S development as well. This reviewer

suggested that the team might perhaps put together report(s) for issuance to AHJs as a resource when permitting stationary installations.

The experimental work on lean ignition limits is an outstanding accomplishment and should be made available to the larger technical community The work on barrier walls is also a valuable contribution to the scientific foundation of hydrogen codes and standards. SNL has presented its work in key scientific conferences and has helped establish international recognition for DOE's hydrogen safety RD&D program.

The results from the overpressure work using various wall configurations are very helpful. Jet ignition boundary work could be influential but the nature of the ignition source (energy, duration) could change the results of this study while providing increased usefulness. Autoignition work from relief devices and vent lines could lead to improvements in relief system design and code requirements. Support of risk informed separation distance code changes in NFPA and ISO documents has been excellent.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer said it was nice to see the expansion of collaboration at the international level, as this is very much needed and critical to uniformity in codes and standards development. Another observed that collaboration with codes and standards development organizations, such as NFPA and ISO, is outstanding, and SNL's involvement has noticeably raised the scientific awareness and technical competence of these organizations. It is also playing a key role in important international projects on hydrogen safety, such as those sponsored by IEA and in European Commission projects such as HySafe and HyPER. Similarly, a reviewer said that coordination with BAM is good, but Hysafe and Japanese efforts were good as well. A reviewer spoke of the excellent outreach and dissemination of results to the codes and standards community. Additional clarity concerning the direct involvement of working team members could be provided.

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer said the project is very focused but needs the funding for FY 10 to finish and deliver data, information, and reports; the project is imperative for the advancement of the industry as a whole. The proposed work will continue to focus on critical RD&D needs for codes and standards development. Planned work on partially confined spaces is particularly important, according to the review commenter. The project has appropriate future work items but more information regarding timing, task dependencies, and decision points should be provided.

A reviewer suggested that the team needs to evaluate 'realistic flame'/ ignition point as per SAE J2578 (lit cheesecloth) for a realistic evaluation of LFL for standards. This reviewer also said that high ignition points are interesting, but not realistic.

What are the project’s strengths?

A strength identified by one reviewer was that all of these studies are pertinent and important, especially in the current status of the industry--all of the issues addressed have high priority for the advancement of the industry and progress toward commercialization.

The most important strength of the project to another reviewer is the combination of expertise in experimental design and engineering modeling to increase understanding of critical parameters of hydrogen behavior under plausible release scenarios. This strength enables DOE to provide key data and analysis for codes and standards development, and the collaboration of SNL with standards and development organizations is exemplary. A reviewer further stated that the project is directly and positively affecting code development through excellent outreach and dissemination of results to the codes and standards community. The final strength was that the work gives initial relative data for generation setback distances with regards to multiple wall surfaces.

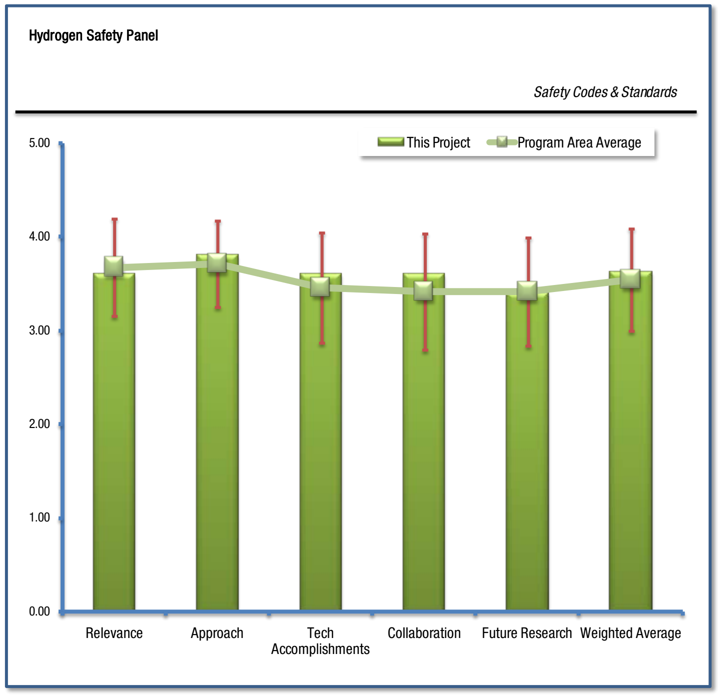
What are the project's weaknesses?

To one commenter, the project staff may be overextended as it is addressing a number of issues and participating in many important efforts with standards development organizations and other RD&D projects. It may be useful to step back and refocus priorities for applying limited resources of expertise and funding. Another weakness was that different types of ignition sources need to be incorporated into the jet ignition boundary effort. The third weakness identified was that the team needs to have realistic ignition point and clearly state a realistic real world lower flammability limit (<8%).

Do you have any recommendations for additions or deletions to the project scope?

Two recommendations were made. The first was that the experimental work on lean ignition limits in turbulent gas flow significantly improves current knowledge of a key parameter of hydrogen behavior and is an outstanding example of the value of RD&D. This work should be made more accessible to the general technical community, which still may not fully understand this important characteristic of hydrogen behavior. The second was that the team needs to state all four ignition sources of studies on one slide (welding arc/spark plug/laser/lit cheesecloth).

Hydrogen Safety Panel: Steven Weiner, Pacific Northwest National Laboratory



Reviewer Sample Size

This project had a total of 5 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer stated that the panel members represent a broad and balanced perspective on safety and technology and give valuable input and guidance to the program. To another, the project is essential to meeting DOE objectives and provides a valuable forum to identify and address safety issues. The Safety Panel is a key component of DOE's safety, codes and standards work. A reviewer said that this is one of the best projects within the hydrogen program portfolio. Due to perceived safety issues, incorporating sound practices into every project is critical to its outcome. Similarly, the panel's mission is important to mitigate the risk of hydrogen incidents, which could hinder the installation and commercialization of technologies. The final comment was that this was a very relevant topic.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

Review comments were that there were excellent results and accomplishments, and that the team has covered a lot of information and had many accomplishments--especially for the low frequency of meetings. The analytical approach and the ability of the PI and his team to stay on top of safety issues were also highlighted. A reviewer stated that PNNL has assembled an excellent mix of experts with a broad range of relevant experience. The interaction of the Panel with practitioners in the field is outstanding, and the level of engagement of the Panel members with the practical issues of hydrogen safety is exemplary.

A reviewer did say that the approach seems a little bureaucratic in general, but the reviewer could not offer a logical alternative to improve that. The approach therefore seems logical to accomplish the intended results. Opportunity for feedback by the applicant is an important part of the approach.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

The amount of reviews and safety recommendations are impressive to one reviewer, and demonstrate the clear need for this kind of resource as the technology is advancing, which is very valuable. Another spoke of the excellent progress towards safety evaluation and integration and the positive feedback from industry participants about the process and accomplishments. A reviewer commented on the very proactive approach which addresses concerns in a timely manner. The panel has accomplished an impressive list of safety reviews, recommendations and the like. There was good engagement with Shell/APCI on the public White Plains incident.

The Panel has established a good record of safety plan reviews and planned follow up. The Panel and PNNL should state more explicitly criteria for selecting facilities for safety plan review and a more formal method to integrate lessons learned from the plan reviews into an overall guidance document of principles for safety in hydrogen projects.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer observed that where the collaboration is outstanding as it is, there are sure to be more valuable relationships established with the continuation of this panel. Other comments discussed the excellent team, the well-coordinated and clear objectives, the good collaboration with EU and the Japanese, and the fact that the nature of the panel incorporates a high degree of collaboration which is good. A reviewer suggested that the team could coordinate better with CaFCP/ JHFC.

The active involvement of Panel members in site visits and evaluation of safety plans of DOE projects is good, in the opinion of the final reviewer. The interaction with industry, such as involvement in evaluating the fire at the Shell fueling station, is also good and adds to the value of the Panel. The involvement of the Panel in reviewing the Fuel Cell Vehicle safety prop and the safety course is a good example of interaction of the Panel with other parts of the DOE safety program.

Question 5: Has the project effectively planned its future work in a logical manner?

Future work plan comments were generally positive: there was an excellent plan for future work, and the panel looks like it has a healthy list appropriate work to address for the next year. A reviewer said that the future work is focused on completing FY09 activities, but FY10 work remains largely undefined. It seems likely that the Panel will continue to conduct important work on a case-by-case basis. A more strategic approach that focuses the expertise of the Panel on critical issues and needs may add more value to the work of the Panel. The final comment was that the follow-up on recommendations from the safety reviews should be the priority to validate the work by the panel.

What are the project’s strengths?

Among the strengths were the excellent team and accomplishments, the technical experts with wide background who are highly professional and responsive, the high degree of participation in events and reviews, and the good list of experts on the Panel and body of work accomplished so far. A further strength is the excellent mix of expertise and experience on the Panel and strong engagement of the Panel with practitioners in the field. The Panel addresses important issues as they come up.

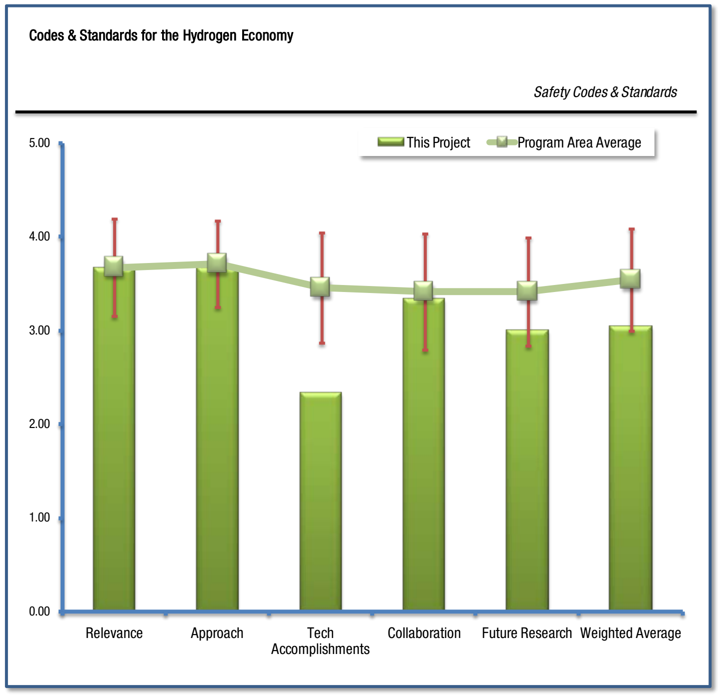
What are the project’s weaknesses?

The weaknesses identified by reviewers were that the team is perhaps too ad hoc and has a reactive approach to selecting activities to focus its expertise, and that the project has a limited budget and reduced scope. A reviewer spoke of the outreach of results from the safety panel to share its accomplishments so industry knows what's being done to insure safety, show lessons learned and validate safety systems already in place if the Panel has evidence where they worked as designed.

Do you have any recommendations for additions or deletions to the project scope?

The Panel has the potential to serve as DOE's primary resource for hydrogen safety assessment and strategic planning. This reviewer thought the team should focus more on programmatic issues rather than individual projects to add more value and make better use of the depth and scope of expertise embodied in the Panel. Exploration of a more formal role for the Panel in gathering information and applying its expertise to accident investigation (for the Hydrogen Safety, Codes and Standards program) should be considered. Another recommendation was to conduct outreach of results from the safety panel to share its accomplishments so industry knows what's being done to insure safety, show lessons learned and validate safety systems already in place if the Panel has evidence where they worked as designed. A third reviewer said this was one of the most essential programs on the hydrogen side, and the budget should not be cut, but rather DOE should increase support if possible in critical areas as defined by team (especially hydrogen station components).

Codes & Standards for the Hydrogen Economy: Gary Nakarado, Regulatory Logic – POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer stated that DOE codes and standards are critical to enabling hydrogen development and programs. Another comment was that development of a coherent set of codes and standards is critical to both vehicle-related standards and infrastructure development and deployment. Awarding of subcontracts is crucial to allowing the subcontractor projects to address the DOE barriers

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

A reviewer highlighted the logical approach designed to award the subcontracts. Another noted that conflicts between national and international standards are being addressed but there is more work to be done. Training of code officials has been very helpful in addressing AHJ concerns through education and outreach. Finally, a reviewer said that the approach in slide 12 appears to be focused on the process of implementing the codes and standards contracts rather than specific items associated with the goal of accelerating the development of codes and standards.

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

A reviewer said that this is a big project, but funds have been no faster to move to the subcontractors using Reg Logic than they were when the funds came directly from DOE. However, there is more work involved for subcontractors as a result. So overall, from this reviewer's perspective, this project has not yet reached the additional efficiency it was designed to accomplish. Another observed that the code pollution process is inherently slow: domestic SDOs and code writing organizations work on a three to five year revision process, and International Standards take years to develop. The final comment was that the accomplishments in task overview slides are focused on project management rather than the progress of codes and standards development. Further information on progress toward overcoming the barriers would be useful. Additional information on the acceleration and progress of other standards would be useful (similar to the CSA slides (for other standards). The Hydrogen/Fuel Cell Codes & Standards website is good but the "future status" or "next steps" of the standards would add value to the website(such as standard committee is active in revising the standard for future release in the third quarter 2009 or standard is complete and currently not being revised by the committee).

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

A reviewer said that communication with subcontractors has been good, but perhaps more action is needed to respond to their frustrations. Another comment was that SAE and CSA have been out in front of the hydrogen codes and standards development. Incorporation of DOE-funded research results has been instrumental in modifying NFPA and I Codes.

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer thought that the proposed future work is appropriate but the team needs to reduce subawardee time and streamline the process. Another said that the future work addresses overcoming some of the identified barriers. It shall be seen what the impact of the latest DOE funding has on future progress. Funding of diverse SDOs may be replaced with funding of targeted individuals who have specific expertise to influence the C&S process. The final comment was that the future work slide included only project management tasks: additional comments regarding plans to address barriers would be useful.

What are the project's strengths?

The strengths identified were that the project has the potential to be a more efficient way to award subcontracts and that streamlining the award process will enable the application of more targeted experts to the code-making process.

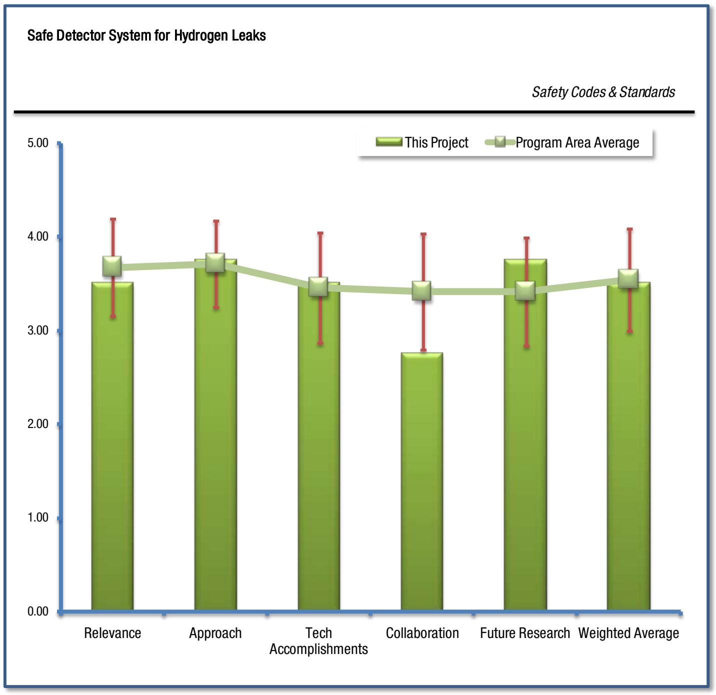
What are the project's weaknesses?

In the first reviewer's opinion, this project has not yet achieved the higher efficiency designed by utilizing them. The efficiency is the same. However, since it takes more work to respond as a subcontractor for the subcontractor, the end result is reduced efficiency. Aggressive addressing of the bullets in future work could improve this. A second reviewer did not identify weaknesses, but suggested the team could perhaps engage more individual expertise as opposed to organizations.

Do you have any recommendations for additions or deletions to the project scope?

It is not clear how a reviewer should approach this project, said the first commenter. Regulatory Logic's effort is largely an administrative one, attempting to streamline contracting and payment processes with a number of codes and standards organizations and expert consultants. In this regard, it seems that Regulatory Logic has performed acceptably (the reviewer would rate all categories Good). If the intent is for the reviewer to assess how well the subcontractors are addressing barriers related to codes and standards, there is hardly sufficient information in the supplied material to make that assessment and the reviewer would not expect Regulatory Logic to be able to provide sufficient information either. The reviewer would suggest that administrative contracts, such as this, not be reviewed as they do not fit the structure of the merit review process. If the intent was to assess the efforts of the subcontractors, please have them present their efforts individually.

Safe Detector System for Hydrogen Leaks: Robert Lieberman, Intelligent Optical – POSTER



Reviewer Sample Size

This project had a total of 4 reviewers.

Question 1: What is your assessment of the relevance to overall DOE objectives – the degree to which the project supports the goals and objectives of the Multi-Year RD&D plan?

A reviewer said that the project aligns with program goals and objectives but it was unclear based on presentation how this aligns with the NREL/UL task on sensors. Another said that data regarding reliable accurate sensors is needed by industry. The final comment was that this was a very relevant sensor for a vehicle or garage.

Question 2: What is your assessment of the approach to performing the work? To what degree are technical barriers addressed? Is the project well-designed, feasible, and integrated with other efforts?

The analytical approach shows much promise for one reviewer, while another highlighted the logical approach to hydrogen sensors. A reviewer offered that there are discrepancies in industry with regard to the usefulness of sensors that are currently required in many applications. Additional data is needed to validate the sensors will perform as indicated/required. The final reviewer had several questions. Why are the specification targets more challenging than the DOE targets from the 2007 workshop? What are the results of the marketing study and application? How does this study get implemented into the research task?

Question 3: Characterize your understanding of the technical accomplishments and progress toward overall project and DOE goals – the degree to which progress has been made, measured against performance indicators and demonstrated progress towards DOE goals.

The first comment was that the project has been progressing on schedule and achieving admirable results. A reviewer said that this sensor should be tested by the NREL protocol and test system to verify the data supports the work published. The final reviewer had three observations: the sensor has no cross-sensitivity with helium or argon; the sensitivity to humidity is compensated within unit; and the unit appears to have potential to be a cost effective, accurate sensor.

Question 4: What is your assessment of the level of collaboration and coordination with other institutions: the degree to which the project interacts with industry partners, universities and laboratories?

To one reviewer, this project had a good team, but a more detailed roles and responsibilities list would have been more effective. Another commented that the presentation was not very well defined regarding collaboration (internal IP). The final commenter said that collaboration shows a mix of industry and research-focused individuals which is good.

Question 5: Has the project effectively planned its future work in a logical manner?

A reviewer felt there was a very good plan regarding future work: another noted that there is much work to be done next year, if the project is funded. The final commenter said that the future work was reasonable based on their results to date. Before integration into a system, the data should be independently verified by the NREL system.

What are the project's strengths?

Strengths noted included the good technical accomplishments and approach, the high potential to utilize if claims are realized, and the low cost, high accuracy potential with no cross-sensitivity. A reviewer said that the team is addressing key areas that need additional work to improve hydrogen sensors. The final comment was that there are discrepancies in industry with regard to the usefulness of sensors that are currently required in many applications. Additional data is needed to validate whether the sensors will perform as indicated/required.

What are the project's weaknesses?

The first reviewer was not clear if this has an application and was not clear what the cost target will be for the system and if this should be a go/no go decision point. The other review comment was that the team could use better collaboration with other sensor experts and companies that would use them.

Do you have any recommendations for additions or deletions to the project scope?

After successfully completing laboratory tests at NREL, it is recommended to do a field trial within a controlled workbay where the other sensors are calibrated (e.g. CGD). A site for a potential contact would be the CaFCP workbay, where CGD have been proven problematic and false alarms are not infrequent.

11. Acronyms

Acronym	Definition
A/SP	Auto/Steel Partnership
A/T	Aftertreatment
ABRP	Advanced Battery Research Program
ACES	Advanced Collaborative Emissions Study
ACM	Acicular Mullite DPF material (Dow)
AEC	Advanced Engine Combustion
AFDC	Alternative Fuels Data Center
AHJ	Authorities Having Jurisdiction
AHSS	Advanced High Strength Steel
ANL	Argonne National Laboratory
APBF	Advanced Petroleum-Based Fuels
APCI	Air Products and Chemicals Inc.
APEEM	Advanced Power Electronics and Electric Machines Program
APRF	Advanced Powertrain Research Facility
APS	Advanced Photon Source
APU	Auxiliary Power Unit
ARRA	American Recovery and Reinvestment Act
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AVFL	Advanced vehicle/fuel/lubricant committee
AVTA	Advanced Vehicle Testing Activity
AVTC	Advanced Vehicle Technology Competition
BAM	Federal Institute for Materails Research and Testing (Germany)
BATT	Batteries for Advanced Transportation Technologies
BES	DOE Basic Energy Sciences
BLDC	Brushless DC motor
BMEP	Brake mean effective pressure
BMS	Battery management system
BSFC	Brake specific fuel consumption
BTE	Brake thermal efficiency
CAE	Computer Aided Engineering
CaFCP	California Fuel Cell Partnership
CAFÉ	Corporate Average Fuel Economy
CARB	California Air Resources Board
CDO	Code development organizations
CF	Carbon Fiber
CF	Cold flow
CFD	Computational fluid dynamics
CGD	Combustible gas detector

Acronym	Definition
CHF	Critical heat flux
CHHP	Combined Heat, Hydrogen, and Power
CLAMP	Center for Lightweighting Automotive Materials and Processing
CLEERS	Cross-Cut Lean Exhaust Emission Reduction Simulation
CLOSE	Collaborative Lubricating Oil Study on Emissions
CNG	Compressed Natural Gas
CNT	Carbon Nanotubes
CO2	Carbon Dioxide
CPI	Compact Power Inc.
CR	Compression ratio
CRADA	Cooperative Research and Development Agreement
CRC	Coordinating Research Council
CSA	Standards development organization
CSI	Current Source Inverter
CSIRO	Australian Commonwealth Scientific and Research Organization
CTE	Coefficient of thermal expansion
CVD	Chemical Vapor Deposition
CVS	Constant volume sampler
DARPA	Defense Advanced Research Projects Agency
DBC	Direct bonded copper
DEER	Diesel Engine-Efficiency and Emissions Research Conference
DISI	Direct injection spark ignited
DLA	Defense Logistics Agency
DLC	Diamond-like carbon
DLFT	Direct Compounded Long Fiber Thermoplastics
DOC	Diesel oxidation catalyst
DOD	Department of Defense
DoD	Depth of Discharge
DOE	Department of Energy
DPF	Diesel particulate filter
E85	85 percent ethanol blend with gasoline
ECES	Electrochemical Energy Storage team
EERE	Energy Efficiency and Renewable Energy
EGR	Exhaust Gas Recirculation
EIA	Energy Information Administration
EISA	Energy Independence and Security Act of 2007
EMC	Electromagnetic Compatibility
EPA	Environmental Protection Agency
EPAct	Energy Policy Act
EPRI	Electric Power Research Institute
ERC	Engine Research Center at University of Wisconsin

Acronym	Definition
ESS	Energy Storage System
ETEC	Electric Transportation Engineering Corporation
EV	Electric Vehicle
FACE	Fuels for Advanced Combustion Engines
FCH2V	Fuel Cell, Hydrogen, and Hybrid Vehicle
FCHEV	Fuel cell hybrid electric vehicle
FE	DOE Office of Fossil Energy
FEA	Finite Element Analysis
FEERC	Fuels, Engines, and Emissions Research Center
FFV	Flexible fuel vehicle
FFVVA	Fully flexible variable valve actuation
FMEP	Friction Mean Effective Pressure
FSEC	Florida Solar Energy Center
FSP	Friction Stir Processing
FSW	Friction Stir Welding
FTIR	Fourier Transform Infrared Spectroscopy
FTP	Federal Test Procedure
FY	Fiscal Year
GATE	Graduate Automotive Technology Education
GBL	Gamma butyrolactone
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse gases
GPRA	Government Performance and Results Act
GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation
GTI	Gas Technology Institute
GTR	Global Technical Regulation
HAMMER	Hazardous Materials Management and Emergency Response center
HARC	Houston Area Regional Council
HCCI	Homogeneous Charge Compression Ignition
HCP	Hexagonal close packed
HD	Heavy-duty
HDD	Heavy-duty diesel
HECC	High Efficiency Clean Combustion
HEDGE	High Efficiency Dilute Gasoline Engine
HEI	Health Effects Institute
HEV	Hybrid Electric Vehicle
HFCIT	Hydrogen, Fuel Cells, and Infrastructure Technologies
HICEV	Hydrogen internal combustion electric vehicle
HIL	Hardware in the Loop
HIPOC	Hydrogen Industry Panel on Codes
HOMO	Highest occupied molecular orbital

Acronym	Definition
HSLA	High strength low alloy steel
HSS	High Strength Steel
HTIPE	High temperature integrated power electronics
HTML	High Temperature Materials Laboratory
HTUF	Hybrid Truck Users Forum
IC	Internal Combustion
ICE	Internal Combustion Engine
IEA	International Energy Agency
IGBT	Insulated-gate bipolar transistor
IMEP	Indicated Mean Effective Pressure
INL	Idaho National Laboratory
IP	Intellectual Property
IQT	Ignition Quality Tester
ISO	International Organization for Standardization
JARI	Japan Automobile Research Institute
JPL	Jet Propulsion Laboratory
JRC	Joint Research Centre (European Commission)
KIVA	Internal combustion engine simulation code (Los Alamos)
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LCA	Lifecycle cost analysis
LD	Light-duty
LDA	Local density approximation
LDRD	Laboratory Directed Research and Development
LES	Large Eddy Simulation
LFP	Lithium iron phosphate
LIBOB	Lithium bis(oxalato)borate
LM	Lightweight Materials
LNT	Lean NOx Trap
LSAM	Lanthanum-aluminate based oxides
LSP	Laser shock peening
LTC	Low Temperature Combustion
LUMO	Lowest Unoccupied Molecular Orbital
MATT	Mobile Automotive Technology Testbed
MBRC	Miles between road calls
MCMB	Mesocarbon Microbeads
MFERD	Magnesium Front End Research and Development
MIT	Massachusetts Institute of Technology
MOU	Memorandum of Understanding
MPO	Metropolitan planning organization
MSAT	Mobile Source Air Toxics

Acronym	Definition
MSU	Michigan State University
MWNT	Multi-wall nanotube
NASA	National Aeronautics and Space Administration
NASEO	National Association of State Energy Offices
NCA	Battery cathode material (nickel cobalt aluminum oxide)
NDA	Non Disclosure Agreement
NDE	Non-Destructive Evaluation
NDT	Non-Destructive Testing
NEC	National Electrical Code
NEMS	National Energy Modeling System
NETL	National Energy Technology Laboratory
NEV	Neighborhood Electric Vehicle
NFPA	National Fire Protection Association
NHA	National Hydrogen Association
NHFCCSCC	National Hydrogen Fuel Cells Codes and Standards Coordinating Committee
NIST	National Institute of Standards and Technology
NMC	Lithiated nickel-manganese-cobalt oxide
NMR	Nuclear Magnetic Resonance
NPBFL	Non-Petroleum Based Fuels and Lubricants
NPS	National Park Service
NREL	National Renewable Energy Laboratory
NSF	National Science Foundation
NSTA	National Science Teachers Association
NTRC	National Transportation Research Center
NVH	Noise/vibration/harshness
NVO	Negative valve overlap
OBD2	Onboard Diagnostics
OEM	Original Equipment Manufacturer
OMB	Office of Management and Budget
ONAMI	Oregon Nanoscience and Microtechnologies Institute
ORC	Organic Rankine cycle
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
OSC	Oxygen Storage Capacity
PA DEP	Pennsylvania Department of Environmental Protection
PCB	Polychlorinated Biphenyls
PCCI	Premixed Charge Compression Ignition
PEEM	Power Electronics and Electric Machines
PEM	Proton Exchange Membrane
PGM	Precious-group metals
PHEV	Plug-In Hybrid Electric Vehicle

Acronym	Definition
PI	Principal Investigator
PM	Particulate Matter
PMEP	Pumping Mean Effective Pressure
PNGV	Partnership for a New Generation of Vehicles
PSAT	Powertrain Systems Analysis Toolkit
PSU	Pennsylvania State University
PZT	Lead zirconate titanate film
R&D	Research and Development
ROI	Return on Investment
RPS	Renewable Portfolio Standard
RT	Room temperature
RWDC	Real world driving cycles
SAE	Society of Automotive Engineers
SAXS	Small Angle X-ray Scattering
SCAQMD	South Coast Air Quality Management District
SCHFCA	South Carolina Hydrogen and Fuel Cell Alliance
SCR	Selective Catalytic Reduction
SDO	Standards development organization
SECO	Texas State Energy Conservation Office
SEI	Solid electrolyte interface
SEMCOG	Southeast Michigan Council of Governments
SEO	State Energy Office
SMC	Sheet Molding Compound
SOA	State of the art
SOC	State of Charge
SOI	Silicon on insulator
SOI	Start of Injection
SRM	Switched reluctance motor
SUV	Sport Utility Vehicle
SWNT	Single wall nanotube
SWRI	Southwest Research Institute
TAG	Technical Advisory Group
TAP	Temporal Analysis of Products
TARDEC	Tank Automotive Research, Development, and Engineering Center
TBO	Time between overhaul
TE	Thermoelectrics
TEG	Thermoelectric Generator
TIM	Thermal Interface Material
TLVT	Technology Life Verification Testing
TMAC	Test Machine for Automotive Crashworthiness
TPFPB	Tris(pentafluorophenyl) borane

Acronym	Definition
TRL	Technology readiness level
TTC	Technology Transition Corporation
UAB	University of Alabama Birmingham
UC	University of California
UCF	University of Central Florida
UHC	Unburned Hydrocarbons
UL	Underwriters Laboratories
ULSD	Ultra-low sulfur diesel
UND	University of North Dakota
USABC	US Advanced Battery Consortium
USAMP	U.S. Automotive Materials Partnership
USFCC	US Fuel Cell Council
UT	University of Tennessee
UW	University of Wisconsin
VCR	Variable Compression Ratio
VSI	Voltage source inverter
VSS	Vehicle Systems and Simulation activity
VTMS	Vehicle Thermal Management Systems
VTP	Vehicle Technologies Program
VVA	Variable Valve Actuation
W	Watt
WBG	Wide bandgap
WEG	Water Ethylene Glycol
WER	Waste Energy Recovery
WFO	Work-for-others
WHR	Waste Heat Recovery
WTW	Well to wheels
YSZ	Yttria-stabilized zirconia
ZT	Thermoelectrics figure of merit (measure of efficiency)

12. Cross-Reference of Project Investigators, Projects, and Organizations

Cross-Reference, Sorted by Project Investigator

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1-43	National Renewable Energy Laboratory (Brooker, Aaron) -- Renewable Fuel Vehicle Modeling and Analysis / Hybrid and Vehicle Systems
10-8	National Renewable Energy Laboratory (Burgess, Robert) -- Hydrogen Safety Sensors / Safety, Codes, and Standards
8-45	National Renewable Energy Laboratory (Caton, Melanie) -- Hydrogen Education for Code Officials / Technology Integration Activities
2-83	National Renewable Energy Laboratory (Dillon, A.C.) -- Nanostructured Metal Oxide Anodes / Energy Storage Technologies
9-20	National Renewable Energy Laboratory (Eudy, Leslie) -- Technology Validation: Fuel Cell Bus Evaluations / Technology Validation
1-46	National Renewable Energy Laboratory (Gonder, Jeffrey) -- Route-Based Controls Potential for Efficiency Gains / Hybrid and Vehicle Systems
3-32	National Renewable Energy Laboratory (Kelly, Kenneth) -- Characterization and Development of Advanced Heat Transfer Technologies / Power Electronics & Electrical Machines Technologies
5-14	National Renewable Energy Laboratory (Knoll, Keith) -- Mid-Level Ethanol Blends Test Program / Fuels and Lubricants Technologies
4-68	National Renewable Energy Laboratory (Lawson, Doug) -- Real-World Studies of Ambient Ozone Formation as a Function of NOx Reductions: Summary and Implications for Air Quality Impacts / Advanced Combustion Engine Technologies
1-48	National Renewable Energy Laboratory (Markel, Tony) -- GPS Travel Survey Data Collection and Analysis / Hybrid and Vehicle Systems
1-21	National Renewable Energy Laboratory (Markel, Tony) -- Light Duty Plug-in Hybrid Vehicle Systems Analysis / Hybrid and Vehicle Systems
5-9	National Renewable Energy Laboratory (McCormick, Robert) -- Quality, Performance, and Emission Impacts of Biodiesel Blends / Fuels and Lubricants Technologies
8-25	National Renewable Energy Laboratory (Melendez, Margo) -- Clean Cities Tool Development and Demonstrations / Educational Activities

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