5. Fuel and Lubricant Technologies

As transportation accounts for two-thirds of the nearly $1 billion the U.S. spends daily on foreign oil, it is vital to increase our use of alternative fuels. Increasing the fuels available to drivers reduces price volatility, supports domestic industries, and increases environmental sustainability.

Reaching VTO's goals will help the country meet the Renewable Fuel Standard's goals for use of biofuels in the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007. These goals require the use of 36 billion gallons of renewable fuels annually by 2022.

To reach these goals, VTO supports activities to:

- Research fuels' effects on combustion: Improves understanding of how fuels from new sources can affect advanced combustion systems.
- Research lubricants: Works to develop lubricants that can improve the fuel economy of vehicles in the current fleet.
- Research natural gas: Works to support the development of natural gas engines and renewable natural gas projects.
- Research biofuels and their effects on combustion: Works to determine the impact of biofuels' properties on engines' efficiency, performance, and emissions. Activities include examining ways to increase alternative fuel vehicles' fuel economy, investigating the potential effects of upcoming blends, and improving the quality of current and future biofuel blends, especially biodiesel and E85.

The Fuel and Lubricant Technologies subprogram supports research and development (R&D) to provide vehicle users with cost-competitive options that enable high fuel economy (FE) with low emissions, and contribute to petroleum displacement. This is accomplished through exploitation of fuel properties to enable advanced combustion, development of efficiency-improving lubricants compatible with new and existing engines and vehicles, and fit-for-service evaluations of low-carbon alternatives to petroleum-based fuels. Future transportation fuels will be produced from refinery feedstocks derived increasingly from non-conventional sources including heavy crude, oil sands, shale oil, coal, and renewable resources such as biomass, vegetable oils, and waste animal fats. The impact of changes in refinery feedstocks and processes on finished fuels is an area of interest in terms of impacts on engines, emissions regulations, and end uses. Additionally, new lubricants will require increasingly sophisticated additive packages and higher-quality base fluids that can deliver higher efficiency with better engine protection.

Subprogram activities are intended to: (1) enable future advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; (2) develop efficiency-improving lubricants including products compatible with legacy vehicles (i.e., enabling lubricant retrofits); and, (3) reduce reliance on petroleum-based fuels through direct fuel substitution by non-petroleum-based fuels. These activities are coordinated with and supportive of the U.S. Environmental Protection Agency’s fuels- and emissions-related activities, as mentioned in their strategic plan.

The major subprogram goals for Fuel and Lubricant Technologies are:

- By 2015, expand operational range of low-temperature combustion to 75% of light-duty Federal Test Procedure (FTP).
- By 2015, demonstrate-cost effective lubricant with 2% FE improvement.

Different fuels meeting the same specifications can have widely varying impact on engine performance and emissions.

The Energy Independence and Security Act of 2007 (EISA, P.L. 110-140) mandates the use of enormous amounts of renewable fuels (36 billion gallons annually by 2022). Current ethanol markets are not able to absorb the volumes mandated; use of intermediate blends may be required. In addition, future feedstocks for fuel production are expected to come from alternative fossil sources. Understanding the impact of these fuels and fuel blends on current and advanced combustion engines is critical to increasing their use. Technical issues that need to be addressed include: lack of data and tools for predicting fuel and lubricant property effects on engine

operation; fuel and lubricant effects on emissions and emission control systems. This subprogram is developing data and tools, in collaboration with many partners in industry, academia and government impacting new and old vehicles, as well as small non-road engines.

Subprogram Feedback

The U.S. Department of Energy (DOE) received feedback on the overall technical subprogram areas presented during the 2014 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE Vehicles Technologies Office (VTO) subprogram's activities. The subprogram overview questions are listed below, and it should be noted that no scoring metrics were applied. These questions were used for all VTO subprogram overviews.

Question 1: Was the program area, including overall strategy, adequately covered?

Question 2: Is there an appropriate balance between near- mid- and long-term research and development?

Question 3: Were important issues and challenges identified?

Question 4: Are plans identified for addressing issues and challenges?

Question 5: Was progress clearly benchmarked against the previous year?

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Question 10: Has the program area engaged appropriate partners?

Question 11: Is the program area collaborating with them effectively?

Question 12: Are there any gaps in the portfolio for this technology area?

Question 13: Are there topics that are not being adequately addressed?

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Subprogram Overview Comments: Kevin Stork (U.S. Department of Energy) – ft000

Question 1: Was the program area, including overall strategy, adequately covered?

Reviewer 1:
The reviewer said yes, and commented that the program was relatively unchanged from last year.

Reviewer 2:
The reviewer said yes, and summarized that the presentation reviewed effects from natural gas, development work in higher octane and cetane fuels, and other future fuels. The reviewer noted a lube effort regarding predictive modelling, engineered surfaces, and opportunities for retrofit-able technologies.

Reviewer 3:
The reviewer commented that the program mainly focused on end-use fuels research and development (R&D) with emphasis on internal combustion engine (ICE) combustion and integration of lubricant program. The reviewer remarked that this program is comprehensive. The reviewer perceived that including a big picture of the whole program would be very helpful to make a connection between current projects, past and future direction. This should help to better understand the overall strategy.

Question 2: Is there an appropriate balance between near-, mid- and long-term research and development?

Reviewer 1:
The reviewer said yes, and commented that beyond octane and cetane, fuels offer a long-term challenge/opportunity.

Reviewer 2:
The reviewer said yes, and clarified that some goals are stretch targets, but for large gains, things must be invented.

Reviewer 3:
The reviewer remarked that the presentation did not include a clear distinction between near-, mid- and long-term goals.

Question 3: Were important issues and challenges identified?

Reviewer 1:
The reviewer said yes. Of particular interest for this reviewer were the 2% fuel economy improvement from oil additives versus Mobil 1, reactivity controlled compression ignition (RCCI) fuel development, biofuels and alternate fuels, and increased availability of medium-duty (MD) natural gas engines.

Reviewer 2:
The reviewer said yes, and elaborated that the program manager has clearly identified major challenges. In particular, the reviewer commented that the connection with ICE combustion program is excellent to ensure challenges are well integrated with other programs.

Reviewer 3:
The reviewer noted that funding was addressed, and increased over previous years.

Question 4: Are plans identified for addressing issues and challenges?

Reviewer 1:
The reviewer said yes. The reviewer pointed out that the presentation described the methodology for tools development, and that more details would be in subsequent presentations.

Reviewer 2:
The reviewer noted that Slide 13 showed the strategies to address challenges for the lubrication program. The reviewer said that a similar slide for fuel program would be very helpful.

Question 5: Was progress clearly benchmarked against the previous year?

Reviewer 1:
The reviewer said yes, and observed that not much had changed.

Reviewer 2:
The reviewer noted nano-technologies, ionic liquids, and replaced zinc dialkyl-dithio-phosphate (ZDDP) with materials better suited to catalysts/aftertreatment.

Reviewer 3:
The reviewer said no, and the presentation mostly focused on the importance of the program.

Question 6: Are the projects in this technology area addressing the broad problems and barriers that the Vehicle Technologies Office (VTO) is trying to solve?

Reviewer 1:
The reviewer responded yes, clarifying that the projects directly supported Vehicle Technologies Office (VTO) objectives of petroleum displacement and increasing fuel efficiency in vehicles.

Reviewer 2:
The reviewer said yes, and remarked improved economy via reduced frictional losses.

Reviewer 3:
The reviewer commented that some octane ratings were incompatible with current engines (e.g., ethanol content greater than 10-15% is not compatible with current generation of cars).

Question 7: Does the program area appear to be focused, well-managed, and effective in addressing VTO's needs?

Reviewer 1:
The reviewer said yes, and gave as examples higher-octane fuels, higher compression ratios for future engines, ethanol and charge cooling effect, and renewable and reduced carbon fuels.

Reviewer 2:
The reviewer said yes.

Reviewer 3:
The reviewer stated that looking into the defined projects and after listening to most of the projects' presentations in this program, this reviewer can confirm that the area is focused on VTO's needs and that all the projects support VTO needs. Some projects have focus on fundamental aspects and some have focus on practical aspects, but all are in the direction to address VTO's needs.

Question 8: What are the key strengths and weaknesses of the projects in this program area? Do any of the projects stand out on either end of the spectrum?

Reviewer 1:
The reviewer pointed out new standards for biodiesel.

Reviewer 2:
The reviewer commented that scalability/implementation appear to be issues to overcome once technology is proven.

Reviewer 3:
The reviewer said that the program covers a good range of projects dealing with fundamental to practical aspects of fuel effects on ICE combustion. There is more concentration on fundamental understanding in this program. The reviewer commented that while fundamental understanding is critical, it is important that those fundamental projects do not lose sight of practicality. This reviewer heard a presenter say that this is a fundamental study and we do not care about practicality for now. So for this reviewer, it is important to ensure the fundamental projects are well-linked to practical projects or at least have a clear roadmap for this interaction.

Question 9: Do these projects represent novel and/or innovative ways to approach these barriers as appropriate?

Reviewer 1:
The reviewer said yes, and gave as examples RCCI and lean lifted flame combustion (LLFC) related projects clearly indicated novel approaches which can potentially lead to very promising outcomes.

Reviewer 2:
The reviewer said yes, and commented very interested in ionic liquids.

Reviewer 3:
The reviewer suggested to expand the operating range of RCCI operation.

Question 10: Has the program area engaged appropriate partners?

Reviewer 1:
The reviewer said yes, and cited as examples Clean Cities and many others.

Reviewer 2:
The reviewer said yes, most of the projects include strong partnerships including fuel/engine original equipment manufacturers (OEMs), national laboratories and academia. In addition, the program has an excellent collaboration with the ICE program.

Reviewer 3:
The reviewer agreed that the program appeared to have collaboration.

Question 11: Is the program area collaborating with them effectively?

Reviewer 1:
The reviewer said yes.

Reviewer 2:
The reviewer said yes. The reviewer commented more synergy with fuel economy standards, greenhouse gas (GHG) emissions, and biofuels strategies (referenced on Slide 9). The reviewer also cited fuel properties for future engines.

Reviewer 3:
The reviewer said not enough information to judge.

Question 12: Are there any gaps in the portfolio for this technology area?

Reviewer 1:
The reviewer said not that come to mind.

Reviewer 2:
The reviewer reported that an inquiry was raised regarding the possibility of pursuing GHG emission reductions as aggressively as criteria pollutant emissions.

Reviewer 3:
The reviewer commented that given that there are limited funding resources, it would be good to come up with a strategic plan for this program that identifies which fuels have higher priority. This reviewer explained that there is a large range of oxygenated fuels, biodiesel, and petroleum-based fuels. For example, natural gas seems to have high priority in fiscal year (FY) 2015. The reviewer suggested that having a roadmap will be helpful.

Question 13: Are there topics that are not being adequately addressed?

Reviewer 1:
The reviewer said no. This reviewer particularly liked mention of co-development of engines and fuels. The reviewer specified high-octane fuels and advanced combustion development.

Reviewer 2:
The reviewer said not that come to mind.

Question 14: Are there other areas that this program area should consider funding to meet overall programmatic goals?

Reviewer 1:
The reviewer suggested conclusive comparative studies to help define a roadmap to determine the future focus of the Fuels Technologies program for future fuels.

Reviewer 2:
The reviewer inquired about the best way to use natural gas in transportation and cited heavy-duty (HD) trucks, marine, and rail. The reviewer also added the removal of barriers to natural gas use.

Question 15: Can you recommend new ways to approach the barriers addressed by this program area?

Reviewer 1:
The reviewer said no.

Reviewer 2:
The reviewer said natural gas refueling infrastructure, HD range issues, and storage.

Reviewer 3:
The reviewer noted that the program may encourage and demand more collaborative efforts among the projects, so the loops are well-connected as some of the projects just focus on fuel and some mainly do experimental engine study.

Reviewer 4:
The reviewer commented that fuel, combustion, and control/calibration are the three key elements that determine final outcome for fuel economy and emissions from an ICE engine/vehicle. The reviewer said that defining integrated projects in this area will be critical to bridge fuel R&D program to VTO's needs.

Question 16: Are there any other suggestions to improve the effectiveness of this program area?

Reviewer 1:
The reviewer said no.

Reviewer 2:
The reviewer recommended supporting precompetitive biofuels work, and advanced deployment of natural gas engines. The reviewer also commented pursuing lubes work with new base oils, VI improver that are less sensitive to temperature variation, and advanced lube additives.

Project Feedback

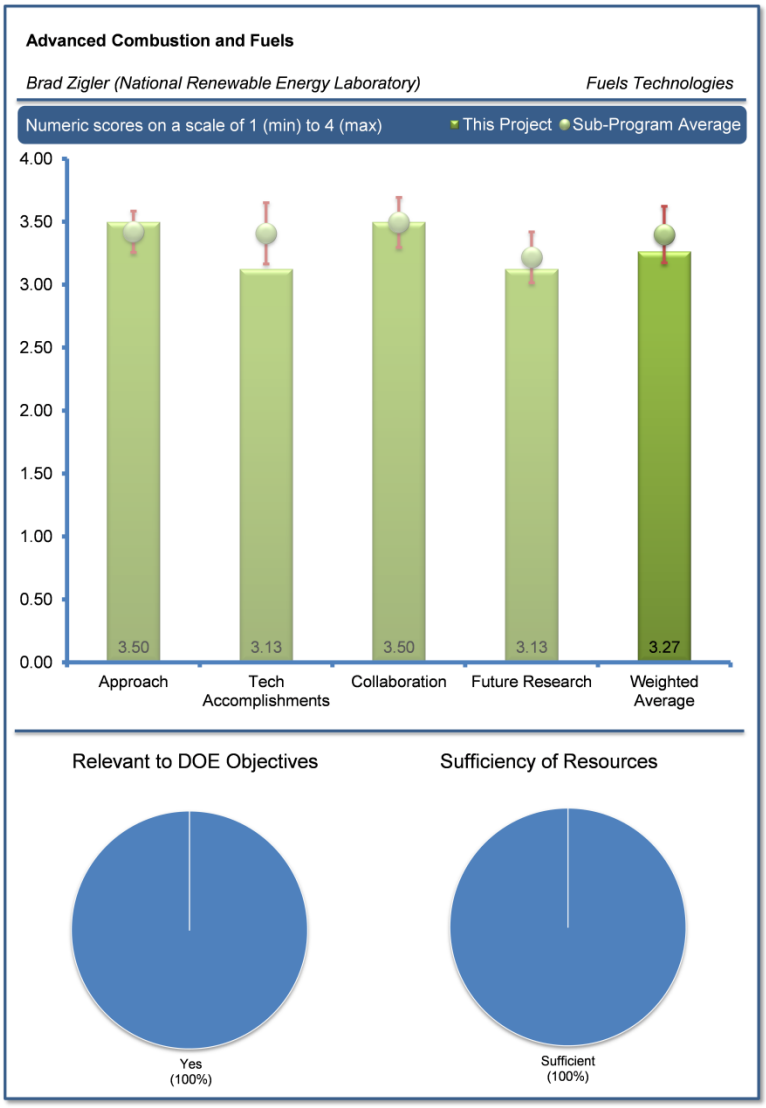
In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses *(on a scale of 1.0 to 4.0)*. In the pages that follow, the reviewer responses to each 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 Combustion and Fuels	Brad Zigler (National Renewable Energy Laboratory)	5-9	3.50	3.13	3.50	3.13	3.27
Performance of Biofuels and Biofuel Blends	Bob McCormick (National Renewable Energy Laboratory)	5-12	3.63	3.50	3.38	3.50	3.52
Fuel Effects on Mixing-Controlled Combustion Strategies for High-Efficiency Clean-Combustion Engines	Chuck Mueller (Sandia National Laboratories)	5-15	3.63	3.50	3.63	3.25	3.52
Advanced Lean-Burn DI Spark Ignition Fuels Research	Magnus Sjoberg (Sandia National Laboratories)	5-19	3.60	3.60	3.20	3.20	3.50
Fuel Effects on Emissions Control Technologies	Todd Toops (Oak Ridge National Laboratory)	5-23	3.50	3.50	3.67	3.50	3.52
Gasoline-Like Fuel Effects on Advanced Combustion Regimes	James Szybist (Oak Ridge National Laboratory)	5-25	3.38	3.50	3.50	3.25	3.44
† Engine Friction Reduction Technologies	George Fenske (Argonne National Laboratory)	5-28	3.17	3.00	3.50	3.00	3.10
Ionic Liquids as Anti-Wear Additives for Next-Generation Low-Viscosity Fuel-Efficient Engine Lubricants	Jun Qu (Oak Ridge National Laboratory)	5-30	3.67	3.83	4.00	3.50	3.77
Demonstration/Development of Reactivity Controlled Compression Ignition (RCCI) Combustion for High Efficiency, Low Emissions Vehicle Applications	Rolf Reitz (Wisconsin Engine Research Consultants LLC)	5-33	3.50	3.88	3.38	3.25	3.64
High Compression Ratio Turbo Gasoline Engine Operation Using Alcohol Enhancement	John Heywood (Massachusetts Institute of Technology)	5-36	3.50	3.60	3.40	3.40	3.53
Fuel Properties to Enable Lifted-Flame Combustion	Eric Kurtz (Ford Motor Company)	5-40	3.14	3.21	3.50	2.86	3.19
Boric Acid as a Lube Additive	Ali Erdemir (Argonne National Laboratory)	5-45	3.25	3.25	3.75	3.13	3.30
Lubricant Formulations to Enhance Engine Efficiency in Modern Internal Combustion Engines	Wai Cheng (Massachusetts Institute of Technology)	5-48	3.25	3.13	3.25	3.25	3.19
Development of Modified Polyalkylene Glycol High VI High Fuel Efficient Lubricant for Light-Duty Vehicle Applications	Arup Gangopadhyay (Ford Motor Company)	5-51	3.38	3.25	3.63	3.13	3.31
† Can hard coatings and lubricant anti-wear additives work together?	Jun Qu (Oak Ridge National Laboratory)	5-54	3.33	3.33	3.33	3.33	3.33

Presentation Title	Principal Investigator and Organization	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
† CFD simulations and experiments to determine the feasibility of various alternate fuels for compression ignition engine applications	Sibendu Som (Argonne National Laboratory)	5-56	3.33	3.33	3.33	2.83	3.27
Overall Average			**3.42**	**3.41**	**3.50**	**3.22**	**3.40**

† denotes poster presentations.

Advanced Combustion and Fuels: Brad Zigler (National Renewable Energy Laboratory) - ft002



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

This reviewer commented that the project had a good mix of experimental and modeling work.

Reviewer 2:

This reviewer pointed out that expansion of the capabilities of the ignition quality tester (IQT) instrument should help determine the cetane number of samples only available in small quantities, as well as develop data needed to validate kinetic mechanisms.

Reviewer 3:

The reviewer explained that this project focuses on solving problems that cut across fuels technologies and advanced combustion, but characterizes conventional and alternative fuels and fuels designed for advanced combustion. The reviewer went on to say that it simultaneously builds a database on fuel behaviors and demonstrates linkages between combustion simulation and experimentation.

Reviewer 4:

The reviewer observed that the approach mainly centered on using IQT. While the current approach is very good, further expansion to complete the fuel and combustion modeling loop would add to the value of this project. For example, it is great to see the outcome was used in *iso*-cetane (HMN) mechanism. Given the base engine is the same as Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL), there should be enough opportunities for joint works to complete the fuel and combustion loop. The reviewer suggested that including at least one slide for showing this loop would add to the value of presentation in future AMRs. The reviewer also noted that it was unclear what the main use of the CONVERGE model for IQT was.

Question 2: 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.

Reviewer 1:

The reviewer praised the project's good progress and noted the technical paper going into print from the work with the IQT and simulations. The reviewer commented on how the project serves to validate reduced mechanisms and explores emerging fuel compounds and formulation. This reviewer observed that the extension to gasoline and gasoline direct injection (GDI) combustion is a bit of a stretch, in that the structure of the reaction environment in the IQT may not reflect that which is occurring in the GDI engine environment. The basic ignition information is still valuable, the reviewer offered, but there is a discrepancy between the IQT test environment and structure, and that which is expected to occur in a lube oil droplet initiation of autoignition in a wall-guided GDI engine.

Reviewer 2:
The reviewer noted that there was good progress in expanding IQT capabilities, including reducing size of samples needed for measurements, testing fuels under conditions where the negative temperature coefficient (NTC) regime occurs, and obtaining fundamental combustion data needed to refine kinetic combustion models.

Reviewer 3:
The reviewer brought to light that this project provided a critical understanding for characterizing fuel ignition delay. This is particularly important for new fuels such as biodiesel, for which little information is available. The results from this project help to develop reduced-order chemical kinetic mechanisms and also develop low-order models of ignition delay for combustion control applications. Given the current focus of internal combustion engine (ICE) program on low-temperature combustion (LTC) engines, it is necessary to ensure that IQT testing covers all the fuels which have been exploited in LTC engine studies. The reviewer offered that it is critical to ensure proper separation of chemical kinetics ignition delay and spray physical delay in measurements and analysis.

Reviewer 4:
The reviewer expressed that the milestones are weak, and that the project status updates need real, performance-based, milestones. The reviewer added that it took many years, but it appears that modified IQT can now be considered a useful kinetic tool.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that the project includes strong involvement with industry, academia, and other national labs. Providing the data from this project in a common database platform such as Cross-Cut Lean Exhaust Emissions Reduction Simulation (CLEERS) or others can leverage further collaboration opportunities and expand the application of the results from this project.

Reviewer 2:
The reviewer reported that there was a broad team including labs, universities and industry, through the Advanced Engine Combustion (AEC) Memorandum of Understanding (MOU) and Coordinating Research Council (CRC) relationships.

Reviewer 3:
The reviewer affirmed that there were mostly collaborations with other national laboratories and universities, including Colorado School of Mines (CSM) and the University of California-Berkeley. Some collaboration with industry through Project 18 under Advanced Vehicle/Fuel/Lubricants (AVFL-18) of the CRC on improved surrogate diesel fuels.

Reviewer 4:
The reviewer remarked that although a combustion MOU is valuable, the reviewer did not consider it a collaboration, and asserted that collaboration means actually working together. The reviewer went on to express that collaboration with CSM is very valuable for modeling support, and that working with other labs in kinetics such as ANL and Lawrence Livermore National Laboratory (LLNL) is a valuable collaboration.

Question 4: 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.

Reviewer 1:
The reviewer confirmed that the plans seem reasonable, and thought that it will be interesting to see if the IQT can provide meaningful data for the low-speed pre-ignition (LSPI) issue.

Reviewer 2:
The reviewer stated there is a solid plan in place to complete the goals of the project by the due date. Looking into a range of oxygenated fuels, such as those with a different research octane number (RON) will be important. The reviewer suggests that if possible, studying surrogate fuels from Sandia National Laboratories (SNL), specifically Principal Investigator (PI) Mueller, could be rewarding in order

to make a link between different U.S. Department of Energy (DOE)-funded programs. The reviewer concluded that injector characterization seems an important factor to separate spray physical delay from chemical kinetics delay.

Reviewer 3:
The reviewer observed that it is probably not necessary to spend a lot of time developing the ability to test with less than 25 milliliters (mL) of a fuel. LSPI work needs to close the loop with another group doing engine sampling. The reviewer would like to see more about how the project team chooses fuels and compounds to study in the IQT and engine.

Reviewer 4:
The reviewer acknowledged that the project expanded the experimental capabilities, but difficulties in linking to engine work, especially in LSPI, will remain. Moving to the CID 510 sounds promising as a means of expanding experimental capability, but even with that device, there may remain challenges in linking these results to GDI and LSPI issues.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer commented that this project combines research to support fuel technology and combustion technology applications that can reduce fuel consumption and displace petroleum with biofuels.

Reviewer 2:
The reviewer indicated that this project supports DOE objectives of petroleum displacement by creating a knowledge platform for fuel ignition properties to further utilize advanced and renewable fuels in combustion engines.

Reviewer 3:
This reviewer remarked that the project contributes to the kinetic community for mechanism development and provides screening of new biofuel components.

Reviewer 4:
The reviewer explained that expanded capabilities of IQT instrumentation help to obtain data needed for refining mechanistic models which are needed for design of advanced engines.

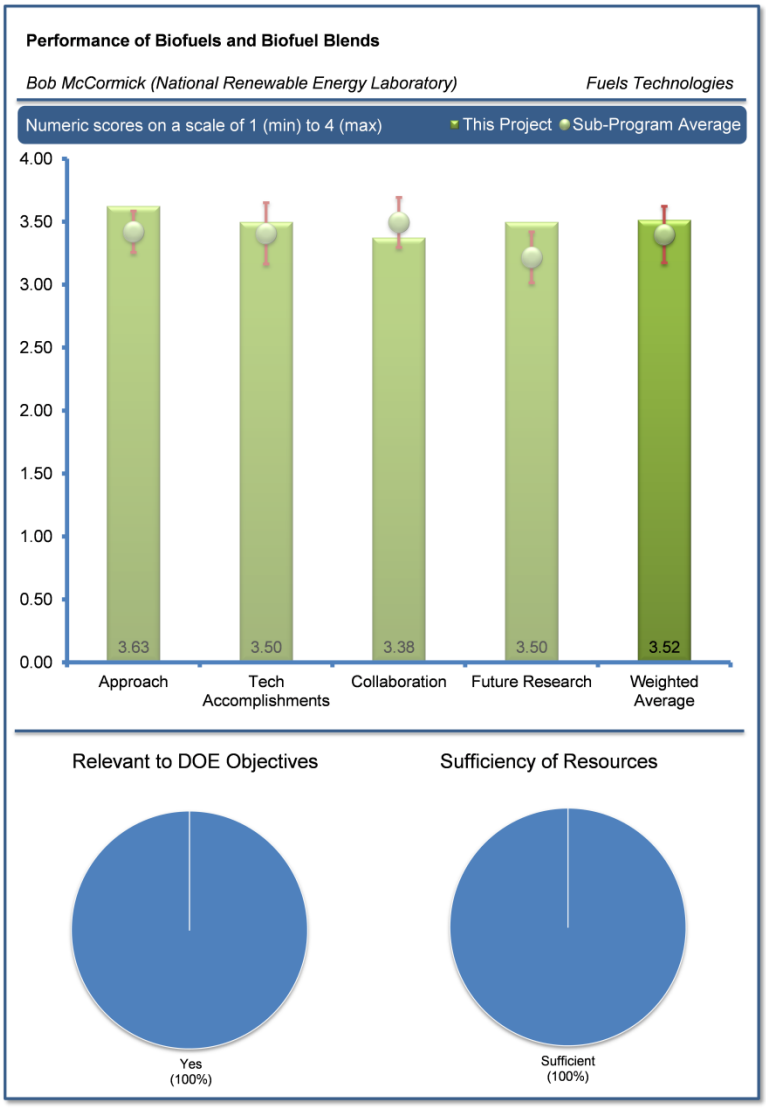
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that resources appear adequate to meet objectives.

Reviewer 2:
The reviewer expressed that there is a good funding level, but that it needs to be kept stable year-to-year to maintain continuity in these efforts.

Reviewer 3:
The reviewer found that sufficient equipment exists to complete the goals of this project.

Performance of Biofuels and Biofuel Blends: Bob McCormick (National Renewable Energy Laboratory) - ft003



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded a nice approach to a useful, though narrow, research topic.

Reviewer 2:

The reviewer explained that the project examined combustion of partially oxygenated fuel blending components from pyrolysis and other processes. It answered questions about oxygenate levels that are compatible with American Society for Testing and Materials (ASTM) standards for fuel quality and performance, and performed combustion and emissions testing, and performing durability studies - including designed oxygenates and residual oxygenates left over from process technologies.

Reviewer 3:

The reviewer expressed that the National Renewable Energy Laboratory (NREL) is well qualified to perform this research.

Reviewer 4:

The reviewer indicated that this project has carried out a comprehensive study looking into solubility, storage (gum formation), and emission characteristics for range of biofuels and their blends.

Question 2: 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.

Reviewer 1:

The reviewer pointed out that there is a lot of detailed data, which will help when the results can be a bit more integrated into a broader set of conclusions.

Reviewer 2:

The reviewer offered that both removal of oxygen from biomass, and looking into candidate fuels compatible with distribution infrastructure, are challenging but rewarding. This project shows promising results to address and assess this challenge. The results from this study can be potentially used to find optimum compositions for biofuels for ICE operation. The reviewer also voiced that given that the project ends in September 2014, it is surprising that two major milestones (diesel engine testing and GDI engine testing) are scheduled for the last month of the project.

Reviewer 3:
The reviewer observed that the project has examined gasoline property impacts of residual oxygenates, and showed mostly no impacts of critical fuel quality tests. The project has also examined diesel fuel property impacts of residual oxygenates, and showed impacts are modest for low blend levels (i.e., 5% by weight or less). The reviewer went on to describe how the project looked at diesel performance and emissions, but noted that the project focused on regulated emissions. The reviewer asked about the effect of unregulated emissions. The reviewer asked what the fate is of the furanics, and said that the project will be looking at these questions, but will need to be aware of the analytical challenges.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer applauded strong involvement including academia, the NREL consortium, and other laboratories. The reviewer went on to suggest that more involvement from industry will be advantageous.

Reviewer 2:
The reviewer said that the correct industry people are involved and participating.

Reviewer 3:
The reviewer commended the good collaboration so far, and went on to say that it would be ideal to get more biomass treaters involved if possible.

Reviewer 4:
The reviewer pointed out the close collaboration with other entities in the state of Colorado, and compliance entities, but noted that the present team seems primarily a regional team. The reviewer offered that other universities, for example, Iowa State University, have experience in production and processing pyrolysis oils.

Question 4: 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.

Reviewer 1:
The reviewer reported that there is a solid plan to move forward, and that testing of real pyrolysis-derived fuels will be important.

Reviewer 2:
The reviewer recounted that the project will look at unregulated particulate matter (PM) and particle number impacts of residual oxygenates in GDI and compression ignition (CI) engines, including advanced as well as combustion processes. The reviewer mentioned that the project will explore some very interesting impacts of oxygen location in cyclic compounds on PM, and that it will explore impact of furanics on gum formation. The reviewer concluded by noting that the project will examine practical pyrolysis oil samples to compare with model compounds studies pursued to date.

Reviewer 3:
The reviewer cautioned that it seems there may be too much work to be done before concluding this project in less than three months, and offered that the results from this project should open many future research opportunities.

Reviewer 4:
The reviewer suggested that there needs to be discussion on the blending of social acceptance and infrastructure incorporation of any future fuel. Without all parties being involved, even the most brilliant idea will not be adopted.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer emphasized that the research is very relevant for alternative fuel sources as part of DOE's goals.

Reviewer 2:
The reviewer explained that the work can directly support displacement of petroleum through use of biofuels.

Reviewer 3:
The reviewer expressed that this project directly supports DOE objectives of petroleum displacement by analyzing biofuels and their blends for application in combustion engines.

Reviewer 4:
The reviewer stated that the project involves feedstocks other than petroleum sources.

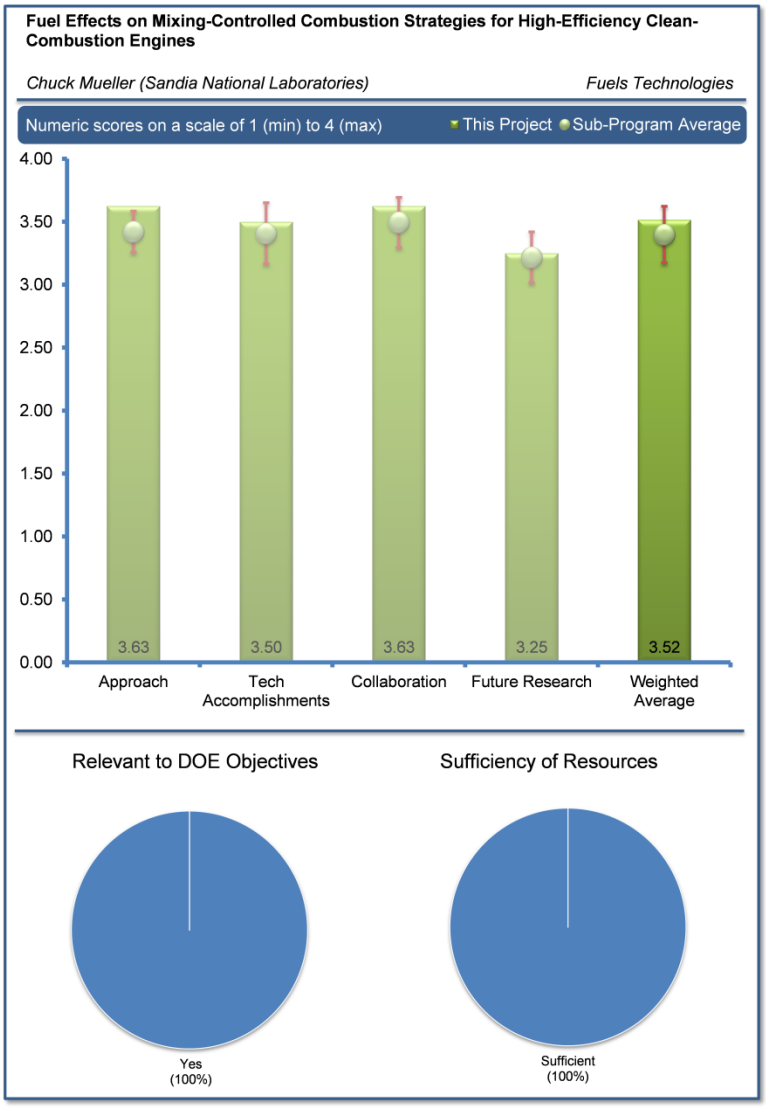
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer commented that funding has been sufficient and is tapering off due to the end of this project.

Reviewer 2:
The reviewer asserted that adequate resources seem to be available to conclude this project.

Reviewer 3:
The reviewer remarked that funding is sufficient for the level of work, but to the reviewer, it sounded like the current funding is ending. The reviewer hoped a similar level of funding can continue, as there is much work to be done.

Fuel Effects on Mixing-Controlled Combustion Strategies for High-Efficiency Clean-Combustion Engines: Chuck Mueller (Sandia National Laboratories) - ft004



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer emphasized that the work on surrogate fuels is excellent and authoritative, and supports the development of predictive engine simulation. Mixing controlled combustion is critical in current and future technology CI engines, so continuing to evolve our understanding can have a huge impact. The reviewer wondered how the purity in the surrogate fuel blend agents (e.g., contaminants) will influence the outcomes from the surrogate mixtures. The reviewer recounted that the project has highly detailed measurements on the fuels being modeled with the surrogate, and mentioned component composition and fidelity, but inquired about the purity needed to ensure good results and consistency.

Reviewer 2:

The reviewer noted the good mix of experimental work and tool development, and liked the focus on surrogate fuels because it allows modeling to be done. The team seems to have identified and mitigated problems with purity of surrogate compounds.

Reviewer 3:

The reviewer remarked that this project uses a sophisticated approach that integrates fuel chemistry studies, optical engine investigation, potential metal engine testing, and future modeling collaboration. The reviewer went on to point out that the surrogate fuels from the project will provide a strong basis for future engine and combustion studies, so the research results from different scholars will be comparable. This is an important initial step to address the technical barrier of developing predictive tools for fuel effects on combustion and emissions.

Reviewer 4:

The reviewer indicated that the project combines development of advanced computational algorithms with the most sophisticated engine experimental, diagnostic, and observational data collection. It includes addressing a long-neglected need for predictive tools based on fuel parameters and combustion properties through the development of surrogate fuels for identifiable target fuels of interest.

Question 2: 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.

Reviewer 1:
The reviewer stated that publication and reporting are strong from this program. There is valuable work on diagnostic development for in-cylinder laser-induced incandescence (LII). The reviewer asserted that surrogate fuel formulation will be useful to many research efforts, including simulation. The reviewer applauded the project for making substantial contributions in understanding fuel effects, and disseminating those results.

Reviewer 2:
The reviewer reported that one major accomplishment is the design of new diesel surrogate fuel for engine and combustion-vessel (CV) testing. This is an essential step for kinetic modeling and developing robust engine combustion control strategies. The reviewer offered that finding the relation between lift-off length and mixing combustion control (soot formation control) is very important. The reviewer added that the optical engine results for soot formation can help modeling efforts in this field by validating computational fluid dynamics (CFD) modeling results. The reviewer suggested an area of improvement to further expand this work given that there is variability in fuel properties even versus time, it would be beneficial for the research community if the PI can develop a guideline how those variations can be included. For example, as additive properties to the surrogate fuel, so the variation effects can be included systematically for combustion modeling and development of engine combustion control strategies. The reviewer understands this is a very challenging area.

Reviewer 3:
The reviewer noted that the research has identified clear relationships between lift-off length at the end of pre-mixed burn and combustion effectiveness and emissions, which have been largely ignored by other research in the field. The project has also developed sets of surrogate fuels for experimental testing and new advanced diagnostic techniques. However, it was not clear to the reviewer the extent to which this research has application beyond the concept of leaner lifted-flame combustion, most of which has apparently been spun off to a separate research project. The practical application of this appears to be quite limited due to its being dependent on tightly specified and standardized fuel parameters, which may be different for different vehicles.

Reviewer 4:
The reviewer noted that the presentation talks about understanding fuel effects, but does not really explain how an overall analysis will be done. The reviewer needs to know more about analysis and compelling trends mentioned on Slide 10.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer said that through the AEC MOU and CRC efforts, this program has direct connection with industry. The reviewer noted direct collaboration with Caterpillar and Ford, and other national laboratories. The project has some work ongoing and more starting with university involvement.

Reviewer 2:
The reviewer did not think that a combustion MOU should be considered a collaboration, and suggested that it would be better to highlight real collaborations with individual members and others.

Reviewer 3:
The reviewer acknowledged substantial collaboration with a long list of major institutions, including engine makers, fuel makers, other DOE laboratories, etc. Extensive coordination with related project led for Ford Motor Company on LLFC.

Reviewer 4:
The reviewer said that the project includes strong involvement/collaboration from industry, academia and other national laboratories.

Question 4: 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.

Reviewer 1:
The reviewer noted that the project will continue work on surrogates, including connection to simulation and predictive engine modeling. The team will also continue to develop an understanding of fuel effects and will explore new methods for enhancing mixing in-cylinder.

Reviewer 2:
The reviewer stated that the future plan is logical. The reviewer suggested important research opportunities. Developing surrogates for biodiesel fuels can be very helpful for the research community because there is large variability among fuel properties of biodiesel fuels. This should be challenging, but very rewarding to connect a large number of independent biodiesel fuel combustion studies. The reviewer also suggested that collaborative work to utilize newly designed surrogate fuels from this project with chemical kinetic mechanisms (for example from LLNL) for combustion modeling and integration with metal engine testing could make an excellent accomplishment for this project.

Reviewer 3:
The reviewer cautioned that ducted chamber work should not be undertaken until there has been more analysis and modeling done. Research would be more valuable if more direct collaboration with kinetic and CFD modelers was established.

Reviewer 4:
The reviewer commented that the presentation suggested various areas of continued research on promising diagnostic and analytical tools. The slides on proposed future work are somewhat unclear on which research would be done under this project and which would be done under the related project (by many of the same team members) on LLFC. The reviewer claimed that the one new direction of future research, the "Ducted Combustion Chamber" for LLFC, was explained vaguely - it is not clear to this reviewer what would constitute the duct walls or how such walls would exist or survive within a combustion chamber, let alone within one with a reciprocating piston.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer mentioned that this project supports DOE objectives of petroleum displacement by creating fundamental basis for surrogate fuels to foster future internal combustion engine research, which can lead to more fuel-efficient combustion engines.

Reviewer 2:
The reviewer noted that it can lead to displacement of petroleum with new fuels and improved efficiency.

Reviewer 3:
The reviewer acknowledged that the research provides a thorough understanding of achieving dilute combustion in a diesel platform, and sets out parameters for achieving efficient combustion.

Reviewer 4:
The reviewer remarked that the project aims to develop advanced diagnostic and evaluative tools that could be used to identify optimal fuel blends or engine configurations to substantially enhance fuel efficiency and reduce emissions. It also enhances understanding of combustion effectiveness as related to fuel parameters and to lift-off in general. It also investigates a specific combustion strategy – LLFC – that is a promising area of research, but it is not clear how practical its implementation would be in a world of multiple fuel blends in the market, but could conceivably point to some areas of ultimate fuel property standardization if the benefits are substantial enough.

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

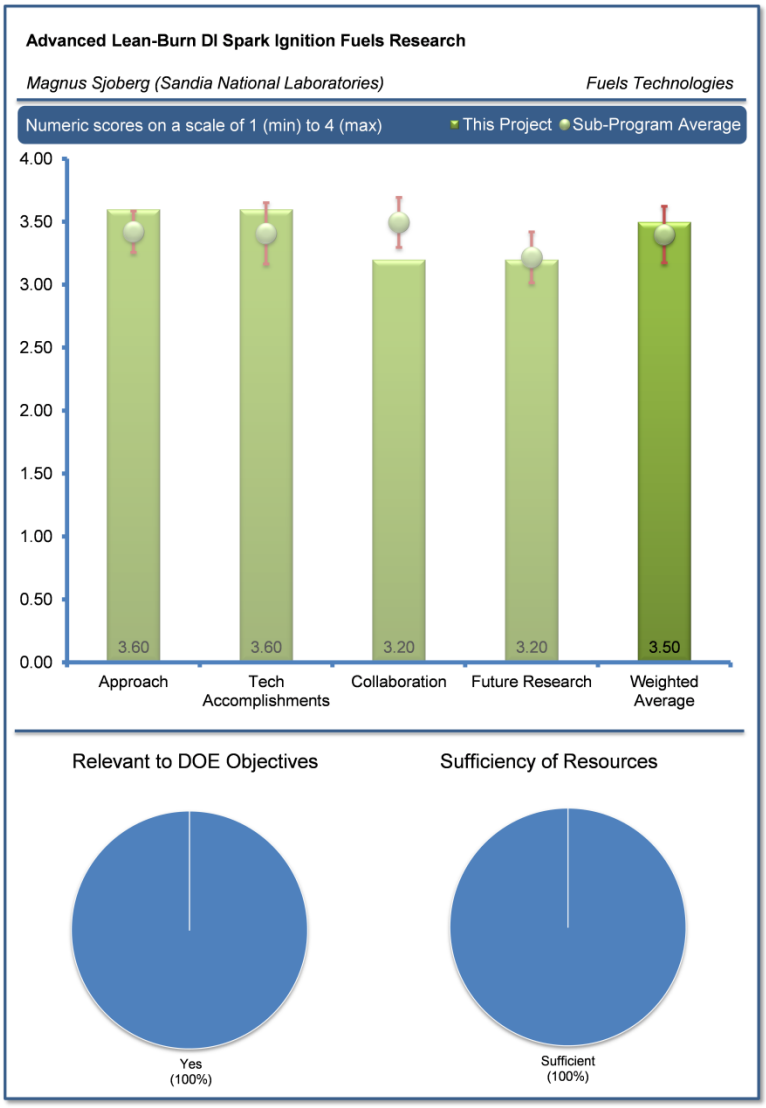
Reviewer 1:
The reviewer commented that the funding is sufficient and level, which is helpful in maintaining program quality and continuity.

Reviewer 2:
The reviewer summarized that resources are adequate for project goals.

Reviewer 3:
The reviewer said that adequate resources seem to be available to the PI.

Reviewer 4:
The reviewer observed that the project has achieved numerous milestones to date but some of the key objectives, such as target and surrogate fuels, have been pursued for a number of years and remain to be completed. Such completion appears to be slated for the coming year although the reviewer pointed out that presentation language is not completely clear on that.

Advanced Lean-Burn DI Spark Ignition Fuels Research: Magnus Sjoberg (Sandia National Laboratories) - ft006



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer agreed that combining metal engine and optical engine testing with modelling is very good. From the presentation it sounded like there are efforts underway to fill the need for CFD collaborators.

Reviewer 2:

The reviewer acknowledged that the approach to combine metal and optical engine experiments to develop an understanding of the impact of fuel properties on advanced spark ignited engines has proven to be very successful.

Reviewer 3:

The reviewer said that the project is studying direct injection spark-ignited (DISI) combustion using spray-guided combustion for lean operation. The project is seeking to develop a fundamental understanding of spray-guided spark ignition (SI) combustion and fuel impacts on spray-guided DISI (particularly ethanol, but also monitoring emerging biofuels). The reviewer recounted how the team is combining metal engines, optical engines, and simulation to better understand ways to mitigate barriers to effective and efficient combustion. The reviewer concluded by saying that the research engine combines metal and optical configurations using the typical SNL single-cylinder research engine (SCRE) configuration. This approach yields fundamental understanding with authoritative measurements.

Reviewer 4:

The reviewer highlighted that the work provides valuable comparison of stratified and lean burn DISI strategies with a number of injection and ignition strategies.

Reviewer 5:

The reviewer explained that the project uses a mainly experimental approach based on metal engine and optical engine results to provide an understanding to optimize combustion for stratified and well-mixed combustion in DISI engines. Analysis of optical engine results for characterizing combustion regime (for example, tail versus head ignition) and relation to heat release rate (HRR) and cyclic variability is excellent. The reviewer mentioned that there is enough room for using CFD models to provide a more in-depth analysis of dilute DISI engines with ethanol-blended fuels. It is good to see that CFD modeling is part of the future plan and this should also help in tackling the barrier of predictive tools for fuel property effects on combustion and engine efficiency optimization.

Question 2: 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.

Reviewer 1:
The reviewer noted that the project is on schedule and that it studied fuel blend impacts on stratified operation. The project is considering the role of ignition location on combustion variability and flame development. In addition, the project team considered well mixed dilute combustion and novel ignition systems. The team observed benefits of ethanol on smoke emissions, but also recognized critical importance of ignition location (i.e., the fact that tail ignition suppresses soot formation) for gasoline. The reviewer acknowledged that high ethanol content helps allow tail or head ignition. These observations are highly valuable for understanding how to control critical engine operating and configuration parameters. Yields well supported interpretation of impacts of control parameters and fuel. The reviewer concluded by saying that the publication rate from the project is very good.

Reviewer 2:
The reviewer stated that the results provide outstanding fundamental understanding for running lean-burn DISI engines at optimum operation. Given all the results are presented for 19-21% exhaust gas recirculation (EGR) and O_2, it raises a question how the dilution level will impact the findings from this study.

Reviewer 3:
The reviewer commended the project on very good progress on meeting milestones. This person pointed out that over the past year progress was made on determining the role of ethanol and gasoline mixture proportions on soot emissions for stratified operation over a range of loads. The project showed that highly stratified operation is not suitable for gasoline for the system tested. The project team was also able to statistically quantify the relationship between the in-cylinder flow fields, spark-plasma development, and combustion variability. The project also determined the role of ethanol and gasoline mixture proportions on the stability of stratified ignition for wide ranges of spark timings.

Reviewer 4:
The reviewer applauded technical accomplishments in both DISI with spray-guided stratified charge combustion system and in the area of DISI with well-mixed dilute combustion system, and stated that they have been very good. Milestones in the project continue to be met including determining the role of ethanol and gasoline mixture proportions on soot emissions across load ranges for stratified engines.

Reviewer 5:
The reviewer felt the project team did not give a good understanding of the research in this presentation and thus the reviewer would need to check publications to understand better.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that collaboration and coordination in this project continue to be excellent. The researchers are working with the 15 industry partners through the AEC MOU along with LLNL, General Motors Company (GM), and several universities, which brings together a great deal of expertise to help make this project a success.

Reviewer 2:
The reviewer stated that the project includes involvement from a large number of industry partners through the MOU, two universities, and another national laboratory.

Reviewer 3:
The reviewer noted that the project has connections to industry through the AEC MOU, and connections to GM for hardware and various collaborators. The reviewer observed the missing element to date is a connection to a simulation partner.

Reviewer 4:
The reviewer commended the good set of collaborators, and suggested that the researchers should consider adding a CFD collaborator.

Reviewer 5:
The reviewer pointed out collaborations with one original equipment manufacturer (OEM) – although the reviewer thought it was not clear if the OEM just provides hardware – several universities, and one national laboratory. As with most of the projects that claim collaboration through the AEC MOU Working Group, it is not clear if the interactions only consist of the questions asked during the twice per year presentations, or if they are more extensive.

Question 4: 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.

Reviewer 1:
The reviewer explained that the project will continue the study of fuel blend effects in stratified operation, complete swirl-stabilization studies, expand from lean and dilute operation to partial stratification, as well as work further on diagnostics and simulation. This is a very productive study and the future work plan is more than satisfactory. The reviewer emphasized, however, the need to link with a CFD partner soon. This person commented that it would be very interesting to compare these ethanol studies, particularly the sooting behavior relative to ignition location and oxygenate content, with studies of butanol (iso-butanol in particular). This could permit the study of oxygen content and octane number individually, because the oxygen and octane are currently varying simultaneously.

Reviewer 2:
The reviewer expressed support for the proposed plans to devote more attention to 0% ethanol blend with gasoline (E0) to 30% ethanol blend with gasoline (E30) blends.

Reviewer 3:
The reviewer asserted that future work identified for the remainder FY 2014 and FY 2015 will be to continue several ongoing projects including studying the effects of fuel blends E0 to E30. The efforts identified for future work will continue to address the barriers of this project.

Reviewer 4:
The reviewer affirmed a logical plan for the continuation of the project.

Reviewer 5:
The reviewer would like to see a more holistic evaluation of the combustion strategies, such as ability to be fuel-robust, the ability to work with conventional aftertreatment, and more information about operating ranges and limits.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer mentioned that pushing engine efficiency to higher levels, which this project can enable, will displace petroleum through reducing consumption.

Reviewer 2:
The reviewer explained that research will help with development of unthrottled lean combustion, which should be more efficient than stoichiometric combustion.

Reviewer 3:
The reviewer asserted that exploration of concepts to improve fuel economy and reduce emissions supports DOE objectives.

Reviewer 4:
The reviewer observed that determining fuel characteristics that enable advanced combustion engines to operate as efficiently as possible helps to meet the DOE goal of petroleum displacement through efficiency gains.

Reviewer 5:
The reviewer indicated that this project directly supports DOE objectives of petroleum displacement by further utilizing renewable fuels and increasing fuel efficiency in lean-burn combustion engines.

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

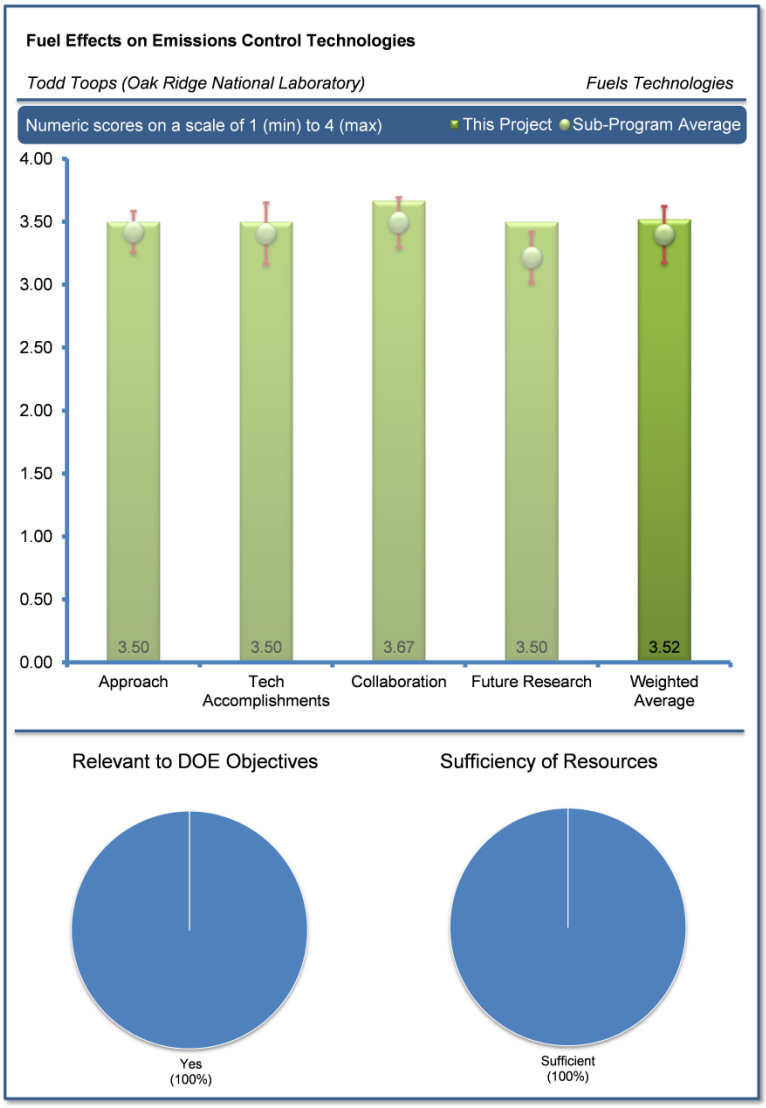
Reviewer 1:
The reviewer recounted that funding should be sufficient for the project to complete the tasks and milestones for this fiscal year. It is not clear if adequate funding is available for the future work that is proposed.

Reviewer 2:
The reviewer offered that the project has a good level of funding and looks stable/increasing.

Reviewer 3:
The reviewer stated that funding seems sufficient to meet objectives.

Reviewer 4:
The reviewer claimed that sufficient experimental facility exists, and adding CFD capability through collaborative efforts will be advantageous.

Fuel Effects on Emissions Control Technologies: Todd Toops (Oak Ridge National Laboratory) - ft007



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer affirmed that the approach to provide in-depth characterization of particulate matter, hydrocarbons, and emission control devices to better understand fuel and lubricant effects has proven to be very successful.

Reviewer 2:

The reviewer indicated that it is unclear how topics are selected and retired for each year's work. ORNL has developed rapid techniques and special sampling and analysis to move work faster and to lead to more knowledge.

Question 2: 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.

Reviewer 1:

The reviewer remarked that the project has made excellent progress in each of the five research areas on addressing the technical barriers. In addition, all of the FY 2014 milestones have either been achieved or are on schedule to be completed this fiscal year.

Reviewer 2:

The reviewer pointed out the good results for each topic, but found it hard to relate some of them to the big picture, and suggested that the significance of the results needs to be pounded home.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:

The reviewer commended the project on a very good set of collaborators including laboratories, universities, catalyst companies, and Manufacturers of Emission Controls Association (MECA).

Reviewer 2:

The reviewer pointed out that this project has several collaborators and partners including national laboratories, universities, additive manufacturers, and OEMs including GM, Ford and Cummins. The partners work on emissions control opportunities with biofuel, fuels and lubricant formulation impacts on GDI particulate emissions and compatibility of new fuels and lubricants with emission control devices and provide excellent coordination for a successful project.

Reviewer 3:
The reviewer suggested that it is probably best to remove the reference to Mobil 1 as the baseline for motor oil. Mobil 1 is a fine motor oil but there are many variations with different additive packages, so other researchers cannot actually tell much from this. The reviewer went on to point out that the researchers should be simply looking for a current, state-of-the-art, GF-5 oil. It is not a problem to use Mobil 1 and mention it verbally, but putting in writing that Mobil 1 is the goal or the baseline can be considered an endorsement that Mobil 1 is the best. Partners at Shell, BP, and other companies also make excellent motor oils that can outperform Mobil 1 in certain conditions. The reviewer summarized that the presentation should please remove the reference to Mobil 1 unless the project team wishes to give more details on it, and refrain from using it for future goals. It may be better to say state-of-the-art light-duty (LD) motor oil with a high-temperature, high shear (HTHS) viscosity of x.x cP.

Question 4: 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.

Reviewer 1:
The reviewer recounted that future directions have been identified for each of the five research areas and have been discussed with the industry partners. The work will continue to address the barriers of inadequate data and predictive tools for fuel effects on emission control systems as well as the long term impact of fuels on emission control systems.

Reviewer 2:
The reviewer observed that the project has a very broad range of research, which perhaps suffers because too many topics are being covered to allow in-depth study and analysis.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer highlighted the fact that the research is generally supportive of developing and understanding emissions control with advanced engines, lubricants, and fuels.

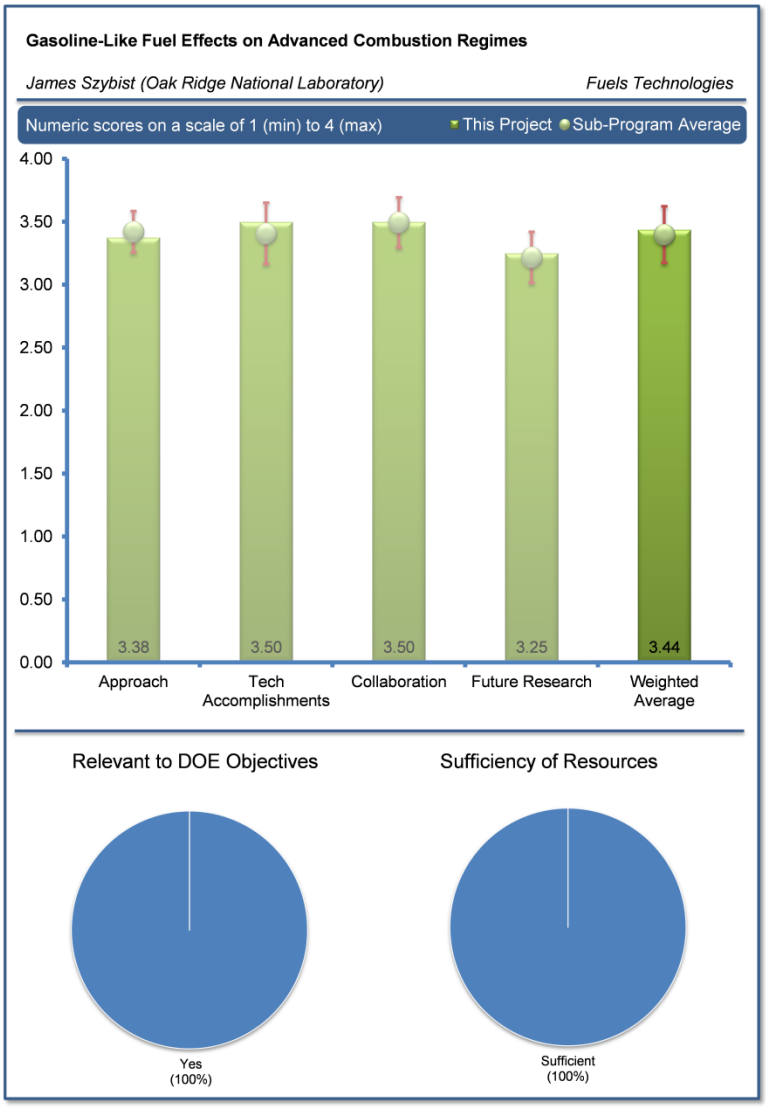
Reviewer 2:
The reviewer agreed that the objective of the project is relevant to petroleum displacement since the objectives are to identify concerns of changes in fuels and lubricants including renewable fuels and investigation of unique characteristics of fuel that will enable increased fuel efficiency.

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

Reviewer 1:
The reviewer affirmed that funding is sufficient to complete work in FY 2014. It is unclear what resources will be available for the proposed future direction.

Reviewer 2:
The reviewer stated that resources are sufficient for this level of effort, but it might be better to focus and go deeper with a smaller set of topics.

Gasoline-Like Fuel Effects on Advanced Combustion Regimes: James Szybist (Oak Ridge National Laboratory) – ft008



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work – the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded a very good set of experiments making useful comparisons to understand fundamental limits in the systems.

Reviewer 2:

The reviewer described the project balancing Corporate Average Fuel Economy standards and Renewable Fuel Standards (RFS) using commonly available oxygenates is a good approach. It would be nice to also include a conventional petroleum super premium in baseline testing. The reviewer wondered how the combustion chamber was optimized for a high compression ratio.

Reviewer 3:

The reviewer observed that the approach of using the same engine platform for each of the four combustion modes studied is very good, and coupling experimental work with Autonomie simulation is good. The reviewer had some concerns over choice of fuels studied. The regular gasoline did not contain any ethanol – which is not representative of the 10% ethanol blend with gasoline (E10) primarily used in the United States. The reviewer said that a comparison of E0 to 24% iso-butanol fuel blend to E30, where fuel composition as well as octane number changes, seems like an apples-to-oranges comparison.

Reviewer 4:

The reviewer explained that the project investigated fuel effects for different promising advanced combustion modes including reactivity controlled compression ignition (RCCI), boosted homogeneous charge compression ignition (HCCI), and partially premixed combustion (PPC). The approach/results look like a collection of highlights for different modes, rather than a systematic approach for comparison of fuel effects on these advanced combustion modes (particularly including apples-to-apples comparisons). The reviewer noted that Slide 19 shows the plan for comparison for PPC and R–CI - the future results in this part will be interesting.

Question 2: 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.

Reviewer 1:

The reviewer applauded a very good set of experimental data. This person also said that it seems like it would be useful to do combustion modeling in parallel with experimental work to help understand data and guide future experiments, and that this could be done by partnering.

Reviewer 2:
The reviewer acknowledged that there was some excellent data. It seems to need a bit more integration to draw overall conclusions, and still seems to be somewhat a collection of individual experiments in this reviewer's mind.

Reviewer 3:
The reviewer pointed out the wide range of results and accomplishments. The choice of fuels (different compositions and different octane numbers) seems to make it difficult to identify specific reasons for different performance of fuels. The reviewer wanted to know if, for example, the better results for E30 are due to the significantly higher octane number or charge cooling effects. In other words, it would be interesting to know the contribution of each.

Reviewer 4:
The reviewer expressed that the project results for 75% coverage with RCCI are promising. However, the reviewer thought it is uncertain how many fuels will be used, and wanted to know if the researchers envision using more than two fuels to get this coverage, as Slide 17 shows four fuels including diesel, gasoline, biodiesel and E30. Results for the capability of using renewable super premium (RSP) for downsizing and downspeeding options are very encouraging; further investigations might be rewarding. The reviewer criticized that results on Slide 19 for fuel economy comparison are misleading, as transient fuel penalty is not included in those results. However, it is very good that the project links both engine data and vehicle data for the FTP drive cycle.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer reported a good set of collaborators between universities, national laboratories, and industry.

Reviewer 2:
The reviewer reinforced the good mix of collaborators from industry (OEMs and an energy company), other national laboratories including SNL, and universities.

Reviewer 3:
The reviewer recounted that the project includes in-depth involvement with industry and academia and other national laboratories. Having joint publications is good evidence of this strong collaboration. The reviewer commented that providing the data from this project in common database platform (for example CLEERS) can leverage further collaboration opportunity and expand the application of this work.

Reviewer 4:
The reviewer observed that there is generally good collaboration. The reviewer said that there are a somewhat limited number of industrial interactions, but observed a very strong collaboration with University of Wisconsin.

Question 4: 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.

Reviewer 1:
The reviewer expressed that the plans seem reasonable.

Reviewer 2:
The reviewer asserted that there is an excellent plan to continue sorting this unique concept against other options and varying fuel types. The reviewer would like to see more on what happens in a total, customer-operated system. The researchers have to cold start, idle, and run transients under all conditions. The Bosch ACCESS project seems to be showing major loss of HCCI opportunity related to transitions in and out of HCCI, and catalyst effects (the data will be in publication soon); similar analyses are required for RCCI. The reviewer wondered what the real benefit is, considering cold start and transients.

Reviewer 3:
The reviewer said that before the six-stroke work is done, energy balances and parasitic losses should be modeled. This person stated that there are good plans for RCCI. The reviewer also affirmed that generally, work should include more engine and combustion type modeling to help with optimization and better understanding of turbo requirements and flame speed effects.

Reviewer 4:
The reviewer indicated that in addition to turbocharger (TBE) and fuel efficiency metrics, emission results are equally important. The presentation did not include substantial emission results (except for Slide 19). Future work may present both fuel economy and emission metrics side by side. The reviewer suggested that more apples-to-apples comparisons will be insightful for the scholars in the field.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted the significant impact on efficiency and emissions.

Reviewer 2:
The reviewer pointed out that the project achieves petroleum savings by both engine efficiency and renewable fuels. The data provides a direct comparison of a variety of combustion strategies and fuel effects and requirements.

Reviewer 3:
The reviewer observed that the investigation of fuel property effects and identification of optimal fuel formulations for LD advanced combustion engines should enable development of fuel-engine systems that have higher efficiencies and lower emissions.

Reviewer 4:
The reviewer commented that this project directly supports DOE objectives of petroleum displacement by further utilizing renewable fuels in advanced combustion regimes.

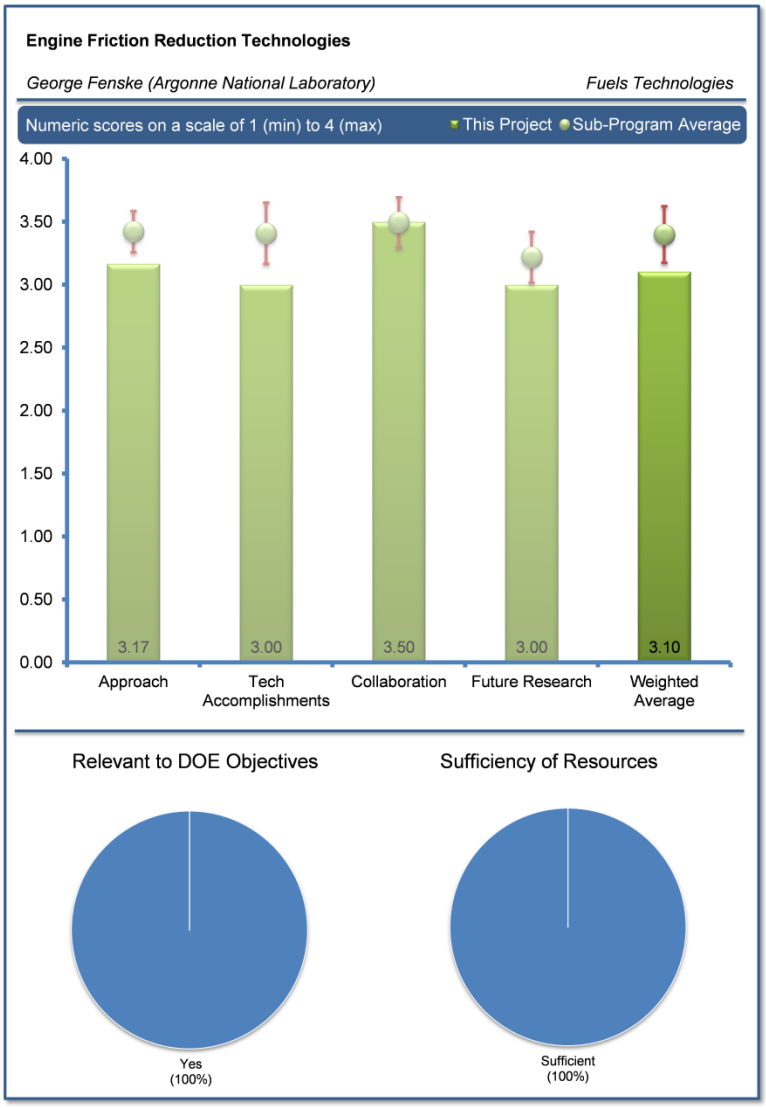
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that the funding is probably sufficient, and expressed interest in seeing some expansion on transient and cold testing and that may need added funding.

Reviewer 2:
The reviewer remarked that resources appear adequate for experimental work, but more may be needed to include increased modeling work.

Reviewer 3:
The reviewer pointed out that it will be very helpful for this project to have access to a Cooperative Fuel Research (CFR) engine for testing different combustion modes which require different compression ratios and then comparing fuel effects on different combustion modes. This can add a strong value to this work, so fuel effects comparisons will be more conclusive.

Engine Friction Reduction Technologies: George Fenske (Argonne National Laboratory) - ft012



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer reported that the project is divided into multiple sub-topics (i.e., protocols, base oils, and additives).

Reviewer 2:

The reviewer expressed that the authors created a very extensive list of barriers faced by crankcase oil industry. It would be advantageous to select one specific area to pursue their interests, for example, HD diesel hardware, LD gasoline hardware, LD diesel hardware, marine, small engines, etc. The reviewer commented that more focus in the approach can provide better opportunities for a successful outcome.

Question 2: 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.

Reviewer 1:

The reviewer asserted that there appeared to be some very good demonstrations of friction and wear reduction. The reviewer is not sure why base oils tested are unique or special, but posited that maybe the researchers are adding knowledge. The reviewer suggested that protocols should be firmed up and published, and that it would be really great if others started using them.

Reviewer 2:

The reviewer offered that the most impressive progress was made on Task 1, aligning lab bench tests to engine tests. However, a better definition of the desired engine hardware needs to be put forward. The reviewer explained that development of novel nano-additives needs to include storage stability studies and exhaust catalyst degradation studies. Failure in any of these two areas will prevent any technical advances. The reviewer went on to say that a narrow focus in frictional or wear results is not sufficient to make additives acceptable for commercialization. The reviewer also pointed out that novel base oils studies did not include additive solubility assessments.

Reviewer 3:

The reviewer stated that it was unclear how much of this work will be published and how it will contribute to future improvements in the field.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer noted that ANL has partnered with lots of excellent companies.

Reviewer 2:
The reviewer commented that ANL has been proven to be very effective in collaborative studies in the past and continues to be a leader in this area.

Reviewer 3:
The reviewer voiced that the project appears to have a wide range of collaborations through Cooperative Research and Development Agreements (CRADA) and other relationships, but some are vague on the poster. The reviewer wanted to know who is committed to real collaboration.

Question 4: 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.

Reviewer 1:
The reviewer expressed that continuing the work is a logical approach.

Reviewer 2:
The reviewer characterized the need to continue to focus on providing relevant data to the DOE program and the lubricants community.

Reviewer 3:
The reviewer suggested that a more detailed plan and a better focus on selective hardware will help to deliver deep fundamental understandings.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer confirmed a good definition of needs, barriers, and plans to make progress to improve system efficiency via lubrication regimes.

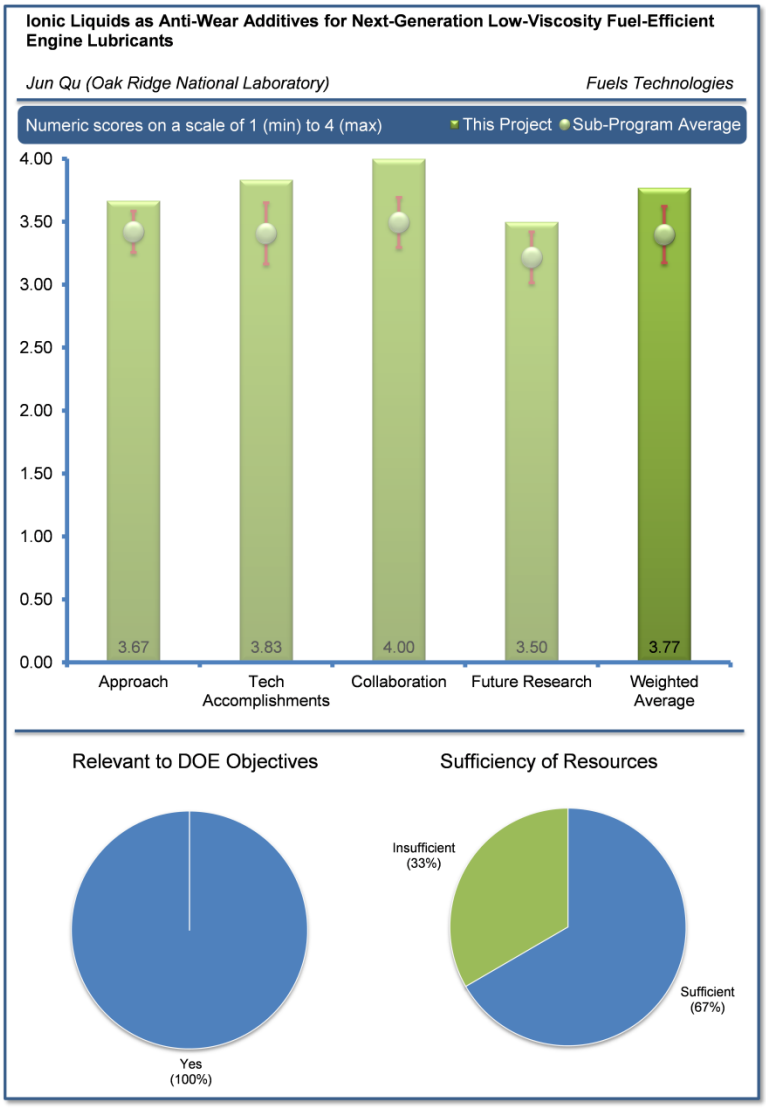
Reviewer 2:
The reviewer pointed out that drop-in lubricants can save fuel.

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

Reviewer 1:
The reviewer mentioned that the financial plan is well defined.

Reviewer 2:
The reviewer acknowledged that resources are sufficient to support potential collaboration.

Ionic Liquids as Anti-Wear Additives for Next-Generation Low-Viscosity Fuel-Efficient Engine Lubricants: Jun Qu (Oak Ridge National Laboratory) - ft014



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked on a very logical approach to answer the most typical questions about introducing a new additive. The researchers are covering all of the necessary questions as they continue.

Reviewer 2:

The reviewer mentioned that the research combines screening, bench tests, and multi-cylinder tests along with ionic liquids (IL) formulation, lube formulation, and fit-for-use tests.

Reviewer 3:

The reviewer indicated that bench testing and engine dynamometer tests demonstrate friction performance well with quantifiable metrics. The wear data and analysis of the tribofilm is documented as well. The lubrication mechanisms are not fully understood and must be addressed in future work.

Question 2: 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.

Reviewer 1:

The reviewer emphasized that demonstrating a 2% fuel efficiency (FE) improvement on Sequence VID tests is a monumental achievement. The reviewer commented that demonstrating a fully formulated oil on full engine tests is about as good as it gets to demonstrate the technology, and that ORNL has gone beyond using just benchtop rigs, which really improves the confidence in the technology.

Reviewer 2:

The reviewer applauded very strong performance indicators, including accomplishing a FE improvement without sacrificing durability. The reviewer criticized that the project lacked the conclusive fundamental understanding of the underlying mechanisms that explain the performance enhancement, although there were some tribofilm analyses and hypotheses that seemed feasible to explain superior performance.

Reviewer 3:
The reviewer offered that the research has demonstrated real benefits along with ability to meet practical requirements for a lubricant such as catalyst effects, water, corrosion, etc. The development of oil soluble ionic liquids (ILs) is a very good step forward. However the reviewer cautioned that it is not clear what the development path was to get to IL-18 and where the project was going next.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer acknowledged an excellent team including an OEM, national laboratory, oil formulator, and additive supplier. There are no weaknesses.

Reviewer 2:
The reviewer stated that the project had very excellent partners: GM for practical requirements and final engine tests; Lubrizol for realistic formulation; and the project team's IL feedstock partner for ability to formulate new ILs.

Reviewer 3:
The reviewer noted that the strong collaboration between automobile OEM and lubricant formulators resulted in a very promising project outcome.

Question 4: 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.

Reviewer 1:
The reviewer indicated that future work should include some work testing the sensitivity and stability of the formulated oil to the extremes of engine operation (water, acid, soot, oxidation, etc). It would be interesting to see how the IL formulation holds up compared to conventional oils as the contaminants increase. The typical condition results look good; knowing how it compares on worst-case scenarios would be useful.

Reviewer 2:
The reviewer claimed that this project is successfully completed and a follow-up project has begun. It was not clear to the reviewer how, or if, new IL chemistries will be developed.

Reviewer 3:
The reviewer specified that this project is completed but did address some research barriers for future work if funded through a different project line.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer offered that this could save more petroleum in one year than electric vehicles (EV) or fuel-cell vehicles will in decades, or ever. A 2% increase across the entire fleet is a huge number.

Reviewer 2:
The reviewer emphasized that this technology could revolutionize anti-wear additives for oils. If superior, it would enable the use of lower viscosity lubricant base stocks without sacrificing durability. A FE enhancement was demonstrated without compromising wear performance.

Reviewer 3:
The reviewer affirmed that drop-in fuel savings of greater than 2% have been demonstrated for a novel lubricant.

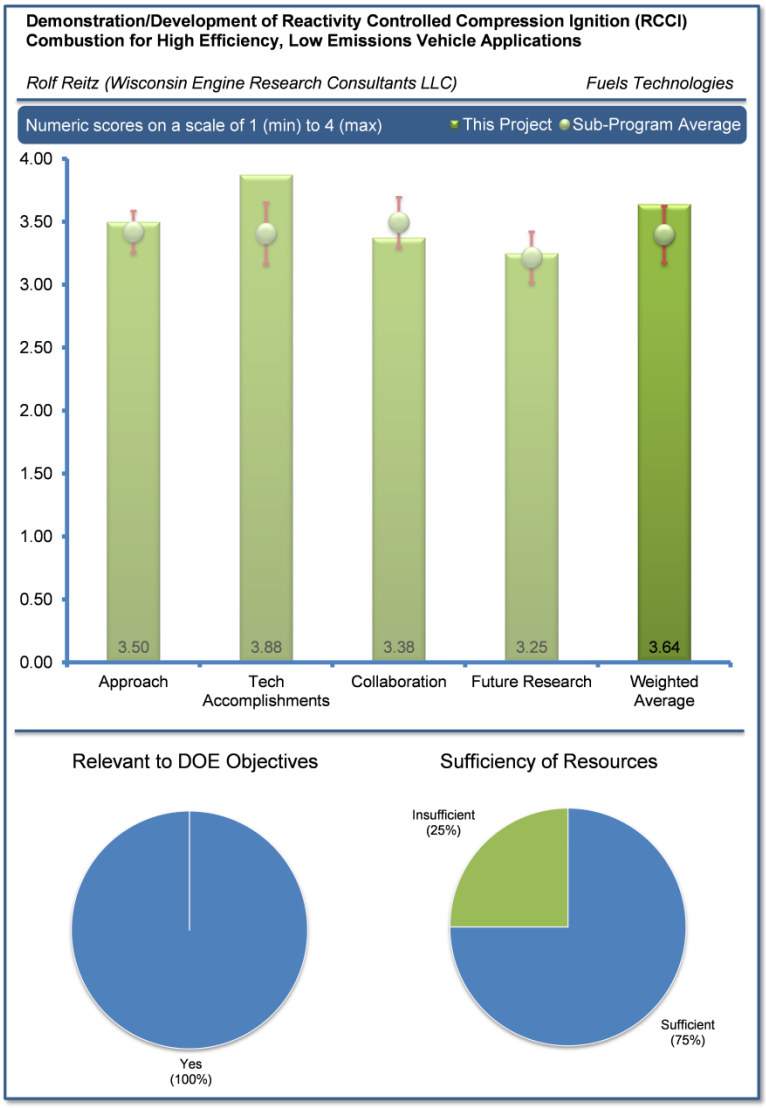
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer reported that this project represents the cutting edge of lubricants research. ILs are the first true competitor to ZDDP in decades. The market introduction is being held back by limited funding. The reviewer explained that the quicker ILs can get into the market, the sooner the existing car parc can experience better fuel efficiency. Funding should be doubled at a minimum; a five-fold would be appropriate.

Reviewer 2:
The reviewer noted that the project meets objectives, and that DOE needs to ensure that follow-up work is funded.

Reviewer 3:
The reviewer commented that the PI's resources combined with the invested collaborators were sufficient to perform the project objectives. All stated milestones were met on time despite some large technical barriers.

Demonstration/Development of Reactivity Controlled Compression Ignition (RCCI) Combustion for High Efficiency, Low Emissions Vehicle Applications: Rolf Reitz (Wisconsin Engine Research Consultants LLC) - ft015



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer affirmed that the team has developed an excellent ability to model and optimize combustion chamber design.

Reviewer 2:

The reviewer mentioned that the approach of coupling engine tests with CFD spray and combustion models to further investigate RCCI is reasonable.

Reviewer 3:

The reviewer noted that the project incorporates a good mix of simulation of experimental work. In particular, use of simulation for developing a new concept piston was very interesting. The reviewer observed that the capability of the model for hydrocarbon (HC) and carbon monoxide (CO) emissions was not presented, while RCCI is typically known to have high HC and CO emissions. This can be added to the final report of the project.

Reviewer 4:

The reviewer expressed that the project had an excellent approach to address a major limitation in RCCI for both LD and HD engines. On the other hand, cold start, idle, and transient issues remain to be addressed.

Question 2: 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.

Reviewer 1:

The reviewer said that there appears to be rapid development of the experimental work, driven by modeling. This should be a style for all DOE work.

Reviewer 2:

The reviewer acknowledged very solid results in the testing and models. A main RCCI limit has been moved significantly, broadening the operation range.

Reviewer 3:
The reviewer described how the results of low rate of pressure rise (RoPR) with low unburned hydrocarbons by using new piston design are very promising. In particular, the results on Slides 10-11 show excellent accomplishments. The reviewer went on to say that including both LD and HD applications in one project is excellent. Including synergy between these two applications in the final RCCI report from this project would be valuable.

Reviewer 4:
The reviewer applauded good progress on further understanding and advancing LD and HD RCCI. It is good to see advancement to multi-cylinder studies in collaboration with ORNL. The reviewer remarked that it looks like good agreement between the models and experimental data. It would be good to see additional work with models to determine optimal amount of 2-ethylhexyl nitrate (EHN) to use with gasoline.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer pointed out the good partnerships with industry and national laboratories, and that the team is very willing to share the work and the credit.

Reviewer 2:
The reviewer offered that the project includes a strong collaboration involving academia, an industry partner, a national laboratory and a consulting company. Tasks are clearly defined for each involved party.

Reviewer 3:
The reviewer affirmed the project's good collaboration with ORNL. The collaboration with Caterpillar seems to be mainly providing hardware to the project. No other industrial collaborations are listed.

Reviewer 4:
The reviewer expressed that there are some collaborations, mainly ORNL and Caterpillar.

Question 4: 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.

Reviewer 1:
The reviewer mentioned that there is a logical plan to complete this project by September 2014, and that this project will open up many new future research opportunities.

Reviewer 2:
The reviewer remarked that research continues in a practical direction of optimization and commercialization. The reviewer suggested continuing to focus on commercial, practical fuels in order to concentrate on optimization of engine concept.

Reviewer 3:
The reviewer stated that plans seem reasonable.

Reviewer 4:
The reviewer was disappointed to see no plans to look at cold start, idle, higher-than-RCCI load, and especially transient work. The Bosch ACCESS project and others have indicated that mode switching limitations can significantly reduce the amount of time actually spent in advanced combustion modes. Mode switches are not instantaneous, and catalysts have a memory effect that limits mode switches. The reviewer cautioned that without addressing these issues, there is a risk the concept can only apply to steady state operations such as stationary engines.

The reviewer thought these issues are not necessarily job stoppers but they are critical to gaining wider acceptance leading to real- world applications, and that the plans shown here do not address these issues.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer expressed that the project is very relevant to DOE goals of efficiency and emissions.

Reviewer 2:
The reviewer affirmed that this project directly supports DOE objectives of petroleum displacement by increasing brake thermal efficiency of IC engines, and creating new opportunity for utilizing renewable fuels in advanced combustion regimes.

Reviewer 3:
The reviewer commented that practical development of RCCI concept will improve engine efficiency to reduce petroleum consumption. Modeling tools and approaches make work more efficient and easier to apply to new variations.

Reviewer 4:
The reviewer pointed out that RCCI represents a promising advanced combustion option. If successfully advanced to commercialization, it would reduce fuel consumption and lower emissions.

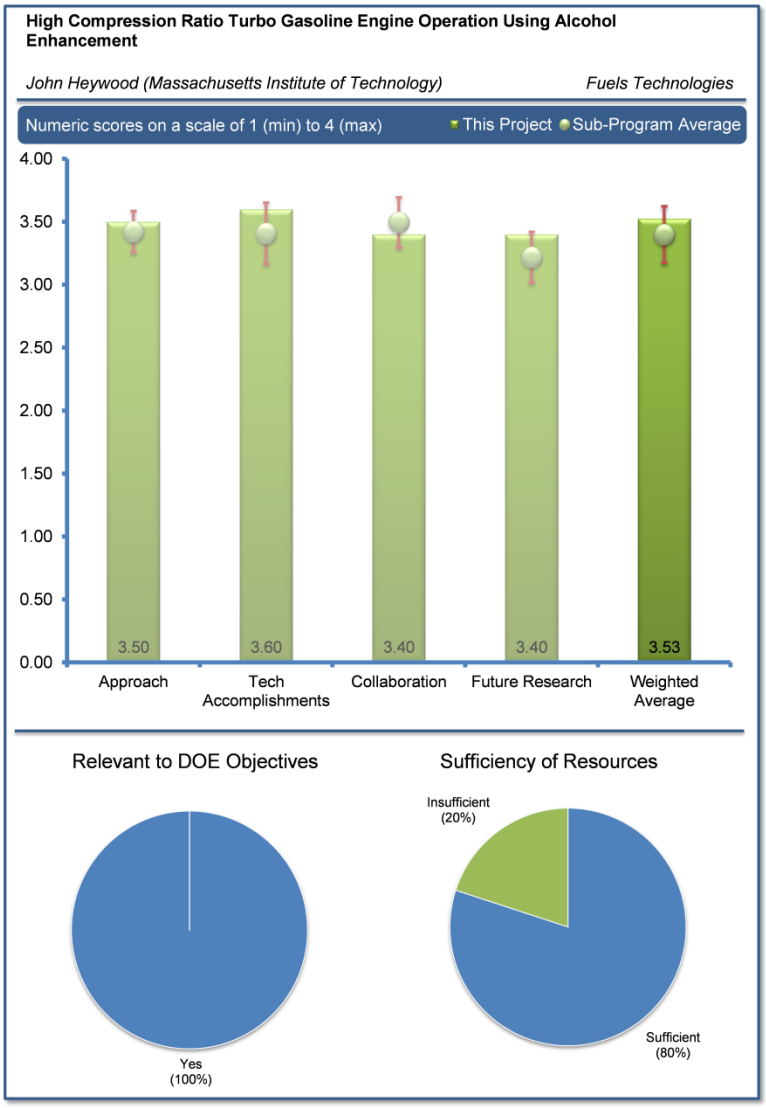
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that there do not appear to be any gaps in research due to funding limitations.

Reviewer 2:
The reviewer asserted that simulation works are mostly completed. The project has access to sufficient experimental facility for both LD and HD engine testing.

Reviewer 3:
The reviewer assumed the reasons for not addressing wider load range, cold start and transients are budget-related – taking those on is a major effort. The funding seems appropriate for the work actually planned. The reviewer believed that expanded funding would be justified if the open issues can be addressed effectively.

High Compression Ratio Turbo Gasoline Engine Operation Using Alcohol Enhancement: John Heywood (Massachusetts Institute of Technology) - ft016



Reviewer Sample Size

A total of five reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer noted that this is a very well-constructed set of analyses and test data to illuminate an interesting idea.

Reviewer 2:

The reviewer stated that there is a good approach to the project by combining some modeling work with experimental data.

Reviewer 3:

The reviewer asserted that this project uses a classic approach of combining engine experimental testing and modeling (using Chemkin and GT-Power). While the modeling work is very valuable, the extension of the results for the area that model is not necessarily valid can limit the conclusions from this work. Further experimental data is required to provide conclusive results from this work. The reviewer went on to point out that no emission data was presented in the work, and expressed interest in knowing if the assumption is that efficiency is studied while a same emission level is maintained.

Reviewer 4:

The reviewer mentioned that the value of ethanol to higher compression ratio (CR) and the associated efficiency is understood. This technique is appropriate to use for octane only when it is required.

Reviewer 5:

The reviewer notes how the project targets the development of knock-free SI engines through blending of alcohol and blending with gasoline. The reviewer asserted that it was unclear how this project complements or expands upon other combustion strategy approaches being explored under DOE funding. For example, there are other projects under the Advanced Technology Powertrains for Light-Duty Vehicles program, such as the 85% ethanol blend with gasoline (E85) injection studies by Ford to extend knock limits, and ORNL efforts on fuel effects in DISI.

Question 2: 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.

Reviewer 1:
The reviewer applauded excellent results. It is very useful in clarifying where the benefit and limitations of downsized and boosted engines arise. This reviewer added that the project pushed the boundaries.

Reviewer 2:
The reviewer observed excellent work. The project demonstrated a practical and feasible technology to improve FE without excessive cost or changes to the infrastructure. The research reached a very interesting conclusion that one does not need to use EGR since the fuel can prevent LSPI.

Reviewer 3:
The reviewer offered that the results from this project provide an excellent understanding for comparing the benefit of using knock-resistant gasoline blends with alcohol (which means use of higher compression ratio), boosting intake air pressure, and downsizing, all of which can contribute to increase engine thermal efficiency. The reviewer also said that engine-in-vehicle simulation results are important, although it is more important to ensure those simulations are valid for transient operating conditions in a common drive cycle.

Reviewer 4:
The reviewer explained that since the project's initiation, engine had been configured, GT-Power model had been configured and calibrated, and other models have been applied to the study. The project explored knock onset limitations and defined fuels to allow extension of knock limits. The research shows that E85 allows wide-open throttle (WOT) operation for this 2-bar boosted engine. The project mapped knock limits for various compression ratios and boost levels to identify limits of high alcohol fuels and interaction with spark retard requirements. Through vehicle drive cycle simulation, the results from the engine combustion mapping have been translated to practical vehicle impacts of the high alcohol optimized strategy. The reviewer indicated that the project demonstrated that downsizing has the greatest impact on miles per gallon (MPG) as compared to increasing CR. Therefore, boost (and downsizing) is more effective at allowing engines to operate at higher CR (which requires high ethanol dosing).

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that the project includes a strong industry collaboration.

Reviewer 2:
The reviewer said that the project has a solid collaboration with Cummins. It would be nice to see a broader collaboration with the LD OEMs and suppliers.

Reviewer 3:
The reviewer pointed out the good link with an industrial partner, but no link to national laboratories or other universities.

Reviewer 4:
The reviewer's only caution is to consider and address through other outside organizations the viability of multiple in-vehicle tanks, or other issues associated with a dual fuel retail or consumer experience.

Reviewer 5:
The reviewer suggested that some integration with a LD OEM and component suppliers might have helped determine if the power cylinder can actually hold up to the very high pressures necessary.

Question 4: 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.

Reviewer 1:
The reviewer recounted the good approach for completing the work in the next year - including more experimental results to evaluate findings from this work will be invaluable.

Reviewer 2:
The reviewer stated that the project is ending but future work is good to complete it.

Reviewer 3:
The reviewer indicated that project is wrapping up in January 2015, so the project is in a phase of consolidating the lessons learned from the project for potential future vehicle design and fueling requirements.

Reviewer 4:
The reviewer voiced that the remaining plan is very good, and that it would be nice to have a future vehicle demonstration to examine some of the issues of transient response and drive cycle effects but that obviously would not fit the budget. The reviewer concluded that the idea of an onboard separation seems worthy of some serious effort, but also may be beyond the scope of the project.

Reviewer 5:
The reviewer commented that lean burn combustion with ethanol needs to be better understood.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer expressed that the project is very relevant to DOE goals of efficiency and alternate fuels use.

Reviewer 2:
The reviewer reported that the project targets the dramatic improvement of light-duty vehicle fuel economy, which can displace petroleum use by improving efficiency.

Reviewer 3:
The reviewer emphasized that this project directly supports DOE objectives of petroleum displacement by proving understanding which will lead to optimum use of renewable fuels in future engine technologies.

Reviewer 4:
The reviewer noted that the project offers an alternative to the simple raise-the-octane argument, which is getting tired. Simply raising the octane for everyone is a waste of money for the vast majority of people. The reviewer believed that refiners have to balance out the streams, and high octane will unquestionably cost more.

Reviewer 5:
The reviewer stated that ethanol is directly replacing HCs as a fuel source.

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

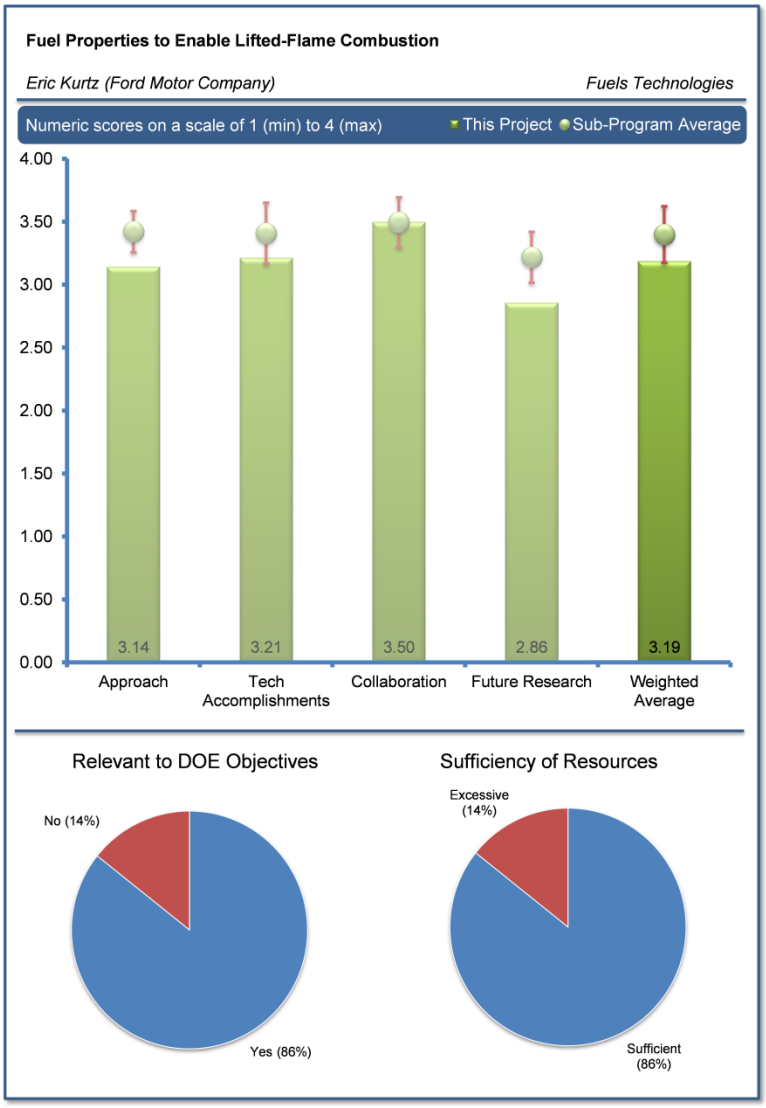
Reviewer 1:
The reviewer said that this is a pretty well funded project and it appears that funding has been stable, which is essential for university-led projects.

Reviewer 2:
The reviewer mentioned that resources are sufficient for the work scope. The reviewer would like to see future funding for vehicle demonstration, and especially for an onboard separation system that would make the idea highly attractive because customers would not have to fill two tanks.

Reviewer 3:
The experimental facility and modeling capability seem to be in place to achieve the targets for the next year.

Reviewer 4:
The reviewer remarked that similar work should continue at Massachusetts Institute of Technology (MIT) or elsewhere in the future, and believed that octane-on-demand ideas are not represented enough.

Fuel Properties to Enable Lifted-Flame Combustion: Eric Kurtz (Ford Motor Company) - ft017



Reviewer Sample Size

A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer stated the researchers have an excellent approach to the project.

Reviewer 2:

The reviewer affirmed that the approach is well thought out and has necessary combination of existing data, new data, and simulation. The reviewer added that the combination of resources is also very nice.

Reviewer 3:

The reviewer affirmed that the project has a good mix of research covering modeling, special measurements, fuel selection, and engine results. However, there is no discussion of nitrogen oxides (NO_x) emissions or engine efficiency in this talk; it needs to be included in future work.

Reviewer 4:

The reviewer mentioned that the project is using LLFC to achieve high efficiency and low emissions. The project is looking to identify fuel properties to enable LLFC, wherein a longer lift-off-length enables greater air entrainment and reduction of local equivalence ratio at base of the flame. The research involves optical spray and combustion engine work, tied with modeling to achieve combustion system optimization.

Reviewer 5:

The reviewer remarked that the project uses a systematic approach, including modeling and experimental testing to provide fundamental understanding for LLFC combustion regimes including fuel effects. Although this project centers on fundamental study, the reviewer felt that it is important to close the loop by the end of this project for how practical is the LLFC with a best candidate oxygenated fuel from this study.

Reviewer 6:

The reviewer mentioned that the project uses a combination of engine testing, advanced optical diagnostics, and computational modelling to study LLFC (and resulting ignition delay) as a function of cetane number and oxygen content of fuel. It was not clear to the reviewer, however, to what extent other fuel parameters will be factored into the analysis (if at all), despite the results to date producing an apparently anomalous result with regard to cetane number (Slide 9). The reviewer concluded that the use of tri-propylene glycol methyl ether (TPGME) as the source of oxygen in the test program was not adequately explained or justified because TPGME is essentially non-existent as a fuel component today.

Reviewer 7:
While the reviewer can support evaluating how fuel effects impact LLFC and the apparent beneficial effects of oxygen-containing compounds, the reviewer does not understand the focus on TPGME blends, especially at high TPGME concentrations studied. TPGME is a specialty chemical produced in relatively small quantities (relative to the amount that would be required at the apparently required level of 25-50% in transportation fuels). It is produced by reacting propylene oxide with methanol. It is stated by Dow to be "completely" water-soluble. The reviewer wondered if there is any reason to believe that 25-50% blends of TPGME (or something similar) can, or will, ever be commercialized. The reviewer inquired whether the U.S. Environmental Protection Agency (EPA) and/or the state regulatory agencies would ever allow the use of another ether in fuels even in the unlikely event that it could be produced at a reasonable cost at the required quantities, and given the issues with methyl tertiary butyl ether (MTBE). The reviewer explained that if TPGME is just being used as a model compound, the researchers should make this very clear and provide their ideas for compounds that are feasible for use in fuels. If there are more feasible alternatives, the reviewer suggested switching the focus to those. The reviewer presumed that bio-derived methyl esters which also contain oxygen may be an alternative. However, perhaps the issue is that since they contain less oxygen than TPGME, the amount required to be blended in fuel may be greater than 50%, which would raise serious issues such as lube oil dilution, cold temperature handling, etc.

Question 2: 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.

Reviewer 1:
The reviewer stated that progress on testing of the fuels is good.

Reviewer 2:
The reviewer described that the project has a good understanding of experimental fuel effects but not much about how fuel effects can be mitigated by mixing parameters. It is a useful result that robust, commercial LLFC cannot be achieved without a special fuel.

Reviewer 3:
The reviewer recounted that spray studies are completed and transitioned to ongoing optical engine studies. The outcome from the spray studies was development of a novel optical diagnostic for luminosity, soot, and lift off length. The reviewer reported that the test fuels analysis is completed. The simulation study on fuel effects, via a combination of physical and chemical surrogate mixtures, led to good agreement between the simulation and spray and single cylinder engine (SCE) experiments, after improvement of kinetic models for TPGME fuel. Overall, there is an impressive amount of valuable outcomes from this research effort.

Reviewer 4:
The reviewer remarked that the work is interesting in that is shows how some fuel properties can reduce soot by a specific mechanism.

Reviewer 5:
The reviewer pointed out that the results on Slide 10 are very interesting for relating flame lift-off and soot for different oxygenated fuels. This should be helpful to understand the required level of oxygenation for proper LLFC operation.

Reviewer 6:
The reviewer applauded the nice accomplishments on understanding the relationship between ignition delay and lift-off length. The role of oxygenated fuels on LLFC is very interesting and provides new information. While outside of the scope, the reviewer will be interested to see how relationships with soot and lift-off length hold for other oxygenated fuels.

Reviewer 7:
The reviewer mentioned that the presentation shows a clear relationship between ignition delay and lift-off length but that is hardly a major discovery as it was presumably expected. It also shows clear relationship to oxygen content and to soot formation but those relationships were apparently already established by prior research under a separate grant. More importantly, the reviewer added, the reported results – that LLFC is dependent on highly specific fuel parameters including oxygen content and others, and that these required parameters may be different for different vehicles (on Slide 26) – point to very limited practical application of the subject technology.

The reviewer remarked that this is an important discovery but one that does not support great promise for the subject technology and suggests that further research should possibly be limited.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer indicated that the researchers have chosen excellent partners for tasks being done outside of Ford. The University of Wisconsin approach of splitting surrogates between physical and chemical is very important for complex modeling of LLFC.

Reviewer 2:
The reviewer stated that the project has ties to national laboratories and the University of Wisconsin.

Reviewer 3:
The reviewer affirmed that SNL is an excellent choice for partnership.

Reviewer 4:
The reviewer offered that nice collaborations pull in world class expertise from SNL, LLNL, and University of Wisconsin. The addition of LLNL on simulation and mechanisms was very good move and important to success.

Reviewer 5:
The reviewer noted that there is strong collaboration involving industry, two national laboratories and one university.

Reviewer 6:
The reviewer said that it looks like good coordination and collaboration between the small number of partners.

Reviewer 7:
The reviewer pointed out that the team includes two DOE laboratories and a university in addition to the major automaker project leader.

Question 4: 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.

Reviewer 1:
The reviewer reported that the project will continue optical engine work and single-cylinder metal engine work to explore different fuel effects on LLFC. The project will also apply the simulation results to better explain the results from the spray studies. There appears a lot remaining to be done by the end of the project in December 2014.

Reviewer 2:
The reviewer suggested that the proposed future research must include NO_x, fuel efficiency, HC, and CO trends.

Reviewer 3:
The reviewer said that continuing to evaluate LLFC makes sense, but strongly suggested moving away from blends (particularly high-level) of TPGME unless the team can develop a convincing case that it has a reasonable chance of being approved for use in high quantities in fuels by regulatory agencies, and could potentially be produced in very large quantities at a reasonable price.

Reviewer 4:
The reviewer noted the logical simulation and experimental testing plan exists before concluding this project in December 2014. The reviewer looks forward to seeing optical engine and metal engine results from this project. It would be important to assess if final results are promising for further research in this area, particularly because the project will need huge research efforts before practical benefits are realized. For instance, developing chemical mechanisms for fuels with different level of oxygenation is a challenging area.

Reviewer 5:
The reviewer summarized that the future work until project completion in December 2014 seems reasonable. Including the single-cylinder metal engine experiments is important. The reviewer mentioned that it would be nice to also see another fuel included for completeness and to better understand if the observations from TPGME blends hold.

Reviewer 6:
The reviewer reported that the project is ending so there is not much more additional work. Additional work could be performed with legacy engines to show the potential for LFC in a future project.

Reviewer 7:
The reviewer indicated that the proposed work tasks are logical, well-conceived steps toward the objectives stated of furthering understanding of LLFC. However, the reviewer added, the results to date seem to indicate that LLFC is likely to be of very limited practical application. The presentation indicates that it would require a very tightly specified fuel to be universally available – cetane, aromatic content, oxygen content, likely specific oxygenate, and etc. would all have to be completely standardized. The reviewer cautioned that even that might not be sufficient, as the Reviewer Only slide (Slide 26) indicates that each vehicle (engine design) may require a different oxygen level. Even assuming that the different oxygen levels could be attained through a kind of diesel "blender pump," the reviewer commented that it was extremely unclear how this could be accomplished in a world of existing vehicle populations, incremental introduction of new engine designs, differing refinery configurations and fuel production streams, etc. The reviewer said that it could require a whole new set of infrastructure, such as separate refueling stations, due to space limitations at existing stations.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer recounted that LLFC can promote high efficiency clean combustion and displace petroleum through improved efficiency and use of biofuels if possible and still provide good combustion performance.

Reviewer 2:
The reviewer responded that, yes, a better understanding of oxygenated bio-based fuels on enabling advanced and high efficiency combustion modes is very important.

Reviewer 3:
The reviewer reported that this project supports DOE objectives of petroleum displacement by providing fundamental understanding which can potentially lead to further application of renewable fuels in advanced combustion regimes.

Reviewer 4:
The reviewer affirmed that it is relevant to understanding low-temperature, clean, and efficient combustion but the requirement of a special fuel may limit future usefulness.

Reviewer 5:
The reviewer asserted that the relevancy is marginal. While the LLFC approach could potentially lead to lower emissions and support DOE goals, the requirement for high levels of TPGME makes it highly unlikely to ever be commercialized.

Reviewer 6:
The reviewer explained that for the reasons stated in their previous response, the practical limitations of this work appear to make it extremely unlikely that it would ever have any real impact in transportation fuel markets so that petroleum displacement appears unlikely.

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

Reviewer 1:
The reviewer stated that the funding level has fluctuated recently, but appears to be sufficient.

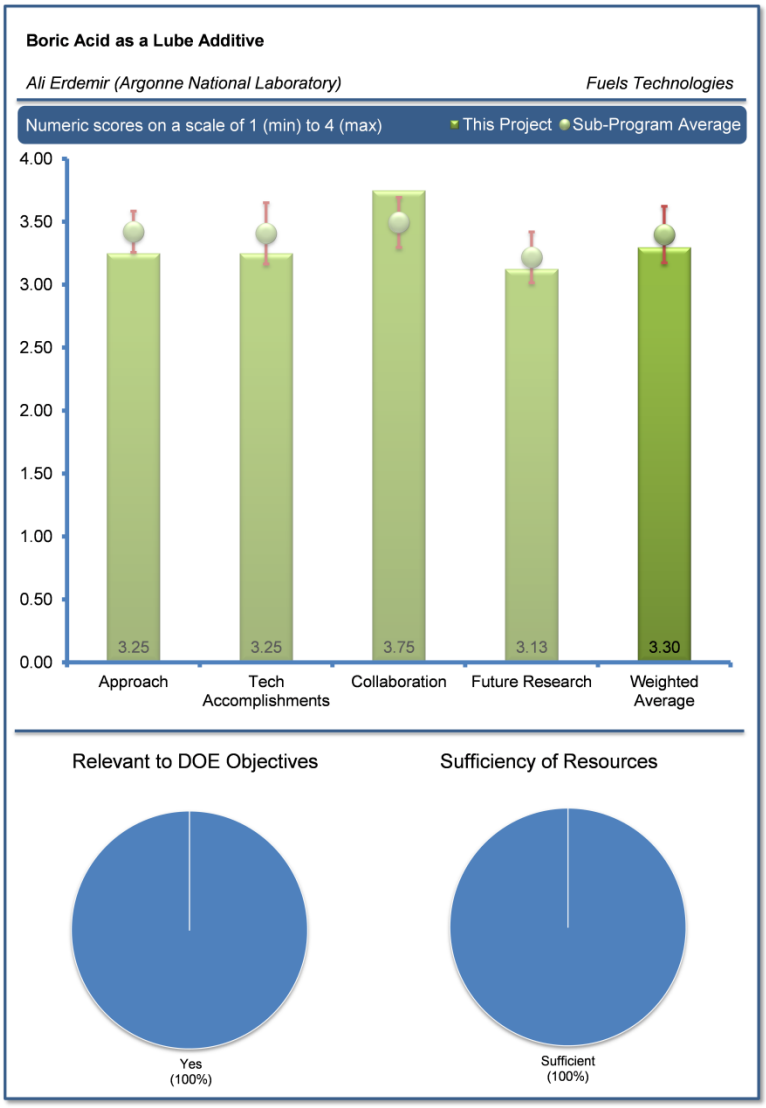
Reviewer 2:
The reviewer agreed that it appears that project goals can be met with current resources.

Reviewer 3:
The reviewer noted that the project seems to have adequate resources to complete the final milestones.

Reviewer 4:
The reviewer observed that resources seem sufficient but it is hard to tell for sure based on the presentation. The project funding is substantial.

Reviewer 5:
The reviewer remarked that for the reasons stated in the previous response regarding the practical limitations of the subject technology, LLFC, the level of funding for the research seems excessive.

Boric Acid as a Lube Additive: Ali Erdemir (Argonne National Laboratory) - ft018



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer recounted that the project combines boron additive formulation with bench tests and final engine performance test.

Reviewer 2:

The reviewer recounted that this is a well-defined project plan regarding bench testing of boron species in PC diesel and HD lubricants and that no storage stability results planned. The reviewer highlighted that there is a less clear definition of advanced, fully formulated lube performance testing such as oxidation, deposit formation, and exhaust catalysts assessments.

Reviewer 3:

The reviewer suggested that the researchers should also consider testing in used oils with high fuel dilution and water content. The current work is all based on a best-case scenario which weakens the confidence in the technology.

Reviewer 4:

The reviewer emphasized that there is still a lot of uncertainty as to why the boron-based nano-additive performs well in boundary lubrication. Thorough investigation through analytical techniques has to be performed post-tribology bench test to truly understand the underlying mechanisms of the nanofluid's performance. The reviewer acknowledged that this issue is addressed in the presentation's future work, but there is some question as to whether the researchers have enough time in the remaining period of performance. It would have been good to see this work being done concurrently with bench-scale testing.

Question 2: 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.

Reviewer 1:

The reviewer stated that there has been excellent progress and results to date.

Reviewer 2:

The reviewer applauded the very impressive bench tests results, and noted that no Sequence VID data was shown on baseline versus boron-containing oil. The reviewer said that a side-by-side comparison with oil formulated using commercially available organic borated species is needed.

Reviewer 3:
The reviewer said that bench-top tribology performance seems very promising, but should only be used as an initial screener for lubricant performance. There is no investigation to explain the mechanisms behind superior lubricant performance, but will be addressed in future work. The engine test demonstrated potential fuel economy (FE) improvement, but far more testing needs to be done before any conclusions can be made.

Reviewer 4:
The reviewer noted that not enough detail was given about additives to assess concentration, chemistry, or dispersants, or how rigorous the development work was. The results appear to be significant in terms of friction and wear reduction, but work needs to be completed and fully presented.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commented that the project has excellent partners, no weaknesses.

Reviewer 2:
The reviewer remarked that there is a good collaborative plan including crankcase lube formulators.

Reviewer 3:
The reviewer observed that there are good collaborations with lube companies and researchers have handed out samples for independent assessment. Good cost share partners show real interest and belief in the results.

Reviewer 4:
The reviewer affirmed that coordination between in-house testing, formulators, and industry engine collaborator seems well thought out and feasible. All of the respective pieces come together to demonstrate a novel lubricant's potential.

Question 4: 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.

Reviewer 1:
The reviewer pointed out that more real engine tests are needed, especially in HD engine area to answer questions related to soot and boron interactions.

Reviewer 2:
The reviewer claimed that proposed work should wrap up this project and determine potential for further development. Further work must assess the water compatibility of the additive and its contribution to ash.

Reviewer 3:
The reviewer suggested that future programs should include stability tests (look for settling) of both used and new oil at both very high and very low temperatures. Water content should also be part of the study.

Reviewer 4:
The reviewer asserted that upcoming collaboration work to close out the period of performance seems sufficient to fully demonstrate lubricant performance through nanofluid reformulation, engine testing, and bench-top tests. The reviewer explained that truly understanding the tribology mechanisms behind superior lubricant performance may not be possible within the remaining time. Supplementary analytical techniques would help the approach to understand the tribofilms (i.e., tribofilm depth chemistry profiles via X-ray photoelectron spectroscopy (XPS).

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer noted that this is a well-focused plan, and more engine performance is needed.

Reviewer 2:
The reviewer remarked that fuel savings from a drop-in lubricant is of great interest to DOE.

Reviewer 3:
The reviewer affirmed that the proposed technology sufficiently demonstrated the potential of a superior lubricant through initial screen testing. Initial fuel economy tests showed the feasibility to meet the DOE objectives.

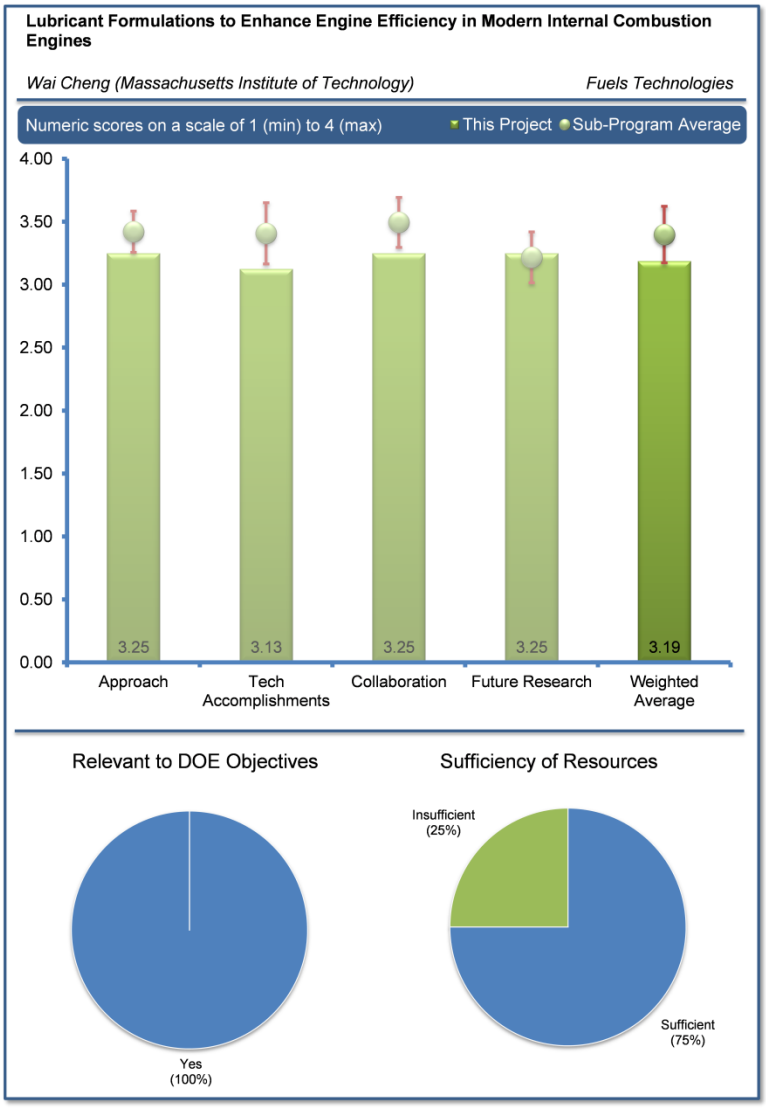
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that there is a very strong research team with a lot of resources at their disposal. Several milestones already met and the project is on schedule.

Reviewer 2:
The reviewer applauded a good approach and plan as well as a good utilization of collaborative laboratories.

Reviewer 3:
The reviewer stated that resources are sufficient to complete work.

Lubricant Formulations to Enhance Engine Efficiency in Modern Internal Combustion Engines: Wai Cheng (Massachusetts Institute of Technology) - ft019



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the project has a good approach to split lubricant requirements of an engine and optimize for each. The main factors studied appear to be viscosity, temperature relationships, and oil changes due to evaporation in the ring zone.

Reviewer 2:

The reviewer noted that the program presents an interesting, but not novel, approach as it contains previously patented ideas. The strength of the approach includes abilities to utilize frictional and lubricant vaporization models.

Reviewer 3:

The reviewer mentioned that the project is an interesting approach to solve a problem. Based on the vastly different operating conditions from the valve train to the power cylinder, it makes logical sense that a large improvement in FE could be gained by separating the systems and optimizing the lubricant individually for each system.

Reviewer 4:

The reviewer affirmed that the modeling and experimental approach is sound and well thought out. The only weakness is the choice to use an older technology engine. The reviewer offers that the chosen engine does not represent modern diesel engines very well. A more modern engine would have cost more but been worth it in hindsight.

Question 2: 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.

Reviewer 1:

The reviewer remarked that the results to date show there is true potential to have different oils in a split system and get gains. The idea is not new, but more worthwhile to pursue now that the FE landscape has changed. The reviewer added that too many people scoff at the idea of a split engine but there is no technical reason it cannot be done. This demonstrates the idea truly has merit and tries to quantify them.

Reviewer 2:
The reviewer affirmed that the project was a good balance of modeling and experimentation. The test rig seems to yield feasible data. The reviewer questioned how translatable this would be to different engine platforms. The whole process would have to be repeated every time, but it provides interesting groundwork to demonstrate the feasibility of a split system engine design. Data from oil optimization for each system illustrates the potential benefits to be had.

Reviewer 3:
The reviewer cautioned that the test engine used in this assessment does not include novel hardware (it is small-engine, IDI technology), therefore experimental data collected may not be directly applicable to current or novel SI or CI engines.

Reviewer 4:
The reviewer commented that not much detail was given about the model, making it hard to assess. The reviewer wondered if the Kohler engine is relevant to modern automotive engines. The reviewer pointed out that there was no detail presented about how oils were modified to change viscosity index (VI) behavior, friction, and volatility. Researchers need to show real data curves for the oils such as viscosity, volatility, and VI behavior.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer stated that involvement of the lubricant additive representative in formulating novel candidate oils is a positive step.

Reviewer 2:
The reviewer commented that Infineum is a good partner for lube formulation.

Reviewer 3:
The reviewer commended the project for coordinating well between all partners to build a split system engine test rig and also to optimize oil formulations. Partners from automobile and oil additive formulators with full participation are completely necessary for the success of this project.

Reviewer 4:
The reviewer asserted that a major on-highway engine manufacturer would have been useful but the other partners are excellent.

Question 4: 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.

Reviewer 1:
The reviewer commented that the project is ending but the proposed future work is good. A follow-on project should be conducted through either MIT or a national laboratory, or both. The reviewer suggested that the next project should definitely try to get a major on-highway partner to see if the project can get the idea into a production model.

Reviewer 2:
The reviewer remarked that the PI has placed himself in such a spot that all scheduled milestones were met to date. The only logical future milestones are to fully demonstrate the split system engine test rig using optimized oils.

Reviewer 3:
The reviewer did not think it was clear if floating liner work will be done. Until FE improvement is demonstrated and explained, there is no reason to study aftertreatment.

Reviewer 4:
The reviewer said that there are no clear plans to include a more modern engine design, no test cycles definition provided.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer acknowledged that the research provides further understanding of engine lubricant requirements and effects on friction.

Reviewer 2:
The reviewer mentioned that the split system engine design has the potential to increase fuel efficiency because it allows for independent selection of lubricants for the power cylinder and valve train.

Reviewer 3:
The reviewer commented that it may be difficult to implement a split oil approach to legacy vehicles.

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

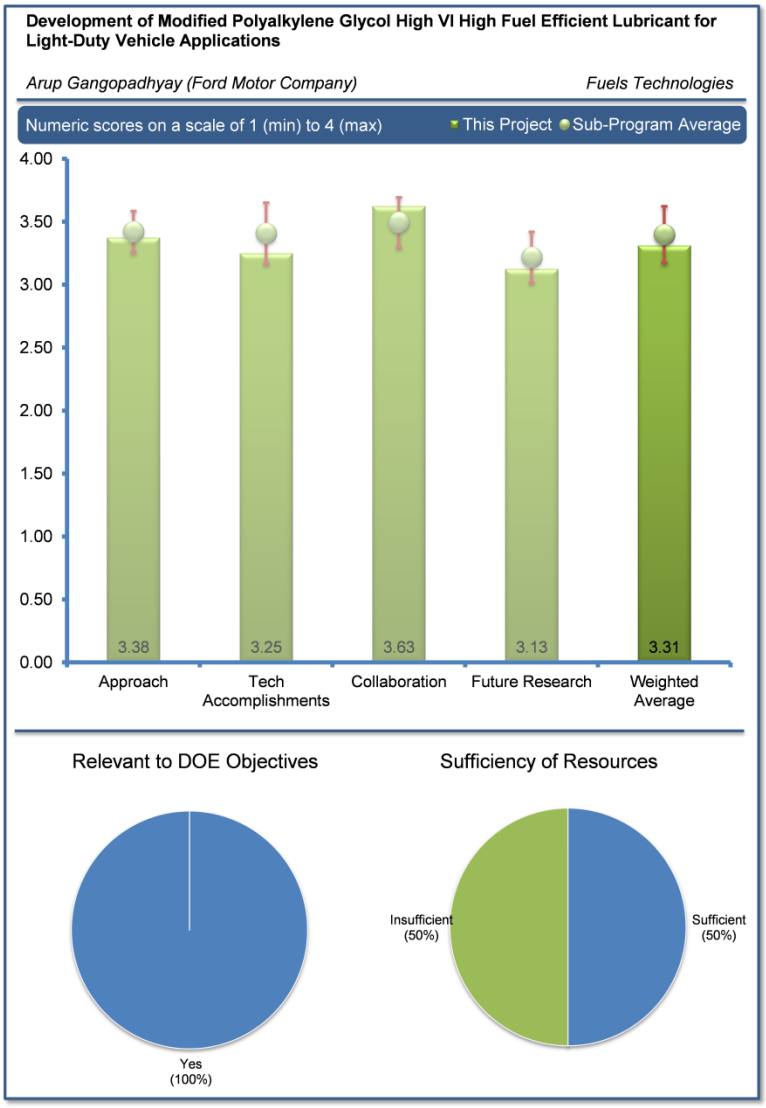
Reviewer 1:
The reviewer offered that the project needs money for a follow-on project.

Reviewer 2:
The reviewer stated that there is a good collaborative testing plan in place.

Reviewer 3:
The reviewer noted that the resources are sufficient to complete work.

Reviewer 4:
The reviewer pointed out that the project has all of the necessary resources at their disposal. Seems the project has full cooperation between all partners.

Development of Modified Polyalkylene Glycol High VI High Fuel Efficient Lubricant for Light-Duty Vehicle Applications: Arup Gangopadhyay (Ford Motor Company) - ft020



Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer remarked that the project has a good mix of experimental bench tests, engine sub-system tests, measurement of wear films, and final evaluation in engines and vehicles.

Reviewer 2:

The reviewer commented that the project had a very logical approach to answering the most pressing questions with the technology.

Reviewer 3:

The reviewer observed a well-documented research program plan and technical/commercial barriers to achieve improved efficiency goals.

Reviewer 4:

The reviewer offered that friction performance was sufficiently demonstrated through bench-top tribology testing but was not accompanied by wear data or post-test characterization. The reviewer pointed out that it may potentially be a better lubricant technology, without fully understanding the mechanisms that explain the claimed benefit. This leaves a large technical barrier that must be addressed very late in the project. However, the reviewer acknowledged that this investigation will be continued in future work.

Question 2: 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.

Reviewer 1:

The reviewer commented that the researchers have made and evaluated a large number of formulations, some of which show real improvement in friction and wear. The reviewer had a hard time distinguishing effects from type of polyalkylene glycol (PAG), additives, and viscosity.

Reviewer 2:

The reviewer affirmed that the results to date are interesting. The only weakness is that there is no clear understanding of how PAG chemistry is affecting friction versus viscosity. Perhaps a national laboratory can partner with Ford to look at some more fundamental aspects on the surface.

Reviewer 3:
The reviewer recounted that the authors reported an impressive set of frictional improvement data. New testing techniques were introduced. No data reporting acceptable hydrolytic stability of PAG based oils were shown or discussed.

Reviewer 4:
The reviewer mentioned how the friction performance is well documented through bench-top testing and motored test rigs. The reviewer found the wear data and post-test characterization investigating the mechanisms behind the superior friction performance lacking.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer asserted that the project appears to have a very close partnership with collaborators. The PI relies on these collaborators for oil formulation, bench testing and post-test characterization.

Reviewer 2:
The reviewer mentioned that it was very good to have Dow for oils and ANL for bench tests and surface analysis. Ford has lots of capabilities for remainder of the research and appears to be committed to completing the project.

Reviewer 3:
The reviewer indicated that there is a well-rounded group of scientific laboratories participating in this study. However, a participation of the lubricant additive representative is missing.

Reviewer 4:
The reviewer pointed out that Dow and Ford are a strong team but a national laboratory with some of the more advanced tools would be helpful. Looking at the tribofilm using a focused ion beam (FIB) is one example where ANL or ORNL could help out the project.

Question 4: 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.

Reviewer 1:
The reviewer recounts that the authors mention other durability sequence testing (i.e., ASTM Sequence IIIG) in the next steps. It will be interesting to see how the authors are proposing to manage to balance FE and durability factors such as oxidation, sludge, wear, etc. Used oil performance will be critical part of this study.

Reviewer 2:
The reviewer asserts that it will be very useful to end up with real vehicle tests with aged oils, as well as a study of wear surfaces and tribofilms. The reviewer wondered if oil 17-1 meets all relevant specifications. Results need to be explained in terms of chemistry, additives, viscosity, and VI behavior of oils. The reviewer said that questions about water and contamination with other oils will need to be answered.

Reviewer 3:
The reviewer cautioned that there are still a lot of technical barriers to overcome before the end of project. Limited time left in period of performance will make it difficult to overcome all of the barriers.

Reviewer 4:
The reviewer suggested that the researchers should include some work on exposing the finished product to a more typical engine environment and testing its stability. Acid, water, soot, etc. are in real oils but it does not appear that the project is testing the extremes (not just a durability engine or drive cycle) of these parameters to see the sensitivity of PAG compared to conventional oils. The reviewer explained that PAG may very well perform better than conventional oils with contaminants but it is not known. There should also be some work to see what happens if conventional oils are mixed with it.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer pointed out that drop-in fuel savings is very relevant to DOE goals.

Reviewer 2:
The reviewer commented that this new lubricant classification seems to hold some promise to reduce frictional losses in an engine.

Reviewer 3:
The reviewer noted that PAG cost and available volume analysis would be critical to commercialization.

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

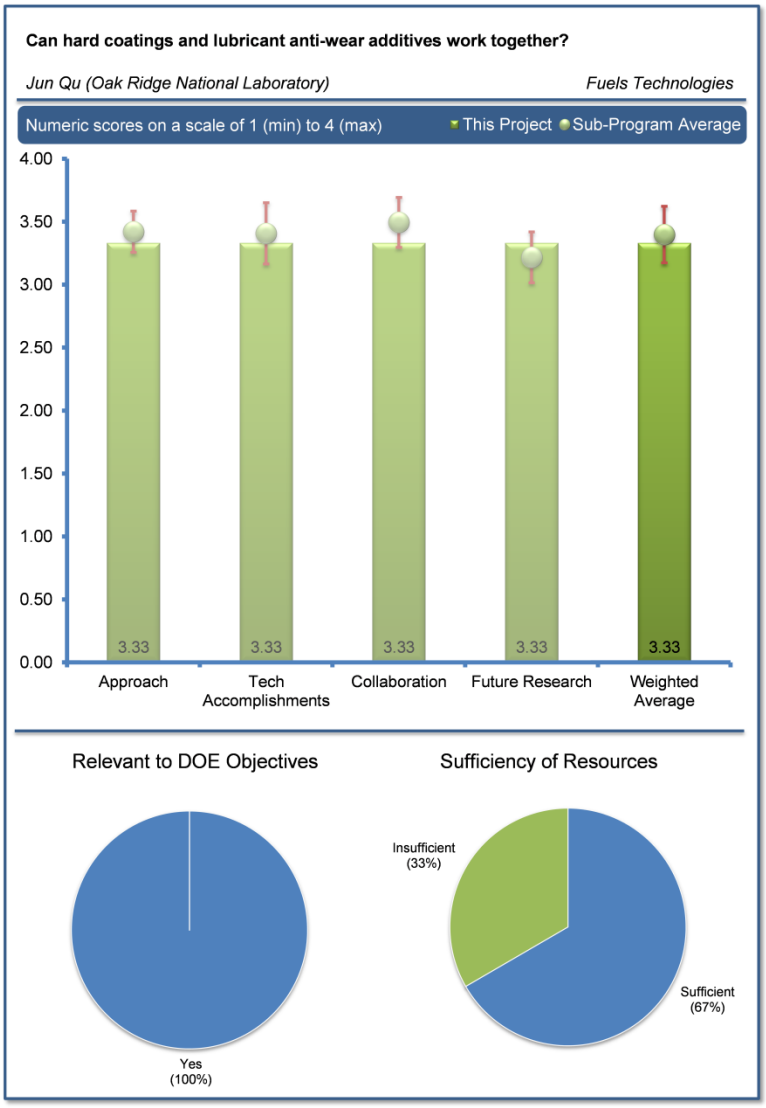
Reviewer 1:
The reviewer mentioned that resources seem sufficient and Ford seems very motivated to finalize the results.

Reviewer 2:
The reviewer suggested that more work on PAGs for axles and transmissions would be useful. The engine oil is nowhere near as likely to come to fruition as the axle and gear lubricants.

Reviewer 3:
The reviewer said that it seems all interested parties are invested in the technology. All necessary resources are at their disposal to see out the project objectives.

Reviewer 4:
The reviewer warned that engine sequence tests are expensive and depending on number of formulations examined the proposed budget may not be sufficient.

Can hard coatings and lubricant anti-wear additives work together?: Jun Qu (Oak Ridge National Laboratory) - ft021



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer asserted that the project answers an excellent question of what will happen when engines start using less ferrous materials.

Reviewer 2:

The reviewer pointed out the project's well-defined technical goals and project plan. No clear description on why boride coatings were selected for this study. The reviewer wondered what the advantage of using boride coatings over chromium nitride- or tungsten-based coatings in SI or CI engine is.

Reviewer 3:

The reviewer commented that the project focuses on studying interactions of ILs and ZDDP on several hard coatings.

Question 2: 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.

Reviewer 1:

The reviewer noted that the project had great results to date.

Reviewer 2:

The reviewer applauded the project's impressive selection of initial friction and wear control data. Since frictional phenomena are driven by formation of tribofilm, the chemistry of examined coatings plays a huge role. The reviewer raised the question of why boride coatings were selected for this study, and which OEM is planning to use them in future engines. The reviewer also wanted to know what happens when IL ages, and if it is still effective in wear control.

Reviewer 3:

The reviewer wondered how coatings were selected, and if it would be better to extend work to other engine materials such as aluminum or copper first.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer suggested that the collaborative team should include an OEM representative, so that the commercially available choice of coatings type is examined.

Reviewer 2:
The reviewer noted that the researchers appear to be able to get parts and coatings from commercial suppliers.

Question 4: 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.

Reviewer 1:
The reviewer asserted that more work with ILs on non-ferrous coatings should be funded.

Reviewer 2:
The reviewer claims that a wider range of commercial coatings need to be studied. Furthermore, wear and friction control in a few engine tests with coated parts needs to be assessed.

Reviewer 3:
The reviewer believed that there needs to be more focus on achieving an in-depth understanding of synergy between ILs and ZDDP and how they interact with surfaces, as opposed to Edisonian testing.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer explained that low friction and hard coatings are already incorporated in engine design and will be used even more frequently in a future.

Reviewer 2:
The reviewer affirmed that research extends additive findings to new materials and includes some study of fundamental mechanisms.

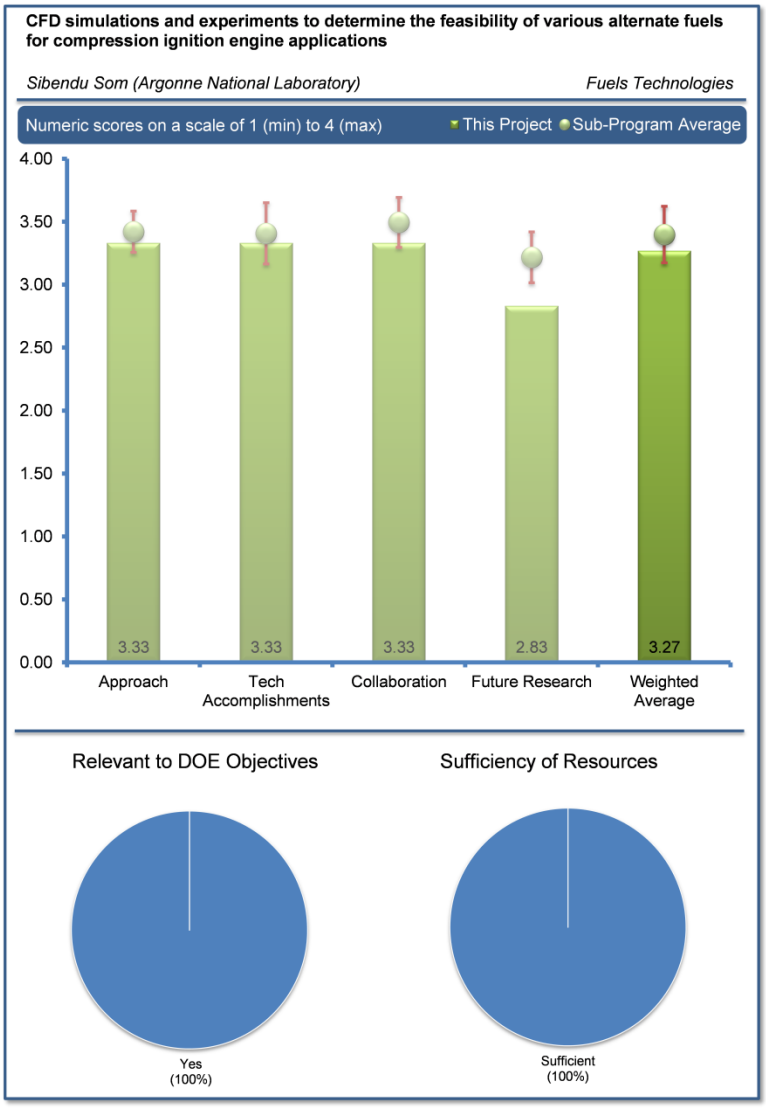
Question 6: Resources: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer brought to light the fact that this is an extremely important topic to handle and there are not enough resources being devoted in the industry. DOE could fill a big hole with more funding.

Reviewer 2:
The reviewer stated that the resources are sufficient to meet deliverables.

Reviewer 3:
The reviewer mentioned that collaboration with OEM laboratory is encouraged.

CFD simulations and experiments to determine the feasibility of various alternate fuels for compression ignition engine applications: Sibendu Som (Argonne National Laboratory) - ft022



Reviewer Sample Size

A total of three reviewers evaluated this project.

Question 1: Approach to performing the work - the degree to which technical barriers are addressed, the project is well-designed, feasible, and integrated with other efforts.

Reviewer 1:

The reviewer applauded project's excellent approach to the CFD work utilizing multiple resources at ANL.

Reviewer 2:

The reviewer recounted that the project is developing a biodiesel surrogate model and studying viscosity effects on fuel injection.

Reviewer 3:

The reviewer reported that the project combines simulations of nozzle spray patterns from biodiesel fuels (and biodiesel surrogate fuels) with kinetic and combustion modeling to better understand injection spray properties of biodiesel. The project observes and models a variety of key nozzle- and spray-related characteristics for different types of biodiesels at different temperatures, pressures, and other conditions.

Question 2: 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.

Reviewer 1:

The reviewer pointed out that the project team has done calculations no one else has to date.

Reviewer 2:

The reviewer observed that the results reported appear to be very informative and long-neglected in helping understand how biodiesel injection and combustion differ from that of conventional diesel, possibly suggesting future hardware changes as biodiesel continues to substantially penetrate diesel fuel markets.

Reviewer 3:

The reviewer said that a lot of people are working in these areas and was unsure if this project is leading or following.

Question 3: Collaboration and coordination with other institutions.

Reviewer 1:
The reviewer commended the project for good collaborations with other laboratories.

Reviewer 2:
The reviewer noted that collaboration appears strong between the lead researcher and other government laboratories and academic institutions. Research might benefit from participation from engine makers or fuel producers, blenders, and refiners.

Question 4: 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.

Reviewer 1:
The reviewer recounted that research will continue to move modeling forward and having SCE work will close the loop.

Reviewer 2:
The reviewer report that the validation of the ignition quality tester results through simulations appears to be a useful exercise. Further testing with Cuphea biodiesel, as proposed, may also be of some value, although such value may be limited considering that Cuphea biodiesel is not in production in any substantial volume and may never be. The reviewer concluded that research of the type undertaken with differing blends of soy methyl ester and petroleum diesel would probably be of greater value.

Question 5: Does this project support the overall DOE objectives of petroleum displacement? Why or why not?

Reviewer 1:
The reviewer mentioned that the project provides an understanding of how new fuels interact in engines relative to physical and chemical properties.

Reviewer 2:
The reviewer explained that biodiesel production and blending has continued to proliferate over the last two decades and RFS2 is likely to dictate that it will continue to do so in the future. The optimal strategies for blend levels and how to take advantage of widespread availability of biodiesel blends have not been adequately investigated. The reviewer went on to say that while biodiesel producers emphasize that the fuel is compatible with engines at up to 100%, engine makers continue to resist that assertion and the fuel's ultimate effects at high blend levels have not been determined, particularly in cold weather conditions. This research could help establish what blend levels would be appropriate at what conditions and how future engines (such as injectors) could be designed to take advantage of those blend levels for enhanced efficiency and reduced emissions.

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

Reviewer 1:
The reviewer asserted that the impressive results shown to date with only one year of research at a fairly low funding level suggest that the funding has been sufficient. It also suggests, however, that additional funding might be justified to better realize the benefits of the research, particularly if multiple blends of biodiesel with petroleum diesel are to be investigated.

Reviewer 2:
The reviewer stated that resources are adequate and collaborative laboratories are helping with the larger effort.

Acronyms and Abbreviations

Acronym	Definition
AEC	Advanced Engine Combustion
AMR	Annual Merit Review
ANL	Argonne National Laboratory
ASTM	American Society for Testing and Materials
AVFL-18	Project 18 under Advanced Vehicle/Fuel/Lubricants of the Coordinating Research Council
CAFE	Corporate Average Fuel Economy
CFD	Computational Fluid Dynamics
CFR	Cooperative Fuel Research
CI	Compression Ignition
CLEERS	Cross-Cut Lean Exhaust Emission Reduction Simulation
CO	Carbon monoxide
CR	Compression ratio
CRADA	Cooperative Research and Development Agreement
CRC	Coordinating Research Council
CSM	Colorado School of Mines
CV	Combustion vessel
DISI	Direct Injection Spark Ignited
DOE	Department of Energy
E0	0 percent ethanol blend with gasoline
E10	10 percent ethanol blend with gasoline
E30	30 percent Eethanol blend with gasoline
E85	85 percent ethanol blend with gasoline
EHN	Ethyl hexyl nitrate
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
EV	Electric vehicle
FE	Fuel Economy
FIB	Focused ion beam
FTP	Federal Test Procedure
FY	Fiscal Year
GDI	Gasoline Direct Injection
GHG	Greenhouse gas
GM	General Motors Corporation
GTDI	Gasoline Turbocharged Direct Injection
HC	Hydrocarbon
HCCI	Homogeneous Charge Compression Ignition
HD	Heavy-duty
HMN	Heptamethylnonane (a.k.a. cetane, a.k.a hexadecane)
HRR	Heat release rate
HTHS	High-temperature, high shear
ICE	Internal combustion engine

Acronym	Definition
IL	Ionic Liquids
IQT	Ignition Quality Tester
LD	Light-duty
LII	Laser-Induced Incandescence
LLFC	Lean Lifted-Flame Combustion
LLNL	Lawrence Livermore National Laboratory
LSPI	Low-speed preignition
LTC	Low-temperature combustion
MD	Medium-duty
MECA	Manufacturers of Emission Controls Association
MIT	Massachusetts Institute of Technology
mL	milliliters
MOU	Memorandum of Understanding
MPG	Miles per gallon
MTBE	methyl tertiary butyl ether
NO_x	nitrogen oxides
NREL	National Renewable Energy Laboratory
NTC	Negative temperature coefficient
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
PAG	polyalkylene glycol
PI	Principal Investigator
PM	Particulate Matter
PPC	Partially premixed combustion
R&D	Research and Development
RCCI	Reactivity Controlled Compression Ignition
RFS	Renewable Fuel Standards
RON	Research octane number
RoPR	Rate of pressure rise
RSP	Renewable super premium
SCE	Single cylinder engine
SCRE	Single-cylinder Research Engine
SI	Spark Ignition
SIDI	Spark Ignition Direct Injection
SNL	Sandia National Laboratories
TBE	Turbo-back exhaust
TDC	Top Dead Center
TPGME	tri-propylene glycol methyl ether
VI	Viscosity index
VTO	Vehicle Technologies Office
WOT	Wide-open throttle
XPS	X-ray photoelectron spectroscopy
ZDDP	zinc dialkyl-dithio-phosphate

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