5. Fuels & Lubricants Technologies

The Fuels & Lubricants Technologies subprogram supports fuels and lubricants R&D to provide vehicle users with cost-competitive options that enable high fuel economy with low emissions, and contribute to petroleum displacement. Transportation fuels are anticipated to be produced from future refinery feedstocks that may increasingly be from non-conventional sources including, but not limited to, heavy crude, oil sands, shale oil, and coal, as well as renewable resources such as biomass, vegetable oils, and waste animal fats. The impact of changes in refinery feedstocks on finished fuels is an area of relatively new concern to engine manufacturers, regulators and users. Advanced engine technologies are more sensitive to variations in fuel composition than were earlier engines, in addition to facing tightening emissions standards. The goals are: (1) to enable post-2010 advanced combustion regime engines and emission control systems to be more efficient while meeting future emission standards; and, (2) to reduce reliance on petroleum-based fuels through direct fuel substitution or by non-petroleum-based fuels efficiency gains. These activities are undertaken to determine the impacts of fuel and lubricant properties on the efficiency, performance, and emissions of current engines as well as to enable emerging advanced internal combustion engines. These advanced engines operate in low-temperature combustion regimes that are expected to become more prevalent in the marketplace because of their higher efficiency and continually improving emissions performance. These activities are coordinated with and supportive of EPA's fuels and emissions-related activities.

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 to 4)*. 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 summary 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
Fuel and Lubricant Effects	Bunting, Bruce (Oak Ridge National Laboratory)	5-2	3.25	3.25	3.00	3.25	3.22
Fuels for Advanced Combustion Engines	Zigler, Brad (National Renewable Energy Laboratory)	5-4	3.50	2.75	3.25	3.50	3.09
Quality, Performance, and Emission Impacts of Biofuels and Biofuel Blends	McCormick, Bob (National Renewable Energy Laboratory)	5-6	3.80	3.60	3.40	3.40	3.60
Optical-Engine and Surrogate-Fuels Research for an Improved Understanding of Fuel Effects on Advanced-Combustion Strategies	Mueller, Chuck (Sandia National Laboratories)	5-8	3.00	3.25	3.50	3.00	3.19
Advanced Lean-Burn DI Spark Ignition Fuels Research	Sjoberg, Magnus (Sandia National Laboratories)	5-10	3.80	3.40	2.80	3.20	3.40
Non-Petroleum-Based Fuels: Effects on Emissions Control Technologies	Sluder, Scott (Oak Ridge National Laboratory)	5-12	3.25	3.00	3.25	3.00	3.09
Gasoline-like fuel effects on advanced combustion regimes	Szybist, James (Oak Ridge National Laboratory)	5-14	3.25	3.25	3.00	3.25	3.22
Chemical Kinetic Modeling of Non-Petroleum Based Fuels	Pitz, Bill (Lawrence Livermore National Laboratory)	5-16	3.50	3.25	3.50	3.25	3.34
Overall Average			3.42	3.22	3.21	3.23	3.27

Note: Italics denote poster presentations.

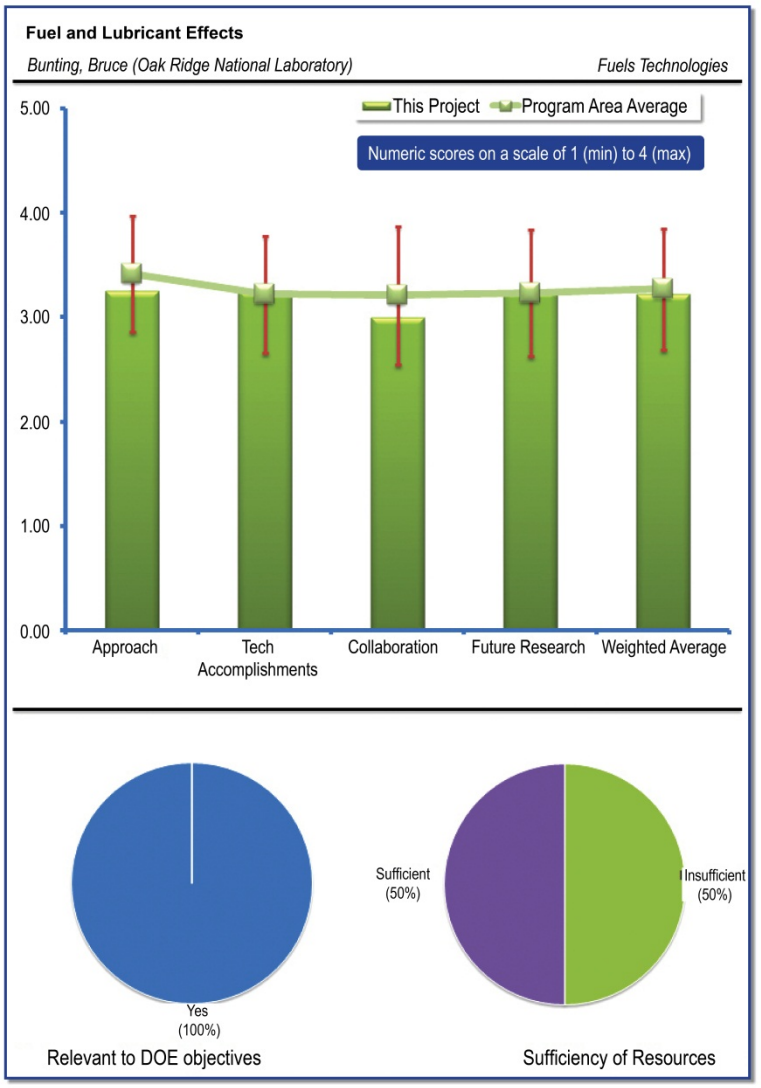
Fuel and Lubricant Effects: Bunting, Bruce (Oak Ridge National Laboratory) - ft001

Reviewer Sample Size

This project had a total of four reviewers.

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

All reviewers indicated that the project contributes to achievement of the DOE petroleum conservation goal. One reviewer said the project is focused on improved efficiency. This reviewer added that it also emphasizes surrogate fuels and energy options and lubricants, and employs a systems approach. A second reviewer described the project as focused on improving fuel economy, which reduces the amount of fuel consumed, as well as supporting the increased use of renewable fuels and advanced lubricants. The third reviewer concurred that new fuels and more efficient combustion will result in petroleum displacement. The reviewer went on to say that the project appears to offer a path to fuel economy improvement, but that it does not provide tools to estimate fuel economy accurately. This reviewer suggested the project could be improved if it also sought means to estimate the accuracy with which fuel economy can be measured. The final reviewer said that as advanced, renewable fuels begin to be blended into conventional fuels, work performed under this project will be critical to understanding the effects of non-traditional blendstocks on engine performance and emissions.



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

Four reviewers commented on this question, also. One praised the performance of kinetic modeling prior to embarking on engine tests as a good approach. A second singled out the testing of various fuels in multiple engine platforms and the use of statistical modeling as indicative of a good approach to performing this work. The third reviewer noted that there was significant interaction with national labs/academia, but only limited interaction with the petroleum and lubricant industry. The final reviewer called for more fuels to be included to establish fundamental understanding, but said the approach will help overcome some barriers.

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

One reviewer noted good progress on testing a variety of fuels under advanced combustion conditions to establish links between performance and fuel properties. A second assessed that the addition of gasoline engine and gasoline/ethanol fuels had progressed well. The addition of 30 fuels to the project's database this year was termed a key deliverable by the third reviewer who went on to opine that the statistical work to determine how many fuel variables are needed to resolve fuel effects on global studies should be investigated further and shared. The last reviewer called for more emphasis on real-life fuel economy measurements and noted that kinetic mechanisms to mimic fuel effects were not reported.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

Reviewers were largely agreed that this project demonstrated good collaboration and coordination with other institutions. One noted significant collaboration with LLNL, and the CRADA work with GM on ionic lubricants. A second reviewer noted that there was a wide range of collaborators and called their work well coordinated. Collaboration was termed outstanding by a third reviewer. The fourth said there appeared to be quite a number of interactions with various universities and some of the national labs, but that interactions with industry seemed fairly limited since the only ones mentioned in the presentation were paying members of Reaction Design's Model Fuel Consortia and GM (the latter in the lubes area).

QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

Three of the four reviewers offered comments on this question. One felt the new research area in ionic lubricants would offer great potential for improving both lubricant wear and fuel economy. Testing of cellulose-derived renewable fuels was deemed by this reviewer to be a critical area in which more data are needed. A second reviewer said that future work should include more fuels. The third wondered if results of the MIT consortium project would be available for public discussion. If not, this reviewer felt the project should not be listed or supported with DOE funds.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

One reviewer deemed project resources sufficient for the planned program. A second, while considering that good use had been made of resources to date, felt that greater funding might be required to complete the work. A reviewer expressed the view that considerable additional work would be required to understand the effects of advanced renewables on emissions and fuel economy, as these blendstocks are incorporated into conventional fuels and lubricants. This reviewer also questioned whether more resources would be needed, especially as the ethanol “blend wall” was approached in 2012.

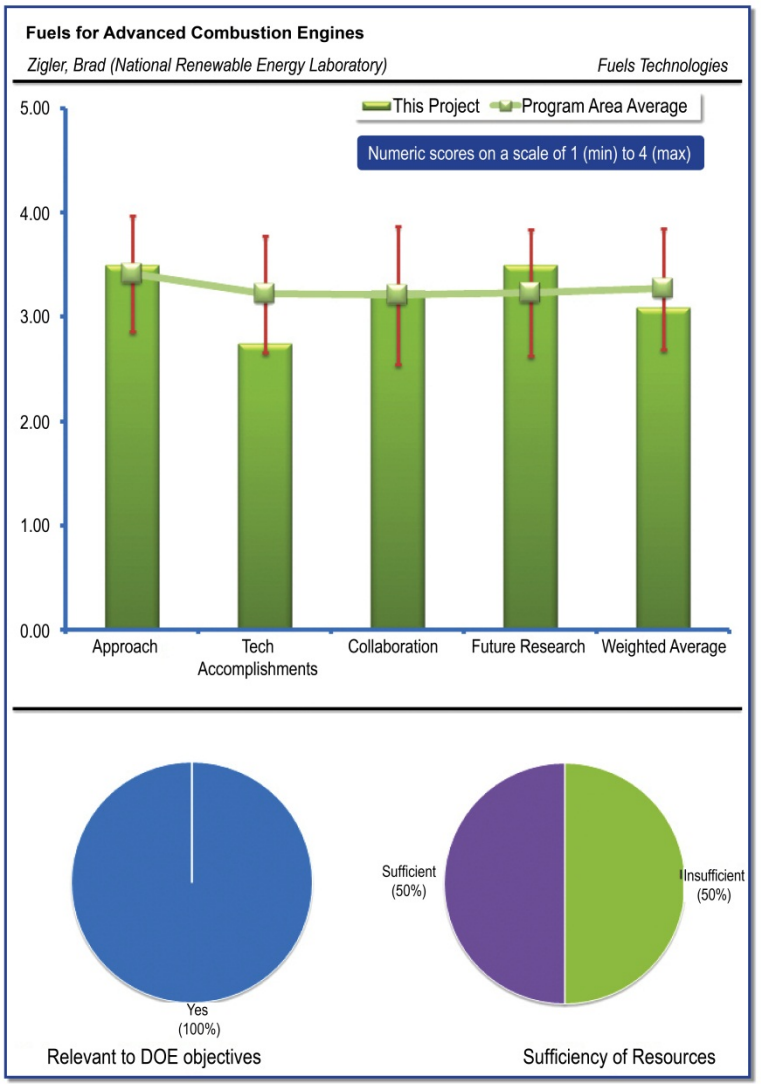
Fuels for Advanced Combustion Engines: Zigler, Brad (National Renewable Energy Laboratory) - ft002

Reviewer Sample Size

This project had a total of four reviewers.

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

Three of the four reviewers submitted comments on this question. Two responded with affirmative comments. One said fuels can enable improved and more efficient operation of advanced combustion engines, so this project has significant potential to promote development of cleaner, more efficient engines, which can directly displace petroleum. The second concurred in similar terms, noting that by enabling advanced combustion engines with improved fuel economy through understanding the fundamental relationship between fuel properties and combustion, the project could advance DOE's fundamental goal. However, this reviewer expressed the view that the project should include more alternative fuels such as biofuels and ethanol blends. The third reviewer said that the project would support the goal of petroleum conservation by characterizing and recommending sets of fuels to be used in a wide range of research studies.



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

All four reviewers commented. One termed the approach excellent, adding that multi-disciplinary work by many labs and outside partners is a key to enabling fuel characterization to support advanced combustion engine research. The second agreed, saying that having a standard set of fuels for a variety of combustion studies that draw on sound experimental design to span key fuel properties is a great idea. However, the reviewer continued, the fuels for advanced combustion engines (FACE) fuels composition dictated by the stakeholders is strange in some cases, with bi-modal composition rather than smooth variations across the boiling range. In a similar vein, the third reviewer said that development of a set of gasoline and diesel fuels, the characterization of their physical and chemical properties and their use by various researchers will constitute a good approach. Finally, the fourth reviewer noted the project's wide cooperative efforts among various organizations.

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

All four reviewers commented on this aspect of the project. The first praised the work done to characterize the diesel fuel set as very impressive. On the other hand, the reviewer lamented the slow progress in adding gasoline and advanced renewable fuels as disappointing but said that appeared to be due to lack of funding rather than to inadequate effort. The second and third reviewers'

comments supported both assessments expressed by the first. One noted that the project had completed significant work on FACE diesel and made progress on FACE gasoline; the other considered the technical accomplishments to have come rather slowly and thought they could be speeded up. The last reviewer viewed the research program as being clearly defined, noting the many activities that used the FACE matrix of fuels and termed the fuels characterization plan well-developed and -executed.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

All four reviewers appeared to approve of the project's collaboration and coordination with other institutions. A reviewer deemed this project to be one exhibiting the broadest collaboration of any seen. Another reviewer noted that a multifaceted array of organizations is participating in this project. One reviewer described the FACE program as an excellent example of public-private partnership serving to advanced societal goals. This reviewer felt there was one weakness, however, namely a lack of substantial university involvement, noting that universities are involved on the downstream end, rather than in the beginning with decision making on formulation and program strategy. The final reviewer acknowledged the collaboration of the auto and oil companies, the fuel blenders and researchers and encouraged continuing collaboration with academia and the CRC.

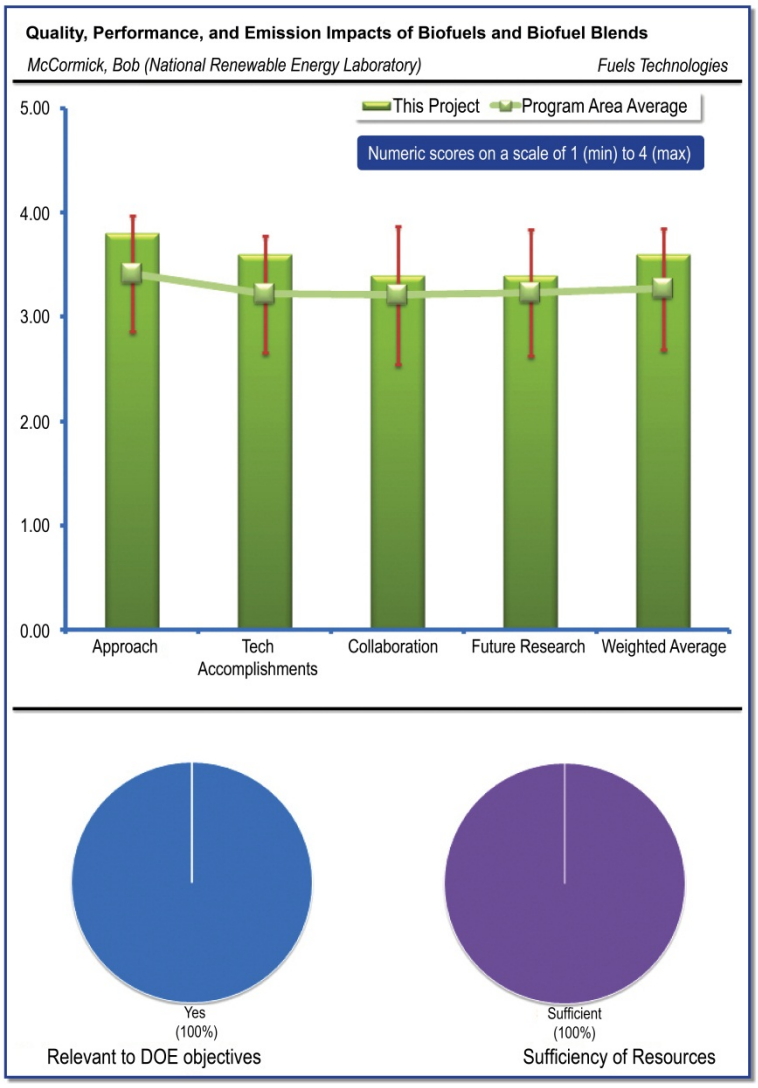
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The project's clearly defined goals were noted by a reviewer and another reviewer noted that future work would extend FACE diesel to include advanced alternative fuels and would complete development of FACE gasoline pursuant to its deployment. Two of the four reviewers made specific recommendations for future work under this project, one saying the proposed work with advanced alternative renewable fuels should be the top priority as these blend stocks start to become commercially viable. The second urged that the FACE working group should compare its engine-based data with other engine studies, using the FACE research fuels when possible.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

One reviewer, noting the many tasks to be conducted, felt that insufficient resources were available to complete them. The second reviewer expressed a similar view, noting that funding had been stable in previous years, but that it had been cut for 2011. This reviewer commented that funding should be increased and more effort invested in getting university involvement in this project, since this activity offered excellent educational opportunities that are not being realized. The third reviewer was likewise concerned that continued or further cutbacks in funding will likely erode collaborative programs with industry through the CRC. The fourth reviewer considered that an apparent lack of funding is significantly delaying some of these research fuels available for advanced combustion engine testing.

Quality, Performance, and Emission Impacts of Biofuels and Biofuel Blends: McCormick, Bob (National Renewable Energy Laboratory) – ft003



Reviewer Sample Size

This project had a total of five reviewers.

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

The four reviewers who provided comments were in general agreement that this project supports DOE's petroleum conservation goal. One said so explicitly, noting that this project, by examining biofuels that can displace petroleum, can directly displace petroleum use and does so now. The second agreed, saying the project's focus is on biofuels and biofuel blends whose use directly displaces petroleum. The third reviewer commented that biofuels and their blends increase the fuel supply, but suggested shifting project emphasis to hydrocarbon renewable fuels and considering long-chain alcohols. A fourth reviewer stated solve problems related to usage of biofuels and biofuel blends.

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

One reviewer approved of the approach, saying its focus on the technical problems preventing expansion of the market for current biofuels and their blends is good. The reviewer added that measuring the quality of these fuels is critical to overcoming barriers. The second agreed, calling the approach to overcoming barriers sound. The third reviewer commented at greater length, noting the project's examination of both first-generation biofuels (those in current use) and advanced biofuels, and its consideration of fuel quality effects, impurities and fuel properties. This reviewer further noted the project's broad and comprehensive scope, encompassing both the mundane, such as fuel quality, which is essential in view of past problems, and the subtle, such as the types of inorganics in biodiesel, their impacts on ash formation and the implications for DPF and SCR systems. The final reviewer spoke of the project's impressively broad scope and its wide industry collaborations.

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

One reviewer said simply that eight significant technical goals were reached, without enumerating them. Another reviewer commented at greater length, noting the project's significant observations on biofuel impacts on clean vehicle systems (DPF SCR), and low-temperature behavior. This reviewer also pointed to the project's exploration of the properties and combustion and emissions behavior of emerging oxygenates, an area in which the reviewer urged greater university involvement because of the significant educational opportunity such exploratory work offers. Another opined that surveys of the quality of biofuels being sold in marketplace fills an important need. This reviewer joined the second in calling attention to the good progress made in understanding impacts of biofuels and impurities on engine and exhaust aftertreatment system performance. The fourth reviewer praised the work on B20 effects on DPF

and SCR durability and the effects of saturated monoglycerides as very relevant, mentioning a desire to see more information published on next-generation oxygenates and hydrocarbons. Finally, the fifth reviewer termed the effects of metals important.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

One reviewer described the collaborating institutions as a broad team including industry-wide organizations – MECA, EMA and the CRC – other laboratories and a university, although urging more university involvement in this very important program. The second echoed this comment, adding the commercial partner BASF to the list of collaborators and deeming their efforts well-coordinated. The third likewise noted good collaboration with EMA and MECA member companies, and the fourth noted a multifaceted approach to involve relevant organizations.

QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

The four reviewers offering comments on this topic agreed generally that the proposed future research was appropriate. One mentioned its well defined goals and targets, a second characterized planned work as excellent, suggesting it be expanded to include additional fundamental studies of the ignition behavior of some emerging oxygenates and their impacts on soot formation. This reviewer's expectation was that such work would help illuminate how these compounds might function in SI, CI and advanced combustion systems. The third reviewer recommended continued work with oxygenated diesel components and thermodynamic modeling of phase equilibrium. The fourth reviewer looked forward to the application of new analytical methods to advanced biofuels.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

One of three commenting reviewers felt funding, which according to this reviewer had been relatively stable to date, should be maintained or expanded to permit greater involvement of academic collaborators. The second anticipated the possibility that additional funding might be needed. The third, however, saw no indication that funding was insufficient.

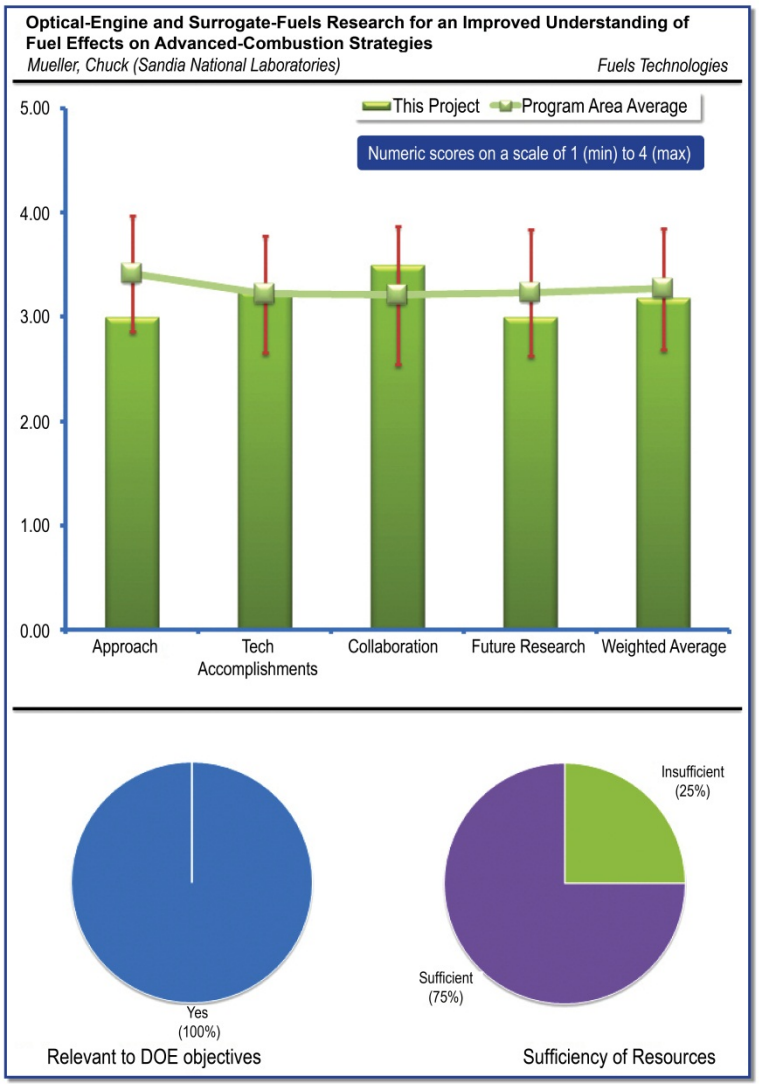
Optical-Engine and Surrogate-Fuels Research for an Improved Understanding of Fuel Effects on Advanced-Combustion Strategies: Mueller, Chuck (Sandia National Laboratories) –ft004

Reviewer Sample Size

This project had a total of four reviewers.

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

Three reviewers commented on this topic, two of whom agreed that the project supports achievement of the DOE goal. One pointed out that improved fundamental understanding of combustion and fuel effects should enable improved engine performance and design resulting in higher fuel economy and potentially in wider use of alternative fuels, both of which lead to less petroleum usage. In similar language, the second reviewer said that higher efficiency and clean combustion results in decreased use of petroleum-derived hydrocarbon fuels. A third reviewer remarked establish fundamental knowledge to create high efficiency/clean combustion engines. This seems to state the aim of the project, but does not explicitly state that achievement of that aim will advance DOE's petroleum conservation goal.



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

Four reviewers offered opinions on the approach to the work of this project. Two of them addressed the use of optically accessible engines as research tools specifically, and both approved of that approach. One said an optical engine with design similar to that of "real" engines seems to be a good tool for viewing combustion while having direct relevance to real "metal" engines. The reviewer added that development of improved surrogate fuels offering very similar performance to real fuels, but with fewer components, albeit more components than the simplest surrogates, should be very useful for improving understanding of fuel effects on engine performance and for improving engine and fuel design. The second reviewer offered a supporting opinion, agreeing that combining experimental work with optical engines is leading to a better understanding of fuel effects on advanced combustion strategies. However, the third reviewer was less sanguine concerning use of optically accessible research engines, opining that they may not be the ideal platform. Re-entrainment may be a problem with this approach and not all technical barriers may be overcome. Nonetheless, the reviewer noted that project milestones have been met. The final reviewer deemed the project to be a system approach to gathering fundamental knowledge.

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

All four reviewers noted project technical accomplishments and in general regarded them as significant. One cited the institution of enhanced lab capabilities; the completion of lean lifted flame combustion (LLFC) studies and the achievement of soot-free combustion with a two-hole fuel injector tip and the coordination and leadership of the CRC fuel program. The second reviewer commended the very good progress made in furthering understanding of issues with LLFC and potential solutions as well as good progress in diesel fuel surrogate development. Another reviewer deemed the ten-factor parametric study and Project 18 under the Advanced Vehicle/Fuel/Lubricants of the Coordinating Research Council (AVFL-18) good accomplishments. The last reviewer concurred, calling the parametric study of lean lifted flame combustion impressive, noting that it had identified two previously unknown barriers to LLFC.

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

All four reviewers offered generally positive assessments here. One cited the extensive collaboration beyond the national laboratory level, and a second observed fairly well coordinated participation of the CRC and Caterpillar. The third noted that some collaborations were mentioned in the presentation, including that with industry through the CRC program. The fourth reviewer noted a multifaceted matrix of organizations.

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

Reviewer opinions here were divided. One simply said the proposed plans sound good. The second noted that work on fuel and injection strategy effects on mixing-controlled combustion is an area still needing fundamental work. The reviewer anticipated that completion of the diesel surrogate fuel work should result in a very useful tool for researchers. The third reviewer noted that numerous programs plans were listed in the presentation but felt that some might not be realistic, citing examination of the oil-sands diesel fuel in the 2011/12 timeframe. The fourth mentioned the need to quantify fuel and injection strategy but felt the usefulness of diesel surrogate fuels to be open to question.

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

Only one reviewer commented, suggesting that larger funding could be required by anticipated laboratory upgrades.

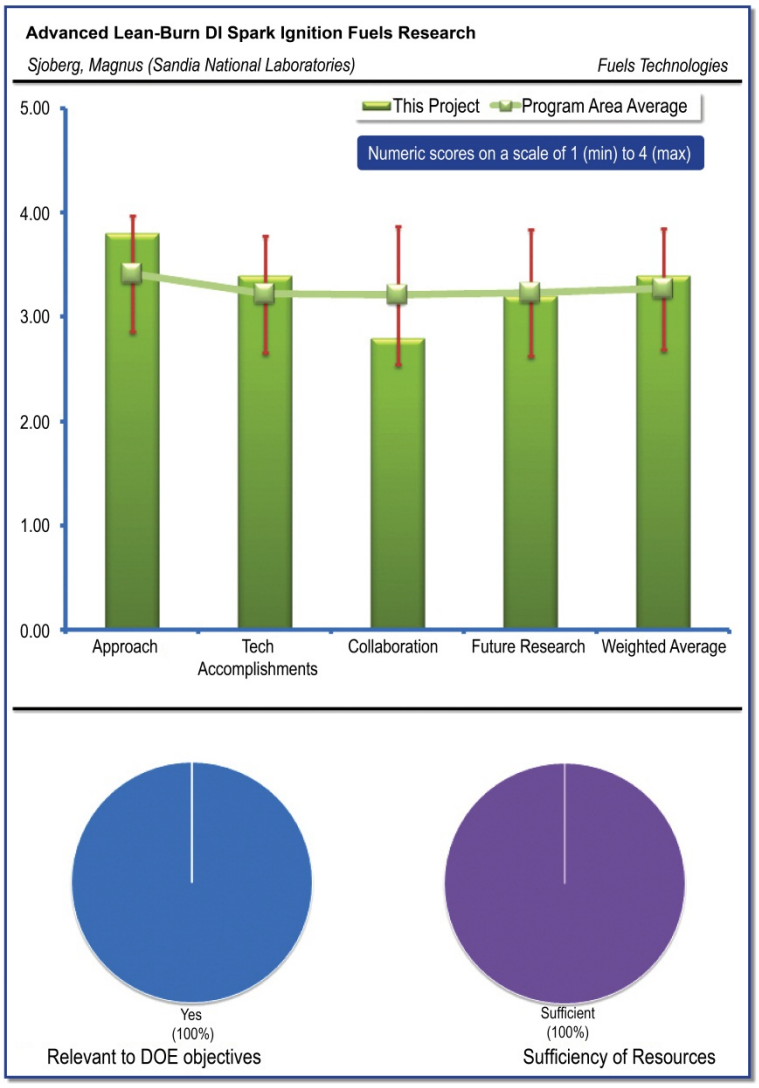
Advanced Lean-Burn DI Spark Ignition Fuels Research: Sjoberg, Magnus (Sandia National Laboratories) – ft006

Reviewer Sample Size

This project had a total of five reviewers.

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

Two of the four reviewers commenting on whether this project supports DOE's petroleum conservation goal were explicit in affirming that it does. One noted that advanced combustion has the potential to displace petroleum by permitting high-efficiency, lean combustion, including combustion of domestic alternative fuels. The other, noting the project's focus on improving engine efficiency using alternate fuels, said this will directly reduce amount of petroleum needed. The third reviewer linked combustion robustness and fuel efficiency, saying that both are important and that the project focuses on both, with the focus initially on E85. The fourth reviewer re-stated the goal and approach of the researchers conducting the project, saying it was to obtain fundamental knowledge of how emerging fuels will impact combustion of highly efficient LD engines, focusing on E85 and gasoline.



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

In responding to this question, one reviewer commented at considerable length, and with strong approval of the approach employed in performing the project work. This reviewer said that the combination of highly skilled investigator and highly specialized, optically accessible engine creates the opportunity for transformative knowledge generation. Continuing, this reviewer noted that the engine design mimics the typical Sandia optical engine design, with industry input on combustion chamber design, employing a complementary metal engine for more conventional combustion studies and validation. The approach, in this reviewer's estimation, offers a great combination of commercial guidance in an advanced experimental platform. Consideration of improving gasoline, including E85, combustion, in a high compression-ratio engine provides the chance to raise SI engine efficiency dramatically, while relying on biofuel. Finally, the reviewer observed that considering levels of charge stratification to optimize combustion and efficiency improvements permits lower equivalence-ratio operation, which lowers pumping losses. The second reviewer commented in a similarly positive vein, albeit more briefly, saying the approach of using both optical and metal engines as well as modeling is excellent and deemed the study's parametric studies fairly robust. Echoing that reviewer, the third said the combination of metal and optical engines with modeling is important to understanding the impact of fuel properties. The fourth reviewer concurred, terming the combination of optically accessible and metal engines with modeling techniques to better understand the impact of renewable fuels on

DISI excellent. The fourth reviewer simply noted the combination of conventional and optical engines without comment on its appropriateness.

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

Three reviewers commented on the accomplishments of this project, one noting the impressive progress made on engine set-up and understanding TE, another saying it had made good progress for a program that has recently started, with a need to set up a laboratory and test engine. The third acknowledged that the research team had commissioned a test engine and initiated performance testing of the all-metal engine. The fourth reviewer noted the project was showing means of significantly improving gasoline and E85 combustion, albeit at light load. The reviewer described the experiments as well-thought-out, and anticipated that they are leading to authoritative results which will explain well where additional knowledge is needed and what is constraining further improvements.

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

Five reviewers commented. One praised the excellent project collaboration with industry and overseas partners. Four reviewers noted collaboration with General Motors, one observing that it involved both hardware and consultation, a second that GM appeared to be the most direct and frequent industry collaborator, with a third concurring, terming GM the primary industry collaborator. The fourth referred less specifically to collaboration with an OEM. Two reviewers mentioned project collaboration with universities, one citing the modeling and kinetics work specifically; one reviewer noted national laboratory involvement in the project. Three reviewers mentioned is collaboration with the AEC MOU working group but to one reviewer it was unclear how much direction and interaction had been obtained beyond the few questions brought up during the AEC MOU semi-annual meeting. Likewise, another reviewer observed that while the AEC MOU offered potential collaboration with the EMA and OEMs, that interaction appeared to be less than with other project collaborators.

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

Four reviewers commented on proposed future work in this project, two of them offering suggestions for that work. One of these opined that understanding low-speed pre-ignition should be made a high priority and speculated that engine oil may be playing a role in this phenomenon. The other recommended hardware alterations to allow deactivation of one valve to create swirl flow. Heat of vaporization, this reviewer went on, is an important factor in future fuels and needs to be pursued. The third reviewer expressed the view that variability (i.e., COV) is limiting the ability to operate at higher IMEP and high efficiency, which is seen in extended combustion duration (weak burning). Continuing work with the optical engine to probe the combustion process fundamentals will enable understanding of this process. That work will also study mid- and high-mid-range ethanol blends, which can address the blend wall challenge. The fourth reviewer found future work plans to be reasonable.

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

Only two reviewers spoke to this question, one saying that project support was apparently adequate and the other seeing no indication that resources are not sufficient/appropriate.

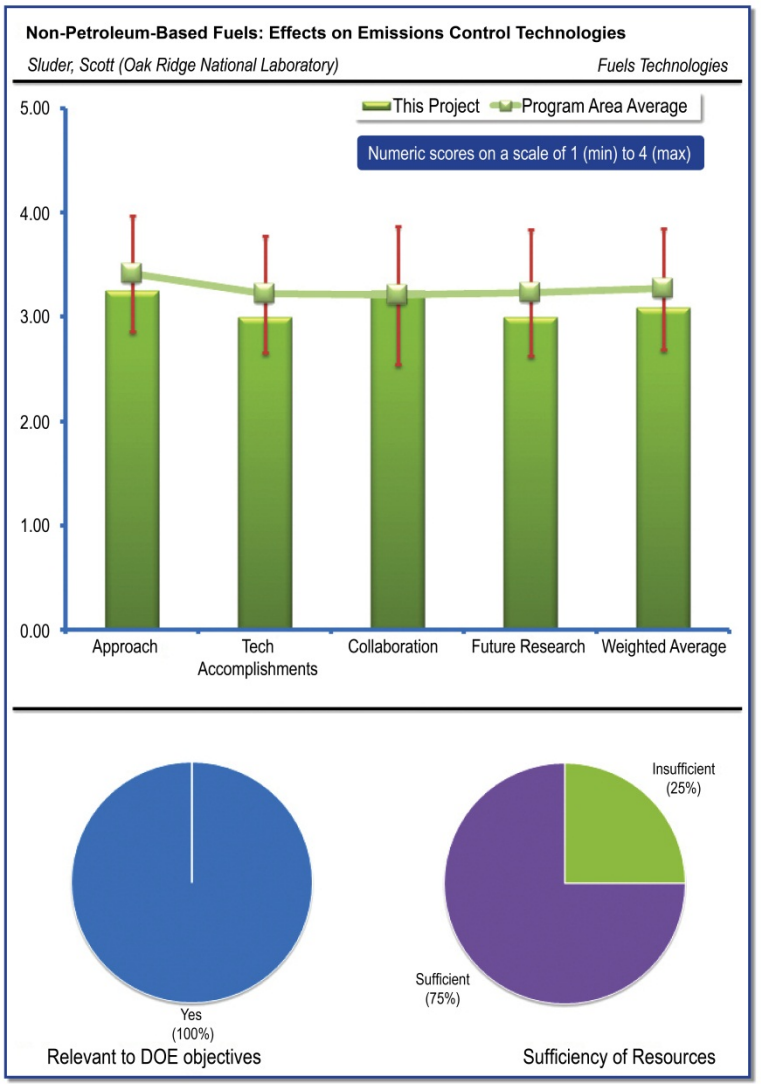
Non-Petroleum-Based Fuels: Effects on Emissions Control Technologies: Sluder, Scott (Oak Ridge National Laboratory) –ft007

Reviewer Sample Size

This project had a total of four reviewers.

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

Of the three reviewers offering comments on this subject, one was explicit in crediting this project with support of DOE's petroleum conservation goal, observing that greater utilization of non-petroleum blend fuels (NPBF) will result in petroleum displacement and that optimization of the engine and emissions control system is necessary to enable use of fuels from new, emerging sources. The second reviewer, describing the focus of the project as being on identifying and understanding issues related to use of non-petroleum alternative fuels to enable development of solutions and wider use of alternative fuels, implied that DOE's goal would be supported by this work. The third reviewer's comment was apparently on the aim of the project, saying it is to gather data to support predictive tools regarding fuel properties vs. combustion and effective emissions control.



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

The project approach was endorsed by all four reviewers. One termed it a good approach, using both engine and bench-scale studies. Another agreed, saying the project brings together targeted, engine-based and bench reactor studies. The approach, this reviewer went on, helps address barriers to market penetration of NPBFs. The third reviewer felt that using engine-based and bench reactor studies to pursue an in-depth characterization of PM and HC emissions and their control represents a well-focused program. The final reviewer cited new characterization techniques.

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

One reviewer cited good progress in a number of areas without further elaboration. The other two were more specific, one mentioning NPBF effects on EGR cooler performance, the effect of sodium from biodiesel combustion on emissions control and regarded the project as moving well toward DOE goals. The third also mentioned sodium's impact on, emissions control systems, citing SCR specifically, and the evaluation of mechanisms of EGR cooler deposit formation and PM oxidation.

QUESTION 4: WHAT IS YOUR ASSESSMENT OF THE LEVEL OF COLLABORATION AND COORDINATION WITH OTHER INSTITUTIONS?

Again, three reviewers commented, one citing a wide spectrum of collaborators, another collaborations with several automakers (Ford, GM) and OEMs (Modine, MECA) and the third mentioning Ford and other OEMs, MECA, and academia.

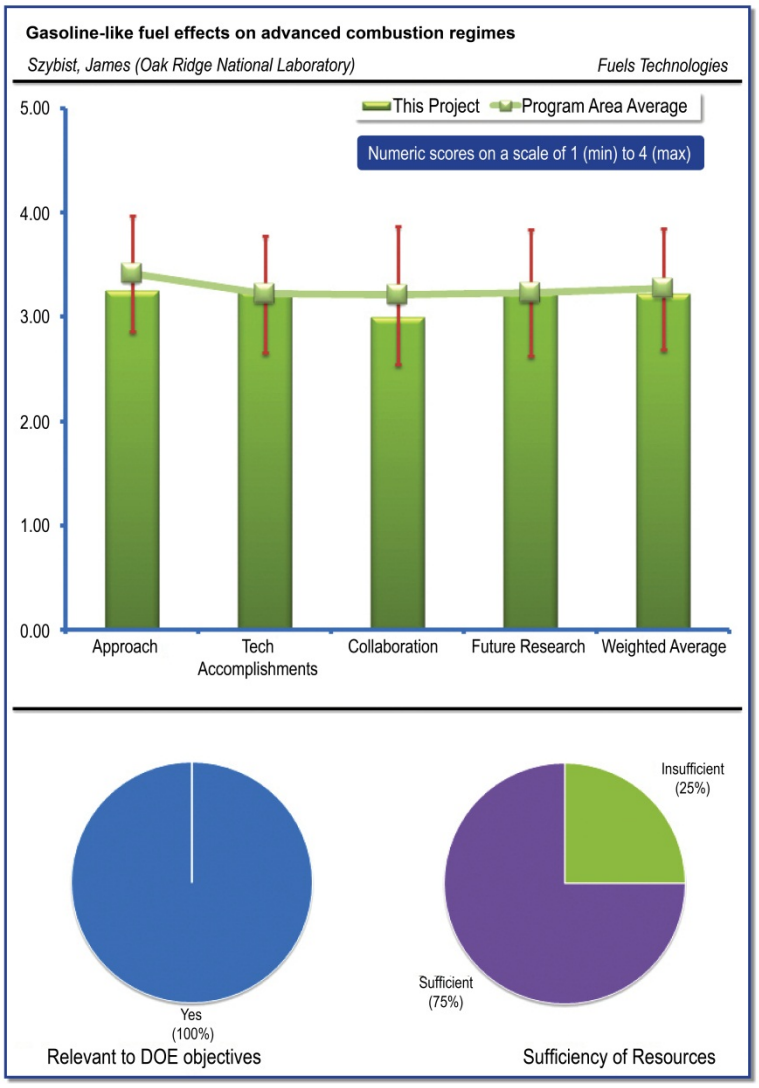
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

Two reviewers suggested areas of research they felt should be part of this project's future work. One said the effect of turbocharger deposits on engine thermal efficiency should be investigated. The other called for additional industry input, mentioning the compatibility of emission control systems with lubricants and the efficiency of lubricants. The third endorsed study of soot oxidation and EGR fouling as areas of interest to industry and added that study of the effect of higher molecular-weight alcohols will be timely.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

Opinion on this subject was divided. One reviewer said current funding seems sufficient, the second that the project needs more funding. The third observed that the funding level in 2011 has been reduced, and that future funding could be expected to remain at reduced levels. Additional funding would allow additional research, which the reviewer deemed critical to as these technologies and fuels are commercialized, especially given the potential corrosion issues attending biofuels use. It is not clear, in this reviewer's opinion, that this work can be conducted timely at current funding levels.

Gasoline-like fuel effects on advanced combustion regimes: Szybist, James (Oak Ridge National Laboratory) – ft008



Reviewer Sample Size

This project had a total of four reviewers.

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

Better understanding of the effects of fuel properties and chemistries of advanced combustion regimes should enable improved engine efficiency, leading to decreased fuel consumption, according to one reviewer, who added that improving the efficiency of E85 use would lead to its wider use in future vehicles. The second reviewer, noting that fuel diversity is increasing due to the Energy Independence and Security Act of 2007 (EISA), mentioned fuel property effects on advanced combustion, RCCI and emissions and efficiency improvements. The last reviewer's comment was work towards real world.

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

Two of four reviewers approved of the work approach, one calling it a good approach, of testing several different advanced combustion strategies, the other saying the work on reactivity controlled combustion seems well focused. The third reviewer dissented, saying the project approach was not well defined and wondered how many different areas were to be studied. The fourth reviewer simply observed that the project employs an ethanol-optimized engine for E20 and E85.

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

Three of four reviewers offered approving comments on the accomplishments and progress of this project, one citing its development of impressive technical data, the other noting good progress in several areas. The third said that the work on fuel effects for RCCI and spark-assisted HCCI is helping to overcome barriers to its implementation and fill gaps in engine map operation for advanced-combustion engines. The final reviewer's comment was that the early, near-optimal and late injection timing studies had been completed and noting that fueling and breathing strategies also affect particle emissions.

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

One reviewer saw excellent collaboration with industry and universities, and a second saw collaboration with a few OEMs. A third reviewer noted the collaboration of the AEC/HCCI Working Group, the University of Michigan, Delphi, University of Wisconsin, and an unspecified OEM, and felt the collaboration was well-coordinated. The final reviewer commented that the project did not have many industrial partners.

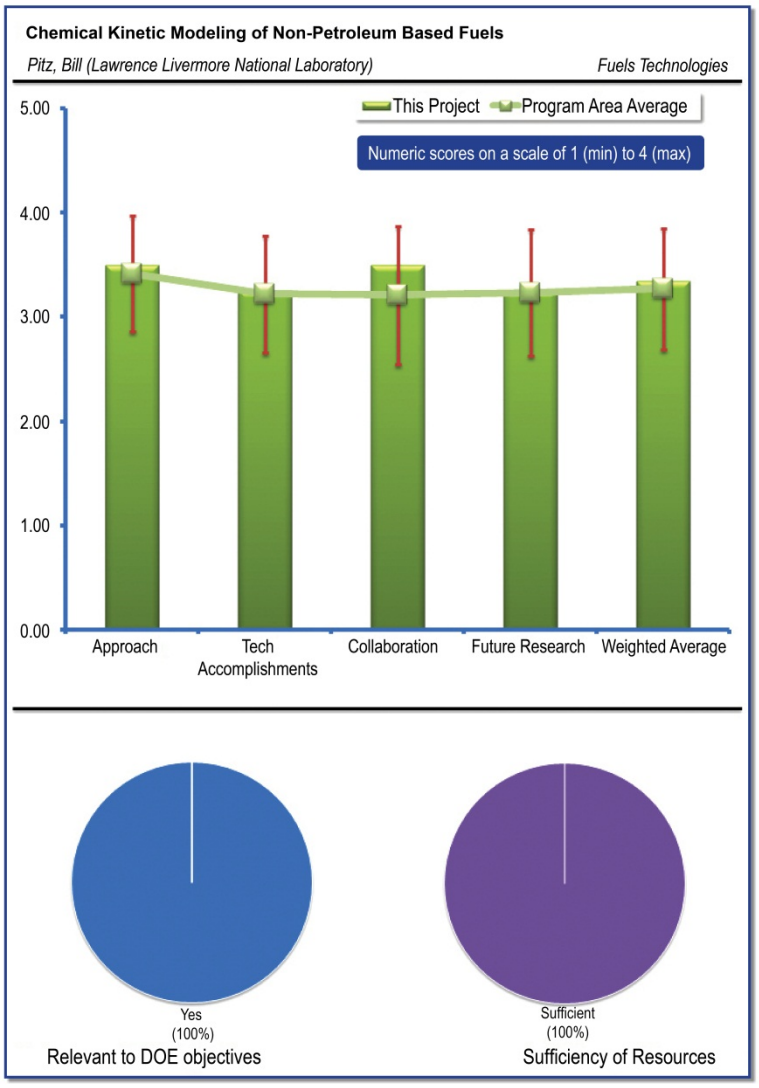
QUESTION 5: HAS THE PROJECT EFFECTIVELY PLANNED ITS FUTURE WORK IN A LOGICAL MANNER BY INCORPORATING APPROPRIATE DECISION POINTS, CONSIDERING BARRIERS TO THE REALIZATION OF THE PROPOSED TECHNOLOGY, AND, WHEN SENSIBLE, MITIGATING RISK BY PROVIDING ALTERNATE DEVELOPMENT PATHWAYS?

One reviewer said the plans seem good. Another said simply OK. The third reviewer mentioned dual-fuel RCCI combustion, stoichiometric spark-assisted Homogeneous Charge Compression Ignition (SA-HCCI) and ethanol optimization. This reviewer added the words translate SA-HCCI efficiency benefits to real-world fuel economy improvement with modeling.

QUESTION 6: HOW SUFFICIENT ARE THE RESOURCES FOR THE PROJECT TO ACHIEVE THE STATED MILESTONES IN A TIMELY FASHION?

One reviewer offered the impression that quite a bit of work had been accomplished and progress made for $200,000, unless the total funding was larger and the results presented were from a larger program. A second reviewer called the work timely, said it was breaking new ground in the area of SA-HCCI and that there was considerable interest in the dual-fuel RCCI work. This reviewer mentioned that additional funds would expedite development of answers to some of the questions being uncovered in this research.

Chemical Kinetic Modeling of Non-Petroleum Based Fuels: Pitz, Bill (Lawrence Livermore National Laboratory) – ft010



Reviewer Sample Size

This project had a total of four reviewers.

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

The first reviewer said that understanding the chemical kinetics of combustion is even more important in advanced combustion and for unconventional fuels to achieve truly predictive simulation capabilities. In a similar vein, the second reviewer said this program is focused on development of kinetic models for nonpetroleum fuel components, which is important for their optimal use in existing engines and the design of future engines. The third reviewer commented high efficiency engines optimization of fuel formulations. One reviewer remarked replacement of petroleum.

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

The first reviewer said that the approach of mechanism development has proven very effective to support simulation, because the kinetic models are continually being updated and validated. The network of connections to the fundamental and applied combustion communities provides a technically rigorous and rapidly responding basis for mechanism development. The second reviewer lauded the excellent approach of developing fundamental kinetic models for fuel components; validating models with experimental data from other labs; reducing the mechanisms to reduce computing time and making mechanisms and models widely available. The development of fundamental kinetic models, this reviewer went on, seems very appropriate for the national labs. The third reviewer noted that model development is ongoing. Combine mechanisms, according to this reviewer, for representative fuel components to provide surrogate models for NPBFs. The final reviewer's comment was develop and improve kinetic models.

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

Two reviewers noted project accomplishments with approval. One noted the completion of kinetic models for major components of biodiesel and for iso-pentanol, a new biofuel. These are extremely valuable accomplishments, this reviewer concluded, to support advanced combustion and combustion of non-petroleum fuels. The second reviewer was of similar opinion, saying that important contributions had been made, including completion of kinetic models development for some of the key C16 and C18 biodiesel components and the continuing development of kinetic models for butanol isomers. The last reviewer also mentioned the development of chemical models for butanol isomers and diesel surrogate fuels. The biodiesel model would also be useful.

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

One of the four reviewers perceived outstanding collaboration with academia and national labs. The second said the project was collaborating with many groups through application of the models to prediction of experimental results and for validation and improvement of the kinetic mechanisms. This reviewer also mentioned participation of project staff in the DOE- and industry-supported working groups. The third reviewer saw some collaboration with other national labs (such as Sandia) and with universities. Primary direct collaboration with industry appeared to the third reviewer to be through CRC working groups such as AVFL-18, with some input also appearing to be obtained at presentations made at AEC semi-annual meetings. The fourth reviewer cited the universities of Wisconsin and Michigan, University of Connecticut (UCONN), FACE and the AEC working group (WG).

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

Developing kinetic mechanisms for butanol isomers is an excellent goal, said one reviewer, since butanol can be made from lignocellulose and has many benefits over ethanol. This proposed work, this reviewer continued, should support future development of advanced and conventional combustion of butanol. Other areas of expansion of models reflect emerging new fuels such as DMF and algal fuels. A second reviewer called plans to develop mechanisms for other methyl esters, DMF and cycloalkanes worthwhile. The third reviewer named kinetic models for algae, biomass fuel, DMF, iso-pentanol and validation of mechanisms for large methyl esters.

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

One of three reviewers addressing this point said project funding has been stable despite the overall cuts in VTP. Given how important this work is to the entire engine/combustion community, that is very good news. The other two reviewers deemed funding sufficient.