5. Advanced Power Electronics

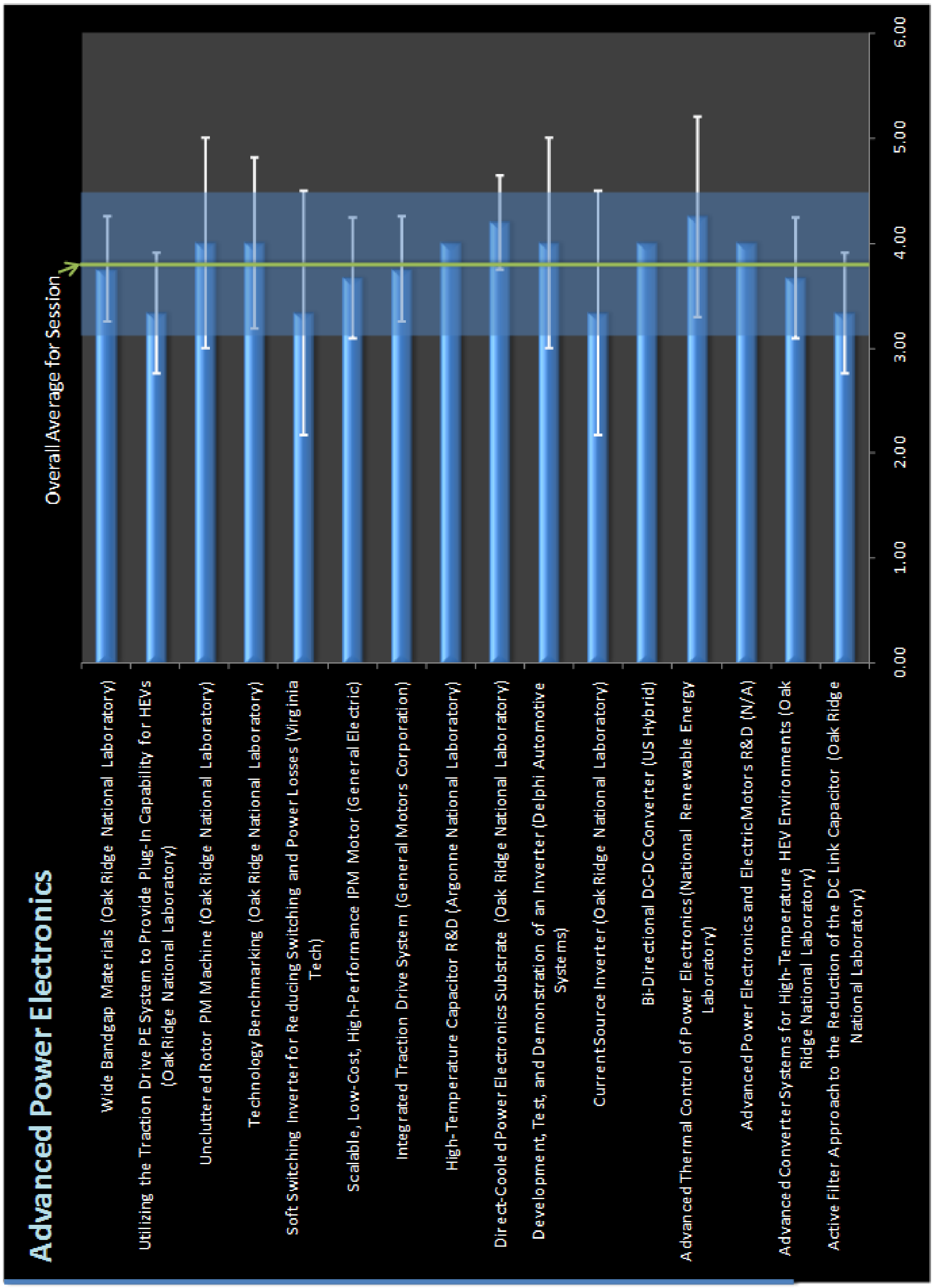
Introduction

Achieving the power electronics and electrical machines goals will require the development of new technologies. These new technologies must be compatible with high-volume manufacturing; must ensure high reliability, efficiency, and ruggedness; and must simultaneously reduce cost, weight, and volume. Of these challenges, cost is the greatest. Key components for hybrid vehicles (with either fuel cell advanced combustion engines as the prime mover) include motors, inverters/converters, sensors, control systems, and other interface electronics. Power electronics and electrical machines research is a collaboration among government, national laboratories, academia, and industry partners. These partners work together to ensure that technical attributes, vehicle-scale manufacturing, and cost sensitivities are addressed in a timely fashion and that the resulting technologies can be adopted by companies willing and able to supply products to automakers.

In this merit review activity, each reviewer was asked to respond to a series of six questions, involving multiple-choice responses, expository responses where text comments were requested, and one numeric score response. 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 pictorial form in eight graphs as the last page of each project, and the expository text responses will be summarized in paragraph form for each question. A table and graph presenting the average and standard deviation for each project relative to the overall average and standard deviation for this session is presented below.

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
5-4	Active Filter Approach to the Reduction of the DC Link Capacitor (Ozpineci, Burak, Oak Ridge National Laboratory)	3.33	0.58
5-6	Advanced Converter Systems for High-Temperature HEV Environments (Ozpineci, Burak, Oak Ridge National Laboratory)	3.67	0.58
5-8	Advanced Power Electronics and Electric Motors R&D (N/A, N/A)	4.00	
5-10	Advanced Thermal Control of Power Electronics (Kelly, Ken, National Renewable Energy Laboratory)	4.25	0.96
5-13	Bi-Directional DC-DC Converter (Goodarzi, Abas, US Hybrid)	4.00	0.00
5-15	Current Source Inverter (Marlino, Laura, Oak Ridge National Laboratory)	3.33	1.15
5-17	Development, Test, and Demonstration of an Inverter (Taylor, Ralph, Delphi Automotive Systems)	4.00	1.00
5-19	Direct-Cooled Power Electronics Substrate (Olszewski, Mitch, Oak Ridge National Laboratory)	4.20	0.45
5-22	High-Temperature Capacitor R&D (Balachandran, Uthamalingam, Argonne National Laboratory, and Dirk, Shawn, Sandia National Laboratories)	4.00	0.00
5-25	Integrated Traction Drive System (Smith, Greg, General Motors Corporation)	3.75	0.50

Page	Project Title and Principal Investigator	Project Average Score	Project Score Standard Deviation
5-27	Scalable, Low-Cost, High-Performance IPM Motor (Salasoo, Lembit, General Electric)	3.67	0.58
5-29	Soft Switching Inverter for Reducing Switching and Power Losses (Lai, Jason, Virginia Tech)	3.33	1.15
5-32	Technology Benchmarking (Olszewski, Mitch, Oak Ridge National Laboratory)	4.00	0.82
5-34	Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors (Marlino, Laura, Oak Ridge National Laboratory and Anderson, Iver, Ames National Laboratory)	4.00	1.00
5-37	Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs (Marlino, Laura, Oak Ridge National Laboratory)	3.33	0.58
5-39	Wide Bandgap Materials (Ozpineci, Burak, Oak Ridge National Laboratory)	3.75	0.50
	Overall Session Average and Standard Deviation	**3.81**	**0.68**


Advanced Power Electronics
Overall Average for Session
Wide Bandgap Materials (Oak Ridge National Laboratory)
Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs (Oak Ridge National Laboratory)
Uncluttered Rotor PM Machine (Oak Ridge National Laboratory)
Technology Benchmarking (Oak Ridge National Laboratory)
Soft Switching Inverter for Reducing Switching and Power Losses (Virginia Tech)
Scalable, Low-Cost, High-Performance IPM Motor (General Electric)
Integrated Traction Drive System (General Motors Corporation)
High-Temperature Capacitor R&D (Argonne National Laboratory)
Direct-Cooled Power Electronics Substrate (Oak Ridge National Laboratory)
Development, Test, and Demonstration of an Inverter (Delphi Automotive Systems)
Current Source Inverter (Oak Ridge National Laboratory)
Bi-Directional DC-DC Converter (US Hybrid)
Advanced Thermal Control of Power Electronics (National Renewable Energy Laboratory)
Advanced Power Electronics and Electric Motors R&D (N/A)
Advanced Converter Systems for High-Temperature HEV Environments (Oak Ridge National Laboratory)
Active Filter Approach to the Reduction of the DC Link Capacitor (Oak Ridge National Laboratory)
0.00
1.00
2.00
3.00
4.00
5.00
6.00

Active Filter Approach to the Reduction of the DC Link Capacitor (Burak Ozpineci, of Oak Ridge National Laboratory)

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

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
The first reviewer noted that limiting capacitors limits the need to find high-power-density, high-temperature ones, which is normally a very difficult technical challenge. This is a nice way to solve the problem by avoiding it. Another person commented that reducing the total cost of power electronics systems will be of importance in HEV and PHEV applications. One person added that the work could lead to some cost savings.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
Responses to this prompt were mixed. One person indicated that it should be possible to achieve the goals with clever electrical design. Another stated that an active filter is a nice concept, but no technical details or designs have been identified in this project. The team needs to develop a detailed approach that can work at this high frequency and still be cost effective. One other reviewer stated that no real deployment plan had been presented.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
One person stated that no detailed technical approach has been proposed, while the other reviewer said it seems to be early on and has not moved beyond the simulation stage.

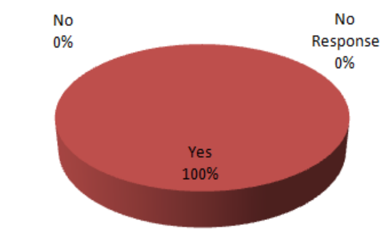
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The first reviewer stated that the reduction in the size of the capacitor may be offset by the complexity of the design. This reviewer would expect the reliability of the system to be worse, since the capacitor is not eliminated and the design adds more switches. One other person commented that it is not about knowing how the active filter is designed, but rather about whether it is fast enough to perform the required filtering task.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that resources are sufficient to perform this task.

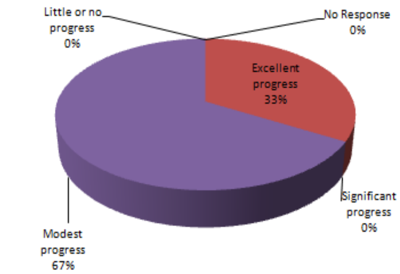
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Active Filter Approach to the Reduction of the DC Link Capacitor

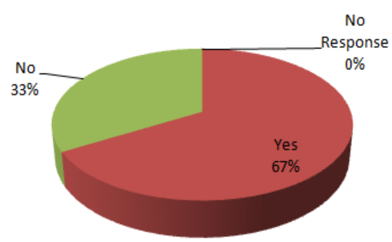
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



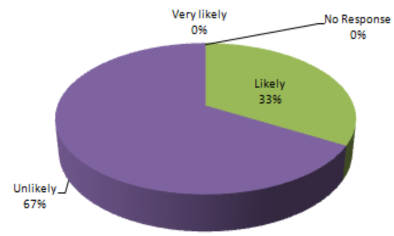
Question 3: Characterize the technical accomplishments and progress toward goals.



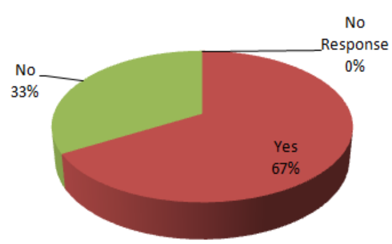
Question 2a: Are the goals of the project technically achievable?



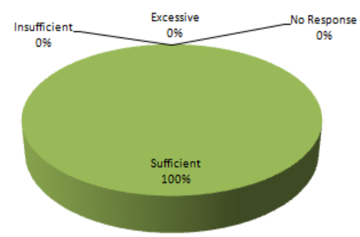
Question 4: How likely is the project team to move technologies into the marketplace?



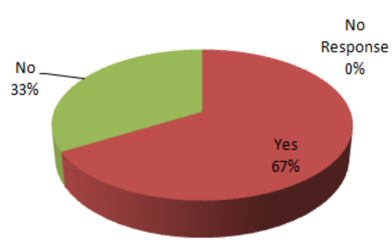
Question 2b: Have the technical barriers been identified and addressed?



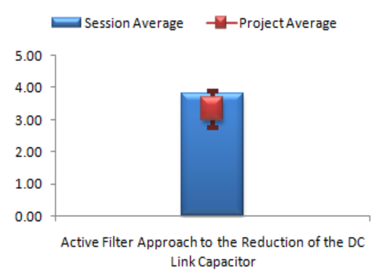
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Converter Systems for High-Temperature HEV Environments (Burak Ozpineci, of Oak Ridge National Laboratory)

Reviewer Sample Size

This project had a total of 3 reviewers.

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

One reviewer stated that this is a critical component in future vehicles, while another commented, similarly, that converter systems, especially ones designed and packaged for high temperature environments, are very important for achieving DOE's vehicle goals. One other respondent stated that an SiC converter is one potential candidate for high temperature applications, adding that there are many challenges and barriers in applying this technology. A 55kW DC-DC converter is very ambitious if SiC is used. If Si is used, then there is limited potential to achieve the desired high temperature capabilities.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

The first respondent indicated that widespread use of this design depends greatly on the cost of the SiC devices, adding that they will likely find uses in the military and aerospace markets. Another reviewer commented that, if SiC is used, then at a lower power rating it is possible for deployment. The reviewer adds that the available SiC JFET and MOSFET may not be available for the application. When parallel-connecting the devices to achieve the power rating of 55kW, parasitic stray inductance and capacitance will have a large impact on the current and voltage (reverse recovery current, etc.).

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer commented that the technical approach and plan is reasonable to achieve the goal, while another said that the project has made progress in using Si for high temperature capability. This person also noted that SiC has not been investigated yet.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer stated that DC-DC converters at much higher powers have been developed (5.5KW). Even though these are working at a high temperature, this reviewer feels that they may not be of interest to the industry. One person suggested considering the military and aerospace or other niche applications.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

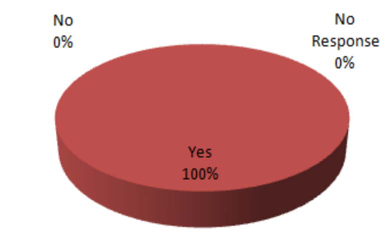
The lone respondent stated that resources are sufficient.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

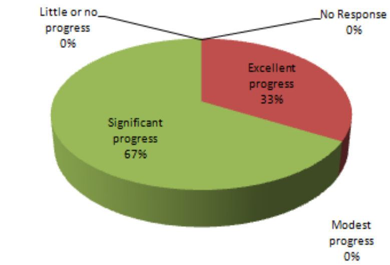
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Converter Systems for High-Temperature HEV Environments

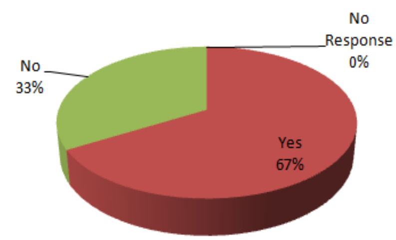
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



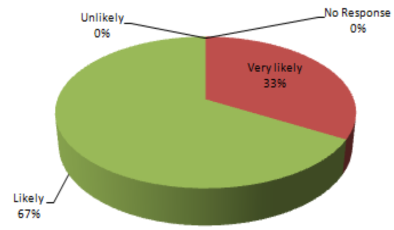
Question 3: Characterize the technical accomplishments and progress toward goals.



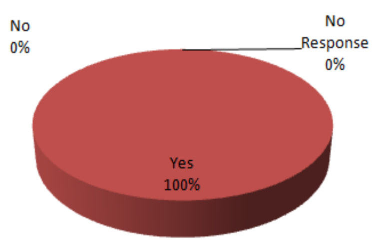
Question 2a: Are the goals of the project technically achievable?



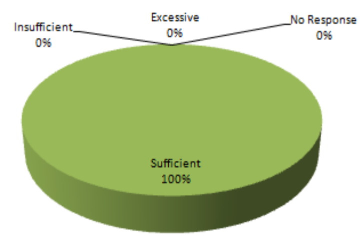
Question 4: How likely is the project team to move technologies into the marketplace?



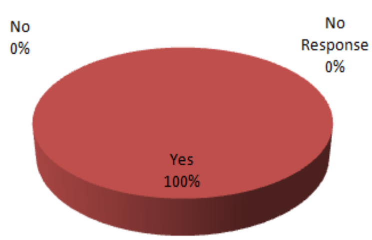
Question 2b: Have the technical barriers been identified and addressed?



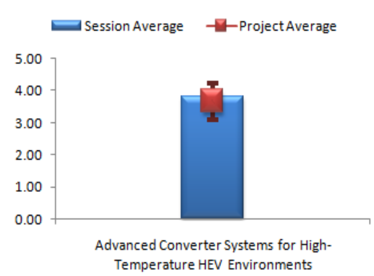
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Power Electronics and Electric Motors R&D

Reviewer Sample Size

This project had a total of 1 reviewer.

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

The lone respondent stated that this project summarizes efforts for APEEM for a better assessment of future research directions to meet DOE goals.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

The lone respondent stated that this was not really applicable to a summary poster.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

The lone respondent commented that the projects as a whole have shown good progress.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

There were no responses to this prompt.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

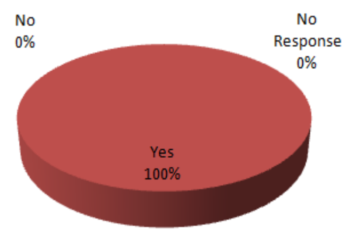
There were no responses to this prompt.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

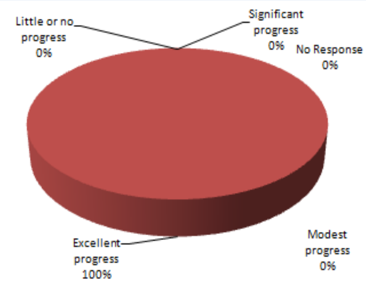
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Power Electronics and Electric Motors R&D

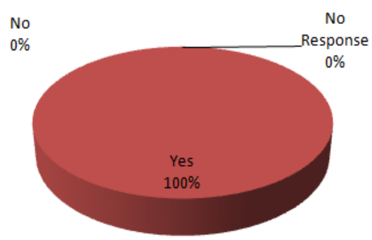
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



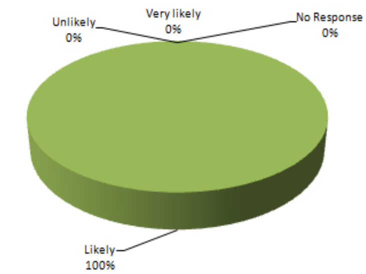
Question 3: Characterize the technical accomplishments and progress toward goals.



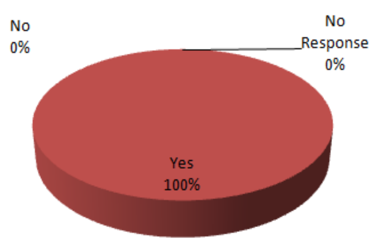
Question 2a: Are the goals of the project technically achievable?



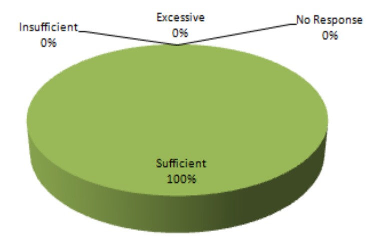
Question 4: How likely is the project team to move technologies into the marketplace?



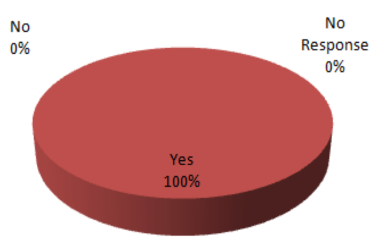
Question 2b: Have the technical barriers been identified and addressed?



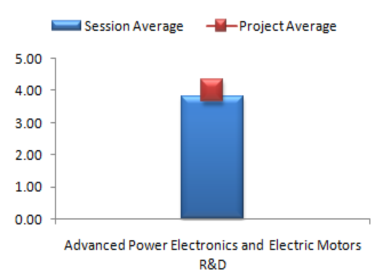
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Advanced Thermal Control of Power Electronics (Ken Kelly, of National Renewable Energy Laboratory)

Reviewer Sample Size

This project had a total of 4 reviewers.

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

One reviewer stated that thermal management is of particular interest in advanced vehicle (HEV, PHEV) applications, and it is essential to reduce size, volume, cost, and increase reliability, and efficiency. Another individual commented that the cooling of the power electronics is critical to having a reliable power electronics design for the HEV. Similarly, another reviewer indicated that thermal management is critical to enabling the electronic systems to ensure reliable, efficient performance of HEVs. APEEM program goals for a 105°C coolant require advances in the areas addressed by this effort. One final reviewer stated that advanced thermal control technologies are critical to enabling higher power densities and the associated reduction in the need for fuel without producing such high temperature levels that performance, life, and reliability of power electronic components are significantly degraded, especially at the desired coolant temperature of 105°C.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

The first reviewer stated that the goals of the project are clearly defined: reach $12/kW, 400W/cm^2, and 105°C inlet temperature. The group has examined Prius, Camry, and Lexus designs in cooling. The barriers are correctly identified with regards to heat flux density capability, and three types of solutions were compared to reduce costs. There are currently five projects in thermal / cooling from NREL. One person added that, by looking at a broad range of cooling materials and technologies, this will allow for one of the best solutions to be brought forward.

One reviewer stated that they recognize the need to improve measurements in all areas. The TIM goal is ambitious given how much effort industry has been put into this area. While using air to cool power electronics is desirable, it seems impractical to meet the required 200+ W/cm^2. Important barriers to implementing modeling tools for reliability are identified, but path to addressing them is not clear. This reviewer adds that standards for reliability are important.

One final reviewer commented that many advanced cooling projects were discussed concurrently. Most of the research seems to be focused on modeling and assessing existing materials and technologies, and not on identifying and overcoming technical barriers that are standing in the way of HEV development. A good example of this is in the area of thermal interface materials, where most work characterizes existing TIMs and there is no clear path to the "BREAKTHROUGH" material desired as the final output.

The reviewer was also not clear what new technology is being developed in air-cooled microchannel heat exchangers. Finally, the goal in the thermal stress and reliability program of having a quantitative method to evaluate the 15-year-life target of new technologies is being achieved right now at leading universities, companies, and government agencies that are already working on this. Major players in this area need to be brought onboard in more than an interviewee role to ensure timely and cost-effective success. For example, the reviewer adds, Daimler/Ford/GM have been working in this area for at least a decade.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer commented that the program is on track with its scheduled milestones and suggested that they work closely with power electronics experts (universities, etc.) to quantify the loss and effectiveness of the cooling methodology based on driving profiles (when the heat is not uniformly distributed nor constant function of time).

Another person stated that there has been good progress in improving characterization techniques. The integration of experimentation and modeling is good. The TIM program incorporating materials other than CNT is key to cost/risk reduction. Direct backside cooling represents a high-risk approach to cooling, and this may lead to mechanical fatigue problems in the electronic module. The reviewer added that more work needs to be done to address reliability and cost. There is currently insufficient data regarding thermal stress and reliability to validate models. The uncertainty in each step of approach is unknown, so how this uncertainty propagates through multiple modeling steps significantly impacts the predictions of the system model (robust design).

One final reviewer noted that, in the area of thermal interface materials, significant effort has been devoted to reproducing the ASTM standard set up with its significant limitations and using it to characterize off-the-shelf TIMs instead of pursuing and validating promising new approaches in testing or materials development. Also, most of the accomplishments appear to be conference papers, not actual hardware or technology improvements demonstrating progress toward overcoming barriers.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first respondent stated that some of the technologies being looked at will move into the final package design, while another individual stated that the group is working closely with industry partners on methodologies, materials, and modeling. One reviewer added that there is potential for the method and material to be used by industry. The CRADA with Semikron is a good indication of implementation in the marketplace.

To contrast, one response stated that there is no clear pathway for the development, let alone the marketing of new TIM materials, heat exchangers, or reliability tools.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that the resources are sufficient in the study, while another noted that funding should be ongoing into 2009. Another person added that this is an important component of the APEEM program and sustained funding is justified.

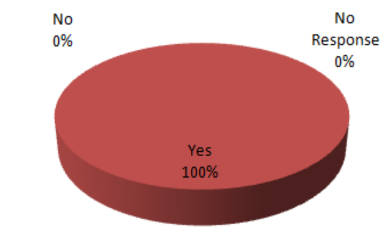
One final reviewer said that too many resources are being spent rebuilding existing test method setups and re-evaluating and assessing existing materials, existing technologies, and existing reliability models already developed and characterized by the power electronics community. If kept at the current level of funding, NREL needs to distribute more of the funding through partnerships with leading research institutions to actually move the technology forward.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

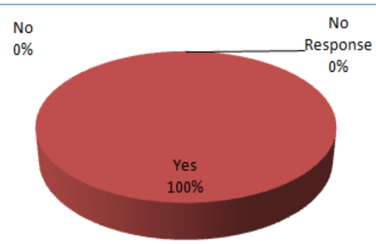
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Advanced Thermal Control of Power Electronics

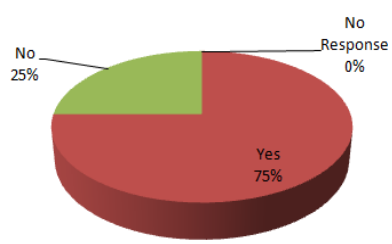
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



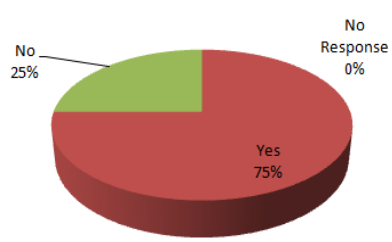
Question 2a: Are the goals of the project technically achievable?



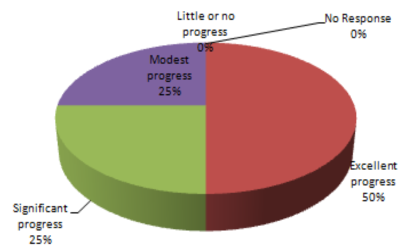
Question 2b: Have the technical barriers been identified and addressed?



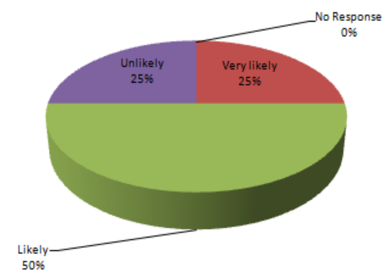
Question 2c: Is the proposed work likely to overcome technical barriers?



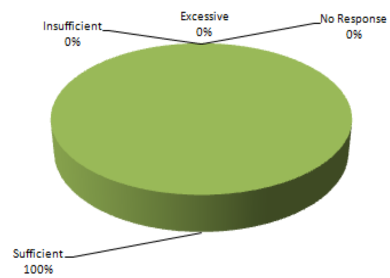
Question 3: Characterize the technical accomplishments and progress toward goals.



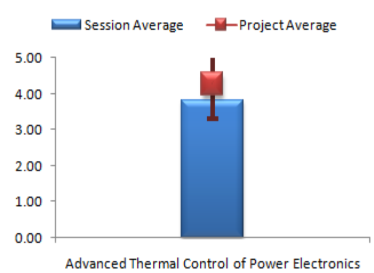
Question 4: How likely is the project team to move technologies into the marketplace?



Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 6: Overall Rating



Bi-Directional DC-DC Converter (Abas Goodarzi, of US Hybrid)

Reviewer Sample Size

This project had a total of 3 reviewers.

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

The first response stated that a DC-DC converter is an important component in HEVs to manage batteries and increase battery life, as well as matching the voltage with the DC bus and battery terminal. Another reviewer commented that the use of a bi-directional DC-DC converter allows the use of multiple energy storage units, and the flexible DC-link voltages can enhance the performance of the electronics. Similarly, one other person stated that HEVs/PHEVs will have multiple DC voltage levels, and that makes the DC/DC converter important. The product can be more significant in the FCV.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One reviewer stated that efficiency is critical, noting the DC link voltage optimization to combine a high energy battery and a high power battery (ultracap?). Another reviewer commented that higher motor efficiency is achieved by increasing the DC bus voltage. The dual energy storage system – one for energy density and one for power density with a DC-DC converter and DC link volt regulator – allows for a SOC-versus-time curve that is flat, as opposed to decreasing as the battery is drained. One other person stated that they did not see a plan to deploy the product.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer indicated that some testing has been done, but more detailed research at the system level (packaging and parallel connection of SiC chips, etc.) should be explored. The other respondent stated that the effort completed so far covers the concept study and design. This progress is significant and headed in the right direction.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer commented that all SiC DC-DC converters may have a cost concern in terms of marketing them for general use in vehicles. The other respondent stated that DC/DC is a significant component and a Si converter can readily transfer to market. The SiC solution will depend entirely on the ability to meet cost targets and reliability performance.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

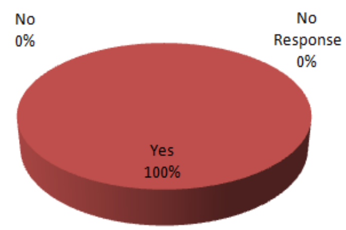
One reviewer stated that the funding level is sufficient to complete the tasks, while another felt that the project seems underfunded ($293k) for the goals stated.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

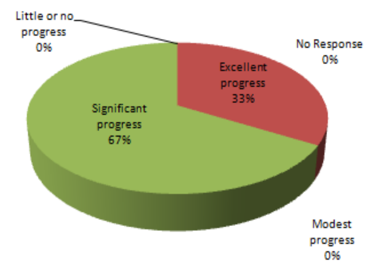
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Bi-Directional DC-DC Converter

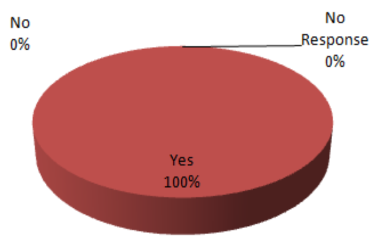
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



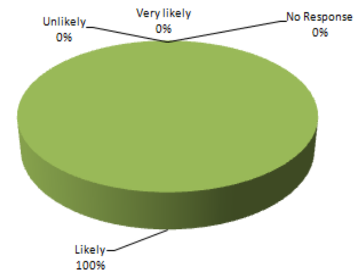
Question 3: Characterize the technical accomplishments and progress toward goals.



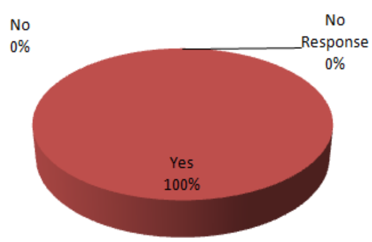
Question 2a: Are the goals of the project technically achievable?



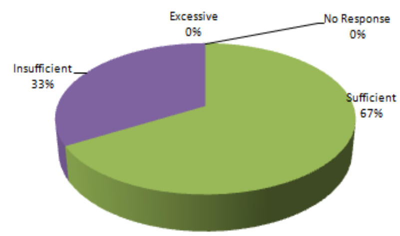
Question 4: How likely is the project team to move technologies into the marketplace?



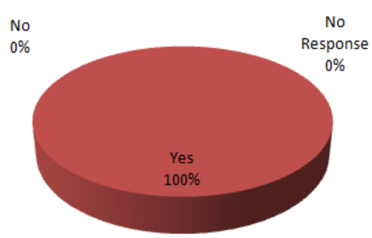
Question 2b: Have the technical barriers been identified and addressed?



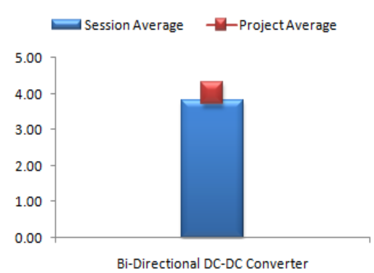
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Current Source Inverter (Laura Marlino, of Oak Ridge National Laboratory)

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

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer commented that inverters are critical elements in HEV electronic propulsion systems. Another person stated that, even though advanced power electronics are critical for the successful implementation and commercialization of HEVs, in general the US is way behind Japanese automotive companies. Personally, this reviewer does not think that a current source inverter is a good choice for HEV applications.

One other reviewer stated that the concept is worth investigating to achieve the stated goals of the program, but this may be a case of simply replacing the issues of the voltage source inverter with the new issues in the CSI, which is of equal difficulty. This reviewer felt that there are significant packaging issues, but the end reward of significantly reducing the capacitance justifies the effort.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that the barriers are likely to be overcome but still need serious work and innovative ideas. The other respondent did not hear a deployment strategy.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The lone respondent stated that it is too early in the project to give this project a higher rating.

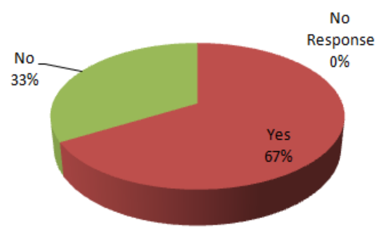
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
The lone respondent stated that he or she could not be sure until they see more information and test results.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
There were no responses to this prompt.

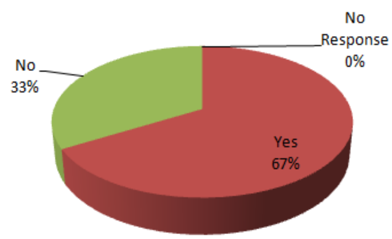
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project’s summary score.

Project: Current Source Inverter

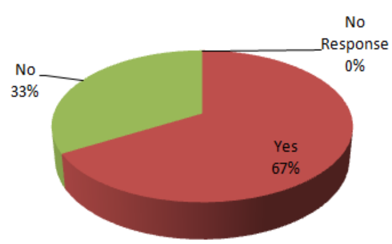
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



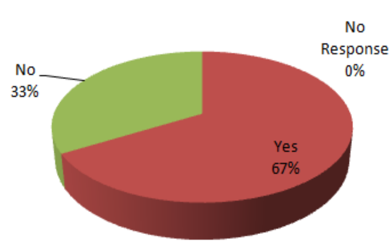
Question 2a: Are the goals of the project technically achievable?



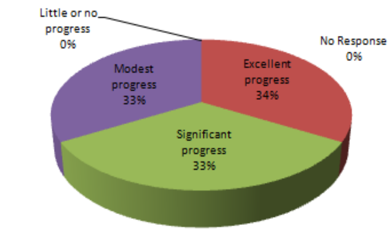
Question 2b: Have the technical barriers been identified and addressed?



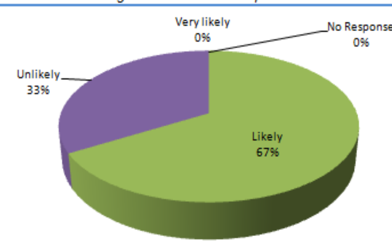
Question 2c: Is the proposed work likely to overcome technical barriers?



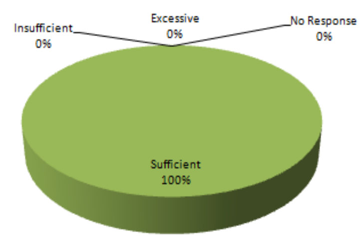
Question 3: Characterize the technical accomplishments and progress toward goals.



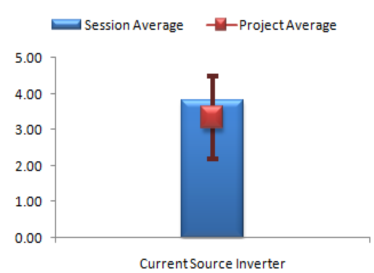
Question 4: How likely is the project team to move technologies into the marketplace?



Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 6: Overall Rating



Development, Test, and Demonstration of an Inverter (Ralph Taylor, of Delphi Automotive Systems)

Reviewer Sample Size

This project had a total of 3 reviewers.

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

One person stated that high temperature inverter technology is critical to the development of HEVs, while another added that high temperature inverters will reduce future vehicle system costs and improve reliability. One other reviewer commented that the inverter is an important part of HEVs and PHEVs, and it must be investigated in terms of operation efficiency, temperature, cost, and reliability.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One reviewer indicated that there is good work being done in the comparison of different technologies, while another stated that there is a very good plan and partners selected to be able to bring the technology to market quickly if successful. One other individual noted that the project requires the integration of a number of new developmental technologies for success, and so is high risk. However, this reviewer adds that the technologies chosen are promising and seem to be ready for such an integration.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

Results were similar in this section. One reviewer commented that this is a new project and so there are not many results yet. The results shown were promising. Another person added that some preliminary investigation has been performed. One other reviewer stated that the only progress shown to date was the creation of the project team.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer noted that Delphi itself is a Tier 1 supplier, and therefore it will be easy to implement if the research is successful. Another stated that, if not all the technologies, some of the technologies that come from this project will most likely make it to a successful product.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

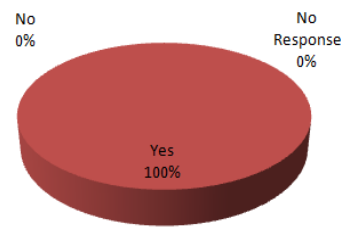
The lone respondent stated that the funding is sufficient for the project, and probably more than what it needs.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

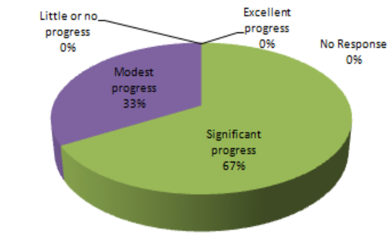
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Development, Test, and Demonstration of an Inverter

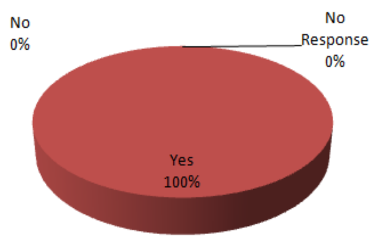
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



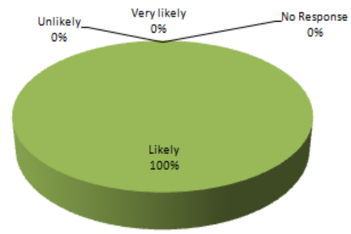
Question 3: Characterize the technical accomplishments and progress toward goals.



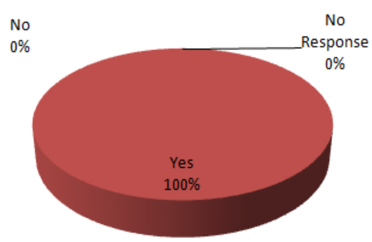
Question 2a: Are the goals of the project technically achievable?



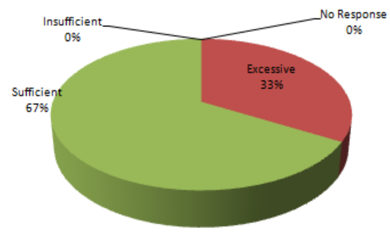
Question 4: How likely is the project team to move technologies into the marketplace?



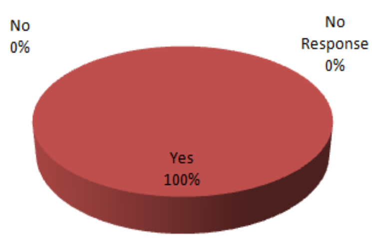
Question 2b: Have the technical barriers been identified and addressed?



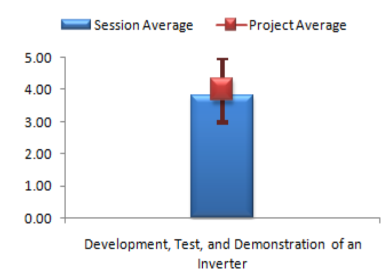
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Direct-Cooled Power Electronics Substrate (Mitch Olszewski, of Oak Ridge National Laboratory)

Reviewer Sample Size

This project had a total of 5 reviewers.

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

One reviewer commented that cooling technologies are essential for next generation power electronics and for fuel use reduction, while another added that the project's impact on cooling the power semiconductors could be very significant for power electronics. One reviewer stated that developing a novel thermal management methodology is critical for HEV and PHEV power electronics, while another person similarly wrote that thermal management is critical to enabling the electronic systems to ensure reliable, efficient performance of HEVs. One final reviewer stated that this is a novel approach to improving cooling by eliminating the heat sink. If successful, this reviewer adds, the results could be ground-breaking in terms of packaging power modules.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

Responses to this prompt were generally mixed. One reviewer called this a well-defined and scoped project, while another indicated that the barriers are identified and a technical approach is proposed, with a potential density of 15kW/L with 105^{o}C coolant using Si devices. One other person stated that, from a cooling standpoint, the project could have a major impact on the power semiconductor operating temperature/heat flux density and the size of the power electronics. The impact on EMC should be evaluated, as this approach may have a negative impact on EMC.

In contrast, one reviewer stated that the presenter identified the technical barriers well, but did not present any information to lead this reviewer to think that the barriers could be overcome. One other individual also noted that there are significant barriers to developing these technologies. Many have been identified. Thermal stressing due to CTE mismatch is a significant problem. They have a methodology to address it, but no path has been identified. Manifolding will also be an important issue.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer commented that progress has been made on the shapes of the coolant path in the ceramic substrate.

Another person indicated that the project is still at a starting stage: the reviewer would like to see early experiments on the approaches proposed. Similarly, one reviewer stated that it is a new project, so they may need more time to show progress. One final reviewer also noted the newness of the project, adding that this is why all the barriers have not yet been addressed. This reviewer added that stress analysis results are not yet available, and alternative designs were alluded to, but not shown.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that the technology should be transferrable to a wide range of inverter/converter technology. Another person commented that the basic concept has high potential to make a significant impact on cooling the power semiconductors. If coolants are compatible with the device materials and costs to manufacture are inline, the likelihood that the technology will move forward is high.

In contrast, one individual stated that it is too early to know the feasibility of the approach, and added that it may face serious technical barriers in implementation of the approach. Another review indicated that, since at this stage it is only a concept and no information was presented with regards to overcoming the very significant technical barriers and cost issues, one would have to say at this time it looks unlikely to make it to market.

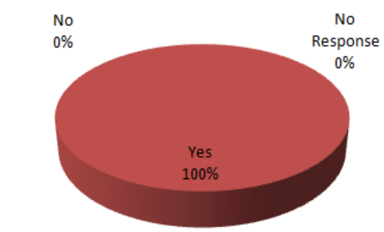
One final reviewer noted that this is a high-risk approach. Industrial adoption will be difficult and manufacturing cost is likely to be greater than estimated.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that the funding level is appropriate, while another commented that resources are consistent with the effort described. One individual stated that, because of the high risk involved and high-payoff nature of this project, more should be spent on the feasibility phase of the project. Another reviewer indicated that funding for this year is sufficient, but future years' funding will be required to advance the technology. Funding should be ongoing into 2009 depending on 2008 results.

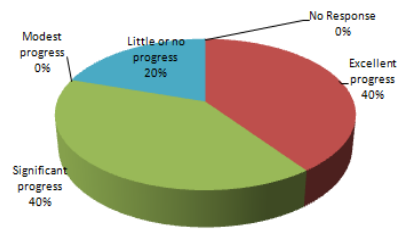
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Direct-Cooled Power Electronics Substrate

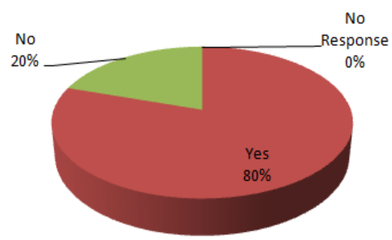
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



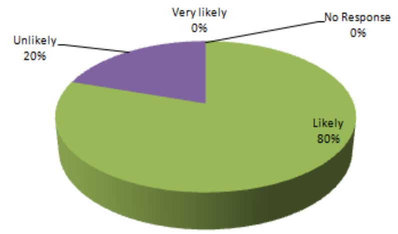
Question 3: Characterize the technical accomplishments and progress toward goals.



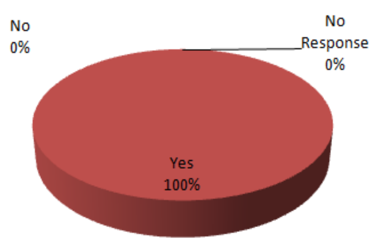
Question 2a: Are the goals of the project technically achievable?



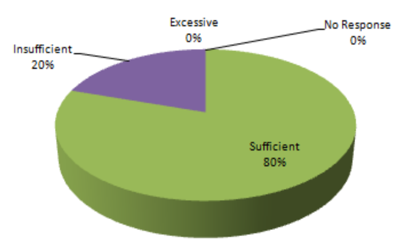
Question 4: How likely is the project team to move technologies into the marketplace?



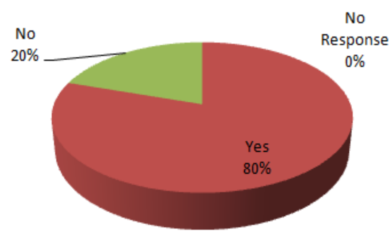
Question 2b: Have the technical barriers been identified and addressed?



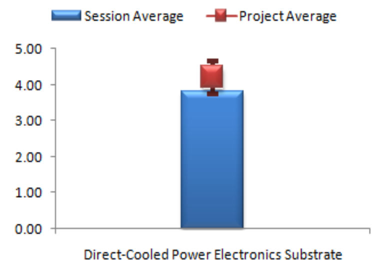
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



High-Temperature Capacitor R&D (Uthamalingam Balachandran, of Argonne National Laboratory and Shawn Dirk, Sandia National Laboratories)

Reviewer Sample Size

This project had a total of 4 reviewers.

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

One reviewer stated that capacitors are the limiting factors for high temperature applications, and are therefore worthwhile to investigate. Another person commented that, at the moment, the capacitor component in the inverter for HEV / EV and FCV vehicles is the weakest link in terms of moving to higher operating temperatures. One reviewer stated that higher temperature and fail-safe capacitors are needed for the power electronics in the HEV. One final commenter wrote that capacitor development can lead to size and weight reductions in one of the largest, heaviest, and least reliable elements of the motor drive: the DC bus capacitor. Smaller, higher power density capacitors with higher performance and reliability will reduce the electronics' weight and improve the ability of these systems to store and process energy, leading to increases in fuel efficiency.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One person commented that the current three-pronged approach provides redundant paths for success and the ability to choose from several successful solutions for the optimum path for future deployment. One reviewer also commented on these different approaches, while a third person stated that these parallel technology approaches should continue.

Another reviewer stated that the group seemed to have selected the right partners to commercialize the technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer stated that certain progress has been made, while another wrote that good progress has been shown on all the different technical approaches. One final reviewer stated that the project has demonstrated good performance and reliability of film-on-foil dielectric capacitors, along with a graceful failure mode. This reviewer adds that TRS has demonstrated a high energy density capacitor made from LCD glass plate, and a polymer film capacitor from Sandia has been demonstrated in lab-scale production with good levels of performance.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer commented that one of the technologies could reach the market, while another response stated that, since higher temperature and high density capacitors are desperately needed, it is highly likely that one of the technologies under development (polymer, glass, etc.) will make it to market. This reviewer adds that the polymer solution seems most likely to succeed.

One other respondent stated that, if successful, it has potential to significantly reduce size, volume, and increase operational temperature of power electronic systems. One final reviewer commented that a U.S. patent has been granted for film-on-foil capacitors. Penn State is collaborating with Corning and Schott Glass to adapt LCD-display manufacturing to capacitors. This reviewer adds that

TRS, Inc., a small business, is committed to the development and marketing of the LCD glass capacitor.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

One reviewer stated that this is making good progress on the current level of resources. Efforts are now focused on prototyping, development/improvement, and marketing activities, and are unlikely to require an increase in resources over the current level. One other response suggested that funding should continue on all three technologies into 2009.

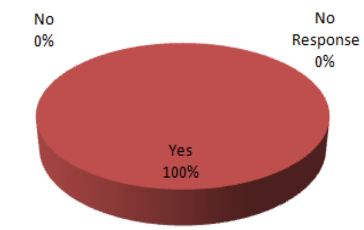
One other person recommended putting more resources into this effort to speed up the development and bring the technology to market sooner.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

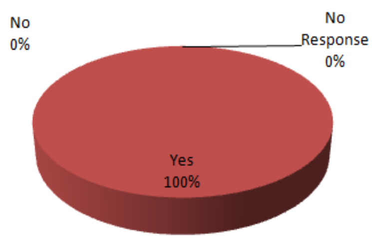
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: High-Temperature Capacitor R&D

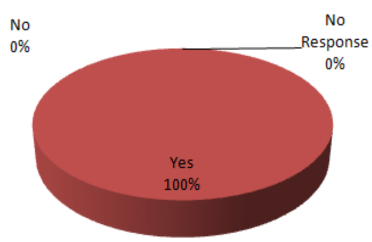
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



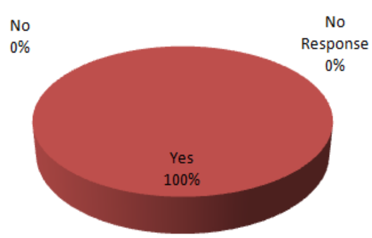
Question 2a: Are the goals of the project technically achievable?



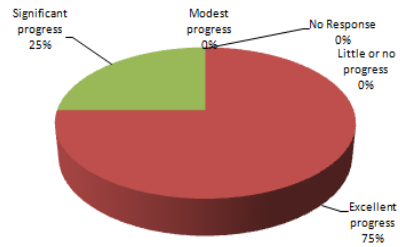
Question 2b: Have the technical barriers been identified and addressed?



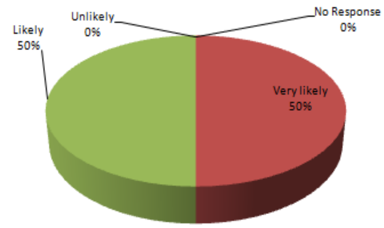
Question 2c: Is the proposed work likely to overcome technical barriers?



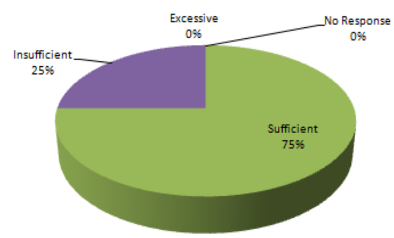
Question 3: Characterize the technical accomplishments and progress toward goals.



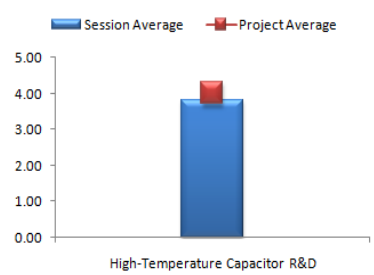
Question 4: How likely is the project team to move technologies into the marketplace?



Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 6: Overall Rating



Integrated Traction Drive System (Greg Smith, of General Motors Corporation)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One person noted that this project is to develop an inverter for the HEV, which would tie directly to the HEV fuel savings. Another reviewer commented that the US is very late in HEV and PHEV development and commercialization, and the hope is that this will add to the efforts of the auto companies. One other reviewer stated that system level integration presents its own set of problems and should be investigated to reduce the cost of the hybrid drive train.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer commented that the barriers were correctly identified, including thermal, switching frequency, cost, capacitor, motor, etc. Another person stated that the concepts for cooling the power electronics and the packaging of the power semiconductors appear likely to be deployed.

One other respondent stated that this is a new project, and thus it is too early to make any significant comments regarding deployment. However, this reviewer noted that GM is large enough to deploy the technology, should it prove to be viable.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first reviewer stated that there were no technical details to help them to come to a meaningful conclusion. Another commented that, since it is too early in the project, no significant progress has been made to overcome the technical barriers. This reviewer added that a good plan was presented to achieve success. One final reviewer noted that this was a new start to the program and that the basic concepts appear likely to work.

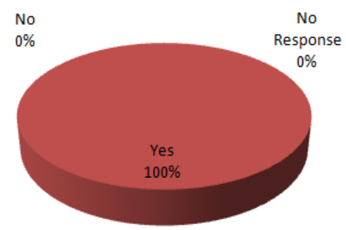
Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that the basic concepts appear likely to work, while another indicated that, if the project meets its goals, then it is highly likely that the technology will make its way to GM vehicles. One reviewer stated that GM is the OEM but they may never make electric powertrain components. This reviewer hopes it will work out well with a supplier.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer stated that they would like to see the funds spread out to a few companies or universities to support more projects, adding that it seems that the grantee is just doing system integration, not developing any of the system components. One other reviewer stated that the project will require addition funding for future years, adding that funding should be ongoing into 2009.

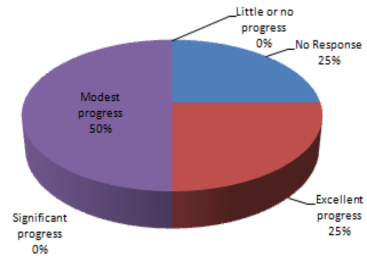
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Integrated Traction Drive System

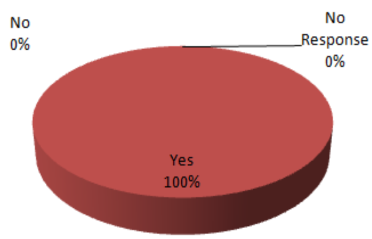
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



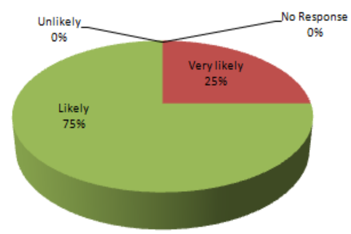
Question 3: Characterize the technical accomplishments and progress toward goals.



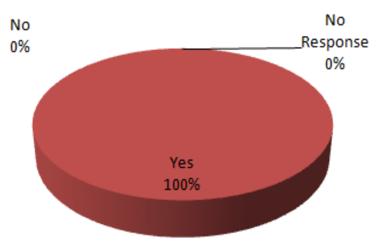
Question 2a: Are the goals of the project technically achievable?



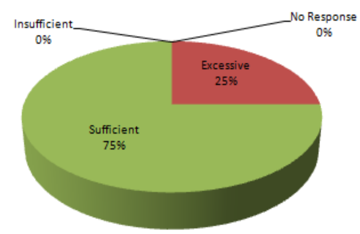
Question 4: How likely is the project team to move technologies into the marketplace?



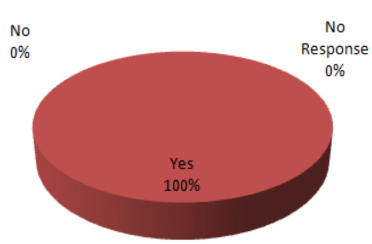
Question 2b: Have the technical barriers been identified and addressed?



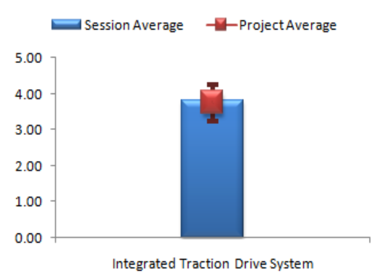
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Scalable, Low-Cost, High-Performance IPM Motor (Lembit Salasoo, of General Electric)

Reviewer Sample Size

This project had a total of 3 reviewers.

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

One reviewer indicated that this is one of the areas that can improve the efficiency of HEV motors. The other respondent stated that, since the electric motor is expected to be the prime mover in all future vehicles, work on new motors is very much justified.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

The first response stated that this is an interesting new motor development. Another stated that the nanostructured material to reduce iron loss is good. This reviewer asked, are there any technical breakthroughs? There is no or little information on the technology for the reviewers to understand.

One reviewer felt that the project is unlikely to achieve 95% efficiency over the entire operating range of the motor.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer noted that it was still an early phase of the project, while another respondent said there were few technical details provided for review, as it started in October 2007.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer stated that GE has the capability to commercialize the results if successful. Another person commented that, if the project can achieve its goals, then the motor technology will certainly make it to the market through GE's consumer division.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

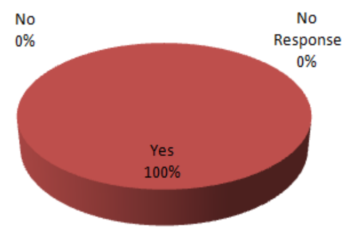
The lone respondent would like to see DOE spread the funds to more projects.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

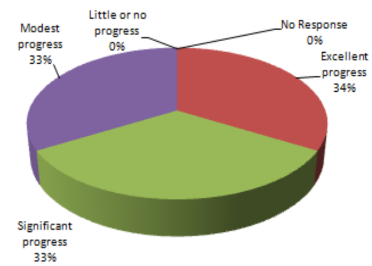
There were no expository comments for this question: refer to the graphic on the next page for this project’s summary score.

Project: Scalable, Low-Cost, High-Performance IPM Motor

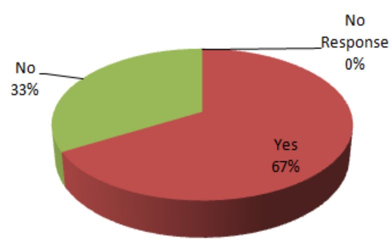
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



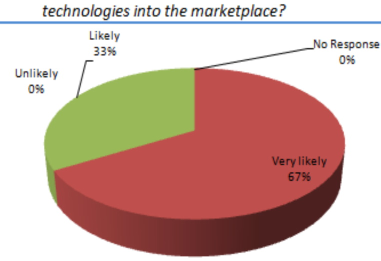
Question 3: Characterize the technical accomplishments and progress toward goals.



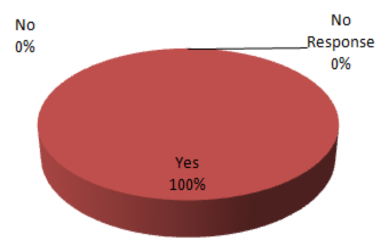
Question 2a: Are the goals of the project technically achievable?



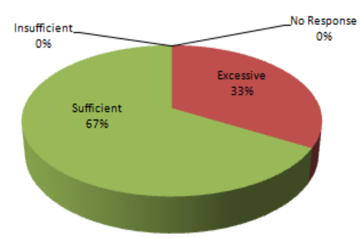
Question 4: How likely is the project team to move technologies into the marketplace?



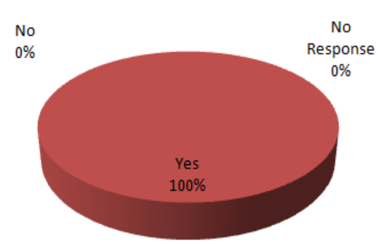
Question 2b: Have the technical barriers been identified and addressed?



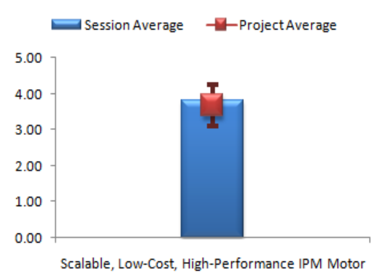
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Soft Switching Inverter for Reducing Switching and Power Losses (Jason Lai, of Virginia Tech)

Reviewer Sample Size

This project had a total of 3 reviewers.

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

One reviewer commented that reduced switching and power losses contribute to improved fuel efficiency in the HEV, while another added that power loss reduction of power devices is of paramount importance to the further efficiency increase of HEV systems. One other reviewer, to contrast, stated that the complexity in design, (likely) lower operational reliability, and packaging complexities of a soft-switching inverter will most likely outweigh any benefits gained from inverter efficiency in a vehicle traction application.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One reviewer indicated that advanced soft-switching is a cost-effective way to permit a single 105°C loop to be used instead of a dual loop without requiring the use of SiC or loss reduction techniques that can result in poorer EMI and drive efficiency. The barriers of needing an ultra-low thermal impedance package, high temperature capacitors, and high temperature circuit components have been identified. Another reviewer commented that the 125°C operating temperature and 98% efficiency target are set for the project. The issues have been identified; for single-loop cooling, component level cost will be a major barrier, including the use of SiC, bulk cap, etc. High temperature operation and system cost are together the major barriers overall. This reviewer is not sure how soft switching is used in fulfill these goals, noting that soft switching is usually implemented in DC-DC converters; using it for an inverter could be cumbersome. One reviewer did not see a clear plan or industry partners to deploy the technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

The first reviewer stated that some progress has been made (papers, patent preparations, etc.), though hardware experiments are not extensive yet. More experiments are needed to show how the actual soft switching can be implemented in motor drive applications at high switching frequencies.

Another person noted this was a new project – just funded and mostly in the planning stage, so there is not currently much in the way of accomplishments. However, the results shown so far were excellent. One other reviewer commented that the presenter did not present any significant new information.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

Responses were mixed in this section. One reviewer commented that there was no reason to believe that it cannot be transitioned to the marketplace. Since it is still early in the program, there is no marketing program at this time. Another person stated that is it possible unless is it infeasible to implement at a reasonable cost.

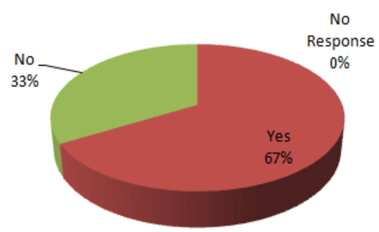
To contrast, one response stated that the concept of soft-switching inverters has been around for a number of years and thoroughly researched. This reviewer thinks that the increased system complexity, cost, and the likely reduction in operational reliability will lead to an unfavorable cost-benefit outcome.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
The lone respondent stated that the project has sufficient funds and human resources.

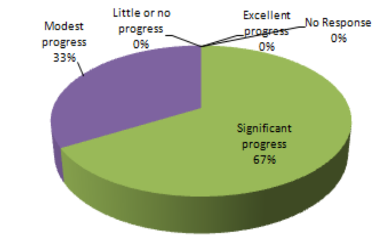
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Soft Switching Inverter for Reducing Switching and Power Losses

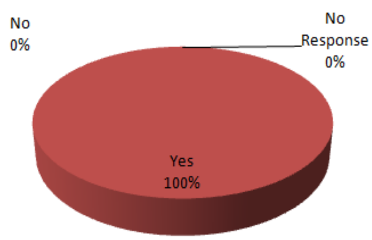
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



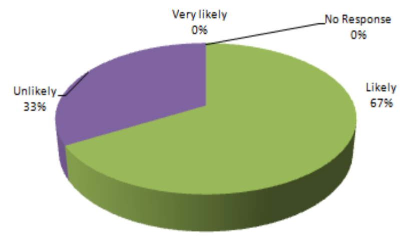
Question 3: Characterize the technical accomplishments and progress toward goals.



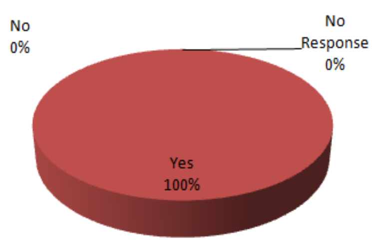
Question 2a: Are the goals of the project technically achievable?



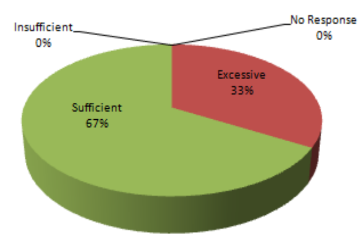
Question 4: How likely is the project team to move technologies into the marketplace?



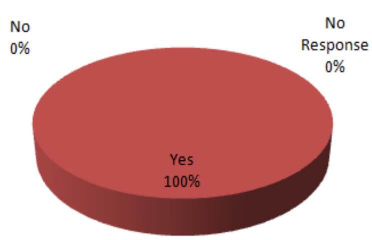
Question 2b: Have the technical barriers been identified and addressed?



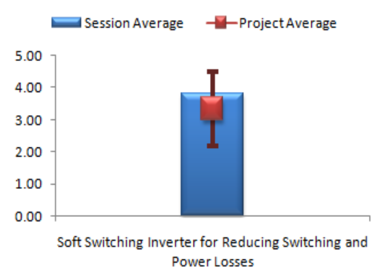
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Technology Benchmarking (Mitch Olszewski, of Oak Ridge National Laboratory)

Reviewer Sample Size
This project had a total of 4 reviewers.

Question 1: Does this activity support the overall DOE objectives of petroleum displacement? Why or why not?
One reviewer stated that this was a great service to the US industry, while another commented that the benchmarking activity is required to keep abreast of technology from other key suppliers of HEV's. To contrast, one other reviewer did not agree that DOE should spend this much effort to investigate the Japanese rivals' technology. They need to work on advancing the technology and commercializing their technology.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.
One reviewer stated that there was a good approach to benchmarking technologies for incorporation into FreedomCAR activities. The other respondent stated that the data generated from the benchmarking is valuable to any player in the automotive industry.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.
The first respondent noted that they were still at the start of the project. One other reviewer was not sure whether there were any technical barriers to overcome, as this is a benchmarking service of products in the market.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.
One reviewer stated that there was a good selection of technologies, while another person commented that benchmarking can guide in the development of improved systems that are already in the market place. Another reviewer indicated that the information gathered from the benchmarking service is readily used by the industry. This reviewer asked whether component-level data was available as well. For example, it would be nice to see what kind of current sensor is used and what the performance is of the sensor, etc.

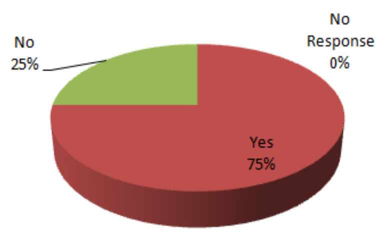
One other person asked how you can commercialize someone else’s technology.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?
One reviewer suggested that they may need additional resources to gather component-level data. Another commented that funding should be ongoing into 2009.

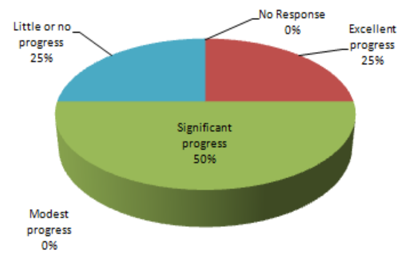
Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.
There were no expository comments for this question: refer to the graphic on the next page for this project’s summary score.

Project: Technology Benchmarking

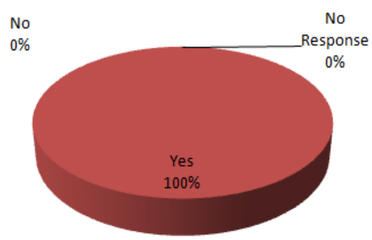
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



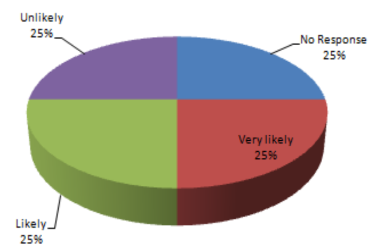
Question 3: Characterize the technical accomplishments and progress toward goals.



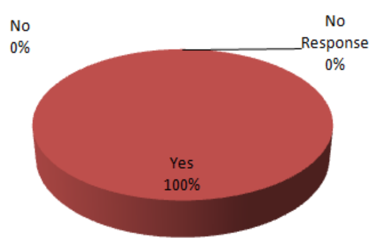
Question 2a: Are the goals of the project technically achievable?



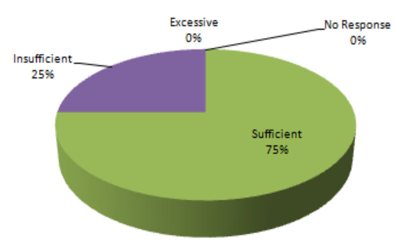
Question 4: How likely is the project team to move technologies into the marketplace?



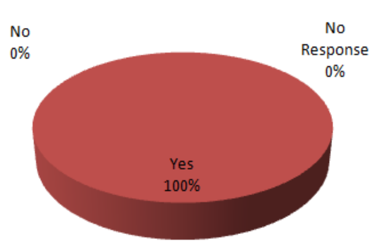
Question 2b: Have the technical barriers been identified and addressed?



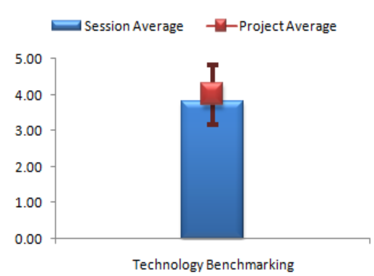
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Uncluttered Rotor PM Machine, Axially Excited Electro-Magnetics Synchronous Rotor Motor, Application of Concentrated Windings to Electric Motors, Amorphous Core Material Evaluation, and Magnetic Material for PM Motors (Laura Marlino, of Oak Ridge National Laboratory and Iver Anderson, of Ames National Laboratory)

Reviewer Sample Size

This project had a total of 3 reviewers.

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

One reviewer stated that advanced motor concepts are important for HEVs and PHEVs, and this project therefore is in line with DOE goals. Another person stated that the uncluttered rotor concept offers increased integration in HEV and PHEV drivetrains and possible cost savings. This is good to have as an alternative to PM material.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

The first response cited the good combination of motor technologies and materials technologies (magnetic permanent motor materials) to enhance performance and reliability. Another reviewer commented that the plan for the uncluttered rotor seems to be to build the prototype and then convince potential users of its benefits. This reviewer thinks it is important to get buy-in from at least one industry partner.

One final respondent notes that some of this concept was originated in 2001. This reviewer would like to see earlier prototypes and demonstrations. It seems that some of the prototyping was slow. Also, they need to work closely with automotive suppliers to investigate the feasibility of their technology.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer noted that it appears there is still no prototype uncluttered rotor unit available for testing. The other respondent would like to see a prototype demonstration earlier than the scheduled 2009. This presentation covers five projects, and some of these are on track while others have just started with little progress.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first response indicated that there was good buy-in from key players in the materials, motors, and user communities.

In contrast, another reviewer stated that, unless demonstrated feasibility and cost benefits are shown by prototype, the uncluttered motor cannot be used in real life. One reviewer added that it is hard to understand the benefits of the uncluttered rotor concept when compared to the simple motor and generator configuration used in most mild-hybrid drivetrains.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

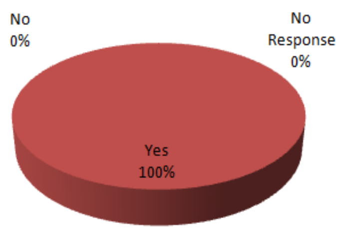
One reviewer stated that the funds are sufficient, while the other respondent recommended allocating more resources to the concentrated windings motor.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

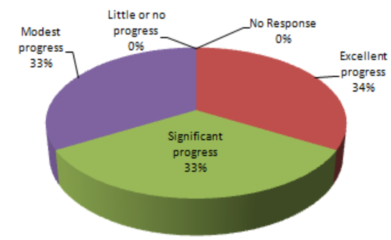
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Uncluttered Rotor PM Machine

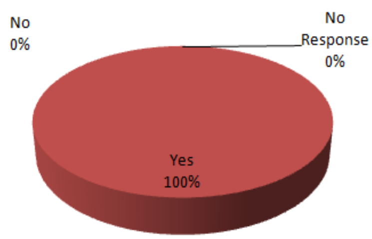
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



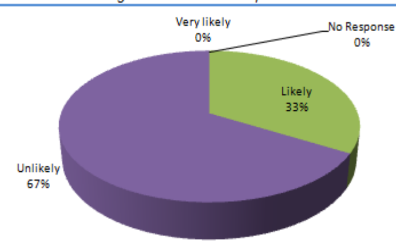
Question 3: Characterize the technical accomplishments and progress toward goals.



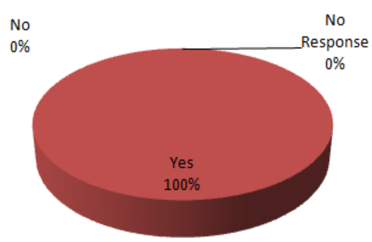
Question 2a: Are the goals of the project technically achievable?



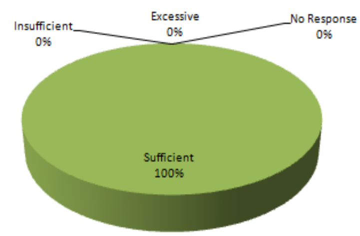
Question 4: How likely is the project team to move technologies into the marketplace?



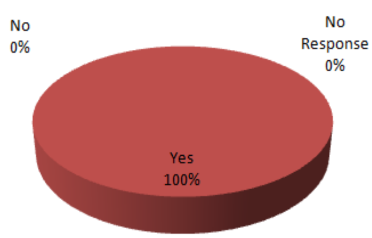
Question 2b: Have the technical barriers been identified and addressed?



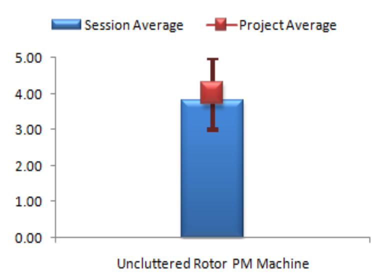
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs (Laura Marlino, of Oak Ridge National Laboratory)

Reviewer Sample Size

This project had a total of 3 reviewers.

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

One reviewer commented that this is excellent and creative work in support of PHEVs, while another commented that PHEV charging technology is behind and therefore DOE needs to look into this area. One other response stated that PHEVs will be available in the market over the next 2-3 years, so this work is significant and should have started earlier.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One reviewer had a number of questions and was not sure about the technology proposed. Why is the motor winding in the loop of the circuit? Is it being used as an inductor? Would the resistance consume power? Would it cause heating problems for the motor? How is the cooling done while the vehicle is parked? The other respondent stated that it was not really clear what the solution was, and this makes it difficult to comment.

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One person stated that there has been some limited progress on the project, while another said that the level of progress achieved was not clear.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

One reviewer commented that, if the stated objectives are met, then this technology should transfer to the market. Another person noted that, without understanding the technology, he or she did not think the proposed approach is legitimate.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

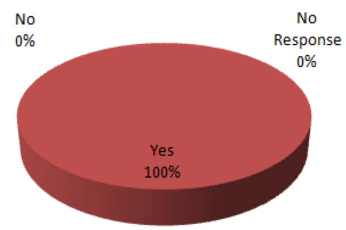
There were no responses to this prompt.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

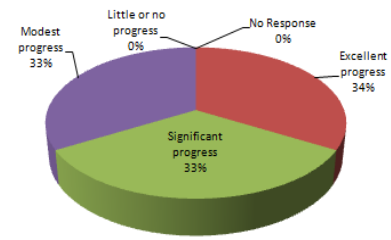
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Utilizing the Traction Drive PE System to Provide Plug-In Capability for HEVs

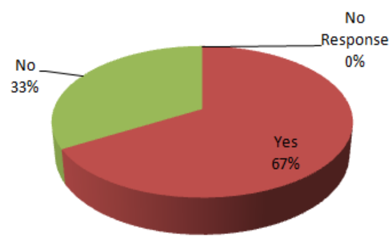
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



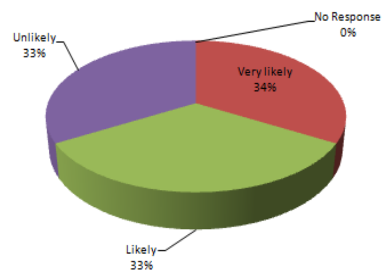
Question 3: Characterize the technical accomplishments and progress toward goals.



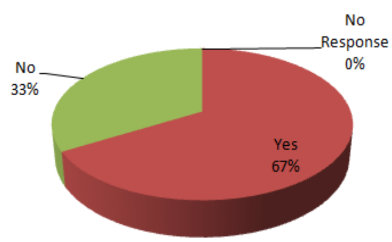
Question 2a: Are the goals of the project technically achievable?



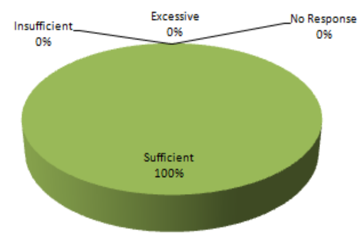
Question 4: How likely is the project team to move technologies into the marketplace?



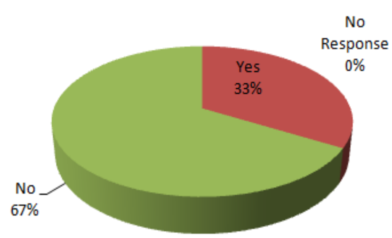
Question 2b: Have the technical barriers been identified and addressed?



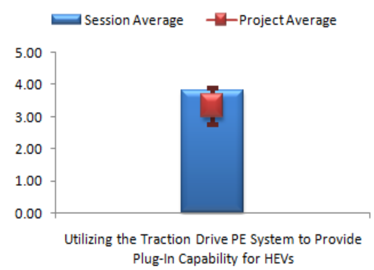
Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating



Wide Bandgap Materials (Burak Ozpineci, of Oak Ridge National Laboratory)

Reviewer Sample Size

This project had a total of 4 reviewers.

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

One reviewer stated that the development of power electronics based on wide bandgap semiconductors is necessary to provide intelligent power management at under-hood temperatures in hybrid electric vehicles. This intelligent power management is necessary both to maximize fuel efficiency and to provide effective control of the hybrid electric propulsion system. Another reviewer stated that tests can be a good source to determine the feasibility of the various WBG devices coming out of the R&D labs.

One other person indicated that SiC has the potential to operate at high temperatures for use in special applications, as well as increasing switching frequency, adding efficiency, and reducing size. Similarly, one individual wrote that the SiC technology has the potential to become the power semiconductor switching technology in the drives if the costs come in line and the devices are readily available.

Question 2: Are the goals of the project technically achievable? Have the technical barriers been identified and addressed? Is the project likely to overcome those technical barriers? Please comment on the project's strategy for deployment of technologies.

One reviewer noted that this project is making the data available to the industry, while another stated that keeping abreast of the technology and evaluating the present states of device technology is needed. One final reviewer commented that the team has developed a hybrid package with heat barriers for Si gate drivers and high temperature SiC modules, and developed a PSAT loss model. The SiC converters are potential candidates for high temperature applications. The reviewer notes that there are many challenges and barriers in apply this technology and a 55kW DC-DC converter is very ambitious, but at a lower power rating it is possible. But the available SiC JFET and MOSFET may not be available for the application. By parallel-connecting the devices to achieve the desired power rating of 55kW, the reviewer indicated that parasitic stray inductance and capacitance will have a big impact on the current and voltage (reverse recovery current, etc.).

Question 3: Characterize your understanding of the technical accomplishments and progress toward DOE goals: please state the reasons for your assessment.

One reviewer felt that the group was making good progress in solving packaging issues when testing high temperature devices, while another stated that the program is keeping abreast of the technology as it develops. To contrast, one person wanted to see more activities regarding system packaging.

Question 4: What is the likelihood that the project team will move the technologies toward or into the marketplace? Please state the reasons for your selection.

The first reviewer indicated that military applications are probably the first ones to emerge in SiC converter/inverters. Another person stated that some of the solutions developed in testing the high temperature devices, like gate drives, can readily transfer to industry. One other reviewer indicated that, with time, it is likely that the technology will be used in the power electronic systems.

Question 5: How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

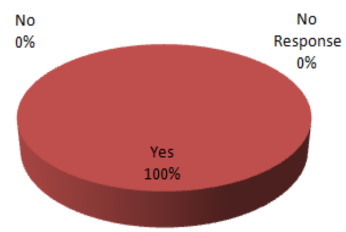
One reviewer stated that the resources are sufficient for the project, while another noted that they are probably sufficient for the moment, due to the relative immaturity of WBG devices available in the market today. One other reviewer commented that funding should be ongoing into 2009.

Question 6: Summary rating: when scoring this project, consider the relevance of the work to DOE's objectives, potential impacts on DOE/VT goals, project accomplishments, likelihood of technology transfer, and sufficiency of project resources.

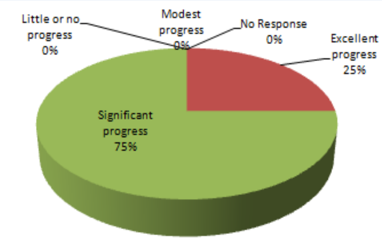
There were no expository comments for this question: refer to the graphic on the next page for this project's summary score.

Project: Wide Bandgap Materials

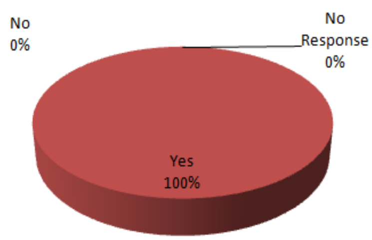
Question 1: Does this project support the overall DOE objectives of petroleum displacement?



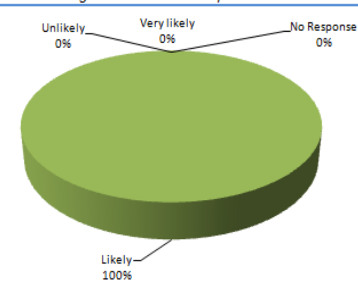
Question 3: Characterize the technical accomplishments and progress toward goals.



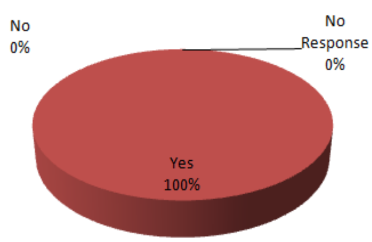
Question 2a: Are the goals of the project technically achievable?



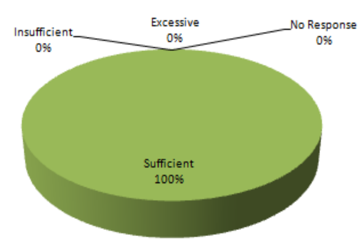
Question 4: How likely is the project team to move technologies into the marketplace?



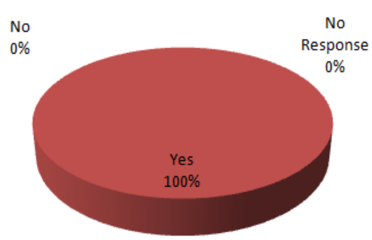
Question 2b: Have the technical barriers been identified and addressed?



Question 5: Characterize the resources available for this project to achieve the stated milestones in a timely fashion.



Question 2c: Is the proposed work likely to overcome technical barriers?



Question 6: Overall Rating