Prologue

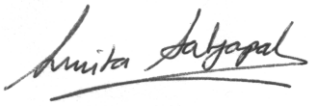
Dear Colleague:

This document summarizes the comments provided by peer reviewers on hydrogen and fuel cell projects presented at the fiscal year (FY) 2012 U.S. Department of Energy (DOE) Hydrogen and Fuel Cells Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting (AMR), held May 14–18, 2012, in Arlington, Virginia. In response to direction from various stakeholders, including the National Academies, this review process provides evaluations of the Hydrogen and Fuel Cells Program's projects in applied research, development, demonstration, and analysis of hydrogen, fuel cells, and infrastructure technologies. A joint plenary session opened the meeting with a presentation on "Transforming Transportation Toward a Very Efficient, Low-Carbon Energy Future," followed by overview presentations from the DOE Office of Basic Energy Sciences, Hydrogen and Fuel Cells Program, and Vehicle Technologies Program. A plenary for Hydrogen and Fuel Cells Program participants included overviews on each of nine sub-programs: Hydrogen Production and Delivery; Hydrogen Storage; Fuel Cells; Manufacturing R&D; Market Transformation; Technology Validation; Safety, Codes and Standards; Education; and Systems Analysis. An overview of American Recovery and Reinvestment Act (Recovery Act) activities was also presented.

DOE values the transparent, public process of soliciting technical input on projects from relevant experts. The recommendations of the reviewers are taken into consideration by DOE technology development managers in generating future work plans. The table that follows lists the projects presented at the review, evaluation scores, and the major actions to be taken during the upcoming fiscal year (October 1, 2012–September 30, 2013). The projects have been grouped according to sub-program and reviewed according to appropriate evaluation criteria. This year's AMR featured the third annual review of hydrogen and fuel cell projects funded under the Recovery Act. The weighted scores for all of the projects are based on a four-point scale. To furnish principal investigators (PIs) with direct feedback, all of the evaluations and comments are provided to each presenter; however, the authors of the individual comments remain anonymous. The PIs are instructed by DOE to fully consider these summary evaluation comments, along with any other comments by DOE managers, in their FY 2013 plans.

In addition to thanking all participants of the AMR, I would like to express my sincere appreciation to the reviewers. You make this report possible, and we rely on your comments, along with other management processes, to help make project decisions for the new fiscal year. We look forward to your participation in the FY 2013 AMR, which is presently scheduled for May 13–17, 2013, in Arlington, Virginia. Thank you for participating in the FY 2012 AMR.

Sincerely,



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Hydrogen Production and Delivery

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
PD-002	Biomass-Derived Liquids Distributed (Aqueous Phase) Reforming *David King; Pacific Northwest National Laboratory*	2.4		X		According to reviewers, this project is technically sound and effectively identified optimal catalysts for use in reforming the aqueous phase of biomass- derived liquids. However, they expressed concern over the high cost of feedstock for hydrogen production and lack of a clear pathway to meeting U.S. Department of Energy (DOE) cost targets. Recommendations were made to complete the project and document results, and to consider economically feasible niche applications for this method of hydrogen production.
PD-004	Distributed Bio-Oil Reforming *Stefan Czernik; National Renewable Energy Laboratory*	3.1		X		Reviewers noted the progress of the project and commended the team's focus on feedstock preparation and reformation. Reviewers noted the lack of a clear path forward to meet cost targets based on feedstock cost and catalyst cost and durability. It was recommended that future work focus on specific methods to improve hydrogen yield, understanding differences in bio-oil composition and its effect on hydrogen production, and completing a lifecycle analysis for catalyst choices.
PD-013	Electrolyzer Development for the Cu-Cl Thermochemical Cycle *Michele Lewis; Argonne National Laboratory*	2.6		X		Reviewers praised the project for its relatively simple three-step thermochemical process at a low temperature of 550°C and compelling concept which could produce hydrogen from waste heat without concurrent greenhouse gas emissions. Reviewers noted that while progress was made on the key issue of copper crossover, there was a lack of focus on the mechanisms of degradation. It was recommended that the project address degradation and barriers to implementation of the full cycle, while putting less focus on scaling up.

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PD-014	Hydrogen Delivery Infrastructure Analysis *Marianne Mintz; Argonne National Laboratory*	3.6	X			According to the reviewers, this project is extremely important to the identification of potential cost reductions in the delivery pathways. Reviewers felt that this is a strong project which has effectively identified current technological challenges and ways to resolve them. Reviewers recommended that prioritization of analysis topics, industry input and vetting of data, and validation of predicted costs be addressed in future.
PD-016	Oil-Free Centrifugal Hydrogen Compression Technology Demonstration *Hooshang Heshmat; Mohawk Innovative Technology, Inc.*	3.4	X			Reviewers commented that this project has made good progress toward an essential facet of hydrogen delivery through thoughtful design and good collaborations with outside organizations. It was recommended that a test with hydrogen be performed and capital cost estimates be refined prior to scaling up unit production.
PD-017	Development of a Centrifugal Hydrogen Pipeline Gas Compressor *Frank Di Bella; Concepts NREC*	3.2	X			Reviewers felt this project has made adequate progress and addresses a critical component for safe and cost effective hydrogen delivery. Reviewers suggested development of a one-stage prototype rather than a two-stage prototype to reduce cost and expansion of industry collaborations to ensure market relevance.
PD-021	Development of High Pressure Hydrogen Storage Tank for Storage and Gaseous Truck Delivery *Don Baldwin; Lincoln Composites*	3.4	X			According to reviewers, this project shows significant progress towards lowering the cost of hydrogen delivery. The reviewers appreciated the identification of the commercial barriers and the planning and execution of adjustments to address issues encountered. Reviewers encouraged continued development of this technology to the 350 bar level.

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PD-022	Fiber Reinforced Composite Pipelines *Thad Adams; Savannah River National Laboratory*	3.4	X			Reviewers praised the progress made in conducting tests and working in conjunction with partners such as ASME. Reviewers specifically cited identification of potential failure modes and materials. According to reviewers, further work is needed to clearly define, via a cost-benefit analysis, what can be learned from a large-scale pipeline demonstration and to characterize fiber-reinforced polymer (FRP) composite pipeline performance with test data.
PD-024	Composite Pipeline Technology for Hydrogen Delivery *Barton Smith; Oak Ridge National Laboratory*	3.2			X	According to reviewers, this project team has well defined barriers and technical targets for the qualification of FRP pipelines, which is critical to the long-term goal of reducing hydrogen delivery costs. Reviewers cited good progress in crack resistance and permeability. It was suggested that future work focus on data needed to qualify composite pipeline for hydrogen service.
PD-025	Hydrogen Embrittlement of Structural Steels *Brian Somerday; Sandia National Laboratories*	3.4	X			Reviewers noted that this project has a sound combination of experimental and modeling work. Reviewers encouraged review of the results by organizations that operate high pressure hydrogen pipelines to help validate the findings. Reviewers suggested performing temperature, pressure, and frequency cycles simultaneously.
PD-027	Solar High-Temperature Water Splitting Cycle with Quantum Boost *Robin Taylor; Science Applications International Corporation*	2.6		X		Reviewers commended the progress on improved voltage and the use of modeling to understand efficiency of the thermochemical cycle, particularly in the electrolysis step. However, they expressed concerns regarding the complexity of this cycle and indicated that more attention should be given to defining targets for cell voltage and current densitites, assessing balance of plant costs, and analyzing the economics to define the overall value proposition of this cycle.

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PD-028	Solar-Thermal ALD Ferrite-Based Water Splitting Cycles *Al Weimer; University of Colorado*	3.0	X			Reviewers favorably cited the team's use of advanced fabrication and characterization methods for the reactant materials and their initial investigation of isothermal operation. Reviewers felt that the reactor design and potential for 24/7 operation should receive more attention. It was recommended that the team address issues of reactor mechanical strength and its relation to lifecycle and cycle time, pressure and temperature ranges to reduce process cost, and hercynite/alumina composition effects on redox performance and particle robustness.
PD-029	High-Capacity, High Pressure Electrolysis System with Renewable Power Sources *Paul Dunn; Avalence LLC*	2.6			X	Reviewers appreciated the progress made despite the difficulties that were present. Reviewers noted that the work could benefit from further collaboration with an academic team. They expressed concern due to the lack of cost analysis. Reviewers also felt that investigators insufficiently addressed safety concerns with regards to the new multiple tube approach.
PD-030	PEM Electrolyzer Incorporating an Advanced Low Cost Membrane *Monjid Hamdan; Giner Electrochemical Systems, LLC*	3.7			X	According to reviewers, investigators made excellent progress with a good blend of analysis, design, and experimentation. Reviewers highlighted the significant reductions in material and manufacturing costs as well as the team's work with industry partners. Reviewers recognized that electrolysis systems are limited by the cost of electricity.
PD-031	Renewable Electrolysis Integrated System Development and Testing *Kevin Harrison; National Renewable Energy Laboratory*	2.7	X			Reviewers appreciated the importance of the team's test facility as an independent third party test site to validate technical and economic claims. They however expressed uncertainty about the project's impact on the stated barriers of cost and system efficiency. They also recommended a greater emphasis on integrated renewable electrolysis systems.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
PD-033	Directed Nano-scale and Macro-scale Architectures for Semiconductor Absorbers and Transparent Conducting Substrates for Photoelectrochemical Water Splitting *Thomas Jaramillo; Stanford University/National Renewable Energy Laboratory*	3.3	X			Reviewers commended this project for its well-defined scope and novel approach to addressing key photoelectrochemical (PEC) issues. They highlighted that the high quality of the work and strong collaborations with the PEC working group have led to important progress in developing bandgap-tunable photocatalysts and stable support structures. Reviewers did recognize that this project is still at an early stage, noting that the PEC efficiency at present is too low to meet nearer term goals for efficiency, durability, and cost. They recommended more emphasis be placed on identifying specific losses mechanisms and limitations.
PD-035	Semiconductor Materials for Photoelectrolysis *John Turner; National Renewable Energy Laboratory*	3.3	X			Reviewers noted that good progress was made in demonstrating high efficiency with improved durability in III-V PEC semiconductors. Specific project strengths cited included the demonstration of extended durability (>100 hours) of the PEC interface, standardization of testing and reporting protocols, and efficiency bookmarking under actual sunlight to validate laboratory results. Reviewers recommended continued efficiency and durability studies of the PEC interface under full-spectrum conditions, including atomic-level modeling. They also recommend that the cost effectiveness of nitride-treated III-V PEC cells be evaluated further.
PD-036	Maximizing Light Utilization Efficiency and Hydrogen Production in Microalgal Cultures *Tasios Melis; University of California, Berkeley*	3.6	X			Reviewers praised the progress in identifying genes and proteins that determine algal chlorophyll antenna size to improve light collection efficiency, as well as the focus on potential application of the findings. Reviewers noted that the lack of details on future tasks prevents evaluation of likely progress and suggested the development of collaborations with experts for planned cyanobacteria experiments, to explicitly link the project to hydrogen production to quantify how changes to photosynthetic structure affects hydrogen yields.

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PD-037	Biological Systems for Hydrogen Photoproduction *Maria Ghirardi; National Renewable Energy Laboratory*	3.4	X			Reviewers approved of the decision to halt the targeted random mutagenesis work and commended the accomplishments of demonstrating light-dependent hydrogen production in an algal hydrogenase knockout mutant with an oxygen-tolerant hydrogenase (Ca1) gene insertion. Reviewers requested more information about future steps and interim goals so that progress could be better understood and evaluated.
PD-038	Fermentation and Electrohydrogenic Approaches to Hydrogen Production *Pin-Ching Maness; National Renewable Energy Laboratory*	3.3	X			Reviewers commended significant steps towards scaling up by demonstrating that immobilization of microbes on the substrate allows easy separation of the growth medium from the acclimated culture. They also praised the progress in the compositional analysis for the microbial electrolysis cell project. Reviewers questioned some of the steps taken, such as making a *dcm*- strain when there are commercially available strains. Reviewers recommended the team establish more specific performance targets, provide more details on how the work will be accomplished, and focus on executing the counter screen for *pyrF* knockout.
PD-039	Hydrogen from Water in a Novel Recombinant Oxygen-Tolerant Cyanobacterial System *Phil Weyman; J. Craig Venter Institute*	3.2	X			According to reviewers, the well-designed approach of this project has allowed for commendable accomplishments. Furthermore, the principal investigator's decision to establish a go/no-go decision based on a definitive hydrogenase activity goal was praised. Reviewers raised concerns that the planned focus on increasing expression might overlook the effect of different ratios of the proteins. It was recommended that alternative approaches be addressed, and that work on engineering the cyanobacteria to increase the hydrogen production to viable levels be continued.

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PD-048	Electrochemical Hydrogen Compressor *Ludwig Lipp; FuelCell Energy, Inc.*	3.1	X			Reviewers commented that this project is focused on the right issues and has made good progress with 12,000 pounds per square inch (psi) cells. Reviewers pointed out the lack of a clear path to achieving DOE cost targets. According to reviewers, future work should include collaboration with parties who can help develop and provide commercial awareness of the technology as well as perform life cycle cost analyses.
PD-053	Photoelectrochemical Hydrogen Production *Arun Madan; MVSystems/Hawaii Natural Energy Institute*	3.2	X			According to reviewers, this project exhibited logical organization and pursuit of the three PEC material classes under investigation. Reviewers specifically cited progress made in improving the a-Si system using surface treatments and in meeting milestones in durability tests for all three material systems. They emphasized the need for continued extended durability tests and for more extensive quantum efficiency measurements to gain a better understanding of material performance and limitations.
PD-065	Unitized Design for Home Refueling Appliance for Hydrogen Generation to 5,000 psi *Timothy Norman; Giner Electrochemical Systems, LLC*	3.3			X	Reviewers commented that this project has made technical breakthroughs that contribute to significant progress toward accomplishing goals. Strenghs identified by reviewers included the emphasis on meeting codes and standards and the completion of a preliminary economic analysis of a commercial home refueling appliance system that falls within DOE targets.
PD-067	Hydrogen by Wire – Home Fueling System *Luke Dalton; Proton OnSite*	2.7			X	Reviewers commented that this project is making good progress towards achieving its objectives. Reviewers noticed a lack of focus on meeting cost objectives and lack of technical detail released on component research and performance. Additionally, reviewers suggested a greater focus on safety.

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PD-070	One Step Biomass Gas Reforming-Shift Separation Membrane Reactor *Mike Roberts; Gas Technology Institute*	2.3		X		According to reviewers, the project's concept of a gasifier membrane to produce hydrogen is novel and particularly interesting. Reviewers noted that most of the progress has been concentrated on modeling and suggested that experimentation should be given more emphasis. Reviewers identified the need to characterize the status of hydrogen purity, selectivity, and membrane durability. Reviewers recommended that integrated gasifier tests be started to validate performance and cost estimates.
PD-071	High Performance, Low Cost Hydrogen Generation from Renewable Energy *Katherine Ayers; Proton OnSite*	3.1	X			Reviewers praised the effective execution and use of collaborations with capable partners. Reviewers gave positive feedback on the team's stack cost reduction, prototype testing, and planned path for continued progress. It was recommended that the team emphasize meeting future cost and efficiency challenges and focus on scale up as well as manufacturing and test qualification.
PD-072	Development of Hydrogen Selective Membranes/Modules as Reactors/Separators for Distributed Hydrogen Production *Paul Liu; Media and Process Technology Inc.*	3.1	X			Reviewers commended the progress made to date, but expressed concern regarding membrane durability during cooling cycles and did not see a clear path toward solving this issue. Reviewers also stressed the importance of validating lab results with a field test. It was further recommended that the team test the water-gas-shift reactor with cycling and that the team work with Ballard to understand how their system will operate during periods of stand-down.

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PD-079	Novel Photocatalytic Metal Oxides *Robert Smith;* *University of Nebraska at Omaha*	2.7			X	Reviewers commended the project for its innovative approach to PEC hydrogen production, including both computational and experimental components. They did express concern that the DFT-DOS calculations were unlikely to prove helpful in identifying new photoactive materials with improved PEC performance. Specific recommendations included expanded collaboration for assistance in characterizing photovoltaic/photoelectrochemical materials and better definition of the scientific and cost barriers to the technology.
PD-081	Solar Hydrogen Production with a Metal Oxide Based Thermochemical Cycle *Ivan Ermanoski;* *Sandia National Laboratories*	2.7	X			Reviewers cited the project's well-balanced approach towards addressing difficult materials challenges and the progress in building the reactor, testing under ambient conditions, and successfully conveying powder particles. Reviewers suggested the project focus on developing the reactant materials prior to planning the scale-up process, state and test material life cycles, complete H2A cost analysis, and develop protocols for material characterization that includes clear metrics for success.
PD-088	Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage *Wei Zhang;* *Oak Ridge National Laboratory*	3.2	X			Reviewers noted the project's potential to reduce the cost of hydrogen bulk storage and the progress made in designing vessels to meet pressure codes while detailing the manufacturing process and cost estimates. Reviewers recommended that design decisions be revisited when appropriate and that on-site fabrication be considered to avoid shipping challenges.

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PD-091	Bio-Fueled Solid Oxide Fuel Cells *Gokhan Alptekin; TDA Research*	3.3	X			Reviewers cited specific strengths of the project including the development of a high-capacity sorbent for sulfur removal, field testing of the skid, and the start of the contracting process with fuel cell manufacturers. Reviewers commented that details on the test results of complex sulfides were not provided nor was a work plan to gauge progress and future work. Reviewers suggested that the team explore the applicability to other technologies for hydrogen generation.

*Permanent consecutive project numbers were assigned for the 2010 AMR to make administration of the AMR more efficient. As projects are discontinued, the corresponding project number is retired. As new projects are added, new consecutive numbers are added. As a result, there are gaps in the consecutive project numbers. In addition, some projects were not selected for review at the 2012 AMR and are not shown in the Prologue Table (see Appendix D for the full list of projects not reviewed).

Hydrogen Storage

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-001	System Level Analysis of Hydrogen Storage Options *Rajesh Ahluwalia; Argonne National Laboratory*	3.2	X			The reviewers commented that the project has provided useful quantitative storage system performance estimates and important insights into the systems analyzed. The reviewers recommended calibration of the compressed tank model and validation of carbon fiber/composite properties to known tank systems, and that the project identify risk mitigation strategies and potential showstoppers for systems analyzed. Continued collaboration with the Hydrogen Storage Engineering Center of Excellence (HSECoE) was encouraged.
ST-004	Hydrogen Storage Engineering Center of Excellence *Don Anton; Savannah River National Laboratory*	3.3	X			This project is for the management of the HSECoE. The reviewers found the HSECoE to be well managed, with good collaboration and communication between partners and satisfactory progress to date. The HSECoE was praised for down-selects of concepts and approaches projected to not be able to meet DOE targets, such as discontinuing work on reversible metal hydrides. Reviewers expressed concern about the current lack of a material with the properties required for a complete system to meet all of the DOE on-board storage targets and the lack of efforts to improve regeneration processes for chemical hydrogen storage materials, although these were recognized to be out of scope for the HSECoE.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-005	Systems Engineering of Chemical Hydride, Pressure Vessel, and Balance of Plant for On-Board Hydrogen Storage *Jamie Holladay; Pacific Northwest National Laboratory*	3.5	X			This project is part of the HSECoE. The reviewers found the project to be highly relevant and the Pacific Northwest National Laboratory team to be very capable with appropriate areas of expertise. They commented favorably on the work performed in the prior year, especially the tank modeling and ammonia borane slurry work. However, several reviewers felt that the ammonia borane slurry work should be carried out in more depth, especially through investigations of micro-scale properties and detailed comparison of slurries with ammonia borane-ionic liquids developed by Los Alamos National Laboratory (LANL).
ST-006	Advancement of Systems Designs and Key Engineering Technologies for Materials Based Hydrogen Storage *Bart van Hassel; United Technologies Research Center*	3.1	X			This project is part of the HSECoE. The reviewers praised United Technologies Research Center's (UTRC's) role in the analyses of reversible metal hydrides systems that contributed to the down-select of metal hydride systems. The reviewers were satisfied with progress on the gas liquid separator, ammonia removal, and UTRC's role leading the integrated modeling framework. It was recommended that UTRC better describe their collaborations with HSECoE partners and how duplication of efforts between partners is avoided.
ST-007	Chemical Hydride Rate Modeling, Validation, and System Demonstration *Troy Semelsberger; Los Alamos National Laboratory*	3.1	X			This project is part of the HSECoE. The reviewers found the LANL project to be highly relevant to the U.S. Department of Energy (DOE) Hydrogen and Fuel Cells Program (the Program). While they found the work and progress to be satisfactory, they commented that they would prefer to be presented with more details on the work to support the claims and more comparisons between fluids containing ammonia borane and other potential exothermic and endothermic release hydrogen carriers to justify the narrow focus on ammonia borane.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-008	System Design, Analysis, Modeling, and Media Engineering Properties for Hydrogen Energy Storage *Matthew Thornton; National Renewable Energy Laboratory*	3.4	X			This project is part of the HSECoE. The National Renewable Energy Laboratory's (NREL's) modeling and simulation activities were thought by the reviewers to be valuable to the HSECoE and very well done. While the collaborations between NREL and the other HSECoE partners were found to be excellent, comments were made that efforts need to be carried out to avoid duplication between partners. The reviewers found that NREL's materials evaluation activities appeared disconnected from their modeling and simulation activities and recommended a review and re-evaluation of the materials efforts.
ST-009	Thermal Management of On-Board Cryogenic Hydrogen Storage Systems *Darsh Kumar; General Motors*	3.1	X			This project is part of the HSECoE. Reviewers observed General Motors (GM) is doing a good job using models and material properties to evaluate heat and mass transfer in order to help determine the optimal adsorption based storage system design. Overall, the reviewers were happy with the progress on the models for both the heating coil and the pelletized storage material, but also recommended validatation of the models with experimental results as a near-term priority. Concern was raised that the models will not be able to accurately predict the thermal behavior of the system given the variability in gas flow patterns in a packed bed system.
ST-010	Ford/BASF-SE/UM Activities in Support of the Hydrogen Storage Engineering Center of Excellence *Mike Veenstra; Ford Motor Company*	3.4	X			This project is part of the HSECoE. Reviewers commented that Ford has made good progress on their activities related to vehicle parameter modeling, absorbent characterization, and as absorbent system lead. The reviewers also commented favorably on the addition of the Failure Mode and Effects Analysis and believe this work should help guide the HSECoE by determining key issues still to be addressed. It was recommended that Ford clearly delineate their characterization work on MOF-5 from that of other partners in the HSECoE to avoid overlap.

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ST-014	Hydrogen Sorbent Measurement Qualification and Characterization *Phil Parilla; National Renewable Energy Laboratory*	3.4	X			The reviewers recognized NREL as one of the few laboratories that can produce credible isotherms for hydrogen sorption materials over a wide range of pressure and temperature conditions of interest. Reviewers also praised the project for providing a robust validation mechanism and for working with other researchers to identify potential sources of error in their measurements. It was recommended that these results be published and this work be the basis used to validate compacted cryo-absorbent media from the HSECoE.
ST-019	Multiply Surface-Functionalized Nanoporous Carbon for Vehicular Hydrogen Storage *Peter Pfeifer; University of Missouri*	2.5		X		The reviewers were encouraged by Missouri's ability to increase the binding energy by methodically doping the carbon-based materials with boron without significantly reducing the surface area. The reviewers also noted Missouri's characterization work and the importance of their approach to develop materials from low-cost raw materials. However, the reviewers commented that the developed materials are still well below the DOE volumetric and gravimetric capacity targets. Independent validation of the sample results was recommended. This project will undergo a phase I/II go/no-go decision at the end of fiscal year (FY) 2012.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-021	Weak Chemisorption Validation *Thomas Gennett; National Renewable Energy Laboratory*	3.0			X	In this effort to determine the viability of hydrogen capacity enhancement through spillover, the reviewers commented that the inclusion of both spillover "supporters" and "doubters" to the team, given the broad disagreement in the scientific community, was very appropriate and critical. It was considered a major accomplishment that the consensus opinion of the team is that the data supports the spillover phenomenon as real, even though the enhancement was small for the particular samples investigated. Additionally the reviewers commented favorably on the breadth of spectroscopic techniques used to investigate the phenomenon. However, the reviewers would have preferred investigation of the enhancement on materials with higher overall hydrogen uptake to avoid reliance on correlation of such small spectra peaks to spillover. The ultimate capacity for spillover materials needs to be established to determine if spillover offers a viable pathway to meet DOE goals.
ST-022	A Joint Theory and Experimental Project in the Synthesis and Testing of Porous COFs for On-Board Vehicular Hydrogen Storage *Omar Yaghi; University of California, Los Angeles*	2.0		X		The reviewers commented favorably on the concept of utilizing both experimental and computational efforts to screen, synthesize, and optimize new sorbent materials with potential to meet the DOE targets. However, the reviewers are highly concerned that the empirical and computational approaches in this project are not well focused or complementary to one another. The reviewers felt there is a lack of collaboration/engagement between the theoreticians and experimentalists and that there was no clear methodology linking the two efforts. The empirical effort appeared focused on quantity of structures and linkers produced rather than material optimization to reach DOE hydrogen storage targets. The reviewers were not satisfied with the progress made this year, with most of the accomplishments presented being from previous years, and with nomaterials developed thus far with potential to meet DOE goals. This project will undergo a phase I/II go/no-go decision at the end of FY 2012.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-023	New Carbon-Based Porous Materials with Increased Heats of Adsorption for Hydrogen Storage *Randy Snurr; Northwestern University*	3.3			X	The reviewers recognized the high relevance of this project which utilizes a combined experimental and computational screening approach, addressing both gravimetric and volumetric targets, to help in the discovery of higher capacity materials. The reviewers noted the project was well focused and excellent progress has been made on the theoretical initiative. The project was also commended for collaboration between researchers as well as with NREL for independent validation of H_2 measurement. However, the reviewers questioned the validity of applying a normalization factor to the NREL data. This project will be completed at the end of FY 2012.
ST-024	Hydrogen Trapping through Designer Hydrogen Spillover Molecules with Reversible Temperature and Pressure-Induced Switching *Angela Lueking; Pennsylvania State University*	2.5		X		The reviewers commended Penn State for modifying its original approach to address reproducibility issues with spillover and for the collaborations with DOE's Basic Energy Sciences program and the coordinated effort with the NREL-led spillover task group. The reviewers were unclear as to how this project would generate new materials capable of meeting DOE targets and had questions on the focus of the project going forward. This project will undergo a phase I/II go/no-go decision in FY 2012.
ST-028	Design of Novel Multi-Component Metal Hydride-Based Mixtures for Hydrogen Storage *Christopher Wolverton; Northwestern University*	2.5		X		The reviewers noted that, in general, the project objectives comply with the DOE targets and goals and that the computational effort has predicted some promising multi-component hydrides. However, the reviewers expressed concern about the lack of focus in meeting DOE targets and an apparent disconnect between the theoretical and experimental components of the project. Furthermore, there appears to have been an unnecessary duplication of previously published work. The reviewers commented that the employed characterization methods are not satisfactory and are insufficient and that nuclear magnetic resonance spectroscopy should be included. Development of a detailed and focused plan forward was recommended.

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ST-040	Liquid Hydrogen Storage Materials *Benjamin Davis; Los Alamos National Laboratory*	3.3	X			The reviewers commended the project for close collaboration and coordination with the HSECoE and directly addressing the HSECoE's needs with respect to liquid phase ammonia borane. It was recommended that the project develop an approach that can narrow the search for an additive that enables a fluid phase spent fuel while maintaining the required storage capacity and meeting the hydrogen purity requirements.
ST-044	SRNL Technical Work Scope for the Hydrogen Storage Engineering Center of Excellence: Design and Testing of Metal Hydride and Adsorbent Systems *Ted Motyka; Savannah River National Laboratory*	3.4	X			This project is part of the HSECoE. Savannah River National Laboratory's (SRNL's) technical work in support of the HSECoE was found to be highly relevant. The validation of the HSECoE models is critical and the data generated on adsorbent systems through SRNL and their collaborators were considered vital in this effort. Comments were made to ensure that the models and system concepts can accommodate incorporation of improved materials as they are developed. Also, system cost projections need to be made.
ST-045	Key Technologies, Thermal Management, and Prototype Testing for Advanced Solid-State Hydrogen Storage Systems *Joseph Reiter; NASA Jet Propulsion Laboratory*	3.2		X		This project is part of the HSECoE. The reviewers commented favorably on the progress made by the Jet Propulsion Laboratory (JPL), in particular on the modeling of cryogenic tanks and the development of a cryogenic tank burst facility. Reviewers noted some inconsistencies and issues with the outgassing of composite overwrapped pressure vessels that need further work. (Note from DOE: As a result of several factors, including the down-select of reversible metal hydride systems from the HSECoE's efforts, JPL's project scope has changed and JPL will not be continued as a full independent partner of the HSECoE after FY 2012.)

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-046	Microscale Enhancement of Heat and Mass Transfer for Hydrogen Energy Storage *Kevin Drost; Oregon State University*	2.9	X			This project is part of the HSECoE. The reviewers noted that using micro-channel technology to reduce system weight, size, and complexity while also enhancing charging and discharge rates was relevant to the goals of the Program. The reviewers also stated that the Modular Absorption Tank Insert (MATI) has seen significant improvements over the last year. They recommended that an absorbent system using the MATI be compared against a baseline system to help illustrate the potential benefits of this approach. They also cautioned it may be difficult to insert the MATI device into a pressure vessel and recommended Oregon State test their concepts soon to determine feasibility and identify remaining development needs.
ST-047	Development of Improved Composite Pressure Vessels for Hydrogen Storage *Norman Newhouse; Lincoln Composites*	3.3	X			This project is part of the HSECoE. The reviewers commended the progress Lincoln Composites has made over the last year including the fabrication of 21 common test vessels for use within the HSECoE for component testing and improvements Lincoln has made in vessel weight, volume, and cost reduction. In addition to vessel materials development, the reviewers commented favorably that Lincoln was expanding its scope to include Type I all-metal and Type III composite pressure vessels with metal liners in addition to Type IV all-composite pressure vessels; reviewers also commented favorably that Lincoln was investigating the ability to incorporate sorbent materials into the pressure vessel and the potential of their operation at cryogenic temperatures.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-048	Hydrogen Storage Materials for Fuel Cell Powered Vehicles *Andrew Goudy; Delaware State University*	2.5			X	The reviewers recognized the principal investigator's expertise in performing studies on the thermodynamics and kinetics of hydrogen reactions with metal hydrides. However, the reviewers felt the complex hydride systems being investigated have limited potential to meet DOE targets given the high temperatures required for solid state diffusion. The reviewers suggested no further consideration be given to systems such as $LiBH_4/MgH_2$ or $LiNH_2/MgH_2$ because of considerable literature already available. The reviewers are not confident that deeper insights will result by continuing this work.
ST-053	Lifecycle Verification of Polymeric Storage Liners *Barton Smith; Oak Ridge National Laboratory*	3.1	X			Overall the reviewers considered the ORNL hydrogen permeation measurements of tank liner materials to be highly relevant to the Program and well executed. Reviewers did comment that planned testing of liner material incorporated with the carbon fiber composite layer is criticaland should be done soon. It was also suggested that consideration be given to having the test methodology promoted as an industry standard.
ST-093	Melt Processable PAN Precursor for High Strength, Low-Cost Carbon Fibers *Felix Paulauskas; Oak Ridge National Laboratory*	2.7	X			Reviewers commented that the goal of reducing carbon fiber precursor costs, with potential carbon fiber cost reductions of about 30%, is highly relevant and important for the Program. While the researchers were considered to be very qualified, addition of other collaborators was recommended. Delays due to issues with winding of the precursor fibers on the laboratory equipment were noted and quick resolution is needed. It was recomemended that conversion of the precursors to carbon fiber be carried out soon to evaluate the status and potential of the project to meet it goals.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ST-098	Development of a Practical Hydrogen Storage System based on Liquid Organic Hydrogen Carriers and a Homogeneous Catalyst *Craig Jensen; Hawaii Hydrogen Carriers, LLC*	2.7			X	This project is focused on the development of Liquid Organic Carriers (LOCs), which the reviewers acknowledged as one of the more promising options for low-pressure automotive hydrogen storage with the potential to exploit the existing gasoline infrastructure. The reviewers felt the work was significantly similar to that previously done by Air Products albeit with the use of a homogenous catalyst as opposed to a heterogeneous catalyst. The reviewers expressed concern about the high cost of the iridium pincer catalyst and the LOC's limited gravimetric capacity of ~ 7 wt. %, which will not be able to meet the DOE Ultimate Targets. Good collaboration with GM and progress on reactor design were noted and collaborating with the HSECoE was recommended.
ST-099	Development of Low-Cost, High Strength Commercial Textile Precursor (PAN-MA) *Dave Warren; Oak Ridge National Laboratory*	2.9	X			The reviewers commented that the goal of this project in significantly reducing the cost of carbon fiber precursors is both relevant to the Program and critical for successful commercialization of high-pressure hydrogen storage. The research team, while limited to two partners, was considered highly experienced and suitable for the research effort. To date, the progress has appeared somewhat slow and the reviewers would like to see increased rate of production, especially in converting the precursors to carbon fiber and evaluating the status and potential of the polymer formulations.

* Permanent consecutive project numbers were assigned for the 2010 AMR to make administration of the AMR more efficient. As projects are discontinued, the corresponding project number is retired. As new projects are added, new consecutive numbers are added. As a result, there are gaps in the consecutive project numbers. In addition, some projects were not selected for review at the 2012 AMR and are not shown in the Prologue Table (see Appendix D for the full list of projects not reviewed).

Fuel Cells

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-006	Durable Catalysts for Fuel Cell Protection During Transient Conditions *Radoslav Atanasoski; 3M*	3.6	X			Reviewers commented on significant improvements in catalyst durability using start-stop cycling protocols, showing <10% loss in electrochemically active surface area on the cathode after 5,000 cycles simulating start/stop. They also noted three orders of magnitude reduction in the oxygen reduction reaction (ORR) current at the anode and 200 cycles of 200 mA/cm^2 simulating cell reversal with anode loadings of 0.045 mg/cm^2 platinum group metal (PGM) with the upper potential remaining <1.8 V. Also, this project demonstrated improved tolerance to cell reversal in stack testing using the oxygen evolution reaction modified nanostructured thin film anode at an original equipment manufacturer (OEM).
FC-007	Extended, Continuous Pt Nanostructures in Thick, Dispersed Electrodes *Bryan Pivovar; National Renewable Energy Laboratory*	2.8	X			Reviewers remarked that the research team has good depth in the area of carbon-free (platinum) material, and good approaches to understanding limitations, such as the dispersion of these novel materials and adding carbon. Reviewers expressed concern that too much emphasis has been put on rotating disk electrode (RDE) to predict performance and membrane electrode assemblies (MEAs) come too late in the project.
FC-008	Nanosegregated Cathode Catalysts with Ultra-Low Platinum Loading *Nenad Markovic; Argonne National Laboratory*	3.4	X			According to reviewers, Argonne National Laboratory (ANL) is carrying out outstanding, thorough work providing an important framework to guide others by identifying the most important factors in making more active ORR catalysts. The reviewers stated that the accomplishments presented were excellent and impressive. They noted that more fuel cell performance and durability testing would be good, which seems to be the plan for future work.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-009	Contiguous Platinum Monolayer Oxygen Reduction Electrocatalysts on High-Stability, Low-Cost Supports *Radoslav Adzic; Brookhaven National Laboratory*	3.6	X			According to reviewers, Brookhaven National Laboratory's (BNL's) approach provides one of the most promising pathways to reduce the use of expensive platinum (Pt) in fuel cells and thus could allow fuel cells to become cost-competitive with other power sources for a range of applications. They noted that BNL has made considerable strides in reducing total precious metal use, as well as reducing Pt. Reviewers also lauded the progress on extending the testing of activity and durability in MEAs, complementing the rotating disk electrodes used in the past. They suggested that the trend towards working with practical MEAs should be continued.
FC-010	The Science and Engineering of Durable Ultralow PGM Catalysts *Fernando Garzon; Los Alamos National Laboratory*	3.0	X			The reviewers noted that the stated objectives of the project will deliver a high-performing, durable catalyst; however, there appears to be no clear path to meet that objective half way through the project. They state that the modeling work has progressed well but the experimental reduction to practice has lagged behind. The reviewers suggested that Los Alamos National Laboratory (LANL) focus on development and analysis of Pt/ Y,Sc nanoplatelet catalysts as well as the Pt nanotube work, and that the other approaches have lower priority.
FC-012	Polymer Electrolyte Fuel Cell Lifetime Limitations: The Role of Electrocatalyst Degradation *Deborah Myers; Argonne National Laboratory*	3.3	X			Reviewers stated that understanding the effect of Pt and Pt alloy properties on voltage decay is a critical issue that must be addressed to enable fuel cell vehicle commercialization. They noted that ANL has done an outstanding job of collecting and analyzing an abundance of data to highlight the key factors that impact voltage loss in dispersed PGM catalysts and MEAs. The reviewers asserted that the approach could benefit from more thorough statistical analysis to better identify second and higher order effects.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-013	Durability Improvements through Degradation Mechanism Studies *Rod Borup; Los Alamos National Laboratory*	3.2	X			According to reviewers, LANL's project is well executed with a focus on the key parameters and interactions needed for high fuel cell durability without added costs. The reviewers noted that the approach taken by this team is comprehensive, coordinated, and well organized. They were intrigued by interesting results that elucidate catalyst degradation including catalyst agglomeration as a function of loading and localized structural changes. They stated that the new findings lead to new durability perspectives and insight into the multi-dimensional problem of degradation.
FC-014	Durability of Low Pt Fuel Cells Operating at High Power Density *Scott Blanchet; Nuvera Fuel Cells*	3.1	X			According to reviewers, this project has a good collaboration partners, consistent experimental data sets, and a balanced approach of in situ and ex situ measurement correlations. Reviewers expressed concern about the low level of detail included on the model results and lack of clarity on how the system characteristics (e.g., thermal gradients in the cell) will be taken into account. Also, they suggested that the model more accurately address commercial fuel cell systems.
FC-016	Accelerated Testing Validation *Rangachary Mukundan; Los Alamos National Laboratory*	3.1	X			The reviewers applauded LANL's efforts to correlate accelerated stress tests with real-world experience as it provides valuable information for fuel cell developers. The reviewers were disappointed that LANL was restricted to evaluating post-mortem from only bus stacks since no automotive data were available. Reviewers questioned the development of an accelerated stress test for gas diffusion layers since that failure mode is rare.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-017	Fuel Cells Systems Analysis *Rajesh Ahluwalia; Argonne National Laboratory*	3.4	X			The reviewers stated that the accomplishments and progress of ANL's system analysis project were significant this year and were well presented. Reviewers felt that the modeling results on optimal low Pt loading were interesting and offer an opportunity to validate the model by comparing with experiment. Reviewers suggested integrating the temperature evolutions during power variations into the N_2 dilution and purge strategy would be interesting.
FC-018	Manufacturing Cost Analysis of Fuel Cell Systems and Transportation Fuel Cell System Cost Assessment *Brian James; Strategic Analysis, Inc.*	3.4	X			Reviewers believe the cost analysis of fuel cell systems is essential for assessing the state of the technology and guiding research. It was suggested that for MEAs, platinum alloy dispersed on carbon should be analyzed as well as nanostructured thin film options. Although progress slowed on the automotive analysis, reviewers were impressed with the rapid progress in the new stationary analyses. The methodology has led to high confidence in results and provides major insights into what the major cost drivers are for the fuel cell systems analyzed. Reviewers provided valuable suggestions, including a suggestion to analyze the cost of fuel cell systems for medium-duty trucks.
FC-020	Characterization of Fuel Cell Materials *Karren More; Oak Ridge National Laboratory*	3.3	X			Reviewers state that this is a valuable, core project in the U.S. Department of Energy (DOE) Hydrogen and Fuel Cells Program (the Program). It provides broad access to electron microscopy for projects studying fuel cell materials, in particular the structure and distribution of catalyst particles. This project has a continuing history of providing insight into fuel cell functions using the newest techniques of microscopy. Suggestions for future improvement included development of in situ liquid TEM techniques.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-021	Neutron Imaging Study of the Water Transport in Operating Fuel Cells *Muhammad Arif; National Institute of Standards and Technology*	3.3	X			Reviewers noted that neutron imaging is a powerful tool for probing into an operating fuel cell and National Institute of Standards and Technology's (NIST's) neutron facility provides unique capability to DOE and industry researchers. NIST has clearly been successful in developing advanced tools to meet customer needs as seen by the numerous projects that have been effectively conducted at the facility. Reviewers would like to learn how such experiments advance the understanding of fuel cells and how neutron imaging will ultimately help reach DOE's technical targets. They noted that more extensive error and uncertainty analysis would be helpful.
FC-026	Fuel-Cell Fundamentals at Low and Subzero Temperatures *Adam Weber; Lawrence Berkeley National Laboratory*	3.1	X			Reviewers state that this project is well designed to answer the complex question of durability mechanisms under freeze conditions. Recognizing the role of freezing in altering the nature of a 3-phase interface, as in the case of a conventional polymer electrolyte membrane (PEM) fuel cell, this effort combines advanced tools such as small angle X-ray scattering, dynamic scanning calorimetry, and high frequency resistance with modeling of transport and kinetics. Good progress has been made in implementing this strategy with good collaborative effort. Reviewers suggested adding studies of a larger variety of MEA configurations and of stack-level freeze cycle transients.
FC-028	Transport Studies Enabling Efficiency Optimization of Cost-Competitive Fuel Cell Stacks *Amedeo Conti; Nuvera Fuel Cells*	3.1			X	Reviewers commented that the performance and modeling targets of the project have been met at low loadings. However, they expressed concern about durability, noting that data at higher temperatures and heat rejection findings should be reported. Reviewers also expressed concern about lack of published results and recommended disclosure of the model in a peer-reviewed forum.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-032	Development of a Low Cost 3-10kW Tubular SOFC Power System *Norman Bessette; Acumentrics Corporation*	3.1	X			Reviewers commented that the project addressed several of the Program's goals focusing on critical barriers of performance, durability, and cost for solid oxide fuel cell power plants for stationary power applications. Reviewers commented favorably on the progress achieved by increasing power plant performance and reducing manufacturing cost. While the project is close to completion, proposed remaining efforts were deemed reasonable.
FC-036	Dimensionally Stable High Performance Membranes *Cortney Mittelsteadt; Giner Electrochemical Systems, LLC*	2.9	X			This project aims to develop low-cost fabrication processes for new support layers with micro-fabricated openings for dimensionally stable membranes. Reviewers stated that the approach of pursuing three processes in parallel increases the chances of achieving both the performance as well as cost targets; and the progress and collaborations are good. Some reviewers questioned the need for better membrane supports as opposed to better membranes. Suggestions for improvement included down-selection to one process, testing membrane in MEA, use of current distribution modeling for designing the structure, testing MEA's with thinner supports, and providing details on potential cost reduction.
FC-044	Engineered Nano-scale Ceramic Supports for PEM Fuel Cells *Eric Brosha; Los Alamos National Laboratory*	2.8	X			According to reviewers, overall good progress was made in electrochemical evaluation by RDE and MEA, even if the results were not that good. The reviewers noted that LANL showed that significant carbon content contributes to a lack of durability under severe carbon-corrosion tests. The reviewers also noted that LANL attempted incorporation into MEAs and MEA testing, although performance is poor due to integration issues. The reviewers suggested that more emphasis needs to be placed on direct measurements of conductivity after exposure to relevant conditions.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-048	Effect of System Contaminants on PEM Fuel Cell Performance and Durability *Huyen Dinh; National Renewable Energy Laboratory*	2.9	X			Reviewers commended the extensive knowledge base about contaminants, the in-situ and ex-situ testing capabilities, and the collaborations with stack manufacturers. Some questions remain for each contaminant. Reviewers wondered what the mechanism of degradation is, if the degradation is recoverable at a lower concentration, if contaminants crossover to the anode, and what the mechanism of recovery is, if one exists. Reviewers suggested that more efforts should be directed towards understanding what the accelerating effects are for different species and towards identifying the critical levels for each type of contaminant.
FC-049	Development of Micro-Structural Mitigation Strategies for PEM Fuel Cells: Morphological Simulations and Experimental Approaches *Silvia Wessel; Ballard*	3.5	X			The reviewers commented that progress shown has been very good, milestones have been met, and the model-based simulations have been experimentally validated. The reviewers expressed concern, however, about how specific the model is to Ballard technology, and the extent to which this model will be available for other fuel cell developers.
FC-052	Technical Assistance to Developers *Tommy Rockward; Los Alamos National Laboratory*	3.4	X			According to reviewers, this project was more relevant to DOE goals than last year as LANL focused more on tasks that addressed essential questions related to fuel cell performance and durability. Reviewers noted that significant work was completed in many different areas including microporous layers, startup/shut down, and hydrophobic bipolar plate treatments. Reviewers also noted that it is a great idea to have one of the most credible teams in the fuel cell field helping developers meet the developmental targets for their fuel cell component technologies.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-054	Transport in PEMFC Stacks *Cortney Mittelsteadt; Giner Electrochemical Systems, LLC*	2.9	X			The objective of this project is to improve understanding of the correlation between material properties and model equations of PEM fuel cell stacks. Reviewers agreed that the project relevance and team of collaborators are very good. However, there were divergent opinions on the approach and progress. Suggestions for improvement included increasing focus on the stack transport issues, instead of cells and components; conducting more sensitivity analysis using the model; reporting on thermal conductivity and catalyst layers; providing greater detail on the methodology behind the model treatment of water transport in gas diffusion layers; and publishing results and making them more readily available to the community.
FC-063	Novel Materials for High Efficiency Direct Methanol Fuel Cells *David Mountz; Arkema*	2.6		X		Reviewers felt the project relevance for direct methanol fuel cells (DMFC) and the team were very good; however, the progress and results to date were lacking. The approach for membrane development is good, but the catalyst development work has not been sucessful. Reviewers recommended that the remaining resources should be shifted to focus on developing membranes with high conductivity and reduced methanol permeability. MEA performance testing and efficiency validation should be carried out using DMFC benchmark catalysts.
FC-064	New MEA Materials for Improved DMFC Performance, Durability, and Cost *Jim Fletcher; University of North Florida*	3.1			X	The reviewers stated that this project had a strong team, had good success with water management issues, and demonstrated a DMFC system with long-term durability. The project took a practical engineering approach with strong linkages with an industrial catalyst partner to enable commercialization. Suggested improvements included further optimization of water management, increasing temperature while maintaining water balance, and optimization of system operating parameters and conditions. This project ended June 2012.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-065	The Effect of Airborne Contaminants on Fuel Cell Performance and Durability *Jean St-Pierre; Hawaii Natural Energy Institute*	3.0	X			According to reviewers, the effect of airborne impurities on fuel cell performance is important to study. Reviewers noted that the team's approach is good, that the results generated are reliable, and the models that result will be useful. Reviewers would welcome a more in-depth understanding of the causes of observed performance losses and were concerned that the data set is not sufficiently large to make the models as reliable as possible. Reviewers suggested that the University of Hawaii recommend tolerance limits for the contaminants.
FC-067	Materials and Modules for Low-Cost, High-Performance Fuel Cell Humidifiers *Will Johnson; W.L. Gore*	3.1			X	Reviewers agreed that humidifiers are a key component for fuel cell system performance. The reviewers thought the approach was sound; however, some would like the project expanded to consider a larger set of membrane materials and some wanted to see emphasis on module design. Reviewers commended the work in understanding durability loss.
FC-070	Development of Kilowatt-Scale Coal Fuel Cell Technology *Steven Chuang; University of Akron*	1.8			X	The reviewers commented that the project is not relevant to the Program's goals, as it is using coal as a potential fuel for fuel cells. Furthermore, they commented that while the direct coal utilization fuel cell concept offers potential for carbon capture, the project had only demonstrated modest progress. It was also stated that while the project has been completed, it would have benefited from the inclusion of a major solid oxide fuel cell developer.
FC-072	Extended Durability Testing of an External Fuel Processor for SOFC *Mark Perna; Rolls-Royce Fuel Cell Systems (US) Inc.*	3.2			X	According to reviewers, the project pertained to the Program's objectives as it involved the development of fuel processing subsystems in support of solid oxide fuel cells for distributed power generation. Reviewers commended the project for having a good program plan and well-defined targets, and for the technical progress it has achieved. The project has been completed with subsystems developed and tested for durability.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-076	Biomass Fuel Cell Systems *Neal Sullivan;* *Colorado School of Mines*	2.8			X	The reviewers noted that this project is a good combination of academic expertise and industry experience, and there is good correlation between modeling and hardware testing. However, reviewers thought that the project's progress was slow given the three-year project timeline. The reviewers suggested that the remaining time should be spent testing the long-term durability of the fuel cell stack using biogas.
FC-077	Fuel Cell Coolant Optimization and Scale-up (plus work under SBIR III project) *Satish Mohapatra;* *Dynalene*	2.9	X			According to reviewers, the project's innovative approach may lead to a significant positive impact on the fuel cell system in terms of mass, weight, and maintenance by eliminating the resin filter. The reviewers expressed concern about the long term durability and identification/understanding of degradation mechanisms. The Small Business Innovation Research (SBIR) portion of the project is continuing; the congressionally directed project (CDP) has ended.
FC-078	21st Century Renewable Fuels, Energy, and Materials Initiative *Joel Berry;* *Kettering University*	2.1			X	The reviewers stated this project is unfocused, that it does not appear to have specific targets or milestones for performance, and much of the project is not aligned with the Program's goals. According to the reviewers, the fuel cell membrane work was able to improve on the conductivity they obtained with polybenzimidazole-phosphoric (PBI-phosphoric) acid by doping the PBI-phosphoric acid with sulfonated-polyhedral oligomeric silsesquioxane (SPOSS), but have not improved on the high-temperature conductivity of PBI-phosphoric acid reported in the literature.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-079	Improving Fuel Cell Durability and Reliability *Prabhakar Singh; University of Connecticut Global Fuel Cell Center*	2.4			X	Reviewers identified this project as atypical, as it is comprised of 10 independent projects, with program objectives being addressed through a wide range of interactions with industry partners. According to reviewers, the project has a broad approach and improved coordination between the different tasks is required. They identified work covering some of the technical areas, such as molten carbonate fuel cells, which would otherwise be absent from the Program's portfolio. Reviewers felt that the project has demonstrated progress in at least some areas, and commended the project on its multiple collaborations between academic partners and industry. It was suggested that, for the remaining duration of the project, some of the project's tasks need to be reevaluated and prioritized.
FC-081	Fuel Cell Technology Status—Voltage Degradation *Jennifer Kurtz; National Renewable Energy Laboratory*	3.3	X			The reviewers commended the break down of results from different platforms, test configurations, and test protocols, as well as break down among tests run using steady state, duty cycle, and accelerated protocols. The reviewers also commended the new website. The reviewers would like to see additional data and data types, as well as an enhancement of the accuracy of the decay prediction.
FC-083	Enlarging Potential National Penetration for Stationary Fuel Cells Through System Design Optimization *Chris Ainscough; National Renewable Energy Laboratory*	2.3		X		Reviewers saw the potential value of the model as a high-level policy analysis tool and for providing a collection of building energy characteristics appropriate for combined heat and power systems. They were uncertain whether details of fuel cell systems in the model were sufficient. Reviewers highlighted that collaboration and leveraging NREL's buildings program is the right path and will be extremely important to the success of this project. Progress has been slow with the change in PI and the first useful results are expected in fiscal year (FY) 2013.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-084	WO3 and HPA Based Systems for Durable Platinum Catalysts in PEMFC Cathodes *John Turner;* *National Renewable Energy Laboratory*	2.7	X			The reviewers commended the strength of the research team. According to the reviewers, some progress was shown in the synthesis and feasibility of new supports and increased durability using new supports, but no data was presented on reduced cost or increasing performance. The reviewers were concerned about the number of approaches being investigated.
FC-085	Synthesis and Characterization of Mixed-Conducting Corrosion Resistant Oxide Supports *Vijay Ramani;* *Illinois Institute of Technology*	3.0	X			According to the reviewers, the project has shown the potential of using mixed proton electron conducting materials for improving support corrosion resistance, and it has shown good corrosion resistance for some model systems. The reviewers also noted the involvement of an automotive OEM as a strength. The reviewers expressed concern about the high Pt loading used. The reviewers recommended durability tests on the materials for downselection. Cost analysis was also recommended.
FC-086	Development of Novel Non-Pt Group Metal Electrocatalysts for Proton Exchange Membrane Fuel Cell Applications *Sanjeev Mukerjee;* *Northeastern University*	2.9	X			Reviewers commended the approach and the level of collaboration. They noted the high ORR activity for 2─3 electrocatalysts and the improved stability, as well as the strength of the mechanistic studies. Reviewers cautioned against extrapolation of Tafel slopes using few points to project activity. Reviewers also recommended additional effort to verify the reaction mechanisms and more long-term stability tests for the catalysts.
FC-087	High-Activity Dealloyed Catalysts *Fred Wagner;* *General Motors*	3.4	X			Reviewers commented favorably on the project's well-designed and well-focused approach and the good collaboration between all of the project's participants. The project was further praised for the good progress achieved to date toward meeting catalyst activity and durability targets. However, concern was expressed whether catalyst activity and durability targets could be met simultaneously by a single sample. Some reviewers suggested that focusing more on evaluating durability would benefit the project.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-088	Development of Ultra-Low Platinum Alloy Cathode Catalyst for PEM Fuel Cells *Branko Popov; University of South Carolina*	3.2	X			Reviewers agree that this project is highly relevant to DOE objectives of platinum reduction in the fuel cell catalyst to reduce cost and enable commercialization. The outstanding approach, progress, and team collaborations were noted. Suggestions for improvement included developing more durability data; providing a more detailed explanation of methods, catalyst formulation, and test data; clarifying the effect of membrane on performance; and focusing on one or two high-potential catalysts.
FC-089	Analysis of Durability of MEAs in Automotive PEMFC Applications *Randy Perry; DuPont*	2.3		X		The reviewers found the background work performed by Nissan to be the project's strength, and the details of the test protocols informative and helpful in interpreting the results. The reviewers were concerned that the accomplishments have been limited, specifically the contributions from IIT. Furthermore, the reviewers noted the development of the model based on experimental/characterization results and that the application of the suite of characterization techniques listed were not evident. Further review of this project and progress towards its go/no-go decision milestone is needed.
FC-090	Corrugated Membrane Fuel Cell Structures *Stephen Grot; Ion Power*	2.6	X			The relevance and approach of this novel stack design concept was rated good by the reviewers; however, the reviewers had reservations about the likelihood for success due to many new issues associated with the innovative design. The reviewers rated the collaboration team highly. There is a lack of progress in demonstrating the feasibility of the concept due to delays in initiating a subcontract. A Go/No Go decision will be made in FY 2013.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-091	Advanced Materials and Concepts for Portable Power Fuel Cells *Piotr Zelenay; Los Alamos National Laboratory*	3.4	X			Reviewers thought that the LANL project had a good balance between introducing new materials into direct methanol fuel cells and working on enabling technology for next generation fuels. Reviewers applauded the multi-directional approaches taken for the completion of all tasks and the impressive performance observed with multi-block copolymer membranes. Reviewers recommended increased interactions with SFC Energy to ensure practicality and progress against realistic goals and operating scenarios.
FC-092	Investigation of Micro- and Macro-Scale Transport Processes for Improved Fuel Cell Performance *Jon Owejan; General Motors*	3.6	X			Reviewers rated this project as excellent in all aspects: Relevance, Approach, Progress, Collaboration, and Future Work. Suggestions for refinement included: develop the measurement techniques for the catalyst layer; extend the study to include durability/duty-cycle aspects; and include thin catalyst layers, such as nano-structured thin film. Reviewers felt that this project had outstanding synergy between experiment and model along with a strong team and that the results will be highly relevant and useful to the fuel cell community.
FC-096	Power Generation from an Integrated Biomass Reformer and Solid Oxide Fuel Cell (SBIR Phase III) *Quentin Ming; InnovaTek*	3.1	X			According to the reviewers, good progress has been made, and most technical milestones have been met. Reviewers noted the initial test of bio-kerosene reforming has been successful in long term testing and operation on bio-fuels producing power is impressive. However, the reviewers noted the critical technical milestone to achieve 40% system efficiency has not been met (achieved only 27.5%). The reviewers also expressed concern about whether the second generation will achieve required durability.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
FC-101	PEM Stationary Power Plant *Tom Skiba; UTC Power*	2.5		X		While the reviewers noted the technically strong team, they were very concerned about the limited progress based on the time and money spent on the project. The reviewers noted the number of stop-starts throughout the project's history resulting in a lack of continuity of results. The reviewers also noted the results do not give high confidence that the system proposed can meet the technical targets. Further review of this project and progress towards its go/no-go decision milestone is needed.
FC-102	New High Performance Water Vapor Membranes to Improve Fuel Cell Balance of Plant Efficiency and Lower Costs *Earl Wagener; Tetramer Technologies, LLC*	3.0			X	This project was a nine-month Phase I SBIR project. According to reviewers, the project focused on one narrow aspect of fuel cells, membrane hydration, so the project is not as broad as some of the other DOE-funded activities. Reviewers found it difficult to evaluate the approach as it is proprietary, but lauded the good progress in the area of performance. Reviewers stated that significant challenges have to be addressed in the area of durability.

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Manufacturing R&D

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
MN-001	Fuel Cell MEA Manufacturing R&D *Michael Ulsh; National Renewable Energy Laboratory*	3.4	X			According to reviewers, the results from the National Renewable Energy Laboratory's (NREL's) project are excellent. Specific project strengths cited include demonstrating the viability of a number of on-line detection tools under commercial operating conditions and expanding into other fuel cell technologies (e.g., solid oxide fuel cells). Reviewers suggested that a prioritized list of defect types and sizes from each supplier may be helpful for coordinating the segmented cell analysis.
MN-004	Manufacturing of Low-Cost, Durable Membrane Electrode Assemblies Engineered for Rapid Conditioning *Colin Busby; W.L. Gore*	3.4	X			According to reviewers, W.L. Gore showed progress in the performance of direct coated cathodes. Reviewers felt that eliminating/reducing backer material will realize significant cost savings in membrane electrode assembly (MEA) production. In addition, they noted that reducing the number of coating passes will reduce MEA costs.
MN-005	Adaptive Process Controls and Ultrasonics for High Temperature PEM MEA Manufacture *Dan Walczyk; Rensselaer Polytechnic Institute*	3.4	X			According to reviewers, the detailed program approach appears to be sound and well thought out and there has been reasonable progress in testing and validating ultrasonically bonded MEAs. They noted favorably that the team included Rensselaer Polytechnic Institute as the lead, BASF (MEA manufacturer), Ballard (stack manufacturer), UltracCell (system manufacturer) and NREL (national lab). Reviewers stated that the accomplishments have been outstanding and the payback potential appears huge. Reviewers suggested that the costing data be published.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
MN-006	Metrology for Fuel Cell Manufacturing *Eric Stanfield; National Institute of Standards and Technology*	3.2	X			The reviewers noted that the non-contact dimension sensor and the scatterometry measurement systems can be very important in reducing manufacturing costs and enabling improved quality for both bipolar separators and catalyzed MEAs. While the reviewers found that the scatterfield metrology effort produced lots of results, they thought that it would be good to show how the results would lead to improved quality control and reduced component cost. The reviewers praised the the highly qualified and experienced team at National Institute of Standards and Technology for successfully collaborating with numerous organizations to prove the viability of the two approaches.
MN-007	High Speed, Low Cost Fabrication of Gas Diffusion Electrodes for Membrane Electrode Assemblies *Emory De Castro; BASF*	3.4	X			According to reviewers, the overall approach of the project is solid and the progress and accomplishments are impressive. The reviewers noted that a four-fold increase in throughput rate, an order of magnitude reduction in defects, and a five-fold reduction in variation of Pt loading were very impressive accomplishments. They also noted that the 75% cost reduction attributed to reducing labor hours was a significant achievement for this project. The reviewers suggested that BASF carry out durability testing of the new catalyst layers.
MN-008	Development of Advanced Manufacturing Technologies for Low Cost Hydrogen Storage Vessels *Mark Leavitt; Quantum Fuel Systems Technologies Worldwide, Inc.*	3.0	X			According to reviewers, the project directly addresses the U.S. Department of Energy's Hydrogen and Fuel Cells Program goals with an approach which will bring down the cost of Type IV storage tanks through improved utilization of carbon fiber. Reviewers noted that initial tests demonstrated good durability using less carbon fiber; however, some reviewers noted that, even if carbon fiber is reduced by as much as 20%–25%, carbon fiber reduction is not sufficient to substantially reduce the cost of hydrogen storage. Reviewers suggested that a thorough cost analysis needs to be performed and released.

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Technology Validation

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
TV-001	Controlled Hydrogen Fleet and Infrastructure Analysis *Keith Wipke; National Renewable Energy Laboratory*	3.8			X	Reviewers concurred with the great importance of this project for providing a statistically valid understanding of the status of technology development relative to the U.S. Department of Energy's (DOE's) Hydrogen and Fuel Cells Program goals. They noted that the approach that has been developed is solid and is serving as a model for collecting data for additional fuel cell applications. Reviewers agreed that collaboration was essential and outstanding. The only weaknesses that reviewers mentioned were that the project was not broader in both participants and time.
TV-008	Technology Validation: Fuel Cell Bus Evaluations *Leslie Eudy; National Renewable Energy Laboratory*	3.3	X			Reviewers recognize the importance of fuel cell buses in DOE's portfolio of fuel cell development and demonstration. It was suggested that the National Renewable Energy Laboratory's collection, analysis, and reporting of performance data have made a vital contribution to the status of the technology relative to newly developed targets for bus applications. Reviewers agreed that the project features good collaboration. Their recommendations included acquiring data on other types of hybrid buses for comparison; improving access to warranty repair costs; and increasing the ability to compare buses with similar age, size, and service conditions.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
TV-012	Florida Hydrogen Initiative (FHI) *David Block; University of Central Florida*	2.3			X	Reviewers noted that many of the individual projects that make up the Florida Hydrogen Initiative were relevant to the Program's objectives, but were largely not relevant to the technology validation sub-program. One reviewer distinguished two projects as achieving good results. These included "Advanced HiFoil Bipolar Plates" (Enerfuel) and "Low Cost High Efficiency 500 W Portable PEM Fuel Cell " (Florida State University/Bing). The reviewer also noted "EV Charging Station Powered by a Fuel Cell" (Enerfuel and Florida Atlantic) achieved moderate success. Reviewers suggested that stronger coordination or a unified goal for the project may have had a greater benefit for the Florida Hydrogen Initiative.
TV-015	Wind to Hydrogen *Kevin Harrison; National Renewable Energy Laboratory*	3.0	X			Reviewers believe that validation of electrolysis is essential and that supporting renewable energy with hydrogen storage and ancillary services is much needed. Reviewers commented that the broad scope of activities is a weakness and the project activities should be more focused on validation of DOE's hydrogen production targets. Focusing on a robust user facility was suggested by one reviewer while another suggested that precompetitive technology be the focus.

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Safety, Codes and Standards

Project Number*	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue / Further Review	Completed or Congressionally Directed Project	Summary Comments
SCS-001	National Codes and Standards Coordination *Carl Rivkin;* *National Renewable Energy Laboratory*	3.4	X			Reviewers recognized this project as essential to the development of Codes and Standards to enable the wide deployment of hydrogen and fuel cell technologies. Reviewers emphasized the strong leadership and appropriate coordination with critical code development organizations and standards development organizations (SDOs). However, they also thought that a focus, as it pertains to the deployment in California, could be added. In addition, simplified approaches providing key pieces of information, such as what gaps and risks exist, would be helpful.
SCS-002	Component Standard Research & Development *Robert Burgess;* *National Renewable Energy Laboratory*	3.0	X			Reviewers acknowledged the technical focus and progress of this project. Specific strengths cited included the project's strong coordination with sensor manufacturers and domestic and international SDOs. However, the role of sensor testing at the National Renewable Energy Laboratory (NREL) in regards to industry and the impact on standards were not clear. Reviewers suggested several topics for future investigation, including wide area sensors, sensor testing with higher concentrations of hydrogen, and non-metallic materials used on the low pressure side of the fuel cell system.
SCS-004	Hydrogen Safety, Codes and Standards: Sensors *Eric Brosha;* *Los Alamos National Laboratory*	3.0	X			Reviewers observed good progress toward developing a reliable, cost-effective hydrogen safety sensor for hydrogen infrastructure and stationary fuel cell applications. Reviewers commented on the project team's strong technical expertise and the involvement of industry. Reviewers indicated that the role of the participating commercial partner and the plan forward for commercialization was unclear. Reviewers recommended a stronger role from industry partner(s) and a cost analysis for the manufacturing of the sensor.

Project Number*	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue / Further Review	Completed or Congressionally Directed Project	Summary Comments
SCS-005	R&D for Safety, Codes and Standards: Materials and Components Compatibility *Daniel Dedrick; Sandia National Laboratories*	3.3	X			According to the reviewers, the project team has a significant impact on standards development and it is clearly filling a critical industry need. They cited excellent international collaborations with research institutions, original equipment manufacturers, and standards organizations. However, they recommended better defining the roles of participants and focusing on other materials used elsewhere in the world. In addition, they suggested that material testing should be conducted as applied to specific standards (e.g., SAE J2579) and include components in extreme cold conditions such as -40°C.
SCS-006	Hydrogen Safety Knowledge Tools *Linda Fassbender; Pacific Northwest National Laboratory*	3.3	X			Reviewers continued to praise the project's progress and ability to maintain critical hydrogen community resources. Reviewers acknowledged the use and increase of website visits, the reference by the Chemical Safety Board, and international collaboration with the International Association for Hydrogen Safety as important accomplishments. However, there was concern on the future direction of disseminating the information internationally and to key personnel such as Authorities Having Jurisdiction. The reviewers suggested examining advanced media options in order to obtain wider reach and exposure.
SCS-007	Hydrogen Fuel Quality *Tommy Rockward; Los Alamos National Laboratory*	3.8	X			Reviewers commented that this project is making steady progress with an internationally accepted, science-based approach to testing and developing hydrogen fuel quality standards. Project strengths mentioned included a strong technical approach and good collaborations with industry and standard development organizations. Reviewers observed the important need to maintain a grasp on the advancement in fuel cell technologies. The reviewers suggested testing on short stacks and considering containments that can be found in a "system environment" from delivery to storage to automobile.

Project Number*	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue / Further Review	Completed or Congressionally Directed Project	Summary Comments
SCS-008	Hydrogen Safety Panel *Steven Weiner;* *Pacific Northwest National Laboratory*	3.2	X			According to reviewers, this project continues to be a key resource—not just for the Safety, Codes and Standards (SCS) sub-program, but also for the overall DOE Hydrogen and Fuel Cells Program (the Program)—and is a "go-to" resource for the community. Examples of cited strengths of the panel include technical expertise, interest in promoting a safety culture, the continuous effort involved in performing site visits, and providing recommendations for the Program's projects. Reviewers felt the work of the panel was straightforward and could benefit from evolution in its approach. Suggestions for consideration included involvement with third parties (e.g., insurers) and coordination with NREL's data collection through the Technology Validation sub-program.
SCS-010	R&D for Safety, Codes and Standards: Hydrogen Behavior *Daniel Dedrick;* *Sandia National Laboratories*	3.1	X			Reviewers commented favorably on this project's ability to provide a science-based approach in hydrogen behavior as it relates to hydrogen release, ignition, and radiation. They recognized the strong collaborations from industry and international SDOs. Due to the large amount of information presented, the impact on the codes and standards efforts was not sufficiently well conveyed. The reviewers suggested continued coordination with appropriate SDOs as well as inclusion of relevant accident scenarios.
SCS-011	R&D for Safety, Codes and Standards: Risk Assessments *Daniel Dedrick;* *Sandia National Laboratories*	3.5	X			The reviewers observed that the risk-informed approach built by the team and the incorporation of this approach into the codes and standards development process continue to be major accomplishments for SCS. It was observed that the approach applies relevant scientific input from targeted numerical and experimental efforts along with consultation and input from stakeholders. With this said, the reviewers commented that there should be a stronger push to obtain relevant industry data. In addition, reviewers suggested that a web-based quantitative risk assessment tool be developed and the incorporation of obstacles in indoor releases be added to the project scope.

Project Number*	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue / Further Review	Completed or Congressionally Directed Project	Summary Comments
SCS-015	Hydrogen Emergency Response Training for First Responders *Monte Elmore;* *Pacific Northwest National Laboratory*	3.6	X			Reviewers commended this project for the progress it has made. They specifically recognized the hands-on training and knowledge of the instructors as invaluable. The reviewers expressed concern surrounding the potential loss of funding before the anticipated vehicle deployment in 2015. The reviewers suggested additional coordination with other key agencies such as emergency medical services, national fire academies, and other important regional/state organizations.

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Education

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
ED-010	Development of Hydrogen Education Programs for Government Officials *Shannon Baxter-Clemmons; South Carolina Hydrogen and Fuel Cell Alliance*	3.6			X	Reviewers commended this project for taking a personal, well-focused approach to interfacing with government and business leaders about hydrogen and fuel cells. In addition, they complimented the project for its economic impact approach that highlights energy and environmental benefits. The reviewers noted the strong collaborations, including a combination of universities, industry, and government. The reviewers agreed with the approach of using the lessons already learned in South Carolina to help neighboring states develop their education efforts for hydrogen and fuel cells, and they would like to see a more aggressive effort in this area. This project is fully funded and will be completed in early 2013.
ED-013	Raising H2 and Fuel Cell Awareness in Ohio *Pat Valente; Ohio Fuel Cell Coalition*	3.5			X	Reviewers noted that the Ohio Fuel Cell Coalition (OFCC) is very strategic and tactical in their approach. Several reviewers noted the OFCC's high level of collaboration with several university and industrial partners and noted that they do an excellent job of staying in touch with the activities in Ohio. Reviewers agreed with the project's approach of using forums and business-to-business networking and matchmaking, particularly the supply chain exchange. Due to OFCC's success in Ohio, reviewers would like to see this project expand their efforts to include neighboring states. This project is fully funded and will be completed in 2012.

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Market Transformation

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
MT-004	Direct Methanol Fuel Cell Material Handling Equipment Deployment *Todd Ramsden; National Renewable Energy Laboratory*	3.1	X			Reviewers commented that this project was cleary relevant and good project planning execution has been made. Several reviewers commented that there should be more than one fuel cell developer. Although technical problems have been numerous, commenters stated that the problem resolutions along the way have been highly effective.
MT-006	Fuel Cell Combined Heat and Power Industrial Demonstration *Dale King; Pacific Northwest National Laboratory*	2.8	X			Several reviewers commented that this project was highly relevant. More emphasis on collecting and analyzing real-world project data and less on modeling was recommended. One fuel cell supplier was considered inadequate by some reviewers who suggested adding more suppliers and fuel cells—e.g., solid oxide fuel cells.
MT-007	Landfill Gas-to-Hydrogen *Shannon Baxter-Clemmons; South Carolina Hydrogen and Fuel Cell Alliance*	3.4	X			Excellent project relevance and planning were the comments from reviewers. Also, outstanding partnering and funds leveraging was observed.
MT-008	Hydrogen Energy Systems as a Grid Management Tool *Mitch Ewan; Hawaii Natural Energy Institute*	2.9	X			A clearer relevance to the U.S. Department of Energy's (DOE's) Hydrogen and Fuel Cells Program goals is needed according to several reviewers. While high DOE funds leveraging was noted, schedule slippage related to DOE partners was considered a significant impediment toward a timely project completion.

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Systems Analysis

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
AN-001	Infrastructure Analysis of Early Market Transition of Fuel Cell Vehicles *Brian Bush; National Renewable Energy Laboratory*	2.7	X			According to reviewers, the Scenario Evaluation and Regionalization Analysis model has been developed and successfully integrates other data analysis tools. Specific project strengths highlighted by reviewers include that the model maintains rigorous consistency scenario parameters with Hydrogen Analysis (H2A) assumptions. However, reviewers felt that more coordination with industry stakeholders and inclusion of a more robust scenario analysis was needed. It was suggested that the model be used to 1) examine a range of vehicle rollout scenarios from highly optimistic to pessimistic and 2) compare fuel cell electric vehicle (FCEV) and battery electric vehicle (BEV) penetration scenarios.
AN-012	GREET Model Development and Life-Cycle Analysis Applications *Michael Wang; Argonne National Laboratory*	3.8	X			Reviewers continue to commend this project for the excellent ongoing progress and relevance it is demonstrating and for the inclusion of new analysis and additional case studies. Reviewers thought this project had significant strengths of providing life cycle analysis capabilities, adding shale and biogas analysis capabilities, and operating as the "gold standard" for greenhouse gas emissions calculations. Reviewers suggested that greater visibility to the underlying assumptions and data is needed.
AN-020	Hydrogen Refueling Infrastructure Cost Analysis *Marc Melaina; National Renewable Energy Laboratory*	3.0			X	Reviewers commented that the project has made expected progress. Reviewers felt that the project's strength stems from the field of resources and collaboration, and from the concept of using four station types to assess how fueling stations might be implemented in the future. However, the project suffered from a small field of respondents and the results of hydrogen production/delivery approaches are aggregated together. Reviewers suggested similar data should be obtained for each type of hydrogen station to quantify and substantiate the results and findings.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
AN-021	Comparing Infrastructure Costs for Hydrogen and Electricity *Marc Melaina; National Renewable Energy Laboratory*	3.0			X	The reviewers noted that a considerable amount of work was accomplished with a good team. Reviewers commented that the analysis project is very relevant to the U.S. Department of Energy's Hydrogen and Fuel Cells Program objectives of reducing petroleum use and that some of the project's assumptions need to be refined and validated. The collaboration used in the project was excellent but should be expanded to a wider array of organizations. However, the project should be expanded and calibrated with other major studies that have been completed.
AN-022	Infrastructure Costs Associated with Central Hydrogen Production from Biomass and Coal *Darlene Steward; National Renewable Energy Laboratory*	3.3			X	Reviewers commented that this analysis project was very relevant to the Program's goals and objectives and made good progress. They commended the project for the use of geographic data in conjunction with cost analysis for hydrogen production from coal and biomass. The collaboration used in the project was excellent but should be expanded to a wider array of organizations. The project could be expanded to compare to present energy distribution systems, including the present gasoline delivery system.
AN-023	H2-Vehicles Market Prospect, Cost, and Social Benefit *David Greene; Oak Ridge National Laboratory*	3.2	X			Reviewers observed that this project has showed the beneficial effect of subsidies and compared fuel cell vehicles to other technologies. They commended the project for the comprehensive sensitivity analysis toward implementation of hydrogen for vehicular applications. The project could be strengthened by including additional input from original equipment manufacturers (OEMs) and adding subsidies for electrical infrastructure. Reviewers suggested performing future studies recognize impact of compliance to U.S. regulatory standards such as CAFE.

Project Number*	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
AN-024	Issues Affecting Hydrogen Pathway Succession *Mark Ruth;* *National Renewable Energy Laboratory*	2.8			X	Reviewers observed that this project had an excellent choice of comparison technologies. They commended the project for the comprehensive sensitivity analysis toward implementation of hydrogen for vehicular applications. The project could be strengthened by adding the impact of technology developments and future technologies. The project score was low because the project is complete and no future work is planned.
AN-025	Impact of Program Targets on Vehicle Penetration and Benefits *Zhenhong Lin;* *Oak Ridge National Laboratory*	3.0			X	Reviewers observed the project approach was sound but was limited by the available funding. They commended the project for the extensive collaboration. The project strength was the focus on the "what if" scenarios and impact on DOE goals. The project could be strengthened by including additional input from OEMs and a wider array of stakeholders. Reviewers suggested future studies recognize impact of compliance to U.S. regulatory standards such as CAFE.
AN-026	Resource Analysis for Hydrogen Production *Marc Melaina;* *National Renewable Energy Laboratory*	3.1			X	Reviewers observed that this analysis project demonstrated good progress and approaches in addressing the resources required to produce hydrogen to support 100 million FCEVs. They commended the project for presenting an easy-to-understand analysis of the impact of renewable hydrogen production on resource supply. Reviewers suggested future analysis includes industry input and regional impact assessments.
AN-027	Cost, Energy Use, and Emissions of Combined Hydrogen, Heat, and Power Tri-Generation Systems *Mark Ruth;* *National Renewable Energy Laboratory*	2.9			X	Reviewers believed that this project was a good application of the fuel cell power model. It was suggested that the project add more industrial input and the analysis assumptions be strengthened. Combined, heat, hydrogen, and power (CHHP) should remain in the portfolio as a possibility for a system approach, but other techniques for optimizing heat, hydrogen, and electricity balance should be addressed.

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AN-029	Employment Impacts of Early Markets for Hydrogen and Fuel Cell Technologies *Marianne Mintz; Argonne National Laboratory*	3.6	X			Reviewers agreed with the purpose of the model, recognizing that understanding economic impact will be critical to advancing industry deployment. They identified the need to get this model to a broad audience. Reviewers acknowledged the impressive list of stakeholders and collaborators for the project. They recommended that future work should validate the economic impacts of individual installations of products for end-users and OEMs. They also noted that the model should be expanded to include FCEV fueling infrastructure.

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American Recovery and Reinvestment Act

Project Number*	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
H2RA-002	Solid Oxide Fuel Cell Diesel Auxiliary Power Unit Demonstration *Dan Hennessy;* *Delphi Automotive*	2.9	X			According to reviewers, the project is on a clear path to commercialization and is addressing a key market for fuel cells—Class 8 sleeper trucks. Reviewers praised Delphi's commitment to the project and their involvement as an end user. However, the reviewers felt the desulfurization work and corresponding schedule delays were a major weakness. It was recommended that Delphi consider additional units for deployment beyond the single unit and look to other markets where auxiliary power units could be applicable.
H2RA-003	Highly Efficient, 5-kW CHP Fuel Cells Demonstrating Durability and Economic Value in Residential and Light Commercial Applications *Donald Rohr;* *Plug Power Inc.*	2.1	X			Reviewers observed that this project has a huge potential for energy reduction at end-user sites (e.g., homes), but were concerned with the significant technical issues (e.g., membrane electrode assembly failures) and corresponding schedule delays. The reviewers felt there was valuable data from the modeling work and that the project team made a good decision to transition the remaining deployment duties to another fuel cell manufacturer. It was recommended that the project team show a cost/benefit analysis for this particular market.
H2RA-007	Accelerating Acceptance of Fuel Cell Backup Power Systems *Donald Rohr;* *Plug Power Inc.*	2.6	X			Reviewers observed that transitioning some of the project responsibilities to another fuel cell manufacturer was a good decision, but are concerned with slow technical progress. The reviewers are uncertain about any commercialization prospects and recommended investigating system reliability. It was also recommended that the project team analyze the business case for this particular market.

Project Number*	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed or Congressionally Directed Project	Summary Comments
H2RA-012	Use of 72-Hour Hydrogen PEM Fuel Cell Systems to Support Emergency Communications *Kevin Kenny;* *Sprint*	3.7	X			Reviewers observed that this project has done a great job of methodically selecting sites and deploying large numbers of fuel cells and continues to make significant progress. The reviewers felt there was strong industry support, and the project has done well to establish a diverse set of collaborators. It was recommended that the project team look into reformer-based technologies to expand their potential deployment-site pool.
H2RA-013	Analysis Results for ARRA Projects: Enabling Fuel Cell Market Transformation *Jennifer Kurtz;* *National Renewable Energy Laboratory*	3.7	X			Reviewers indicated that this project provides extremely valuable information from a variety of collaborators and fuel cell deployment sites. The reviewers felt this effort should continue, even as other Recovery Act projects come to completion. It was recommended that the project team collect data on internal combustion engine and battery applications in addition to the fuel cell data collection. The reviewers also recommended more effort in sharing the results with industry.

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