PROLOGUE

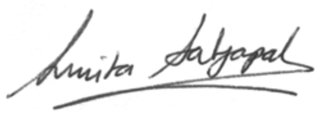
Dear Colleague:

This document summarizes the comments provided by peer reviewers on hydrogen and fuel cell projects presented at the FY 2009 U.S. Department of Energy (DOE) Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting (AMR), held on May 18-22, 2009 in Arlington, Virginia. In response to direction from various stakeholders, including the National Academies, this review process provides evaluations of the Program's projects in applied research, development, demonstration and analysis of hydrogen, fuel cells and infrastructure technologies. The plenary included overview presentations from the Office of Energy Efficiency & Renewable Energy (EERE), Hydrogen Program, Vehicle Technologies Program, and Office of Basic Energy Sciences, as well as international presentations from government organizations in Germany, Japan, and the European Commission.

The recommendations of the reviewers have been taken into consideration by DOE Technology Development Managers in generating future work plans. The table below lists the projects presented at the review, evaluation scores, and the major actions to be taken during the upcoming fiscal year (October 1, 2009 to September 30, 2010). The projects have been grouped according to subprogram (i.e., Production and Delivery, Hydrogen Storage, Fuel Cells, Systems Analysis, Manufacturing) and reviewed according to the five evaluation criteria. The weighted scores are based on a four-point scale. To furnish all principal investigators (PIs) with direct feedback, all evaluations and comments are provided to each presenter; however, the authors of the individual comments remain anonymous. The PI of each project is instructed by DOE to fully consider these summary evaluation comments, as appropriate, in their FY 2010 plans.

I would like to express my sincere appreciation to the reviewers. You make this report possible, and we rely on your comments to help make project decisions for the new fiscal year. We look forward to your participation in the FY 2010 Annual Merit Review, which is presently scheduled for June 7-11, 2010 at the Washington Marriott Wardman Park in Washington, DC. Thank you for participating in the FY 2009 Annual Merit Review and Peer Evaluation Meeting.

Sincerely,



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Hydrogen Production and Delivery

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
PD-02	Bio-Derived Liquids Reforming *Yong Wang; Pacific Northwest National Laboratory*	2.9	X			The researchers understand the role of variables such as space velocity, catalyst, and steam/carbon ratio in reforming and in achieving project goals for sugar and alcohol reforming. The basic catalyst approaches are sound but the catalyst lifetime needs to be included in the economic analysis. The project will continue catalyst modifications and performance characterizations with a focus on the APR systems.
PD-03	Hydrogen Generation from Biomass-Derived Carbohydrates via the Aqueous-Phase Reforming Process *Bob Rozmiarek; Virent Energy Systems, Inc.*	2.9	X			The project team is heading in the proper direction with a goal of commercializing the aqueous phase reforming process and there is good coordination of catalyst development theory with evaluation. The reviewers noted it was difficult to review this project because of project secrecy. The project is in the final budget period and will continue through the end of the agreement.
PD-04	Investigation of Reaction Networks and Active Sites in Bio-Ethanol Steam Reforming over Co-based Catalysts *Umit S. Ozkan; Ohio State University*	3.3	X			Non-precious metal catalyst development is necessary to achieve long-term DOE cost targets. The catalyst development activity will provide a sound basis for a decision on the efficiency and effectiveness of the non precious metal catalyst at the end of the project. A concern remains regarding the lifetime of the catalyst. Next steps include long- term (> 100 hrs) time-on-stream experiments and accelerated deactivation and regeneration studies.
PD-05	Distributed Reforming of Renewable Liquids Using Gas Transport Membranes *U. (Balu) Balachandran; Argonne National Laboratory*	2.3			X	The project aims to develop an oxygen transport membrane (OTM) for distributed reforming of bio-derived liquids to produce hydrogen. Module-scale modeling will be needed to understand the potential hydrogen pressure that might be achieved. Recommendations include addressing flux and heat management issues and third party analysis of costs. The project will continue to optimize OTM for hydrogen production and chemical stability, and will develop an H2A techno-economic analysis of the process. This work will undergo an interim review in 2010 to determine if the project will continue.
PD-06	Zeolite Membrane Reactor for Water-Gas-Shift Reaction for Hydrogen Production *Jerry Y.S. Lin; Arizona State University*	3.3	X			Materials development in the photo-electrochemical arena is clearly relevant, especially if such materials show improvements over photovoltaics/electrolyzer systems. The membrane development team has shown good technical success. A cost analysis is needed to validate the potential for significant cost reductions in hydrogen production. Research would benefit from increased focus on the catalytic aspect and from partnering with industry. The project and will continue modifications of membrane materials to improve performance.
PD-07	High-Performance, Durable, Palladium Alloy Membrane for Hydrogen Separation and Purification *Jim Acquaviva; Pall Corporation*	3.2	X			The team shows strong collaboration and steady progress in the development of a Pd-alloy membrane that enables the production of 99.99% pure hydrogen from reformate, particularly with the flux rate. Next steps include the evaluation of the membrane durability, membrane formation process improvement, and techno-economic analysis.

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PD-08	Solar Cadmium Hydrogen Production Cycle *Bunsen Wong; General Atomics*	2.7	X			Progress has been made on identifying whether the cadmium quench step of this solar thermochemical process can be accomplished without significant back reaction with oxygen and identified a solar receiver in which the reaction can take place on the ground. The reviewers recommend evaluating alternative approaches to the rotating machinery for the hydrogen production step.
PD-09	Solar High-Temperature Water-Splitting Cycle with Quantum Boost *Ali T-Raissi; Florida Solar Energy Center*	2.9	X			The sulfur-ammonia thermochemical cycle team has identified the critical path in this technology to be the electrolyzer development and will focus on this barrier as the project continues. The reviewers recommend that the solar field work be delayed until the electrochemical process is finalized.
PD-10	Solar-Thermal Ferrite-Based Water Splitting Cycles *Alan W. Weimer; University of Colorado, Boulder*	2.8	X			Significant achievements in the use of ferrites for solar thermochemical water splitting processes include the development and testing of the aerosol reactor and the decrease of 200°C in the ferrite reduction temperature. Next steps in this project will focus on cycling the ferrite materials to define particle degradation.
PD-11	R&D Status for the Cu-Cl Thermochemical Cycle *Michele Lewis; Argonne National Laboratory*	3.2			X	The reviewers note that the Cu-Cl cycle is one of the most promising thermochemical cycles and that the team has a solid approach to their work. Recommendations include focusing on the elctrolyzer membrane and on materials compatible with a corrosive environment. The Nuclear Hydrogen Initiative is cancelled as of the end of FY 2009. The Fuel Cell program may continue funding this project subject to appropriations.
PD-12	Sulfur-Iodine Thermochemical Cycle *Paul Pickard; Sandia National Laboratories*	3.3			X	The team has made significant progress in the S-I thermochemical cycle but the reviewers identify the need for improved catalysis, separation of the reaction products, removal of the product gases, and a comprehensive cost analysis. The Nuclear Hydrogen Initiative is cancelled as of the end of FY 2009. Recommend continued R&D if the Fuel Cell program is able to provide funding due to relevance for solar high temperature cycles.
PD-13	Hybrid Sulfur Thermochemical Cycle *William A. Summers; Savannah River National Laboratory*	3.3			X	Good progress has been made on the hybrid sulfur thermochemical cycle and the team was commended for the clever solution to minimize sulfur crossover. Future work should include long term durability testing. The Nuclear Hydrogen Initiative is cancelled as of the end of FY 2009. Recommend continued R&D if the Fuel Cell program is able to provide funding due to relevance for solar high temperature cycles.
PD-14	High Temperature Electrolysis System *Steve Herring; Idaho National Laboratory*	3.1			X	The demonstration of the multi kilowatt electrolyzer stacks was noted as a significant achievement by the team. However, the issues of cell performance need to be addressed before proceeding to future large stack demonstrations. The Nuclear Hydrogen Initiative is cancelled as of the end of FY 2009. Recommend continued R&D if Fuel Cell program is able to provide funding due to relevance for solar high temperature cycles.

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PD-15	Technoeconomic Boundary Analysis of Photobiological Hydrogen Producing Systems *Brian D. James; Directed Technologies, Inc.*	3.4			X	A technoeconomic boundary analysis was completed to evaluate four different hydrogen production option using biological processes: 1) photosynthesis with algae and bacteria; 2) water algae fermentation; 3) lignocellulose fermentation; and 4) microbial electrolysis. These approaches included not only single systems but also multiple system embodiments and system integrations. A final report needs to be completed to close out the project.
PD-16	Maximizing Light Utilization Efficiency and Hydrogen Production in Microalgal Cultures *Tasios Melis; University of California, Berkeley*	3.5	X			The project continues to make excellent progress toward the goal to enhance light usage by shortening the light receptor antenna. Cloning of previously identified genes demonstrates the value and validity of the work with efficiency targets achieved ahead of schedule. Work on this project toward cloning newly identified genes to meet long term targets will continue.
PD-17	Biological Systems for Hydrogen Photoproduction *Maria L. Ghirardi; National Renewable Energy Laboratory*	2.7	X			The project continues to make progress on optimizing photosynthetic water-splitting biological hydrogen production and increasing catalyst stability while improving oxygen tolerance. The partnership between various universities, an international institution, and a national lab is good. However, the reviewers noted that additional progress was expected based upon the funding level.
PD-18	Fermentative and Electrohydrogenic Approaches to Hydrogen Production *Pin-Ching Maness; National Renewable Energy Laboratory*	3.6	X			This project has a very good combination of novel fermentation with MEC technology, which allows for better feedstock utilization. The systematic inhibitor study was excellent in this project, and the molar yields are quite impressive.
PD-19	Development of Water Splitting Catalysts Using a Novel Molecular Evolution Approach *Neal Woodbury; Arizona State University*	2.9	X			Much progress has been made in producing and testing numerous formulations in this project, and automation has enhanced sample throughput. However, the reviewers note that significant progress was not reported since the last review and recommend that a more focused approach should be taken.
PD-20	High-Capacity, High Pressure Electrolysis System with Renewable Power Sources *Martin Shimko; Avalence LLC.*	2.8	X			This is a relatively new project with a unique electrolysis system design. The project focuses on high-pressure electrolysis from potentially renewable sources. It was initiated in May 2008 and is currently on track with respect to its planned schedule of accomplishments. Future work continues current activities. The project should develop a detailed cost estimate, assuming success of their design.
PD-21	PEM Electrolyzer Incorporating an Advanced Low Cost Membrane *Monjid Hamdan; Giner Electrochemical Systems, LLC*	3.7	X			This new project is targeted at developing a high-efficiency, low-cost membrane, a long life lower cost cell separator, and reducing the cost and improving the efficiency of the BOP. The dimensionally stabilized membrane is one step in this direction. The reviewers recommend that the team focus on larger cell stacks and understand the cause of cell degradation.
PD-22	Photoelectrochemical Hydrogen Production: DOE PEC Working Group Overview *Eric L. Miller; Univ. of Hawaii at Manoa*	3.3	X			The photoelectrochemical (PEC) working group is an important effort aimed at coordinating research from a dozen institutions. This project shows good integration of theory, synthesis, surface science, and electrochemistry. This project is encouraged to bring industrial partners into the working group.

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PD-23	Technoeconomic Boundary Analysis of Photoelectrochemical (PEC) Hydrogen Producing Systems *Brian James; Directed Technologies Inc.*	3.2			X	The team has a strong background in H2A type economic analysis and the technoeconomic model is well designed. The PEC systems are still conceptual and will come into the focus when materials are identified. At that point, industrial partners will need to be integrated into the project. A final report needs to be completed to close out the project.
PD-24	Characterization of Materials for Photoelectrochemical Hydrogen Production (PEC) *Clemens Heske; University of Nevada, Las Vegas*	3.3	X			The project is important for the development and analysis of PEC materials, and the team is successfully applying and developing state-of-the art measurement techniques and equipment to achieve required experimental results. Project collaboration and information dissemination is very good. Future work will add abilities to further understand surface chemistry of PEC.
PD-25	Nanostructured MoS2 and WS2 for the Solar Production of Hydrogen *Thomas F. Jaramillo; Stanford University*	3.5	X			The approach of quantum confinement is a novel and unique way to address the search for the optimum PEC material. The project is showing significant progress towards meeting the goal of a 2.0 eV band gap for photo cathodes. Durability needs to be addressed at some point. Future work should include a demonstration of improved photoelectrochemical behavior of the synthesized materials.
PD-26	Development of Hydrogen Selective Membranes/Modules as Reactors/Separators for Distributed Hydrogen Production *Paul KT Liu; Media and Process Technology Inc.*	3.0	X			Design, fabrication, evaluation and economic analysis of H_2 selective membranes work has progressed through the laboratory stage and the project will move to field testing in July. The reviewers recommend that membrane performance measurements be reported in consistent units and that the investigators review the impact of compression on the cost of the process.
PD-28	A Novel Slurry Based Biomass Reforming Process *T.H. Vanderspurt; United Technologies Research Center*	2.3			X	Since the last review, the project changed direction from an acid, which was not yielding positive results, to a base hydrolysis reaction with initial results showing >95% conversion of yellow poplar and 74% H_2 selectivity. The reviews ranged from very positive to disbelief and the final score reflects this difference. The investigators will need to show that the flow through reactor works as well as the batch reactor and a follow up evaluation will determine if progress warrants continuation.
PD-30	Hydrogen Delivery Infrastructure Analysis *Marianne Mintz; Argonne National Laboratory*	3.5	X			Delivery represents a significant portion of the consumers' cost of hydrogen; it is necessary that we understand the costs associated with the various options. The project showed that significant cost reductions are available through flattening the hydrogen demand profile. A recommendation is to add chemical hydrides as a delivery option.
PD-31	H2A Delivery Components Mode *Olga Sozinova; National Renewable Energy Laboratory*	3.2	X			The Hydrogen Delivery Components Model is a well-used tool by the hydrogen community and is essential for cost analysis of hydrogen delivery components and systems on the basis of common and transparent assumptions. The project accomplishments have been steady. The reviewers recommend calibrating the model against an actual installation to determine model accuracy.

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PD-32	Hydrogen Energy Station Analysis in Northeastern US and Hydrogen Sensors for Infrastructure *Eileen Schmura; Concurrent Technologies Corporation*	2.1			X	This project is nearing completion. The majority of the work focuses on analysis of stationary fuel cell sites powered by biogas (landfill and digester gas) in the northeastern U.S. corridor for combined heat and power (CHP) and combined heat, hydrogen, and power (CHHP). A secondary aspect was the evaluation of hydrogen sensors. The reviewers noted little progress on the hydrogen sensors. (This is a congressionally directed project).
PD-34	Oil-Free Centrifugal Hydrogen Compression Technology Demonstration *Hooshang Heshmat, Ph.D.; Mohawk Innovative Technology, Inc.*	3.2	X			Industrial compressors are one of the key barriers to cost effective hydrogen supply and distribution. This new project is pursuing an innovative high-speed supercritical design. The project has good technical competency and industrial players. Future work is focused on design, fabrication, and testing, in support of a down-select decision.
PD-35	Development of a Centrifugal Hydrogen Pipeline Gas Compressor *Francis A. Di Bella; Concepts NREC*	3.3	X			This new project targets the design and demonstration of an advanced centrifugal compressor for high-pressure hydrogen pipeline transport. It is taking a methodical approach to system design and involves industry partners. The design of a system and end rotor seems novel and well thought out. Future work will include materials testing, compressor design, and addressing gearbox issues.
PD-36	Advanced Hydrogen Liquefaction Process *Jerry Jankowiak; Praxair*	2.6	X			This new project is pursuing a reduced energy process targeted to make liquid hydrogen more economically viable as a transportation fuel. The project has a proprietary approach, the details of which need to be made public at some point. The project is in its early stages. Future plans have not been described in sufficient detail.
PD-37	Active Magnetic Regenerative Liquefier *John A. Barclay; Prometheus Energy Company*	3.0	X			This new project is investigating a novel, non-compression technique for hydrogen liquefaction. Good technical results have been achieved. The project team will complete assembly tests by 4th quarter 2009. A detailed system analysis to calculate expected performance and evaluate advantages/disadvantages with respect to conventional liquefaction process will be performed.
PD-38	Reversible Liquid Carriers for an Integrated Production, Storage and Delivery of Hydrogen *Bernie Toseland; Air Products and Chemicals, Inc.*	2.6	X			This project addresses hydrogen carriers for both onboard and off board hydrogen regeneration, but its potential to meet hydrogen production, delivery, and storage targets is not well defined. Also, the evaluation is being performed using a compound that will not be used commercially. The investigators should identify and test the compound of interest. An evaluation is warranted to determine whether a non toxic carrier exists.
PD-39	Inexpensive Delivery of Cold Hydrogen in High Performance Glass Fiber Composite Pressure Vessels *Andrew Weisberg; Lawrence Livermore National Laboratory*	3.1	X			The project seeks to demonstrate inexpensive hydrogen delivery through synergy between low-temperature (200 K) hydrogen densification and glass fiber strengthening, to reduce the cost of storage and tube trailer delivery. The team has made good progress. The selection of the operating regime to reduce delivery cost should be reviewed in the context of total cost.

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PD-40	Development of High Pressure Hydrogen Storage Tank for Storage and Gaseous Truck Delivery *Don Baldwin; Lincoln Composite Inc.*	3.0	X			The project approach begins with the design and qualification of 3600 psi tanks, then will move to 5000 psi tanks. Cost reduction and risk mitigation are the primary objectives. Progress has been made on development and qualification of the 3600 psi tank. Collaboration in the area of testing to ensure the damage tolerance of the design to realistic scenarios should be incorporated.
PD-41	A Combined Materials Science/Mechanics Approach to the Study of Hydrogen Embrittlement of Pipeline Steels *P. Sofronis; University of Illinois at Urbana-Champaign*	3.4	X			The work has generated considerable insight regarding the mechanism of steel pipeline failures due to hydrogen transport. The researchers used pipeline samples supplied by manufacturers (Air Products, Air Liquide, OSM steels) to provide a basis for further work. The experimental and theoretical methods were noted as being very strong.
PD-42	Fiber Reinforced Composite Pipelines *Dr. Thad M. Adams and G. Rawls; Savannah River National Laboratory*	2.5	X			The hydrogen permeation and integrity part of this project is complete. Test samples were prepared and tested for hydrogen solubility, diffusivity and permeability. The team should focus on the requirements needed by authorities with jurisdiction for installing FRP for hydrogen service. The investigators should consider partnering with stakeholders and begin field tests.
PD-43	H_2 Permeability and Integrity of Steel Welds *Z. Feng; Oak Ridge National Laboratory*	3.6	X			The project aims to analyze the fracture behavior of welds in the presence of hydrogen. The approach of analysis for fracture toughness of welds in the presence of hydrogen may need better definition. Baseline fracture tests with notched cylindrical bars of 4340 steel microstructures have been performed. More emphasis should be put on conventional welding processes, in addition to friction stir welding.
PD-44	Composite Pd and Alloy Porous Stainless Steel Membranes for Hydrogen Production and Process Intensification *Yi Hua Ma; Worcester Polytechnic Institute*	2.9	X			The project has shown good progress regarding synthesis, fabrication and testing of Pd and Pd alloy composites membranes for applications in WGS reactors. The experimental testing methods are adequate and carefully performed. The modeling simulations are very useful for predicting the performance of the membrane in a broad range of conditions. Reported test results of the membranes, using simplified gas mixtures, indicate very good long-term H_2 selectivity and stability. However these tests should be extended to gas mixtures that are more realistic and similar in compositions with syngas.
PD-45	Development of Robust Metal Membranes for Hydrogen Separation *Brian D. Morreale; National Energy Technology Laboratory*	2.9	X			A test protocol has been developed to standardize membrane testing and to enable comparison in coal conversion processes. Several alloy compositions have been fabricated and screened for performance, and some alloys have shown potential for S-tolerance. Comments suggested the project team should consider developing a list of selection criteria in trying to optimize membrane development, and testing with real syngas from a gasifier.
PD-46	Scale-up of Hydrogen Transport Membranes for IGCC and FutureGen Plants *Doug S. Jack; Eltron Research & Development Inc.*	2.4			X	The project has shown progress in the development of an H_2/CO_2 separation system for coal gasifier systems. Comments suggested that the project has high potential if successful, but reviewers thought more information and data to support the highlighted results was required to more accurately review this project. Most reviewers believed that additional testing of the membranes is needed before scaling up.

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PD-47	High Permeability Ternary Palladium Alloy Membranes with Improved Sulfur and Halide Tolerance *Kent Coulter, Ph.D.; Southwest Research Institute®*	3.2	X			The experimental and computational modeling approaches employed in this project are generally well planned and effective and the project team is working with a number of very capable groups, with complementary expertise. It was recommended that the computational modeling efforts become more coordinated with laboratory studies. Additionally, more emphasis should be given to improving and validating the modeling procedures for predicting hydrogen permeability of various alloys under different temperature and pressure conditions, and to investigating methods that improve membrane durability. Overall, the project was considered to have significant value to industry by providing a powerful tool to make alloy compositions with high precision.
PD-48	Experimental Demonstration of Advanced Palladium Membrane Separators for Central High-Purity Hydrogen Production *S.C. Emerson; United Technologies Research Center*	2.9			X	The objective of this project is to develop, construct and experimentally validate the performance of 0.1 kg H_2/day PdCu trimetallic alloy membrane separators at feed pressures of 2 MPa (290 psia) in the presence of H_2S, NH_3, and HCl. In this study, The project team has a good approach to develop a sulfur, halide, and ammonia resistant alloy membrane for hydrogen separation. A large number of contaminants in the test gases have been used, making the test results more realistic. Project completion occurs in FY2009.
PD-49	Integration of a Structural Water Gas Shift Catalyst with a Vanadium Alloy Hydrogen Transport Device *Tom Barton; Western Research Institute*	3.0			X	Objectives of this project include development and testing of WGS catalysts capable of operating at high pressures and manufacturing an integrated WGS membrane system to produce 10,000 liters/day of hydrogen from coal-derived syngas. Overall, the technical accomplishments of the project have been good and the team had good collaboration among universities, national laboratories, and industry. It was recommended that the performance tests for the WGS catalysts and membranes should be extended to conditions that better mimic more realistic syngas compositions. Project completion occurs in FY2009.
PD-50	Hydrogen Delivery in Steel Pipelines *Doug Stalheim; Secat, Inc.*	2.8		X		The identification, development and analysis of promising modern low-carbon steel microstructures were identified by the reviewers as a strength of this project. Recommendations are to focus on fracture toughness assessments and the effect of impurities on metal integrity. The project ends in FY2009.
PDP-01	Development and Optimization of Cost Effective Material Systems for Photoelectrochemical Hydrogen Production *Eric McFarland; University of California, Santa Barbara*	3.2	X			This project is advancing many areas of understanding and technology in photoelectrochemical hydrogen production and has made progress in understanding Fe_2O_3 that may also be useful when developing other low gap oxide materials or for using Fe_2O_3 in a tandem system. The team is working toward finding an adequate photoelectrochemical material prior to engineering a complete system.

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PDP-02	Semiconductor Materials for Photoelectrolysis *John A. Turner; National Renewable Energy Laboratory*	3.0	X			This project targets cheap, durable and efficient materials for PEC. Stabilization of the III-V materials class is the central focus, but other important classes are also under investigation. There was progress in the synthesis and characterization of InGaN-based materials. Future work needs to focus strongly both on improving the stability and reducing the cost of the III-V materials.
PDP-03	PEC Materials: Theory and Modeling *Yanfa Yan; National Renewable Energy Laboratory*	3.1	X			The focus of the project is to understand the performance of PEC materials and provide guidance and solutions for performance improvement, design and new materials discovery. Density functional theory (DFT) is the right approach to perform material discovery. The project has good coordination between theory and experiments.
PDP-04	Progress in the Study of Amorphous Silicon Carbide (a-SiC) as a Photoelectrode in Photoelectrochemical (PEC) Cells *Arun Madan; MVSystems, Inc.*	3.0	X			The objective of the project is to fabricate a hybrid a-Si tandem solar cell/a-SiC photoelectrode (PV/a-SiC) device. The approach of tailoring the bandgap with deposition control and multilayer films is a good strategy for capturing the solar spectrum. The project has made good progress in materials development and testing. The project would benefit from a cost assessment to ensure the technology is on the path to achieving overall hydrogen production cost targets.
PDP-05	Progress in the Study of Tungsten Oxide Compounds as Photoelectrodes in Photoelectrochemical Cells *Nicolas Gaillard; University of Hawaii*	3.3	X			The project is relevant to establishing the next steps for photoelectrochemical hydrogen production (PEC) electrode structures. There is a methodical approach that evaluates the individual layers of the PEC electrode. An improvement in WO_3-based PEC electrode performance has been demonstrated via new materials/fabrication techniques, and this will be pursued to further improve PEC performance.
PDP-06	Photoelectremical Hydrogen Production *Jess Kaneshiro; University of Hawaii at Manoa*	3.1	X			The investigation of copper chalcopyrite is good since these materials are inexpensive and durable. High currents have been achieved, but stability needs to be addressed. Voltage bias has been reduced by sulfur incorporation in the materials. The project will continue to focus on the reduction of voltage bias by investigating new and/or different materials.
PDP-07	Critical Research for Cost-Effective Photoelectrochemical Production of Hydrogen *William B. Ingler, Jr.; University of Toledo*	2.5	X			The project seeks to develop critical technologies required for cost-effective production of hydrogen from sunlight and water using thin film (tf)-Si-based photoelectrodes. Only some of the project tasks are directly relevant to the goals of PEC hydrogen production. The project shows some good potential and results, but significant technical barriers still exist. With regard to future activities, there may not be enough time and funding to achieve the project goals.
PDP-10	Composite Bulk Amorphous Hydrogen Purification Membranes *T. Adams; Savannah River National Laboratory*	2.8	X			The project focus on using low-cost metallic glass membranes instead of high-cost palladium is in line with DOE programmatic goals. The currently measured hydrogen flux rates are generally an order of magnitude below those of palladium. Work is in progress to generate thin films of the metallic glass to improve hydrogen flux rates. Future plans include work to generate and measure flux rates in thin films, additional modeling work, and testing of alloys suggested by the modeling work.

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PDP-12	Catalytic Solubilization and Conversion of Lignocellulosic Feedstocks *T.A. Semelsberger; Los Alamos National Laboratory*	3.0	X			The project focus on biomass from non-food/feed crops is an excellent approach for feedstocks for the production of hydrogen. The screening experiments with an array of potential catalysts using solid biomass and potential biomass digestion products to look for evidence of biomass breakdown have resulted in some encouraging results. The future plan includes both additional screening experiments and some focused work on lignin, which has proven to be the most difficult part of the biomass to digest.
PDP-13	Novel Low-Temperature Proton Transport Membranes *Andrew Payzant; Oak Ridge National Laboratory*	2.5		X		The project has successfully synthesized 10 micron films on Y-stabilized zirconia. The reviewers indicated that the results were modest with very low hydrogen fluxes to-date, and that targets, milestones and performance metrics for the project were lacking. This project will be discontinued.
PDP-14	Ultra-thin Proton Conduction Membranes for H_2 Stream Purification with Protective Getter Coatings *Dr. Margaret E. Welk; Sandia National Laboratories*	2.6			X	The reviewers commented that the project team's integrated/monolithic approach to S gettering/H_2 purification should provide a simplified system design and good robustness. Reviewers recommended that the membranes be tested under real in-service operating conditions and that performance and cost comparisons be made with alternative technologies. An interim review will be conducted in FY 2010 to determine if this project will continue.
PDP-15	Distributed Bio-Oil Reforming *S. Czernik; National Renewable Energy Laboratory*	3.2	X			The project was found to be very well thought out and has shown progress in producing hydrogen from pyrolysis oil. The catalyst development work and reducing the methanol concentration were particularly noteworthy. Recommendations for future work include evaluating lower cost catalysts and the life cycle cost of the process.
PDP-16	Pressurized Steam Reforming of Bio-Derived Liquids for Distributed Hydrogen Production *Shabbir Ahmed; Argonne National Laboratory*	2.4			X	The modeling effort over the past year has provided insight into options for pressurized steam reforming of ethanol. However, the reviewers note that the minimal funding that was available in FY 2009 was not sufficient to experimentally verify the model. This work will be evaluated further to determine whether to continue the funding in FY 2010.
PDP-17	Renewable Electrolysis Integrated System Development and Testing *Kevin W. Harrison; National Renewable Energy Laboratory*	3.3	X			The team addresses a key area of hydrogen use with renewable energy sources and provides a good combination of analysis and experimental results. The reviewers feel that long term data generation is critical to the success of this project and that the compressor and fueling station work are diluting the focus.
PDP-18	Hydrogen from Water in a Novel Recombinant Oxygen-Tolerant Cyanobacterial System *Qing Xu; J. Craig Venter Institute*	3.2	X			The team has a well developed plan to identify, isolate, and express oxygen tolerant hydrogenase genes and a vast library and tools for their use. A better explanation should be provided to understand how the results from this project will apply to commercial hydrogen production systems.

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PDP-19	Use of Biological Materials and Biologically Inspired Materials for H_2 Catalysis *John W. Peters; Montana State University*	3.1	X			The focus on improving hydrogenase stability and on enzymes and catalyst supports is good and the investigators have made progress on well defined goals. However, the coordination and even the relationship between the different parts of this project are not clear. The project team should focus more on down selecting different configurations for the biomimetic device.
PDP-20	Hydrogen Embrittlement of Structural Steels *Brian Somerday; Sandia National Laboratories*	2.7	X			The project has shown the dependence of the degree of hydrogen embrittlement on the type of steel. However, questions arise on the variation in the round robin testing and whether all participating labs were calibrating in the same manner. Additional planning and coordination are recommended before proceeding much further.
PDP-21	Oil-Free Rotor-Bearings for Hydrogen Transportation & Delivery *Hooshang Heshmat, Ph.D.; Mohawk Innovative Technology, Inc.*	3.1			X	The project is a Phase II SBIR project aimed at the development of foil bearings (journal and thrust) for hydrogen pipeline compressors. The project has made steady progress and is on its way to the next prototype setup and testing phase. Future activities will focus on a final report of the overall project and dynamic seal tests at high pressures, speeds, and temperature.
PDP-22	Development of Highly Efficient Solid State Electrochemical Hydrogen Compressor (EHC) *Ludwig Lipp; FuelCell Energy, Inc.*	3.5	X			The project will continue as a Phase II SBIR. The project supports a critical delivery objective within the Hydrogen Program. Good progress is being made. The ability to provide a 300:1 compression ratio is impressive. Durability studies (1000 cycles to 3000 psi) demonstrate good durability. The project should establish cost goals in addition to performance in order to focus future work.
PDP-24	Composite Technology for Hydrogen Pipelines *Barton Smith; Oak Ridge National Laboratory*	3.3	X			This project appears to have significant potential to reduce the cost of hydrogen pipelines to meet the DOE targets. Composites experience in the natural gas industry provides a good basis for this work. Surface treatments and associated testing will yield valuable data on the ability to improve the permeability of polymer pipelines. A strong collaboration with pipe, liner, and coupling manufacturers will be pursued moving forward into next year.
PDP-25	Coatings for Centrifugal Compression *George Fenske; Argonne National Laboratory*	3.0	X			The team has used a very practical approach to material failure in a reducing environment and several promising coatings have been tested side-by-side to provide comparisons. The reviewers recommend that the project should focus on understanding the mechanisms by which hydrogen affects the tribological features of interfaces.
PDP-26	Purdue Hydrogen Systems Laboratory *J. Gore; Purdue University*	2.5			X	The project objectives are very broad and wide-ranging. There has been progress towards the objective of identifying ideal process parameters. The bio approach generally suffers from low hydrogen yields, low kinetics, and scale-up issues. There is no clearly described path for taking this technology forward into a commercially viable, scalable process. Future work is a continuation of the current efforts. (This is a congressionally directed project).

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
PDP-27	Developing Improved Materials to Support the Hydrogen Economy *Michael Martin; Edison Materials Technology Center*	2.2			X	The objectives of this project are to demonstrate feasibility with job creation potential, identify cross-cutting breakthrough materials technologies, and stimulate near-term manufacturing-based commercialization. A small number of the projects appear to be generating revenue, which may be a sign of some technical success. The project is essentially complete. (This is a congressionally directed project).
PDP-28	Hydrogen Production and Fuel Cell Research *D. Yogi Goswami; University of South Florida*	1.9			X	The project objectives are to investigate the feasibility of the UT-3 thermochemical cycle theoretically and experimentally, develop calcium oxide reactants with favorable characteristics and better performance, conduct kinetic studies of gas-solid reactions to examine and improve cyclic stability and performance of solid reactants, and lower hydrogen production cost by increasing hydrogen yield with an improved solid reactant. These objectives are too broad and diverse. There is no clear project management organization. Most of the hydrogen production schemes attempted have already been thoroughly studied. Future work needs more focus on overcoming DOE barriers. (This is a congressionally directed project).
PDP-29	Integrated Hydrogen Production, Purification and Compression System *Satish Tamhankar; Linde North America Inc.*	2.8	X			The project approach combines good engineering and pilot scale testing with the complex integration of the membrane reactor and metal hydride compressor (MHC) systems. Needs for additional performance data, particularly with the MHC, and more detailed cost estimates were identified. Suggestions include testing a Pall membrane.

Hydrogen Storage

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
ST-01	Metal Hydride Center of Excellence *Lennie Klebanoff; Sandia National Laboratories*	3.2			X	The Metal Hydride Center of Excellence (MHCoE) is scheduled to be completed in FY2010. The reviewers found the MHCoE to be well coordinated and managed and to have shown flexibility in performing down-selection of materials and refocusing efforts. Efforts going forward will be focused on completing the highest priority activities and documenting all MHCoE work for use by the Program in the future.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
ST-02	Thermodynamically Tuned Nanophase Materials for Reversible Hydrogen Storage: Structure and Kinetics of Nanoparticle and Model System Materials *Bruce Clemens; Stanford University*	2.4			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on using model systems to investigate sorption kinetics, thermodynamics and sorption induced phase changes. The reviewers found that the experimental and analytical work has been very well carried out. However there are questions as to the applicability of the materials and model systems to the materials being investigated within the MHCoE, and progress has been slow. The remaining work should focus on material systems that will be most relevant to the MHCoE and demonstrate the applicability of the results to bulk materials.
ST-03	Discovery and Development of Metal Hydrides for Reversible On-board Hydrogen Storage *Mark Allendorf; Sandia National Laboratories*	3.0			X	This project will conclude in FY2010 and is a partner in the MHCoE directed at discovery of new hydrogen storage materials and improving the kinetics, thermodynamics and sorption properties of storage materials. The project was found to have good coordination between theory and experimental work. Going forward in the limited time remaining, the project should focus on completing tasks associated with the materials with greatest promise.
ST-04	Chemical Vapor Synthesis and Discovery of H_2 Storage Materials: Li-Mg-N-H System *Z. Zak Fang; University of Utah*	3.2			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on investigating new hydride materials with an emphasis on LiMgN. The project was found to be well carried out. With the remaining time, the project should focus on completing the current investigations, including carrying out cycling studies of the material systems.
ST-05	Aluminum Hydride Regeneration *Jason Graetz; Brookhaven National Laboratory*	3.3			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on investigating the desorption and regeneration processes for alane (AlH_3). The project is considered to be well managed, organized and executed. The project should continue as planned. However, closer work with the Hydrogen Storage Engineering Center of Excellence and System Analysis Working Group is encouraged to assess energy balances and feasibility of the regeneration schemes, and the use of slurries.
ST-06	Electrochemical Reversible Formation of Alane *Ragaiy Zidan, Savannah River National Laboratory*	3.1			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on developing electrochemical routes for the regeneration of alane. The project was found to have made tremendous progress over the past year, being able to produce gram quantities of pure α-alane. With the remaining time in the project, it should focus on assessing and improving the well-to-tank energy efficiency of the process, including consideration of improved electrochemical cell design.
ST-07	Fundamental Studies of Advanced, High-Capacity Reversible Metal Hydrides *Craig M. Jensen; University of Hawaii*	3.0			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on developing new reversible hydride materials. The project team is highly respected and has many collaborations around the world. The team has made significant progress. However, due to the breadth of materials it works on, it would benefit by narrowing the scope of materials for future efforts.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
ST-08	First-Principles Modeling of Hydrogen Storage in Metal Hydride Systems *J. Karl Johnson; University of Pittsburgh/Georgia Institute of Technology*	3.4			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on computational modeling to identify promising material systems for focus by MHCoE experimentalists. The coordination between the project and the MHCoE is considered excellent. The team was commended for incorporating gas phase species in their models. It is recommended that the team consider incorporation of entropy in their models and validate their modeling of amorphous materials.
ST-09	Thermodynamically Tuned Nanophase Materials for Reversible Hydrogen Storage *Ping Liu; HRL Laboratories, LLC*	3.0			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on development of reversible hydrides materials through destabilization and nanoconfinement approaches. The work is considered novel and well conducted. With the time remaining, it is recommended that the project focus on fully characterizing the current systems and developing a more complete understanding of the role of the scaffolds.
ST-10	Catalyzed Nano-Framework Stabilized High Density Reversible Hydrogen Storage Systems *X. Tang; United Technologies Research Center*	2.9			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on the development of metal hydride/catalyzed nanoframework combinations that result in reversible hydrogen storage with targeted properties. The project incorporated computational modeling with experimental validation. In the remaining time, this project should focus on completing the incorporation of the hydride into the zirconia frameworks and characterizing the properties of these materials to validate their modeled predictions.
ST-11	Neutron Characterization and Calphad in Support of the Metal Hydride Center of Excellence *Terrence J. Udovic; National Institute of Standards and Technology*	3.4			X	This project will conclude in FY2010. NIST provides characterization resources for both the Metal Hydride Center of Excellence (P.I. Terrence Udovic) and the Hydrogen Sorption Center of Excellence (P.I.s D. Neumann and C. Brown) as well as independent projects within the EERE applied hydrogen storage program as part of an Interagency Agreement. This project provides unique capabilities that employ neutron-based measurement methods for hydrogen storage materials R&D.
ST-12	Analyses of Hydrogen Storage Materials and On-Board Systems *Stephen Lasher; TIAX LLC*	3.2			X	This project is fully funded in 2009, and will complete work in FY2010. Their assessments of storage systems have consistently received high reviews. They are finalizing summary reports with ANL: Compressed Storage (350, 700 bar), Cryocompressed, AX-21, MOF 177, Liquid, N-ethylcarbazole, and an Alane Slurry based system.
ST-13	System Level Analysis of Hydrogen Storage Options *R.K. Ahluwalia; Argonne National Laboratory*	3.6	X			ANL will complete several summary reports with TIAX in FY2010. Analyses will be performed on the most promising materials developed in the Material Centers. Coordination with the Engineering Center will continue.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
ST-15	2009 Overview - DOE Chemical Hydrogen Storage Center of Excellence *Kevin Ott; Los Alamos National Laboratory*	3.8			X	The Chemical Hydrogen Storage Center of Excellence (CoE) will conclude at the end of FY2010. This is a very productive CoE, with excellent interaction and coordination among partners. It is well focused on virtually all DOE targets and technical barriers. The CoE should continue to improve release kinetics, thermochemistry, liquid fuel and efficient AB regeneration, and continue to down-select and focus resources on winning strategies.
ST-16	Amineborane-Based Chemical Hydrogen Storage *Larry Sneddon; University of Pennsylvania*	3.6			X	This project will conclude in FY2010. The project should down-select and converge storage systems as appropriate, and focus AB release R&D in the most promising system. Emphasis should be to investigate effects of additives on AB regeneration, continue to address hydrogen purity, and continue efforts to retain spent fuel in the liquid phase.
ST-17	Chemical Hydrogen Storage R&D at Los Alamos National Laboratory *Anthony Burrell; Los Alamos National Laboratory*	3.8			X	This project will conclude in FY2010. The project should continue to further advance the new AB regeneration system towards DOE targets and update the cost analysis; and continue to improve hydrogen release parameters, liquid fuel and address impurity release from AB. Coordinate with the Engineering CoE to address the on-board system requirements for the AB system.
ST-18	PNNL Progress as Part of the Chemical Hydrogen Storage Center of Excellence *Tom Autrey; Pacific Northwest National Laboratory*	3.6			X	This project will conclude in FY2010. The project should complete the investigation of the AB regeneration scheme and document its efficiency; conduct a cost analysis for AB regeneration scheme; continue to improve hydrogen release parameters, focusing on promising materials, and address impurity release from AB; and document more detailed results/benefits from the IPHE collaboration.
ST-19	Main Group Element and Organic Chemistry for Hydrogen Storage and Activation *David A. Dixon; University of Alabama*	2.7			X	This project will conclude in FY2010. The computational approaches are yielding important results on thermodynamic properties, hydrogen release, and spent fuel regeneration pathways which are vital to the overall success of the CHSCoE. The project should prioritize future work for better focus and use of remaining resources.
ST-20	Low-Cost Precursors to Novel Hydrogen Storage Materials *S. Linehan; Rohm and Haas Company*	3.4			X	This project will conclude in FY2010. The project should down-select between the metal reduction and the carbothermal process; conduct a cost analysis of $NaBH_4$ as the AB first fill raw material, for the selected process; and conduct a cost analysis for the most promising AB regeneration scheme.
ST-21	Ammonia Borane Regeneration and Market Analysis of Hydrogen Storage Materials *David Schubert; U.S. Borax*	3.1			X	This project will conclude in FY2010. The project should update the projection for worldwide boron market demand, assuming fuel cell vehicles are widely adopted throughout the rest of the world and not only in the United States.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
ST-22	Overview of the DOE Hydrogen Sorption Center of Excellence *Anne C. Dillon and Lin Simpson; National Renewable Energy Laboratory*	2.5			X	The Hydrogen Sorption Center of Excellence will conclude at the end of FY2010. In the remaining time, the CoE should focus on go/no-go recommendations of materials of interest to the Hydrogen Storage Engineering CoE based upon experimental data. Gaps should be closed for spillover materials addressing the lack of reproducibility of synthesis (and performance) across laboratories. Go/no-go recommendations should be made to DOE. Theory efforts should continue to incorporate experimental synthesis experience and experimental measurements to validate and update the models. CoE should close gaps such as, “what is the ideal-predicted %B content” and “ideal specific surface area” and “how do these predictions compare with current experimental values.”
ST-23	A Biomimetic Approach to Metal-Organic Frameworks with High H_2 Uptake *Hong-Cai (Joe) Zhou; Texas A&M University*	3.1	X			This project was selected after the initiation of the Sorption CoE; it will continue in FY2010. Good progress has been made. Progress should be accelerated by reducing the empiricism of the approach through collaboration with theory and detailed characterization. Establish trends on the polarizability of dihydrogen to entatic metal centers versus metal type to streamline synthesis options. Have promising results reproduced externally as soon as possible.
ST-24	Hydrogen Storage by Spillover *Ralph T. Yang; University of Michigan*	2.0			X	This project will conclude in FY2010. In the remaining period, the team should focus on reproducibility of synthesis and performance measurements by collaborating with external groups (e.g. round-robin activities). Increased characterization work should be used to understand barriers to increasing kinetics of hydrogen uptake.
ST-25	Optimization of Nano-Carbon Materials for Hydrogen Sorption *Boris I. Yakobson, R. Hauge; Rice University*	2.6			X	This project will conclude in FY2010. Spillover simulations are the key piece of this project. In the remaining period, theory efforts should continue to incorporate experimental synthesis experience and measurement of performance from partners and collaborators to validate and update the theoretical models.
ST-26	NREL Research as Part of the Hydrogen Sorption Center of Excellence *L.J. Simpson; National Renewable Energy Laboratory*	2.9			X	This project will conclude in FY2010. In the remaining period, NREL should put forward a sharply focused effort on improving synthesis and performance measurement reproducibility of spillover materials, including external parties (e.g. round robin efforts). Experimental verification efforts should be prioritized such as the Ca-COFs. Theory efforts should continue to stress verification using experimental data.
ST-27	Hydrogen Storage through Nanostructured Polymeric Materials *Di-Jia Liu; Argonne National Laboratory*	3.4	X			This project was selected after the initiation of the Sorption CoE; it will continue in FY2010. Good progress has been made. The team should increase collaborations with theory and external testing of materials for reproducibility. Efforts should also stress understanding trends such as limits of specific surface area and potential for higher temperature operation (e.g. >77K).
ST-28	Discovery of Materials with a Practical Heat of H_2 Adsorption *Alan Cooper. H. Cheng et al.; Air Products and Chemicals, Inc. (APCI)*	2.4			X	This project will conclude in FY2010. In the remaining period, APCI should focus its efforts on the most promising areas and in summarizing trends identified to date. Effort on finishing the study of the promising aspect of BC_3 spillover is recommended but further work on exploration of higher surface area BCx materials, that have not been successful to date, should be deemphasized.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
ST-29	Optimizing the Binding Energy of Hydrogen on Nanostructured Carbon Materials through Structure Control and Chemical Doping *Jie Liu; Duke University*	2.7			X	This project will conclude in FY2010. In the remaining period, the team should focus on doped carbon materials rather than on spillover catalysts. Emphasize sufficient characterization work in addition to performance measurements.
ST-30	Nanoengineered Graphene Scaffolds with Alternating Metal-Carbon Layers for H_2 Uptake at Ambient Temperatures *James Tour and Carter Kittrell; Rice University*	2.6			X	This project will conclude in FY2010. In the remaining period, the team should focus on graphene dynamic multilayer work. The team should work within and outside the CoE, as appropriate, to obtain a broader range of measurements for pressure-concentration-temperature characterization of the most promising materials.
ST-32	A Synergistic Approach to the Development of New Hydrogen Storage Materials, Part I *Jeffrey R. Long; University of California, Berkeley*	2.7			X	This project will conclude in FY2009. The project team should establish priorities for the remainder of the project based on the most critical technical barriers and the materials most capable of meeting those challenges. Work on destabilization of metal hydrides has been adequately addressed. Results of R&D should be summarized, and physical property data shared with the Engineering Center.
ST-33	Hydrogen Storage in Metal-Organic Frameworks *O. Yaghi (PI), Chris Doonan; University of California, Los Angeles*	2.7	X			This project started in FY2009 and the focus to-date has been on the most significant challenge, i.e., increasing binding energy. The project team should focus on refining theory based on experimental results and on collaboration and leveraging of work with other R&D groups for optimum results.
ST-34	Compact (L)H_2 Storage with Extended Dormancy in Cryogenic Pressure Vessels *Gene Berry; Lawrence Livermore National Laboratory*	2.7	X			LLNL will continue to work with industry on tank cycling tests and investigations of ortho-para hydrogen states as a function of temperature and time. Work will continue to achieve further improvements beyond the 30% lower cost and more than double system capacity over 350 bar tanks currently projected by TIAX and ANL.
STP-01	Lifecycle Verification of Polymeric Storage Liners *Barton Smith; Oak Ridge National Laboratory*	2.9	X			ORNL will continue to make use of their automated test bed and explore a wide range of temperatures and pressures to assess polymer liners. Permeability data and projecting durability of the materials are the highest priorities for the coming year.
STP-02	Electron-Charged Hydrogen Storage Materials *Chinbay Q. Fan; Gas Technology Institute*	2.5			X	This project will continue to develop materials pending the results of an upcoming go/no-go decision milestone to demonstrate 6wt% storage. Next steps include obtaining a better theoretical understanding of the mechanisms behind this storage process.
STP-03	Polymer-Based Activated Carbon Nanostructures for H_2 Storage *Dr. Israel Cabasso; State University of New York*	2.6	X			This project will continue to explore avenues to increase binding energies. They will also need to show more data on uptake near room temperature (-25C) and improve the accuracy of these measurements. Their material may be tested at SWRI for independent verification. A 2010 go/ no-go decision point will be identified.

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STP-04	Low-Cost High-Efficiency High-Pressure H_2 Storage *Carter Liu; Quantum Fuel Systems Technologies Worldwide Inc.*	2.7			X	This project is ending in FY2009. Remaining work in 2009 will focus on reducing component weight, volume and cost, and communicating results in a final report.
STP-17	Solutions for Chemical Hydrogen Storage: Hydrogenation/Dehydrogenation of B-N Bonds *Karen Goldberg; University of Washington*	3.4			X	This project will conclude in FY2010. The team should use rationale design to provide more focus on how and on what basis ligand and metal selections for future catalysts will be made; and develop performance targets and assess catalyst performance to guide more efficient catalyst development.
STP-18	Chemical Hydrogen Storage Using Ultra-High Surface Area Main Group Materials & The Development of Efficient Amine-Borane Regeneration Cycles *Philip P. Power; University of California, Davis*	2.8			X	This project will conclude in FY2010. The team should investigate the optimum amount of nano-BN additions to AB to maximize storage capacity and quantify release of impurities; and redirect the effort for AB regeneration to address and reflect that of the current Center AB regeneration scheme.
STP-19	Electrochemical Hydrogen Storage Systems *Dr. Digby Macdonald,; Pennsylvania State University*	2.2			X	This project will conclude in FY2010. The team should validate the EIS model for complex reaction systems; and increase focus on AB regeneration efforts where it is most relevant.
STP-20	Chemical Hydrogen Storage Using Aluminum Ammonia-Borane Complexes *M. Frederick Hawthorne; University of Missouri - Columbia*	3.0			X	This project will conclude in FY2010. The team should determine the long-term stability, release kinetics, and solid state structure of new materials; and investigate impurity effects in hydrogen release.
STP-21	Novel Metal Perhydrides for Hydrogen Storage *Jiann-Yang Hwang; Michigan Technological University*	2.7			X	This project has a go/no-go decision point at the end of FY2009. The project focus should be to check the reversibility of H_2 adsorption, and determine that the gas desorbed is 100% H_2. The team should collaborate with others for validation of adsorption/desorption measurements on these materials.
STP-22	Purdue Hydrogen Systems Laboratory *J. Gore; Purdue University*	2.4			X	This is a Congressionally-directed project. Investigate and account for Me_3SiOTf in the AB regeneration scheme. Account for potential inefficiency resulting from the formation of a Si-O bond during AB regeneration. Because the slurry reactor product is likely to be solid, investigate removal of solid products from reactor.
STP-23	Hydrogen Storage Research *Lee Stefanakos; University of South Florida*	2.6			X	This is a Congressionally-directed project. Investigate and eliminate experimental artifacts to obtain accurate and reliable PCT measurements for the $LiBH_4/LiNH_2/MgH_2$ complex hydride and nanoporous PANI systems. Validate ab initio calculations. Focus future tasks on the most noteworthy remaining barriers.

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STP-25	Carbon Aerogels for Hydrogen Storage *T.F. Baumann; Lawrence Livermore National Laboratory*	2.9			X	This project will conclude in FY2010. The project has contributed to both the Metal Hydride and Sorption Centers of Excellence. In the remaining period. LLNL should continue to focus on strategies to improve heat conductivity and H_2 transport, and work on aerogels as nanoscale hosts for complex hydrides.
STP-26	Single-Walled Carbon Nanohorns for Hydrogen Storage and Catalyst Supports *David B. Geohegan; Oak Ridge National Laboratory*	3.4			X	This project will conclude in FY2010. In the remaining period, ORNL should continue to stress reproducibility of synthesis and performance by participating with other CoE partners and independent organizations to perform independent measurement on its most promising materials. Theory work should continue to stress incorporation of experimental data to validate predictions.
STP-27	Enhanced Hydrogen Dipole Physisorption: Constant Isosteric Heats and Hydrogen Diffusion in Physisorbents *Channing Ahn; California Institute of Technology*	3.2			X	This project will conclude in FY2010. In the remaining period, CalTech should focus on obtaining a better understanding of the thermodynamic properties of these materials and shedding light on the interrelations of pore size/distribution, enthalpies, temperature and pressure effects, and their influence on hydrogen uptake and release. Emphasis should be placed on the pore-slit/graphitic structures in collaboration with Rice University.
STP-28	Characterization of Hydrogen Adsorption by NMR *Yue Wu; University of North Carolina*	3.2			X	This project will conclude in FY2010. The NMR tool developed in this project is a unique approach to understanding fundamental material properties and their relationship to H_2 uptake. In the remaining period, the PI should work with NREL to prioritize the most important samples for study.
STP-29	Advanced Boron and Metal Loaded High Porosity Carbons *T. C. Mike Chung; Pennsylvania State University*	2.9			X	This project will conclude in FY2010. In the remaining period, Penn State should emphasize obtaining validation of their most promising samples, with increased participation with CoE partners. The project team has demonstrated increased hydrogen capacity in B-doped materials over pure carbon for equivalent surface area. Penn State should make recommendations for a go/go-no decision on further research into these B-containing carbons based upon the limited surface area achieved and other factors.
STP-30	Best Practices for Characterizing Hydrogen Storage Properties of Materials *Karl Gross; H_2 Technology Consulting LLC*	3.6	X			This project has developed a long-needed general guide on hydrogen storage measurements for broad distribution. Contributors to this effort are known experts in the field. Remaining planned chapters address cycling measurements and thermodynamics.
STP-36	Reversible Hydrogen Storage Materials: Structure, Chemistry, and Electronic Structure *Ian Robertson; University of Illinois, Urbana-Champaign*	3.4			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on providing microstructural characterizations and understanding of complex hydride materials to MHCoE partners, and on providing computational modeling of systems. The work is considered of very high quality and a valuable resource to the MHCoE. With the approaching end of the MHCoE, priorities should be placed on materials of greatest import to the MHCoE and efforts should be made to complete characterizations of systems and dissemination of results.

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STP-37	Metal Borohydrides, Ammines, and Aluminum Hydrides as Hydrogen Storage Materials *Gilbert M. Brown; Oak Ridge National Laboratory*	3.1			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on developing reversible hydrogen storage materials, specifically borohydrides, amides/imides, alane and light alanates. While the research team is highly competent with reactive materials and produces high quality work, the work plan was thought to be insufficiently focused and too broad in scope. Future work should focus on materials and approaches that have the highest probability of producing materials of interest.
STP-38	Development and Evaluation of Advanced Hydride Systems for Reversible Hydrogen Storage *Joseph W. Reiter; Jet Propulsion Laboratory*	3.2			X	This project will conclude in FY2010 and is a partner in the MHCoE providing NMR analysis to MHCoE partners. The project validates material sorption properties and projects storage system characteristics. The NMR characterization is considered to be of very high value to the MHCoE, with some of the best hydride characterization capabilities anywhere in the world. The project is very well coordinated and collaborates effectively with the MHCoE. The team should focus on completing the characterization, documentation and dissemination of results to date and be prepared to quickly perform characterizations on MHCoE systems identified as partners complete their efforts.
STP-39	Effect of Trace Elements on Long-Term Cycling/Aging Properties and Thermodynamic Studies of Complex Hydrides for Hydrogen Storage *Dhanesh Chandra; University of Nevada, Reno*	3.6			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on characterizing the effects of impurities and long-term cycling on reversible metal hydride materials, and on determining phase diagrams and vapor behavior in these systems. The high quality and volume of results for the past year and the quality and extent of collaborations, including international, were highly commended. Going forward it was recommended that the project try to extend their cycling analysis to new materials of high interest to the MHCoE.
STP-40	Amide and Combined Amide/Borohydride Investigations *Don Anton, Savannah River National Laboratory*	2.0			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on the characterization of LiMgN and identification of dopants/additives to catalyze its sorption reactions. With the time remaining, the project should complete the characterization work and focus on aiding the MHCoE coordinate with the Hydrogen Storage Engineering Center of Excellence. A go/no-go decision on this material will be made by the end of Q2 FY2010.
STP-41	Synthesis of Nanophase Materials for Thermodynamically Tuned Reversible Hydrogen Storage *Channing Ahn; California Institute of Technology*	3.2			X	This project will conclude in FY2010 and is a partner in the MHCoE focused on understanding why material systems theoretically predicted to be reversible are not. The project team is considered highly talented and performs a useful service to the MHCoE. With the remaining time, it is recommended that the team focus on scaffolding effects and understanding the role they play in aiding and/or modifying sorption properties.
STP-42	Lightweight Borohydrides for Hydrogen Storage *J.-C. Zhao; Ohio State University*	3.1	X			This project is a partner in the MHCoE and is focused on developing borohydride materials. In 2008 the project was expanded to include aluminoborane compounds. The project team should complete their original scope of work for the MHCoE, wrap up their $Mg(BH_4)_2$ work, and then focus on the aluminoborane efforts.

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STP-43	Center for Hydrogen Storage Research at Delaware State University *Andrew Goudy; Delaware State University*	2.6			X	This is a Congressionally-directed project that involves the preparation and characterization of complex hydride materials for hydrogen storage. Many of the systems being investigated are similar to materials under investigation within the MHCoE and therefore the PI would benefit from stronger collaboration with MHCoE partners. The project team should focus on the most promising material systems and try to complement and avoid duplication of other efforts being carried out within the program.
STP-44	Solid-State Hydriding and Dehydriding of $LiBH_4 + MgH_2$ Enabled via Mechanical Activation and Nano-Engineering *Leon Shaw; University of Connecticut*	2.9		X		This is an independent project that involves the mechanical activation and nano-engineering of complex hydride materials for improved hydrogen storage properties. The project has reached an end of a phase and is being completed in December 2009. The systems being investigated are similar to materials under investigation within the MHCoE and the PI has been encouraged to and has collaborated more strongly with MHCoE partners. The project team should wrap up their current efforts and prepare their results for dissemination to the hydrogen storage community.
STP-45	Standardized Testing Program for Solid-State Hydrogen Storage Technologies *Michael Miller; Southwest Research Institute®*	3.2	X			This is an independent project that supports the Hydrogen Program through the operation of a national-level testing facility for the assessing and validating hydrogen storage properties of materials. This facility is a valuable resource to the program. The project team needs to develop additional characterization methods to validate results on samples that have proven difficult to reproduce, such as spillover materials, and help develop an understanding of the reason for the spurious results. With many of the Program's projects coming to completion, SwRI needs to be prepared to process samples more quickly as a higher volume of samples analyzed may be required.
STP-46	An Integrated Approach of Hydrogen Storage in Complex Hydrides of Transitional Elements *Tansel Karabacak; University of Arkansas at Little Rock*	2.6			X	This is a Congressionally-directed project focused on developing novel complex hydrides for hydrogen storage. The project has investigated a wide-range of materials using some interesting preparation techniques. Going forward, it is recommended that the project perform a down-selection and discontinue efforts on less promising materials, such as the metal-decorated and Mg-nanoblades.

Fuel Cells

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FC-01	Lead Research and Development Activity for DOE's High Temperature, Low Relative Humidity Membrane Program *James Fenton; University of Central Florida*	2.9	X			Not all reviewers feel the HTMWG coordination has been as successful as needed. Reviewers were divided on the future plans for centralized fuel cell testing of HTMWG materials, but generally support an expansion of the lead group's standardized characterization methodologies to include membrane durability and stability testing. The project has also worked to develop new membranes, and reviewers note that questions remain on acid leaching and the development path to low relative humidity performance. The membrane portion of the project will not be continued in FY2010 due to programmatic priorities.
FC-02	Dimensionally Stable Membranes *Cortney K. Mittelsteadt; Giner Electochemical, LLC*	3.4	X			This highly rated project's milestones for the year were achieved and interim conductivity targets have been met. Improvements in fuel cell performance have been shown, including electrodes. Reviewers believe future plans, including focus on cost of manufacturing, cycling durability and improved performance, are appropriate.
FC-03	New Polymer/Inorganic Proton Conductive Composite Membranes for PEMFC *Serguei Lvov; Pennsylvania State University*	2.1		X		The project was unable to meet conductivity targets or significantly improve upon Nafion®, and the membranes developed have poor chemical stability. The project will not be continued.
FC-04	Poly(cyclohexadiene)-Based Polymer Electrolyte Membranes for Fuel Cell Applications *Jimmy Mays; University of Tennessee Mohammad Hassan and Kenneth Mauritz; University of Southern Mississippi*	2.2		X		The project was unable to meet conductivity targets or significantly improve upon Nafion® and the materials developed have poor chemical stability. The project will not be continued.
FC-05	Advanced Materials for Proton Exchange Membranes *James E. McGrath; Virginia Polytechnic Institute and State University*	2.8		X		VPI has systematically developed copolymer membranes that have good mechanical properties and durability, but less than necessary conductivity. The project will not be continued.
FC-06	Protic Salt Polymer Membranes: High-Temperature Water-Free Proton-Conducting Membranes *D. Gervasio; Arizona State University*	2.2	X			Effort was placed on fuel cell fabrication and testing too early, and the basic materials were unable to meet conductivity targets or significantly improve upon Nafion®. ASU has added a new approach to anhydrous operation based on indium tin phosphate (ITP) that shows higher conductivity, but reviewers believe issues will be crossover, mechanical stability of the pure ITP, and low-temperature performance.

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FC-07	Fluoroalkyl-Phosphonic-Acid-Based Proton Conductors *Stephen Creager; Clemson University*	2.7		X		Progress was made in molecular dynamics modeling of model compounds, but the membranes synthesized failed in testing and did not meet the conductivity targets. The project will not be continued.
FC-08	Rigid Rod Polyelectrolytes: Effect on Physical Properties Frozen-in Free Volume: High Conductivity at Low RH *Morton Litt; Case Western Reserve University*	2.9	X			CWRU demonstrated membranes with high in-plane conductivity, but through-plane conductivity has not been experimentally demonstrated for these anisotropic materials. Mechanical stability remains an issue and chemical stability has not been demonstrated. Reviewers recommend increased collaboration.
FC-09	NanoCapillary Network Proton Conducting Membranes for High Temperature Hydrogen/Air Fuel Cells *Peter Pintauro; Vanderbilt University*	3.4	X			This highly rated project has met its interim milestones and is on track. Reviewers rate the approach and future plans favorably, and consider electrospinning of conducting polymers to be a notable advance.
FC-10	High Temperature Membrane with Humidification-Independent Cluster Structure *Ludwig Lipp; FuelCell Energy, Inc.*	3.3	X			FCE’s proprietary materials meet or exceed the interim DOE targets. Durability and fuel cell performance data and cost projections have not yet been presented.
FC-11	Novel Approaches to Immobilized Heteropoly Acid (HPA) Systems for High Temperature, Low Relative Humidity Polymer-Type Membranes *Andrew M. Herring; Colorado School of Mines*	2.9	X			The project is meeting conductivity milestones but needs to address mechanical and chemical stability. Reviewers found future work plans lacking in specifics.
FC-12	Improved, Low-Cost, Durable Fuel Cell Membranes *James Goldbach; Arkema*	2.4	X			Membrane conductivity has been significantly below target. Reviewers question the ability to improve conductivity sufficiently with these materials.
FC-13	Membranes and MEAs for Dry, Hot Operating Conditions *Steven Hamrock; Fuel Cell Components*	3.3	X			Membranes have been fabricated with promising conductivity at 50% RH and 80°C, and several approaches are underway to improve mechanical durability and water solubility. Reviewers believe the project will need to narrow its focus in future work.
FC-14	New Polyelectrolyte Materials for High Temperature Fuel Cells *John B. Kerr; Lawrence Berkeley National Laboratory*	2.9	X			Membrane conductivities with anhydrous proton conductors are below target and some reviewers question whether the approach can lead to materials that are stable.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FC-15	Development of Novel PEM Membrane and Multiphase CFD Modeling of PEM Fuel Cell *Susanta K. Das; Kettering University*	1.8			X	This project received the second lowest overall ranking of fuel cell projects at this year's review. Reviewers questioned the characterization methods used and noted the independently measured membrane conductivity was far below target (project is not aligned with DOE goals). Reviewers felt the CFD modeling added nothing new and would require collaboration with a stack developer for relevance and validation. (Congressionally directed project)
FC-16	Applied Science for Electrode Cost, Performance, and Durability *Christina Johnston; Los Alamos National Laboratory*	3.0			X	Reviewers generally commend the sophistication of the experimental techniques and the quality of the science, and note that insights obtained can be used to improve both mass transport and kinetic performance. However, reviewers would like to see collaboration with industrial MEA manufacturers to address high-volume processing. This project will be combined with other similar activities at LANL.
FC-17	Advanced Cathode Catalysts and Supports for PEM Fuel Cells *Mark K. Debe; 3M Company*	3.6	X			This project tied with two others for the highest ranking amongst fuel cell projects in this year's review. This year, single-cell test results show that a 3M membrane electrode assembly has exceeded several key 2015 targets for cost, performance, and durability, hence showing promise for automotive-scale fuel cell stacks. Reviewers generally consider water management to be the toughest remaining challenge.
FC-18	Highly Dispersed Alloy Catalyst for Durability *Vivek S. Murthi; UTC Power*	3.0	X			Alloys under study include iridium, and reviewers continue to question the value of replacing Pt with even less abundant metals, though researchers are working to replace a portion of the Ir with less expensive metals such as Co or Cr. Reviewers believe the approach including fundamental studies/modeling, catalyst synthesis, and cell testing will lead to improved understanding of ORR, but felt plans for future work are weak. In particular, durability of core-shell structures needs further attention.
FC-19	Development of Alternative and Durable High Performance Cathode Supports for PEM Fuel Cells *Yong Wang; Pacific Northwest National Laboratory*	2.7	X			While progress on support stability has been made, some reviewers are concerned that the focus on stability may overlook the effect of the support on necessary catalyst activity and electrode performance. Reviewers also recommend that cost be more explicitly addressed in support screening.
FC-20	Non-Platinum Bimetallic Cathode Electrocatalysts *D. Myers; Argonne National Laboratory*	3.1	X			While reviewers commend the quality of the science, the best performing catalyst is still below the state-of-the-art and comparable performance on a platinum group metal mass activity basis may not be achieved. Reviewers would like to see more focus on durability and more fuel cell testing.
FC-21	Advanced Cathode Catalysts *Piotr Zelenay; Los Alamos National Laboratory*	3.5	X			This project tied with three others for the second highest ranking amongst fuel cell projects in this year's review. Several reviewers deemed the progress "impressive." Reviewers note the complexity of the project and some believe a narrowing of scope would be beneficial, while other reviewers comment on the strength and value in the individual team member contributions. Reviewer recommendations reflect this diversity of opinion.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FC-22	Effects of Fuel and Air Impurities on PEM Fuel Cell Performance *Fernando Garzon; Los Alamos National Laboratory*	3.5	X			This project tied with three others for the second highest ranking in this year's review. Reviewers generally commended the approach, progress, and plans. Recommendations included incorporation of gas mixtures in the test program and reviewers encourage publication of data and models as soon as possible to aid developers.
FC-23	Effects of Impurities on Fuel Cell Performance and Durability *J.G. Goodwin, Jr.; Clemson University*	3.2	X			Reviewers recommended changes in testing approach and urged lower impurity concentrations to be more relevant to the hydrogen quality effort. Reviewers note lack of completed or planned work on mitigation strategies, and recommended closer collaboration with other institutions working on impurity effects.
FC-24	The Effects of Impurities on Fuel Cell Performance and Durability *Trent M. Molter, Ph.D.; University of Connecticut*	3.2	X			The project had difficulty with its commercially supplied membrane electrode assemblies, which hindered progress this year. Reviewers urged lower catalyst loadings and lower impurity concentrations to make the project more relevant to the transportation application. Reviewers recommended closer collaboration with other institutions working on impurity effects.
FC-25	Development and Demonstration of a New-Generation High Efficiency 1-10 kW Stationary PEM Fuel Cell System *Durai Swamy, Ph.D.; Intelligent Energy*	2.7	X			Reviewers note the team continues to work on absorption enhanced reforming, but have shifted the project baseline to steam methane reforming with pressure swing adsorption for gas clean-up. Use of a low-temperature PEMFC for a heat recovery application was questioned. As with many industrial product development projects, technical detail and data shared are limited and progress is hard to assess.
FC-26	Stationary PEM Fuel Cell Power Plant Verification *Eric Strayer; UTC Power*	3.3	X			The advanced system undergoing field testing has reduced parts count, higher efficiency power conditioning, improved air, thermal and water management, a cost reduction of more than 30%, and a power density more than 2.5 times greater than other commercially available systems in the 1 to 5 kW range. Reviewers generally were complimentary of the project and its progress.
FC-27	Intergovernmental Stationary Fuel Cell System Demonstration *Richard Chartrand; Plug Power*	2.9			X	Reviewers note this project is primarily specifying, procuring and assembling existing components (including a Ballard stack). The project uses a definition of "appropriate performance" as being components that demonstrate their "specified performance." This is a straight-forward demonstration project, but will fall well short of DOE targets.
FC-28	Development of a Low Cost 3-10 kW Tubular SOFC Power System *Norman Bessette; Acumentrics Corporation*	3.0	X			Reviewers felt the approach was sound, but had difficulty determining what progress had been achieved under this program as opposed to the preceding project funded by DOE Fossil Energy. As with many industrial product development projects, technical detail and data shared are limited. The micro combined heat and power (mCHP) home appliance demonstrations starting in Europe are certainly of interest.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FC-29	Fuel Cell Systems Analysis *R.K. Ahluwalia; Argonne National Laboratory*	3.2	X			Reviewers note that necessarily generic fuel cell stack models may make the model less useful for design-specific issues such as cold start and freeze, though data being developed in the Department's water transport projects may help in making models more widely applicable. Reviewers would like to see the hard problems attacked, such as impurity effects and aging, and recommend validation against DOE-funded system-level projects.
FC-30	Mass-Production Cost Estimation of Automotive Fuel Cell Systems *Brian D. James; Directed Technologies, Inc.*	3.4	X			This highly rated project is one of two independent system cost estimation efforts funded by the Program. Reviewers note the difficulty in projecting future commodity (for example platinum) cost/pricing, and the difficulty in projecting changing system and component costs without automobile manufacturers and their suppliers being involved. However, reviewers generally commend the effort and approach.
FC-31	Direct Hydrogen PEMFC Manufacturing Cost Estimation for Automotive Applications *Jayanti Sinha; TIAX LLC*	3.1	X			This project is one of two independent system cost estimation efforts funded by the Program, and differs in component detail and approach from the complementary project, providing the Department with diverse assessments. Reviewers generally had more comments on details of this project compared to FC-30, and noted the changes in the "ANL 2009" system description might significantly affect cost results. However, reviewers generally support the effort and approach.
FC-32	Microstructural Characterization of PEM Fuel Cell Materials *Karren L. More; Oak Ridge National Laboratory*	3.6	X			This project tied with two others for the highest ranking of the fuel cell projects in this year's review. Reviewers appreciate the significant increase in capability of and broad access to these state-of-the-art facilities, and note the on-going potential to provide valuable insights into both beginning materials structure and degradation. Reviewers commend the positive feedback from two-way collaboration with users. About the only reviewer concern was whether the open access might crowd out higher priority analyses as the project becomes oversubscribed.
FC-33	Platinum Group Metal Recycling Technology Development *Lawrence Shore; BASF Catalysts LLC*	3.5		X		This project tied with three others for the second highest ranking of fuel cell projects in this year's review. BASF has achieved the platinum recovery objective, identified room-temperature processing alternatives, and reduced reagent usage for platinum leaching. Reviewers generally consider the project a success, and concerns are limited to questions of whether on-going developments, such as nanostructured thin film catalyst-coated membranes or core-shell structures, will require significant process modifications.
FC-34	Neutron Imaging Study of the Water Transport in Operating Fuel Cells *David Jacobson; National Institute of Standards and Technology*	3.5	X			This project tied with three others for the second highest ranking in this year's review. Reviewers commend the high-resolution images shown at this year's review, but note that as membranes continue to get thinner, spatial resolution will need to improve further to provide additional insights. Reviewers also applaud the low-temperature capability demonstrated this year.
FC-35	Water Transport Exploratory Studies *Rod Borup; Los Alamos National Laboratory*	3.3	X			Reviewers generally value the imaging, characterization, and modeling efforts. Some reviewers believe the project could benefit from a reduction in scope and sharper focus on a few tasks in more depth.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FC-36	Water Transport in PEM Fuel Cells: Advanced Modeling, Material Selection, Testing, and Design Optimization *J. Vernon Cole; CFD Research Corporation*	2.9	X			The project is still in the mode of collecting data and building models. Reviewers are concerned that temperature effects may not be adequately treated, and note analyses at constant low-temperature operation provide little useful information. Reviewers did not find plans for future work to address perceived shortcomings.
FC-37	Visualization of Fuel Cell Water Transport and Performance Characterization Under Freezing Conditions *Satish Kandlikar; Rochester Institute of Technology*	3.0	X			Reviewers noted significant technical content arising from the studies, but felt insights described to date were lacking. Plans for future work were rated lower than was approach, accomplishments and collaboration.
FC-38	Subfreezing Start/Stop Protocol for an Advanced Metallic Open-Flowfield Fuel Cell Stack *Amedeo Conti; Nuvera Fuel Cells, Inc.*	3.2	X			Reviewers believe the approach has resulted in data-supported designs that meet DOE targets, but note it is not clear whether or not the design/materials used and the lessons learned from this project are broadly applicable due to the lack of dissemination of details considered proprietary. Fundamental understanding, if it has been obtained, has not been shared. Reviewers do, however, generally consider the project successful.
FC-39	Development of Thermal and Water Management System for PEM Fuel Cells *Zia Mirza; Honeywell*	2.0		X		For this low-rated project, reviewers saw little progress and noted that even if successful, testing of available, well-known components will not improve the technical readiness of fuel cell power systems. This project will be discontinued.
FC-40	Nitrided Metallic Bipolar Plates *P.F. Tortorelli; Oak Ridge National Laboratory*	3.1	X			Reviewers rated the approach high, but rated technical progress and plans below average. There is a concern that the project has not demonstrated that stamped foils can achieve the necessary precise geometry and tolerances. Reviewers recommend characterization of near-surface compositions following stamping for comparison with before-stamped materials to ensure no processing issues interfere with the efficacy of the oxidation and nitridation treatments. Reviewers recommend collaboration with a stack or automotive manufacturer.
FC-41	Next Generation Bipolar Plates for Automotive PEM Fuel Cells *Orest Adrianowycz; GrafTech International Ltd.*	2.8		X		This project is ending this fiscal year. Reviewers generally feel that the materials developed have not been adequately characterized or tested in conditions relevant to the objective.
FC-42	Low Cost, Durable Seals for PEM Fuel Cells *Jason Parsons; UTC Power*	2.7		X		This project is ending this fiscal year. Reviewers note that compositions of seal materials developed have not been disclosed, fuel cell cyclic testing has not been done, and the seals developed for the company's specific material set may not be generically applicable to other stack designs and materials sets.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FC-43	Diesel Fueled SOFC System for Class 7/Class 8 On-Highway Truck Auxiliary Power *Dan Norrick; Cummins Power Generation*	3.1		X		The project is making progress and has largely completed design and subsystem testing, including demonstration of dry catalytic partial oxidation reforming of ultra-low sulfur diesel. Projected system characteristics are below DOE targets. As with many industrial product development projects, technical detail and data shared are limited.
FC-44	Solid Oxide Fuel Cell Development for Auxiliary Power in Heavy Duty Vehicle Applications *Gary D. Blake; Delphi*	3.6	X			This project tied with two others for the highest ranking of the fuel cell projects in this year's review. As with many industrial product development projects, technical detail and data shared are limited, but reviewers commend the two successful on-truck demonstrations, the very good power density, and the complete system packaging. The project is meeting key milestones.
FC-45	Solid Acid Fuel Cell Stack for APU Applications *Hau H. Duong; Superprotonic, Inc.*	2.4			X	For this project, reviewers note progress in cell/stack development and power density, but have concerns with the high platinum catalyst loading and durability. The project is behind on milestones and costs have not been addressed. Reviewers consider the technology immature. (Congressionally directed project)
FC-46	Low-Cost Co-Production of Hydrogen and Electricity *Fred Mitlitsky; Bloom Energy*	2.8			X	The focus of this project is on the stationary power demonstration system built in Alaska, and as with many industrial product development projects, technical details and data shared are limited. Integration of a hydrogen pump with a solid oxide fuel cell stack has not been completed. (Congressionally directed project)
FC-47	Development of a Novel Efficient Solid-Oxide Hybrid for Co-Generation of Hydrogen and Electricity Using Nearby Resources for Local Application *Greg Tao; Materials and Systems Research, Inc.*	3.3			X	Reviewers of this project rated the relevance, approach, progress, collaboration and plans all well above average, and consider the project generally on-track. (Congressionally directed project)
FC-48	Silicon Based Solid Oxide Fuel Cell for Portable Consumer Electronics *Alan Ludwiszewski; Lilliputian Systems, Inc.*	2.6			X	For this project, reviewers note progress in increasing cell power and improvement in sealing, but note numerous difficult challenges that remain. Reviewers consider the technology immature. (Congressionally directed project)
FC-49	Biogas Fueled Solid Oxide Fuel Cell Stack *Praveen Cheekatamarla; NanoDynamics Energy, Inc.*	2.6			X	Reviewers note progress in designing, fabricating and testing single cells in hydrogen and simulated biogas, but note the information presented was very generalized. Approach and collaboration were both rated quite low. (Congressionally directed project)
FCP-02	Component Benchmarking Subtask Reported: USFCC Durability Protocols and Technically-Assisted Industrial and University Partners *Tommy Rockward; Los Alamos National Laboratory*	3.4	X			Reviewers rated the project very high on relevance and collaboration, and high on all other categories. Reviewers generally consider this an important mechanism for the DOE to support researchers and developers.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FCP-03	Research & Development for Off Road Fuel Cell Applications *Richard J. Lawrence; IdaTech*	2.7	X			The fuel cell was developed with Department of Defense funding, so this project is focused on the demonstration. The project contains relatively little research but is generally on track. Reviewers would like to see a commercialization plan developed.
FCP-04	Renewable and Logistics Fuels for Fuel Cells at the Colorado School of Mines *Neal P. Sullivan; Colorado School of Mines*	2.6			X	Reviewers made a number of comments that the multiple tasks do not seem integrated and the project lacks focus, making it unlikely that the state-of-the-art will be significantly advanced. (Congressionally directed project)
FCP-06	Fuel Cell Research at the University of South Carolina *John W. Van Zee; University of South Carolina*	2.9			X	This project funds a diverse and unrelated set of tasks under a single university project. Approach, progress, and collaboration received average scores based on the individual tasks. The project is scheduled to end this fiscal year. (Congressionally directed project)
FCP-07	Development of Kilowatt-Scale Fuel Cell Technology *Steven S.C. Chuang; The University of Akron*	2.1			X	The focus of this project is on direct conversion of coal resulted in a very low score for relevance to the DOE Hydrogen Program. The university has built a high-temperature cell and operated it on hydrogen, but the concept of coal conversion has not been demonstrated. Reviewers note the lack of collaborators with solid oxide fuel cell experience and consider the plans optimistic for the funding available. (Congressionally directed project)
FCP-08	Center for Fundamental and Applied Research in Nanostructured and Lightweight Materials *Drs. Mullins, et al.; Michigan Technological University*	2.0			X	This is a project funding a diverse and unrelated set of tasks developing materials to be used in fuel cell applications and energy storage. The project rated very low on approach due to lack of coordination between tasks, very low on accomplishments for the lack of progress toward relevant DOE targets, and received only slightly better scores for collaboration and plans. (Congressionally directed project)
FCP-09	Engineered Nanostructured MEA Technology for Low Temperature Fuel Cells *Yimin Zhu; Nanosys, Inc.*	2.4			X	The project rated very low on approach and collaboration. It rated below average on progress. Although some milestones were met, progress toward DOE targets was not evident. This project has ended. (Congressionally directed project)
FCP-10	Alternative Fuel Cell Membranes for Energy Independence *K.A. Mauritz; University of Southern Mississippi*	2.6			X	Reviewers rated the relevance high, but the approach and accomplishments below average, and collaborations very low, while plans scored above average. Polymers have been synthesized, but no membranes have been made. (Congressionally directed project)
FCP-11	Extended Durability Testing of an External Fuel Processor for SOFC *Mark A. Perna; Rolls Royce Fuel Systems (US) Inc.*	2.3			X	Reviewers rated the relevance below average, largely because of the system scale, rated the approach and accomplishments well below average, and rated collaboration very low. There was concern that the tests seem to lack diagnostic instrumentation, metrics, and post-test characterization plans. (Congressionally directed project)

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
FCP-12	Hydrogen Fuel Cell Development in Columbia (SC) *Kenneth Reifsnider; University of South Carolina*	2.5			X	This is a project that funds a diverse and unrelated set of tasks under a single university project, similar to FCP-06. Reviewers scored the project below average in all areas, and had difficultly assessing progress as the poster referenced a number of earlier projects. (Congressionally directed project)
FCP-13	Martin County Hydrogen Fuel Cell Development *Jeffrey Bonner-Stewart; Microcell Corporation*	1.6			X	This project received the lowest score of the fuel cell projects in this year's review. Essentially no technical data was provided. The project lacks metrics and partners, and reviewers judge the technology not ready for scale-up and manufacturing. The project is complete. (Congressionally directed project)
FCP-14	Fuel Cell Balance of Plant Reliability Testbed *Vern Sproat; Stark State College of Technology*	2.0			X	Reviewers consider the need for such test beds, the barriers addressed, and the approach to be unclear. Reviewers scored the project low on relevance and very low in all other categories. (Congressionally directed project)

Systems Analysis

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
AN-01	HyDRA: Hydrogen Demand and Resource Analysis Tool *Johanna Levene; National Renewable Energy Laboratory*	3.0	X			Future work will address reviewers' suggestions: (a) develop means to incorporate future resource cost changes in the determination of the future hydrogen cost; and (b) add biogas and renewable fuel resources to the model.
AN-02	Water's Impacts on Hydrogen *A.J. Simon; Lawrence Livermore National Laboratory*	2.9			X	The project will be completed in FY 2009. The project quantifies the impact of water demand for hydrogen production on hydrogen cost and regional resource impacts.
AN-03	Cost Implications of Hydrogen Quality Requirements *S. Ahmed; Argonne National Laboratory*	3.2	X			Argonne National Laboratory's future work will focus on analyzing the impact of fuel quality on stationary fuel cell operation from feedstocks such as biogas and renewable fuels; determining optimum levels for impurity species; and evaluating costs requirements.
AN-04	Macro-System Model *Victor Diakov; National Renewable Energy Laboratory*	3.2	X			Additional work will address reviewers' suggestions of verifying the model outputs and performing validation with industry.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
AN-05	Discrete Choice Analysis of Consumer Preferences for Refueling Availability *Marc W. Melaina; National Renewable Energy Laboratory*	2.6			X	The project will be completed in FY 2009. The project provides a quantitative representation of the cost penalty for limited refueling availability using discrete choice survey and modeling methodology.
AN-06	Analysis of Energy Infrastructures and Potential Impacts from an Emergent Hydrogen Fueling Infrastructure *Andy Lutz; Sandia National Laboratories*	2.9	X			Sandia National Laboratory will address the reviewers' suggestions to consider all-electric vehicles; use an iterative approach for supply and demand; and incorporate biofuels as another competitive choice.
AN-07	Hydrogen Deployment System Modeling Environment (HyDS-ME) *Brian W. Bush; National Renewable Energy Laboratory*	3.2	X			National Renewable Energy Laboratory will incorporate reviewers' suggestions to include a model validation step, biogas feedstock options and stationary fuel cells as an option for combined heat, power and fuel generation.
AN-08	Analysis of Hydrogen Production and Delivery Infrastructure as a Complex Adaptive System *George S. Tolley; RCF Economic and Financial Consulting, Inc.*	3.0			X	The project will be completed in FY 2009. The project enables agent based modeling to assess supply of hydrogen fuel and purchase of hydrogen fuel cell vehicles. The purpose is to provide insight regarding the private sector's willingness to invest in hydrogen infrastructure and the policies needed to enable infrastructure construction.
AN-09	Adapting the H2A Hydrogen Production Cost Analysis Model to Stationary Applications *Michael Penev; National Renewable Energy Laboratory*	3.2	X			National Renewable Energy Laboratory will incorporate reviewers' suggestions to include the impact of potential fuel economy and emission standard legislation of gasoline powered vehicles, and an impact assessment and evaluation of criteria pollutants.
AN-10	Hydrogen and Fuel Cell Analysis: Lessons Learned from Stationary Power Generation *S.E. Grasman; Missouri University of Science and Technology*	1.8		X		The project considered opportunities for hydrogen in stationary and portable applications, and analyzed different national and international strategies and will be completed in FY 2009. However, the project was not rated favorably. The project received poor reviewer ratings for relevance to the overall DOE objectives and technical accomplishments. The project was determined to be too general and the data analysis was inadequate.
AN-11	Modeling the Transition to Hydrogen *Paul N. Leiby; Oak Ridge National Laboratory*	3.2	X			Future work will address reviewers' suggestions: (a) evaluate supply and demand impacts on feedstock cost; and (b) consider the influence of market, technology and regulation drivers.
AN-12	Fuel-Cycle Analysis of Fuel-Cell Vehicles and Fuel-Cell Systems with the GREET Model *Michael Wang; Argonne National Laboratory*	3.3	X			Argonne National Laboratory's future work will address reviewers' suggestions: new fuel economy and emission standard regulations will be included; and all the hydrogen production pathways in the GREET model will be included.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
AN-13	Evaluation of the Potential Environmental Impacts from Large-Scale Use and Production of Hydrogen in Energy and Transportation Applications *Don Wuebbles; University of Illinois at Urbana-Champaign*	3.0			X	The project will be completed in FY 2009. The project identified and examined possible ecological and environmental effects from the production and use of hydrogen from various energy sources.
AN-14	Potential Environmental Impacts of Hydrogen-Based Transportation & Power Systems *Mark Z. Jacobson; Stanford University*	3.0			X	The project will be completed in FY 2009. The project compared the emissions of hydrogen to six criteria pollutants (CO, SOx, NOx, particulate material (PM), ozone and lead) for near-term and long-term hydrogen production technologies and evaluated the effects of emissions on climate, human health, and the ecosystem.
ANP-01	Pathways to Commercial Success: Technologies and Products Supported by the HFCIT Program *Steve Weakley; Pacific Northwest National Laboratory*	2.9			X	This project has evaluated the commercial benefits of the Program through 2008. The project has found that 144 patents, over 20 commercial products and over 50 emerging products are attributed to DOE R&D. As fuel cell R&D continues, this project will update annually the commercial benefits due to DOE R&D. The project will be revised to match the future direction of the Fuel Cell Technologies Program.
ANP-03	Thermodynamic, Economic, and Environmental Modeling of Hydrogen (H_2) Co-Production Integrated with Stationary Fuel Cell Systems (FCS) *Whitney Colella; Sandia National Laboratories*	3.2	X			Sandia National Laboratory's future work will address reviewers' suggestions: (a) include the effect of financial incentives related to criteria pollutant emission trading; and (b) consider how to transition from the present situation (conventional stand-alone systems for electricity, heat and hydrogen) to the intermediate scenario of combined heat and power without stranding earlier investments.

Manufacturing R&D

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
MF-01	Fuel Cell MEA Manufacturing R&D *Michael Ulsh; National Renewable Energy Laboratory*	3.2	X			This project is relevant and has a good team with strong collaborations; however additional industrial partners would strengthen the validation of future work. Identification of non-random defect sources in a realistic manufacturing environment using 2-D autocorrelation would benefit the project. The potential impact of in-line MEA defect identification on manufacturing cost should be assessed.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
MF-02	Reduction in Fabrication Costs of Gas Diffusion Layers *Colleen Legzdins; Ballard Material Products*	3.6	X			Reduction of manufacturing costs of the Gas Diffusion Layer is highly relevant and this project has demonstrated reasonable progress during the past year. Plans for future activities such as commissioning of process technology and on-line measurement tools are aggressive and challenging. The cost reductions associated with the developed process should be clearly assessed. The ultimate benefits of the project will be dependent on the effective transfer of the manufacturing processes and on-line measurement techniques to the fuel cell manufacturing community.
MF-03	Modular, High-Volume Fuel Cell Leak-Test Suite and Process *Ian Kaye; UltraCell Corporation*	3.4	X			Rapid in-line leak testing during fuel cell stack manufacture is very relevant and this project has made reasonable progress in the past six months. Integration of the prototype testing hardware in a realistic assembly process will enable a meaningful go/no-go decision for the project in the future. Emphasis on how this process will improve manufacturing yield should be included in the project.
MF-04	Manufacturing of Low-Cost, Durable Membrane Electrode Assemblies Engineered for Rapid Conditioning *F. Colin Busby; W.L Gore and Associates, Inc.*	3.3	X			High-volume manufacturing of fuel cell MEAs at low-cost is a relevant goal of this project. Improved integration of the efforts of the individual members of this strong team would enhance the potential benefits of the project. Close coordination between the modeling and experimental efforts will be required to achieve the projected manufacturing cost reductions. Future plans are quite aggressive and project scope and schedule may need to be adjusted.
MF-05	Adaptive Process Controls and Ultrasonics for High Temperature PEM MEA Manufacture *Raymond Puffer; Rensselaer Polytechnic Institute*	3.3	X			The application of adaptive process control to the manufacture of high temperature MEAs is relevant and the potential of ultrasonic welding to support high-volume production appears promising. In the early stages of this project progress is adequate, however future effort needs to be better defined and meaningful go/no-go decision points included in the project schedule. The potential for manufacturing cost reductions needs to be fully quantified for this project as early as possible.
MF-06	Development of Advanced Manufacturing Technologies for Low Cost Hydrogen Storage Vessels *Carter Liu; Quantum Fuel Systems Technologies Worldwide Inc.*	2.8	X			This project was considered relevant in terms of it potential to lower the cost of high-pressure hydrogen containment vessels; however it was noted that the focus of the project was "product improvement" and, thus, the relevancy to manufacturing was questionable. A good team with composites expertise was noted. The project suffers from inadequate stress and safety analysis and lack of a credible cost projection and potential manufacturing cost reduction estimate. Testing protocols should have been discussed in greater detail. If continued, the go/no-go decision point should be moved earlier in the schedule.
MF-07	Digital Fabrication of Catalyst Coated Membranes *Peter C. Rieke; Pacific Northwest National Laboratory*	3.5		X		This project is completed. It is very relevant based on its potential for significant process improvement and cost reduction, however an initial economic assessment would have strengthened the progress to date. A strong team and integrated future plans indicate the potential for significant improvements in the manufacture of catalyst-coated membranes.

Project Number	Project Title *PI Name & Organization*	Final Score	Continue	Discontinue	Other	Summary Comment
MFP-01	Inexpensive Pressure Vessel Production through Fast Dry Winding Manufacture *Andrew Weisberg; Lawrence Livermore National Laboratory*	2.4	X			This project was considered to be relevant based on the potential of the "dry-wind" manufacturing process, but supporting evidence of the proposed process and cost benefits would have strengthened validation of the approach and progress to date. More detail regarding process parameters, without disclosing propriety information, was needed to accurately evaluate accomplishments and progress. Additional confirmation of the integration of team effort and specific roles of the project partners was needed. A comprehensive comparison of this process with conventional manufacturing techniques is needed to adequately validate the advantages of this process.