INTRODUCTION

The FY 2009 U.S. Department of Energy (DOE) Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting (AMR) was held on May 18-22, 2009 at the Crystal Gateway Marriott and Crystal City Marriott in Arlington, Virginia. This report is a summary of comments from AMR peer reviewers regarding the hydrogen and fuel cell projects funded by DOE's Office of Energy Efficiency and Renewable Energy (EERE). Hydrogen production projects funded by the Offices of Fossil Energy and Nuclear Energy were also reviewed and included in the report. The work evaluated in this document supports DOE, and the results of this merit review and peer evaluation are major inputs utilized by the DOE in making funding decisions for following fiscal years.

The objectives of this meeting were as follows:

- Review and evaluate FY 2009 accomplishments and FY 2010 plans for DOE laboratory programs, industry/university cooperative agreements, and related research and development (R&D) efforts.
- Provide an opportunity for program stakeholders/participants (e.g., fuel cell manufacturers, component developers, etc.) to shape the DOE-sponsored R&D program in such a way that the highest priority technical barriers are addressed and technology transfer is facilitated.
- Foster interactions among the national laboratories, industry, and universities conducting R&D.

The peer review process followed the guidelines of the Peer Review Guide developed by the Office of Energy Efficiency and Renewable Energy (EERE). The peer review panel members, listed in Table 1, provided comments on the projects presented. These panel members are experts from a variety of related backgrounds related to hydrogen and fuel cells R&D, and they represent national laboratories, universities, various U.S. Government agencies, and manufacturers of hydrogen production, storage, delivery, and fuel cell technologies. Each reviewer was screened for conflicts of interest (COI) as prescribed by the Peer Review Guide. A complete list of the meeting participants is presented as Appendix A.

Table 1: Peer Review Panel Members

No.	Last Name, First Name	Organization
1	Aardahl, Christopher	Pacific Northwest National Laboratory
2	Abdel-Baset, Tarek	Chrysler, LLC
3	Aceves, Salvador	Lawrence Livermore National Laboratory
4	Adjemian, Kev	Nissan Technical Center North America, Inc.
5	Adzic, Radoslav	Brookhaven National Laboratory
6	Ahluwalia, Rajesh	Argonne National Laboratory
7	Ahmed, Shabbir	Argonne National Laboratory
8	Ahn, Channing	California Institute of Technology
9	Akiba, Etsuo	Energy Technology Research Institute
10	Anderson, Arlene	U.S. Department of Energy, EERE
11	Anderson, Michele	ONR Naval Materials Division
12	Anderson, Robert	U.S. Environmental Protection Agency
13	Anton, Donald	Savannah River National Laboratory
14	Atanasoski, Radoslav	3M Center

15	Bailey, Carol	RDS, LLC
16	Balachandran, U. (Balu)	Argonne National Laboratory
17	Balema, Viktor	Sigma-Aldrich
18	Bardasz, Ewa	Lubrizol
19	Baturina, Olga	Naval Research Laboratory
20	Bavarian, Farshad	Chevron
21	Benard, Pierre	Institut de recherche sur l'hydrogène
22	Bender, Guido	Hawaii Natural Energy Institute/ University of Hawaii
23	Bendersky, Leonid	National Institute of Standards and Technology
24	Benjamin, Thomas	Argonne National Laboratory
25	Blair, Larry	U.S. Department of Energy
26	Borup, Rod	Los Alamos National Laboratory
27	Bose, Arun	U.S. Department of Energy
28	Bourgeois, Richard	General Electric Global Research Center
29	Bowman, Robert	Oak Ridge National Laboratory
30	Buxbaum, Robert	REB Research & Consulting
31	Cai, Mei	GM Research & Development Center
32	Cairns, Julie	CSA America
33	Carter, J.	Argonne National Laboratory
34	Carter, Robert	GM Fuel Cell Activities
35	Casey, Dan	Chevron
36	Choudhury, Biswajit	DuPont Fuel Cells
37	Cooper, Alan	Air Products and Chemicals, Inc.
38	Cox, Philip	PolyFuel Inc.
39	Cross III, James	Nuvera Fuel Cells, Inc.
40	De Jonghe, Lutgard	Lawrence Berkeley National Laboratory
41	Debe, Mark	3M Company
42	DeCastro, Emory	BASF Fuel Cell, Inc.
43	Deutsch, Todd	National Renewable Energy Laboratory
44	Dobbins, Tabbetha	Louisiana Tech University
45	Driscoll, Daniel	U.S. Department of Energy
46	Eddaoudi, Mohamed	University of South Florida
47	Eisman, Glenn	Rensselaer Polytechnic Institute
48	Erdle, Erich	EFCECO
49	Ernst, William	Retired, Plug Power
50	Fahr, Askar	National Institute of Standards and Technology
51	Farese, David	Air Products
52	Fenske, George	Argonne National Laboratory
53	Filiou, Constantina	European Commission
54	Fort, William	Shell Global Solutions (U.S.), Inc.
55	Gabrielov, Alexei	Shell Technology Center Houston
56	Ge, Qingfeng	Southern Illinois University
57	Ghirardi, Maria	National Renewable Energy Laboratory
58	Gittleman, Craig	Fuel Cell Research Labs
59	Glass, Robert	Lawrence Livermore National Laboratory
60	Goldbach, James	Arkema, Inc.
61	Goudy, Andrew	Delaware State University
62	Graber, Joe	U.S. Department of Energy
63	Grassilli, Leo	D&L Energy
64	Gross, Karl	Hydrogen Technology Associates
65	Gupta, Nikunj	Shell Hydrogen, LLC
66	Haberman, David	National Energy Technology Laboratory
67	Hamdan Giner, Monjid	Giner, Inc.

68	Hamrock, Steven	3M Fuel Cell Components Program
69	Hardis, Jonathan	National Institute of Standards and Technology
70	Harrison, Kevin	National Renewable Energy Laboratory
71	Hebling, Christopher	Fraunhofer Institute for Solar Energy Systems
72	Herbert, Thorsten	NOW GmbH
73	Herring, Andy	Colorado School of Mines
74	Hershkowitz, Frank	ExxonMobil Research & Engineering Co.
75	Hesterberg, Tom	Navistar, Inc.
76	Hirano, Shinichi	Ford Motor Company
77	Holladay, Jamie	U.S. Department of Energy
78	Hua, Thanh	Argonne National Laboratory
79	Imam, M.	Naval Research Laboratory
80	Jacobson, David	National Institute of Standards and Technology
81	James, Brian	Directed Technologies, Inc.
82	Jensen, Craig	University of Hawaii
83	Johnston, Christina	Los Alamos National Laboratory
84	Jorgensen, Scott	GM R&D
85	Kabir, Zakiul	ClearEdge Power
86	Kabza, Alexander	Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW) Baden-Württembergix
87	Kegerreis, Jim	Exxon Mobil
88	Kerr, John	Lawrence Berkeley National Laboratory
89	King, Dave	PNNL
90	Kopasz, John	Argonne National Laboratory
91	Kumar, Romesh	Argonne National Laboratory
92	Kuriyama, Nobuhiro	National Institute of Advanced Industrial Science and Technology Research
93	Lasher, Stephen	TIAX, LLC
94	Lewis, Michele	Argonne National Laboratory
95	Lipp, Ludwig	FuelCell Energy, Inc.
96	Maness, Pin-Ching	National Renewable Energy Laboratory
97	Mann, Margaret	National Renewable Energy Laboratory
98	Markovic, Nenad	Argonne National Laboratory
99	Maroni, Victor	Argonne National Laboratory
100	Masten, David	General Motors, Fuel Cell Activities
101	Mazumder, Malay	University of Arkansas
102	McFarland, Eric	University of California, Santa Barbara
103	McQueen, Shawna	Energetics Incorporated
104	Mehall, Mark	Ford Motor Company
105	Meisner, Gregory	GM Research & Development Center
106	Melis, Tasios	University of California, Berkeley
107	Merritt, James	Department of Transportation
108	Mettes, Jacques	Power and Energy
109	Meyers, Jeremy	University of Texas, Austin
110	Miller, Eric	University of Hawaii at Manoa, HNEI
111	Miller, James	Argonne National Laboratory
112	Miller, Michael	Southwest Research Institute
113	Minh, Nguyen	Consultant
114	Mitchell, George	GM Solutions, LLC
115	Mohtadi, Rana	Toyota Motor Engineering and Manufacturing of North America
116	More, Karren	Oak Ridge National Laboratory
117	Moreland, Greg	Retired, Consultant (Sentech)
118	Myers, Deborah	Argonne National Laboratory

119	Nguyen, Kevin	Chevron Energy Technology Company
120	Nkansah, Asare	Chicago State University
121	Olson, Greg	Retired, HRL
122	Ozkan, Umit	Ohio State University
123	Ozolins, Vidvuds	University of California, Los Angeles
124	Padro, Catherine	Los Alamos National Laboratory
125	Parks, George	FuelScience, LLC
126	Paster, Mark	Consultant, Retired DOE
127	Patel, Pinakin	Fuel Cell Energy
128	Pecharsky, Vitalij	Iowa State University
130	Penev, Michael	National Renewable Energy Laboratory
131	Perret, Robert	Nevada Technical Services, LLC
132	Peters, John	Montana State University
133	Petrovic, John	Petrovic and Associates
134	Pinkerton, Frederick	General Motors Research and Development Center
135	Pintauro, Peter	Vanderbilt University
136	Pivovar, Bryan	National Renewable Energy Laboratory
137	Podolski, Walt	Argonne National Laboratory
138	Quah, Cheng-Guan Michael	Concurrent Technologies
139	Ronnebro, Ewa	Pacific Northwest National Laboratory
140	Ramani, Vijay K.	Illinois Institute of Technology
141	Rambach, Glenn	Third Orbite Power Systems, Inc.
142	Remick, Robert	National Renewable Energy Lab
143	Richards, Mark	Versa Power Systems
144	Roan, Vernon	Retired, National Academies Member
145	Rocheleau, Richard	University of Hawaii at Manoa
146	Rossmeissl, Neil	U.S. Department of Energy
147	Saber, Jim	NextEnergy
148	Sandrock, Gary	Oak Ridge National Laboratory
149	Shultz, Travis	U.S. Department of Energy
150	Siegel, Don	University of Michigan
151	Simnick, James	BP Global Fuels Technology
152	Sink, Carl	U.S. Department of Energy
153	Sofronis, Petros	University of Illinois, Urbana-Champaign
154	Spendelow, Jacob	Los Alamos National Laboratory
155	Stanfield, Eric	National Institute of Standards and Technology
156	Stevenson, Jeff	Pacific Northwest National Laboratory
157	Steward, Darlene	Hydrogen Technologies & Systems Center
158	Stolten, Detlef	Forschungszentrum Jülich, GmbH
159	Stroh, Ken	Sentech, Inc.
160	Stubos, Thanos	NCSR Demokritos
161	Sudik, Andrea	Ford Motor Company
162	Summers, William	Savannah River National Laboratory
163	Surdoval, Wayne	U. S. Department of Energy
164	Swider Lyons, Karen	Naval Research Laboratory
165	Tao, Greg	Materials and Systems Research, Inc.
166	T-Raissi, Ali	University of Central Florida
167	Tran, Thanh	NSWC Carderock
168	Tumas, William	Los Alamos National Laboratory
169	Turner, John	National Renewable Energy Laboratory
170	Uddin, Nasim	Global Automotive Management Council, Inc.
171	Vanderborgh, Nicholas	Los Alamos National Laboratory, retired
172	Veenstra, Mike	Ford Motor Company

173	Voecks, Gerald	Retired, GM
174	Wainright, Jesse	Dept of Chemical Engineering, Case Western Reserve University
175	Waldecker, James	Ford Motor Company
176	Walker, Gavin	University of Nottingham
177	Wang, Yong	Pacific Northwest National Laboratory
178	Weeks, Brian	Advanced Energy Systems
179	Weidner, John	University of South Carolina
180	Wheeler, Douglas	DJW Technology, LLC
181	Williams, Mark	Retired, National Energy Technology Laboratory
182	Wipke, Keith	National Renewable Energy Laboratory
183	Wolverton, Christopher	Northwestern University
184	Woodbury, Neal	Arizona State University
185	Xu, Qing	J. Craig Venter Institute
186	Yvon, Klaus	Université de Genève
187	Zawodzinski, Thomas	Case Western Reserve University
188	Zelenay, Piotr	Los Alamos National Laboratory
189	Zhao, Yiping	University of Georgia

SUMMARY OF PEER REVIEW PANEL'S CROSS-CUTTING COMMENTS AND RECOMMENDATIONS

AMR panel members provided comments and recommendations regarding selected DOE hydrogen and fuel cell projects, overall management of the Program, and the AMR peer evaluation process. Project comments and scores are provided in the following sections of the report. Comments on subprogram management are provided in Appendix B.

ANALYSIS METHODOLOGY

A total of **216** projects were reviewed at the meeting. As shown above, **189** panel members participated in the AMR process providing a total of **1,066** project evaluations (not every panel member reviewed every project). These reviewers were asked to provide numeric scores (on a scale of 1 to 4, with 4 being the highest) for five aspects of the research presented. Sample evaluation forms are provided in Appendix C. Scores and comments were submitted on a provided laptop to an online, private database allowing for real time tracking of the review process. A list of projects that were presented at the AMR but were not reviewed is provided in Appendix D.

Project scores were based on the following five criteria and weights:

Score 1: Relevance to overall DOE objectives (20%)
Score 2: Approach to performing the R&D (20%)
Score 3: Technical accomplishments and progress toward achieving the project and DOE goals (40%)
Score 4: Technology transfer and collaborations with industry, universities, and other laboratories (10%)
Score 5: Approach to and relevance of proposed future research (10%)

For each project, an average score was calculated (from the scores of individual reviewers) for each of the five aforementioned criteria. These average scores were then weighted and combined to produce a final overall score for each project. In this manner, a project's final overall score can be meaningfully compared to that of another project. The following formula was used to calculate the weighted, overall score:

Final Score = [Score 1 x 0.20] + [Score 2 x 0.20] + [Score 3 x 0.40] + [Score 4 x 0.10] + [Score 5 x 0.10]

Some new projects were reviewed, for which the third criterion (Technical Accomplishments) did not apply because of the projects' recent startup. In this case, the other four criteria were scaled proportionately in the weighting calculation. The weighting value for the remaining scores [weight + (40/60 * weight)] was used to establish a final score formula for these projects. The result was the following:

Final Score = Score 1 x {0.20 + [(40/60) x 0.20]} +
Score 2 x {0.20 + [(40/60) x 0.20]} +
Score 4 x {0.10 + [(40/60) x 0.10]} +
Score 5 x {0.10 + [(40/60) x 0.10]}

A perfect, overall score of "4" would indicate that a project satisfied the five criteria to the fullest possible extent; the lowest possible, overall score of "1" would indicate that a project did not satisfactorily meet any of the requirements of the five criteria.

Reviewers were also asked to provide qualitative comments regarding the five criteria, specific strengths and weaknesses of the project, and/or any recommendations relating to the work scope. These scores and comments were placed into a database for easy retrieval and analysis. These comments are summarized in the following sections of this report.

ORGANIZATION OF THE REPORT

The project comments and scores are grouped by Subprogram (i.e., Production and Delivery, Hydrogen Storage, Fuel Cells, Systems Analysis, and Manufacturing) in order to align with DOE Program planning scheme. Each of these sections begins with a brief description of the general type of research being performed. This is followed by the results of the analysis for each of the projects presented at the 2009 Annual Merit Review. A summary of the qualitative comments is provided for each project, as well a graph showing the overall project score and a comparison of how each project aligns with all other projects in its Subprogram area. A sample graph is provided in Figure 1.

The project comparisons illustrated in the report are criteria based. Each rectangular blue bar in the chart represents that project's average score for one of the five designated criteria. Each of these scores (each blue bar) is then compared with the related maximum, minimum, and average score for the same criterion across all projects in the same Subprogram. The black line bars that

overlay the blue rectangular bars represent the maximum, average, and minimum scores for each criterion.

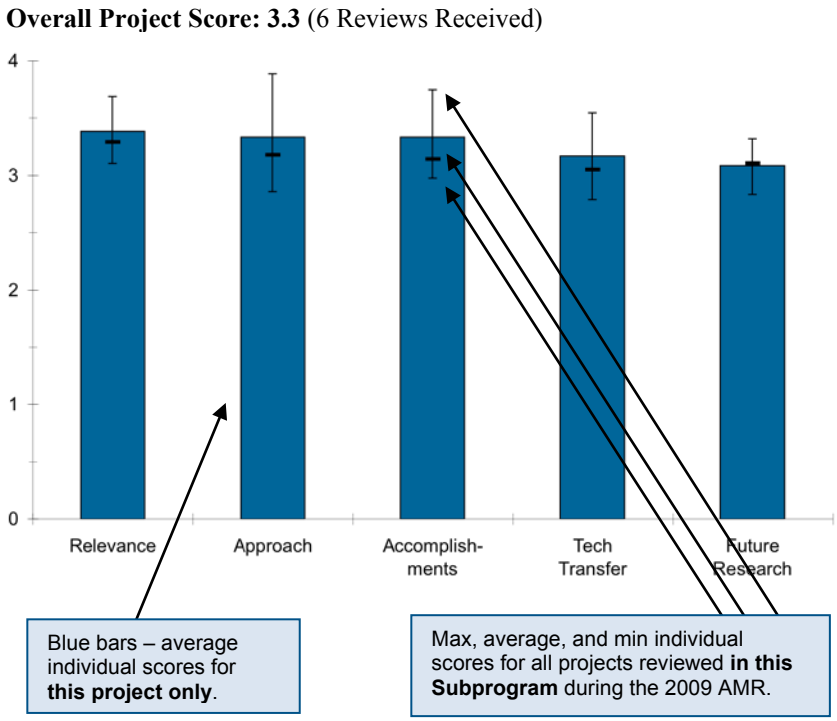

Figure 1: Project Score Graph with Explanation

For clarification, consider a hypothetical review in which only three projects were presented and reviewed in a Subprogram; Table 2 displays the average scores for each of the project's five, rated criteria.

Table 2: Sample Project Scores

	Relevance (20%)	Approach (20%)	Technical A&P (40%)	Tech Transfer (10%)	Future Research (10%)
Project A	3.4	3.3	3.3	3.2	3.1
Project B	3.1	2.8	2.7	2.7	2.9
Project C	3.0	2.6	2.7	2.8	2.9
Project D	3.4	3.5	3.4	3.2	3.3
Project E	3.6	3.7	3.5	3.4	3.4
Max	3.6	3.7	3.5	3.4	3.4
Average	3.3	3.2	3.1	3.0	3.1
Min	3.0	2.6	2.7	2.7	2.9

The Project A chart would contain five, blue rectangular bars to represent the values listed for Project A above. A black line bar indicating the related maximum, minimum, and average values for each criterion would overlay each of the blue bars to facilitate comparison with other projects in the Subprogram. In addition, each project's criterion scores would be weighted and combined to give a final, overall project score that could be meaningfully compared with those of other projects. Below is a sample calculation for the Project A weighted score.

Final Score for Project A = [3.4 x 0.20] + [3.3 x 0.20] + [3.3 x 0.40] + [3.2 x 0.10] + [3.1 x 0.10] = 3.3