INTRODUCTION

The FY 2010 U.S. Department of Energy (DOE) Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting (AMR) was held June 7–11, 2010, at the Marriott Wardman Park in Washington, D.C. This report is a summary of comments by AMR peer reviewers on the hydrogen and fuel cell projects funded by DOE's Office of Energy Efficiency and Renewable Energy (EERE) and the hydrogen production projects funded by the Office of Fossil Energy. The results of this merit review and peer evaluation are utilized by the DOE in making funding decisions for upcoming fiscal years.

The objectives of this meeting were as follows:

- Review and evaluate FY 2010 accomplishments and FY 2011 plans for DOE laboratory programs, industry/university cooperative agreements, and related research, development, and demonstration (RD&D) efforts
- Provide an opportunity for program stakeholders/participants (e.g., fuel cell manufacturers, component developers, etc.) to shape the DOE-sponsored RD&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 RD&D

The peer review process followed the guidelines of the Peer Review Guide developed by 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 involving hydrogen and fuel cells, 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 (COIs) 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.	Name	Organization
1	Tarek Abdel-Baset	Chrysler LLC
2	Kev Adjemian	Nissan Technical Center North America, Inc.
3	Radoslav Adzic	Brookhaven National Laboratory
4	Channing Ahn	California Institute of Technology
5	Etsuo Akiba	ETRI, National Institute of Advanced Industrial Science and Technology (AIST)
6	Anthony Androsky	U.S. Fuel Cell Council
7	Laurent Antoni	Commissariat A l'Energie Atomique (CEA)
8	Koorosh Araghi	National Aeronautics and Space Administration
9	Katherine Ayers	Proton Energy Systems
10	U. (Balu) Balachandran	Argonne National Laboratory
11	Viktor Balema	Sigma-Aldrich
12	Farshad Bavarian	Chevron
13	Pierre Benard	Hydrogen Research Institute
14	Guido Bender	National Renewable Energy Laboratory
15	Leonid Bendersky	National Institute of Standards and Technology
16	Thomas Benjamin	Argonne National Laboratory

17	Larry Blair	U.S. Department of Energy
18	Christopher Bordeaux	Bordeaux International Energy Consulting, LLC
19	Rod Borup	Los Alamos National Laboratory
20	Nico Bouwkamp	California Fuel Cell Partnership
21	Robert Bowman	Oak Ridge National Laboratory
22	Craig Brown	National Institute of Standards and Technology
23	Tobias Brunner	BMW Group
24	Tony Burrell	Los Alamos National Laboratory
25	F. Colin Busby	W. L Gore & Associates
26	Robert Buxbaum	REB Research & Consulting
27	Julie Cairns	CSA America
28	Stephen Campbell	Automotive Fuel Cell Cooperation
29	Dan Casey	Chevron
30	Richard Chahine	Institut de recherche sur l'hydrogene
31	Biswajit Choudhury	DuPont Fuel Cells
32	John Christensen	National Renewable Energy Laboratory (ret., DLA-DOD)
33	Mike Ciocco	Independent Civil Engineering Professional
34	William Collins	UTC Power
35	Alan Cooper	Air Products and Chemicals, Inc.
36	Phil Cox	University of North Florida
37	James Cross III	Nuvera Fuel Cells, Inc.
38	Ben Deal	California Air Resources Board
39	Mark Debe	3M
40	Emory DeCastro	BASF Fuel Cell, Inc.
41	Huyen Dinh	National Renewable Energy Laboratory
42	G. Charles Dismukes	Rutgers University
43	Tabbetha Dobbins	Louisiana Tech University
44	Junhang Dong	University of Cincinnati, Department of Chemical and Materials Engineering
45	Daniel Driscoll	U.S. Department of Energy
46	Dave Edlund	Element 1, LLC
47	Erich Erdle	EFCECO
48	Mitch Ewan	Hawaii Natural Energy Institute
49	Chinbay Fan	Gas Technology Institute
50	David Farese	Air Products and Chemicals, Inc.
51	Linda Fassbender	Pacific Northwest National Laboratory
52	George Fenske	Argonne National Laboratory
53	Magali S. Ferrandon	Argonne National Laboratory
54	James Fletcher	University of North Florida
55	Stuart Funk	LMI
56	Jennifer Gangi	Fuel Cells 2000
57	Fernando Garzon	Los Alamos National Laboratory
58	Thomas Gennett	National Renewable Energy Laboratory
59	Don Gervasio	Arizona State University
60	Craig Gittleman	Electrochemical Energy Research Labs
61	Robert Glass	Lawrence Livermore National Laboratory
62	James Goldbach	Arkema, Inc.
63	Andrew Goudy	Delaware State University
64	Joe Graber	U.S. Department of Energy
65	Jason Graetz	Brookhaven National Laboratory
66	Leo Grassilli	Office of Naval Research
67	Karl Gross	Hydrogen Technology Associates
68	Nikunj Gupta	Shell Hydrogen, LLC

69	Monjid Hamdan	Giner, Inc.
70	Jennifer Hamilton	California Fuel Cell Partnership
71	Steven Hamrock	3M Fuel Cell Components Program
72	Jonathan Hardis	National Institute of Standards and Technology
73	Barbara Hennessey	U.S. Department of Transportation
74	Thorsten Herbert	NOW GmbH
75	Andy Herring	Colorado School of Mines
76	Shinichi Hirano	Ford Motor Company
77	Mark Hoberecht	National Aeronautics and Space Administration
78	Clark Hochgraf	Rochester Institute of Technology
79	Jamie Holladay	U.S. Department of Energy
80	Aaron Hoskin	Natural Resources - Canada
81	Thanh Hua	Argonne National Laboratory
82	Jimmy Humphrey	J.L. Humphrey & Associates
83	Ashraf Imam	Naval Research Laboratory
84	David Jacobson	National Institute of Standards and Technology
85	Brian James	Directed Technologies, Inc.
86	Tom Jarvi	UTC Power
87	Craig Jensen	University of Hawaii
88	Scott Jorgensen	General Motors
89	Nick Josefik	US Army Corps of Engineers (USACE-DOD)
90	Zakiul Kabir	ClearEdge Power
91	Alexander Kabza	Zentrum für Sonnenenergie und Wasserstoff Forschung (ZSW) Baden-Württemberg
92	Ian Kaye	UltraCell Corp.
93	Jay Keller	Sandia National Laboratory
94	John Kerr	Lawrence Berkeley National Laboratory
95	Shyam Kocha	National Renewable Energy Laboratory
96	Chet Kolodziej	Freedom Field
97	John Kopasz	Argonne National Laboratory
98	Robert Kozak	Atlantic Biomass Conversions, Inc.
99	Matt Kromer	TIAX, LLC
100	Melissa Laffen	Alliance Technical Services
101	Michael Laughlin	New West Technologies, LLC
102	William Lear	University of Florida
103	James Lee	Johns Hopkins University
104	Clovis Linkous	Florida Solar Energy Center
105	Francis Lipiecki	Consultant, previously at Rohm and Haas
106	Ludwig Lipp	FuelCell Energy, Inc.
107	Nenad Markovic	Argonne National Laboratory
108	Victor Maroni	Argonne National Laboratory
109	Shawna McQueen	Energetics Incorporated
110	Gregory Meisner	General Motors Global Research & Development
111	Tasios Melis	University of California, Berkeley
112	Jonathan Melman	Intematix
113	James Merritt	U.S. Department of Transportation
114	James Miller	Argonne National Laboratory
115	Michael Miller	Southwest Research Institute
116	Eric Miller	University of Hawaii at Manoa, HNEI
117	Robert Miller	Air Products and Chemicals, Inc.
118	George Mitchell	University of Michigan
119	Rana Mohtadi	Toyota Motor Engineering and Manufacturing of North America (TEMA)
120	Karren More	Oak Ridge National Laboratory

121	Gregory Moreland	Sentech, Inc.
122	Jason Morgan	Ballard Material Products
123	Bryan Morreale	National Energy Technology Laboratory
124	David Mountz	Arkema, Inc.
125	Deborah Myers	Argonne National Laboratory
126	Kevin Nguyen	Chevron Energy Technology Company
127	Mike Nicholas	University of California, Davis
128	James Ohi	Consultant to U.S. Department of Energy
130	Kelly Oleary	General Motors
131	Gregory Olson	Sentech, Inc.
132	Jon Owejan	General Motors Electrochemical Energy Research
133	Umit Ozkan	Ohio State University
134	Catherine Padró	Los Alamos National Laboratory
135	George Parks	FuelScience LLC
136	Pinakin Patel	FuelCell Energy
137	Vitalij Pecharsky	Iowa State University
138	Michael Penev	National Renewable Energy Laboratory
139	Robert Perret	Nevada Technical Services, LLC
140	Mike Perry	United Technologies Research Center (UTRC)
141	John Petrovic	Petrovic and Associates
142	Guido Pez	Air Products and Chemicals, Inc. (retired)
143	Peter Pintauro	Vanderbilt University
144	Bryan Pivovar	National Renewable Energy Laboratory
145	Walt Podolski	Argonne National Laboratory
146	Raymond Puffer	Rensselaer Polytechnic Institute
147	Vijay Ramani	Illinois Institute of Technology, Chicago
148	Glenn Rambach	Trulite, Inc.
149	Mark Richards	Versa Power Systems
150	Vernon Roan	University of Florida
151	Ewa Rönnebro	Pacific Northwest National Laboratory
152	Neil Rossmeissl	U.S. Department of Energy, Biomass Program
153	Tecle Rufael	Chevron
154	Mark Ruth	National Renewable Energy Laboratory
155	Jim Saber	NextEnergy
156	Gary Sandrock	Sandia National Laboratory
157	Patrick Serfass	Technology Transition Corporation
158	Travis Shultz	U.S. Department of Energy
159	Don Siegel	University of Michigan
160	Robert Sievers	Teledyne Energy Systems
161	James Simnick	BP America
162	Darlene Slattery	University of Central Florida—Florida Solar Energy Center
163	Petros Sofronis	University of Illinois, Urbana-Champaign
164	Jacob Spendelow	Los Alamos National Laboratory
165	Eric Stanfield	National Institute of Standards and Technology
166	Vesna Stanic	EnerFuel
167	Mike Steele	Advanced Technology Center
168	Marc Steen	Institute for Energy, Joint Research Centre, European Commission
169	Darlene Steward	Hydrogen Technologies & Systems Center
170	Detlef Stolten	Forschungszentrum Jülich GmbH
171	Ken Stroh	Sentech, Inc.
172	Andrea Sudik	Ford Motor Company
173	Wayne Surdoval	U. S. Department of Energy

174	Dr. Robert Sutton	Argonne National Laboratory
175	Karen Swider Lyons	Naval Research Laboratory
176	Satish Tamhankar	Linde LLC
177	Leonard Tender	U.S. Naval Research Laboratory
178	George Thomas	U.S. Department of Energy (retired)
179	Ali T-Raissi	University of Central Florida—Florida Solar Energy Center
180	Michael Ulsh	National Renewable Energy Laboratory
181	Nicholas Vanderborgh	Los Alamos National Laboratory (retired)
182	Mike Veenstra	Ford Motor Company
183	George Vernstrom	3M
184	Vilayanur Viswanathan	Pacific Northwest National Laboratory
185	Gerald Voecks	General Motors (retired)
186	Jesse Wainright	Case Western Reserve University
187	James Waldecker	Ford Motor Company
188	Heli Wang	National Renewable Energy Laboratory
189	Douglas Wheeler	DJW Technology, LLC
190	Robert Wichert	U.S. Fuel Cell Council
191	Mark Williams	URS
192	Keith Wipke	National Renewable Energy Laboratory
193	Christopher Wolverton	Northwestern University
194	Kin Wong	U. S. Department of Transportation
195	Neal Woodbury	Arizona State University
196	Piotr Zelenay	Los Alamos National Laboratory
197	Yimin Zhu	Nanosys, Inc
198	Richard Ziegler	Sentech, Inc.

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 sub-program management are provided in Appendix B.

ANALYSIS METHODOLOGY

A total of **216** projects were reviewed at the meeting. As shown above, **198** panel members participated in the AMR process, providing a total of **1,165** 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 work presented. Sample evaluation forms are provided in Appendix C. Scores and comments were submitted using laptops (provided on-site) 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.

Scores were based on the following five criteria and weights (for all projects except American Recovery and Reinvestment Act projects, which used separate criteria):

Score 1: Relevance to overall DOE objectives (20%)
Score 2: Approach to performing the work (20%)
Score 3: Technical accomplishments & progress toward project and DOE goals (40%)
Score 4: Collaboration and coordination with other institutions (10%)
Score 5: Proposed future work (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 entered into a database for easy retrieval and analysis. The comments are summarized in the following sections of this report.

Reviewers of American Recovery and Reinvestment Act (ARRA) projects used the following criteria:

Score 1: Relevance (20%)
Score 2: Development/ Deployment Approach (30%)
Score 3: Technical Accomplishments and Progress (40%)
Score 4: Collaborations (10%)

Reviewers were also asked to provide summary comments regarding ARRA project strengths and weaknesses and to provide specific recommendations.

ORGANIZATION OF THE REPORT

The project comments and scores are grouped by sub-program (Hydrogen Production and Delivery; Hydrogen Storage; Fuel Cells; Manufacturing R&D; Technology Validation; Safety, Codes & Standards; Education; Systems Analysis; and ARRA activities) in order to align with the DOE Program planning scheme. Each of these sections begins with a brief description of the general type of R&D or other activity being conducted. This is followed by the results of the reviews of each of the projects presented at the 2010 AMR. 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 sub-program 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. These scores (blue bars) are then compared with the related maximum, minimum, and average scores for the same criterion across all projects in the same sub-program. The black line bars that overlay the blue rectangular bars represent the maximum, average, and minimum scores for each criterion.

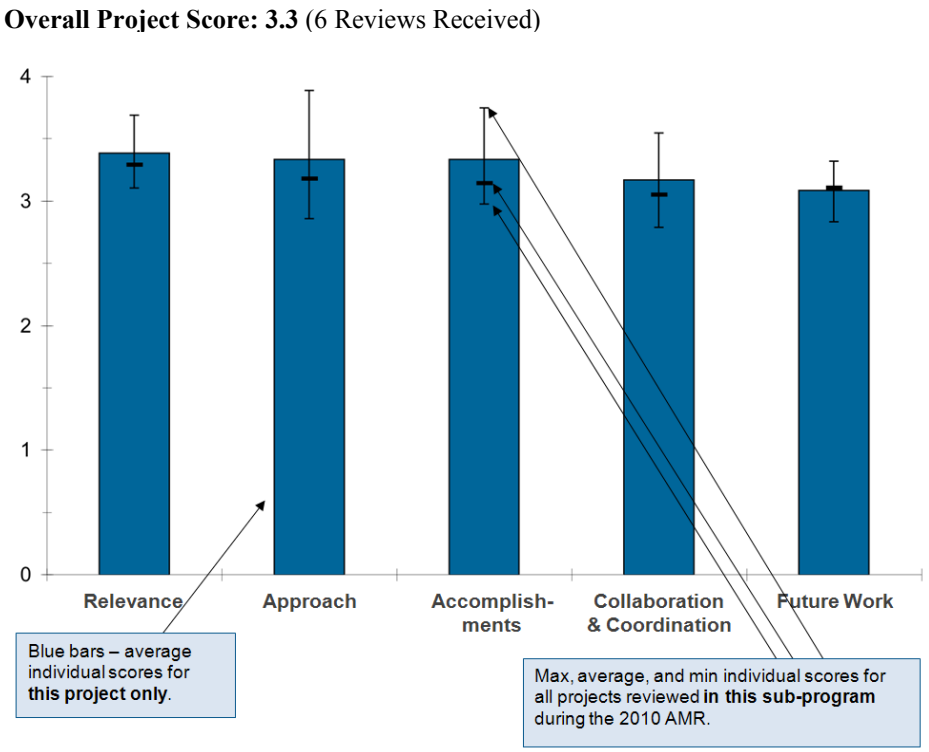

Figure 1: Project Score Graph with Explanation

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

Table 2: Sample Project Scores

	Relevance (20%)	Approach (20%)	Accomplish-ments (40%)	Collaboration & Coordination (10%)	Future Work (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 sub-program. 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