Introduction

The fiscal year (FY) 2013 U.S. Department of Energy (DOE) Hydrogen and Fuel Cells Program Annual Merit Review and Peer Evaluation Meeting (AMR), in conjunction with DOE's Vehicle Technologies Office AMR, was held from May 13–16, 2013, at the Crystal City Marriott and Crystal Gateway Marriott in Arlington, Virginia. This report is a summary of comments by AMR peer reviewers about the hydrogen and fuel cell projects funded by DOE's Office of Energy Efficiency and Renewable Energy (EERE). Projects supported by other DOE offices (including the Office of Science [Basic Energy Sciences] and ARPA-E) in areas relevant to hydrogen and fuel cells were also presented at the FY 2013 AMR. DOE uses the results of this merit review and peer evaluation, along with additional review processes, to make funding decisions for upcoming fiscal years and help guide ongoing performance improvements to existing projects.

The objectives of this meeting include the following:

- Review and evaluate FY 2013 accomplishments and FY 2014 plans for DOE laboratory programs; industry/university cooperative agreements; and related research, development, and demonstration (RD&D) efforts
- Provide an opportunity for stakeholders and participants (e.g., fuel cell manufacturers, component developers, and others) to provide input to help shape the DOE-sponsored RD&D program in order to address the highest-priority technical barriers and facilitate technology transfer
- Foster interactions among the national laboratories, industry, and universities conducting RD&D.

The peer review process followed the guidelines in the *Peer Review Guide* developed by EERE. The peer review panel members, listed in Table 1, provided comments about the projects presented. Panel members included experts from a variety of backgrounds related to hydrogen and fuel cells, and they represented national laboratories, universities, various government agencies, and manufacturers of hydrogen production, storage, delivery, and fuel cell technologies. Each reviewer was screened for conflicts of interest 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	Abdel-Baset, Tarek	Chrysler LLC
2	Adzic, Radoslav	Brookhaven National Laboratory
3	Ahluwalia, Rajesh	Argonne National Laboratory
4	Ahmed, Shabbir	Argonne National Laboratory
5	Ainscough, Chris	National Renewable Energy Laboratory
6	Antoni, Laurent	Commissariat A l'Energie Atomique (CEA)
7	Antos, George	National Science Foundation
8	Araghi, Koorosh	National Aeronautics and Space Administration
9	Ardo, Shane	California Institute of Technology
10	Autrey, Thomas	Pacific Northwest National Laboratory
11	Balbuena, Perla	Texas A&M University
12	Balema, Viktor	Sigma-Aldrich
13	Baturina, Olga	U.S. Navy, Naval Research Laboratory (former)
14	Beattie, Paul	Ballard Power Systems
15	Bender, Guido	National Renewable Energy Laboratory
16	Benjamin, Thomas	Argonne National Laboratory
17	Birdsall, Jackie	Toyota Engineering and Manufacturing America
18	Bonner, Brian	Air Products and Chemicals, Inc.
19	Bordeaux, Christopher	Bordeaux International Energy Consulting LLC
20	Borup, Rod	Los Alamos National Laboratory
21	Bouwkamp, Nico	California Fuel Cell Partnership
22	Bowden, Mark	Pacific Northwest National Laboratory
23	Bowman, Robert	Oak Ridge National Laboratory
24	Boyd, Robert	Boyd Hydrogen LLC
25	Brett, Lois	Consultant
26	Brosha, Eric	Los Alamos National Laboratory

No.	Name	Organization
27	Brown, Craig	National Institute of Standards and Technology
28	Burgunder, Albert	Praxair, Inc.
29	Cai, Mei	General Motors, Research & Development Center
30	Cairns, Julie	CSA Group
31	Campbell, Stephen	AFCC Automotive Fuel Cell Cooperation Corporation
32	Cargnelli, Joe	Hydrogenics
33	Centeck, Kevin	TARDEC
34	Chahine, Richard	Hydrogen Research Institute, Institut de recherche sur l'hydrogene
35	Choudhury, Biswajit	DuPont Fuel Cells
36	Christensen, John	Consultant - U.S. Navy, DOD-DLA (retired)
37	Cole, Brian	U.S. Army RDECOM CERDEC
38	Collins, William	United Technologies (retired)
39	Conti, Amedeo	Nuvera Fuel Cells, Inc.
40	Creager, Stephen	Clemson University
41	Curtin, Dennis	DuPont (retired)
42	Dale, Nilesh	Nissan
43	Datye, Abhaya	University of New Mexico
44	Davis, Benjamin	Los Alamos National Laboratory
45	De Castro, Emory	BASF Fuel Cell, Inc.
46	Dedrick, Daniel	Sandia National Laboratories
47	Dinh, Huyen	National Renewable Energy Laboratory
48	Dixon, David	University of Alabama
49	Dobbins, Tabbetha	Rowan University
50	Dornheim, Martin	Helmholtz Zentrum-Geestadt
51	Duenas, Terrisa	NextGen Aeronautics
52	Ehlers, Peter	CSA Group
53	Erdle, Erich	EFCECO, Erdle Fuel Cell & Energy Consulting
54	Esposito, Dan	National Institute of Standards and Technology
55	Eudy, Leslie	National Renewable Energy Laboratory
56	Ewan, Mitch	University of Hawai'i, Manoa
57	Fan, Chinbay	Gas Technology Institute
58	Farese, David	Air Products and Chemicals, Inc.
59	Fenske, George	Argonne National Laboratory
60	Funk, Stuart	LMI
61	Gangi, Jennifer	Fuel Cells 2000
62	Gennett, Thomas	National Renewable Energy Laboratory
63	Gervasio, Don	University of Arizona
64	Giron, Enrique	Fuel Cells and Hydrogen Joint Undertaking
65	Gittleman, Craig	General Motors, Research & Development Center
66	Graetz, Jason	HRL Laboratories
67	Grassilli, Leo	Consultant - Office of Naval Research
68	Greene, David	Oak Ridge National Laboratory
69	Gross, Karl	H2 Technology Consulting LLC
70	Gross, Tom	Energy Planning and Solutions (Consultant)
71	Grot, Stephen	Ion Power
72	Gu, Wenbin	General Motors
73	Gupta, Ram	National Science Foundation
74	Hall, Karen	Technology Transition Corporation
75	Hamilton, Cyd	U.S. Department of Energy
76	Hamilton, Jennifer	California Fuel Cell Partnership
77	Hardis, Jonathan	National Institute of Standards and Technology
78	Harris, Aaron	Sandia National Laboratories
79	Harvey, David	Ballard
80	Hays, Charles	National Aeronautics and Space Administration, Jet Propulsion Laboratory
81	He, Wensheng	Arkema, Inc.
82	Hennessey, Barbara	U.S. Department of Transportation

No.	Name	Organization
83	Herbert, Thorsten	NOW GmbH
84	Hicks, Michael	H2 PowerTech
85	Hirano, Shinichi	Ford Motor Company
86	Holladay, Jamie	Pacific Northwest National Laboratory
87	Jacobson, David	National Institute of Standards and Technology
88	James, Brian	Strategic Analysis, Inc.
89	Jaramillo, Thomas	Stanford University
90	Jarvi, Tom	Sun Catalytix Corporation
91	Jensen, Craig	University of Hawai'i, Honolulu
92	Jensen, Torben René	Aarhus University
93	Josefik, Nick	U.S. Army Corps of Engineers (USACE-DOD)
94	Junge, Axel	General Motors, Research & Development Center
95	Kasab, John	Ricardo
96	Keller, Jay	Sandia National Laboratories
97	Kerr, John	Lawrence Berkeley National Laboratory
98	Knights, Shanna	Ballard Power Systems
99	Kocha, Shyam	National Renewable Energy Laboratory
100	Kongkanand, Anusorn	General Motors Corporation
101	Kopasz, John	Argonne National Laboratory
102	Koros, William	Georgia Institute of Technology
103	Kraigsley, Alison	National Institute of Standards and Technology
104	Kurtz, Jennifer	National Renewable Energy Laboratory
105	Lakshmanan, Balsu	General Motors Corporation
106	Leachman, Jacob	Washington State University
107	Leduc, Guillaume	Fuel Cells and Hydrogen Joint Undertaking
108	Lieberman, Robert	Intelligent Optical Systems
109	Linkous, Clovis	Youngstown State University
110	Lipp, Ludwig	FuelCell Energy, Inc.
111	Markovic, Nenad	Argonne National Laboratory
112	Maroni, Victor	Argonne National Laboratory
113	McConnachie, Jonathan	Exxon Mobil
114	McGrady, Sean	University of New Brunswick
115	McKone, Thomas	Lawrence Berkeley National Laboratory
116	Melaina, Marc	National Renewable Energy Laboratory
117	Merritt, James	U.S. Department of Transportation
118	Miller, James	Argonne National Laboratory
119	Minh, Nguyen	General Electric Global Research Center
120	Mittelsteadt, Cortney	Giner, Inc./Giner Electrochemical Systems, LLC
121	Moen, Chris	Sandia National Laboratories
122	Moffat, Thomas	National Institute of Standards and Technology
123	Moreland, Gregory	SRA International, Inc.
124	Motyka, Ted	Savannah River National Laboratory
125	Moulthrop, Larry	Proton OnSite
126	Mukerjee, Sanjeev	Northeastern University
127	Mukundan, Rangachary	Los Alamos National Laboratory
128	Myers, Deborah	Argonne National Laboratory
129	Nicholas, Mike	University of California, Davis
130	Oesterreich, Bob	Air Liquide Industrial
131	Ogden, Joan	University of California, Davis
132	Ohma, Atsushi	Nissan Motor Company
133	Olson, Gregory	Consultant – Sentech
134	Ott, Kevin	Los Alamos National Laboratory (retired)
135	Owejan, Jon	State University of New York
136	Padró, Catherine	Los Alamos National Laboratory
137	Parks, George	FuelScience LLC / Phillips 66
138	Paster, Mark	Consultant – Independent
139	Penev, Michael	National Renewable Energy Laboratory
140	Perret, Robert	Nevada Technical Services, LLC

No.	Name	Organization
141	Perry, Mike	United Technologies Research Center (UTRC)
142	Petrovic, John	Petrovic and Associates
143	Pivovar, Bryan	National Renewable Energy Laboratory
144	Podolski, Walt	Argonne National Laboratory
145	Polevaya, Olga	Nuvera Fuel Cells, Inc.
146	Protopappas, Peter	Navigant Consulting
147	Rambach, Glenn	SiGNa Chem
148	Ramsden, Todd	National Renewable Energy Laboratory
149	Richards, Mark	Versa Power Systems
150	Rinebold, Joel	Connecticut Center for Advanced Technology, Inc.
151	Rossmeissl, Neil	U.S. Department of Energy, EERE
152	Sattler, Christian	German Aerospace Center (DLR)
153	Schlasner, Steven	University of North Dakota, EERC
154	Schneider, Jesse	BMW of North America, LLC
155	Siegel, Don	University of Michigan, Ann Arbor
156	Simnick, James	BP America
157	Skolnik, Ed	Energetics Incorporated
158	Sofronis, Petros	University of Illinois, Urbana-Champaign
159	Soto, Herie	Shell Hydrogen LLC
160	Stamenkovic, Vojislav	Argonne National Laboratory
161	Steen, Marc	European Commission, Joint Research Centre
162	Steinbach, Andy	3M
163	Stolten, Detlef	Forschungszentrum Jülich GmbH
164	Sutherland, Ian	General Motors Corporation
165	Swider-Lyons, Karen	U.S. Navy, Naval Research Laboratory
166	Thomas, C.E. (Sandy)	Clean Car Options
167	Trocciola, John	SRA International, Inc.
168	Ulsh, Michael	National Renewable Energy Laboratory
169	Vanderborgh, Nicholas	Los Alamos National Laboratory (retired)
170	Veenstra, Mike	Ford Motor Company
171	Voecks, Gerald	CalTech
172	Vora, Shailesh	National Energy Technology Laboratory
173	Wachsman, Eric	University of Maryland
174	Wagener, Earl	Tetramer Technologies
175	Wagner, Frederick T.	General Motors Corporation (retired)
176	Waldecker, James	Ford Motor Company
177	Walk, Alex	SGL Group
178	Warren, Charles David	Oak Ridge National Laboratory
179	Weber, Adam	Lawrence Berkeley National Laboratory
180	Wei, Max	Lawrence Berkeley National Laboratory
181	Wessel, Silvia	Ballard
182	Wheeler, Douglas	DJW Technology LLC
183	Williams, Mark	National Energy Technology Laboratory
184	Wilson, Mahlon	Los Alamos National Laboratory
185	Wolak, Frank	FuelCell Energy, Inc.
186	Woods, Stephen	National Aeronautics and Space Administration
187	Yang, Joyce	U.S. Department of Energy, EERE
188	Yuzugullu, Elvin	SRA International, Inc.
189	Zhu, Yimin	Silicon Energy Storage

Summary of Peer Review Panel's Crosscutting Comments and Recommendations

AMR panel members provided comments and recommendations regarding selected DOE hydrogen and fuel cell projects, overall management of the Hydrogen and Fuel Cells Program, and the AMR peer evaluation process. The project comments, recommendations, and scores are provided in the following sections of this report, grouped by program area. Comments about program management are provided in Appendix B.

Analysis Methodology

A total of **118** projects were reviewed at the meeting. As shown in Table 1, **189** review panel members participated in the AMR process, providing a total of **752** project evaluations. These reviewers were asked to provide numeric scores (on a scale of 1–4, with 4 being the highest) for five aspects of the work presented. A sample evaluation form is 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 not reviewed, is provided in Appendix D.

Scores were based on the following five criteria and weights:

Score 1: Approach to performing the work (20%)
Score 2: Accomplishments and progress toward overall project and DOE goals (45%)
Score 3: Collaboration and coordination with other institutions (10%)
Score 4: Relevance/potential impact on DOE program goals and RD&D objectives (15%)
Score 5: Proposed future work (10%).

For each project, individual reviewer scores for each of the five criteria were weighted using the formula in the box below to create a final score for each reviewer for that project. The average score for each project was then calculated by averaging the final scores for individual reviewers. The individual reviewer scores for each question were also averaged to provide information on the project's question-by-question scoring. In this manner, a project's final overall score can be meaningfully compared to that of another project.

Final Overall Score = [Score 1 x 0.20] + [Score 2 x 0.45] + [Score 3 x 0.10] + [Score 4 x 0.15] + [Score 5 x 0.10]

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

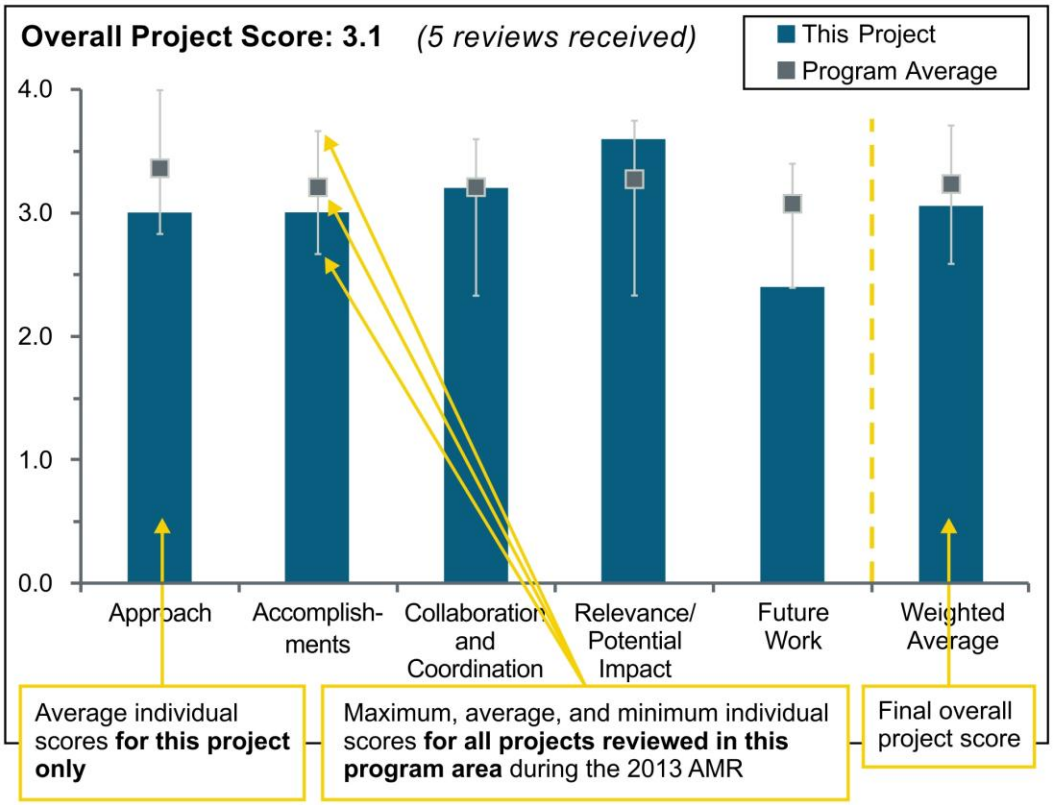
Reviewers were also asked to provide qualitative comments regarding the five criteria, specific strengths and weaknesses of the project, and any recommendations relating to the work scope. These comments were also entered into the online, private database for easy retrieval and analysis.

Organization of the Report

The project comments and scores are grouped by program area (Hydrogen Production and Delivery; Hydrogen Storage; Fuel Cells; Manufacturing R&D; Technology Validation; Safety, Codes and Standards; Market Transformation; and Systems Analysis) in order to align with the Fuel Cell Technologies Office's planning scheme. Each of these sections begins with a brief description of the general type of research and development or other activity being conducted. Next are the results of the reviews of each project presented at the 2013 AMR. The report also includes a summary of the qualitative comments for each project, as well as a graph showing the overall project score and a comparison of how each project aligns with all of the other projects in its program area. A sample graph is provided in Figure 1.

Projects are compared based on a consistent set of criteria. Each project has a chart with bars representing that project's average scores for each of the five designated criteria. The gray vertical hash marks that overlay the blue bars represent the corresponding maximum, average, and minimum scores for all of the projects in the same program.

Figure 1: Project Score Graph with Explanation



For clarification, consider a hypothetical review in which only five projects were presented and reviewed in a program area. Table 2 displays the average scores for each project according to the five rated criteria.

Table 2: Sample Project Scores

	Approach (20%)	Accomplishments (45%)	Collaboration and Coordination (10%)	Relevance/ Potential Impact (15%)	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
Maximum	3.6	3.7	3.5	3.4	3.4
Average	3.3	3.2	3.1	3.0	3.1
Minimum	3.0	2.6	2.7	2.7	2.9

Using this data, the chart for Project A would contain five bars representing the values listed for that project in Table 2. A gray hash mark indicating the related maximum, minimum, and average values for all of the projects in Project A's program area (the last three lines in the table above) would overlay each corresponding bar to facilitate comparison. In addition, each project's criteria scores would be weighted and combined to produce a final, overall project score that would permit meaningful comparisons to 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 0.45] + [3.3 x 0.10] + [3.2 x 0.15] + [3.1 x 0.10] = 3.3