Introduction

The fiscal year (FY) 2014 U.S. Department of Energy (DOE) Hydrogen and Fuel Cells Program (the Program) Annual Merit Review and Peer Evaluation Meeting (AMR), in conjunction with DOE's Vehicle Technologies Office Annual Merit Review, was held June 16–20, 2014, at the Washington Marriott Wardman Park Hotel in Washington, DC. 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 2014 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 2014 accomplishments and FY 2015 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 Group LLC
2	Adzic, Radoslav	Brookhaven National Laboratory
3	Afzal, Kareem	PDC Machines, Inc.
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	Artyushkova, Kateryna	University of New Mexico
10	Atanasiu, Mirela	European Commission, Fuel Cells and Hydrogen Joint Undertaking
11	Autrey, Thomas	Pacific Northwest National Laboratory
12	Ayers, Katherine	Proton OnSite
13	Balema, Viktor	Sigma-Aldrich
14	Barbosa, Nicholas	National Institute of Standards and Technology
15	Barilo, Nick	Pacific Northwest National Laboratory
16	Baturina, Olga	U.S. Navy, Naval Research Laboratory
17	Benjamin, Thomas	Argonne National Laboratory
18	Birdsall, Jackie	Toyota Engineering and Manufacturing America
19	Bonner, Brian	Air Products and Chemicals, Inc.
20	Bordeaux, Christopher	Bordeaux International Energy Consulting LLC
21	Borup, Rod	Los Alamos National Laboratory
22	Bouwkamp, Nico	California Fuel Cell Partnership
23	Bowman, Robert	Oak Ridge National Laboratory

No.	Name	Organization
24	Boyd, Robert	Boyd Hydrogen LLC
25	Brink, Andy	Michelman
26	Brown, Craig	National Institute of Standards and Technology
27	Bunnelle, Eric	ExxonMobil
28	Burgunder, Albert	Praxair, Inc.
29	Burke, Kenneth	National Aeronautics and Space Administration, Glenn Research Center
30	Busby, F. Colin	W.L. Gore & Associates, Inc.
31	Butsch, Hanno	NOW GmbH
32	Cairns, Julie	CSA Group
33	Centeck, Kevin	U.S. Army, TARDEC (Tank Automotive Research, Development and Engineering Center)
34	Choudhury, Biswajit	DuPont Fuel Cells
35	Christiansen, Katy	U. S. Department of Energy, American Association for the Advancement of Science Fellow
36	Co, Anne	Ohio State University
37	Cole, Brian	U.S. Army RDECOM/CERDEC (Research, Development and Engineering Command/Communications-Electronics Research, Development and Engineering Center)
38	Cole, Vernon	CFD Research Corporation
39	Collins, William	Consultant
40	Contini, Vince	Battelle
41	Creager, Stephen	Clemson University
42	Cullen, David	Oak Ridge National Laboratory
43	Curry-Nkansah, Maria	Argonne National Laboratory
44	Dale, Nilesh	Nissan USA
45	Datye, Abhaya	University of New Mexico
46	De Castro, Emory	Advent Technologies, Inc.
47	Debe, Mark	Consultant (formerly 3M)
48	Dedrick, Daniel	Sandia National Laboratories
49	Dinh, Huyen	National Renewable Energy Laboratory
50	Eckerle, Tyson	Zero Emissions Vehicle Infrastructure Project Manager, State of California
51	Elrick, William	California Fuel Cell Partnership
52	Erdle, Erich	EFCECO, Erdle Fuel Cell & Energy Consulting
53	Erlebacher, Jonah	Johns Hopkins University
54	Eudy, Leslie	National Renewable Energy Laboratory
55	Ewan, Mitch	University of Hawaii, Manoa
56	Faldi, Alessandro	ExxonMobil
57	Fan, Chinbay	Gas Technology Institute
58	Farese, David	Air Products and Chemicals, Inc.
59	Felter, Tom	Sandia National Laboratories
60	Fenske, George	Argonne National Laboratory
61	Funk, Stuart	LMI
62	Gangi, Jennifer	Fuel Cells 2000
63	Garzon, Fernando	Los Alamos National Laboratory
64	Ge, Qingfeng	Southern Illinois University
65	Gennett, Thomas	National Renewable Energy Laboratory
66	Gittleman, Craig	General Motors, Research & Development Center
67	Grassilli, Leo	Consultant - Office of Naval Research
68	Greene, David L	Oak Ridge National Laboratory / University of Tennessee
69	Gross, Tom	Energy Planning and Solutions (Consultant)

No.	Name	Organization
70	Grot, Stephen	Ion Power
71	Gu, Wenbin	General Motors
72	Hall, Karen	Fuel Cell and Hydrogen Energy Association
73	Hamdan, Monjid	Giner, Inc.
74	Hamilton, Jennifer	California Fuel Cell Partnership
75	Han, Taehee	Nissan USA
76	Hancock, Dave	Plug Power, Inc.
77	Hardis, Jonathan	National Institute of Standards and Technology
78	Harris, Aaron	Air Liquide
79	Harvey, David	Ballard Power Systems
80	He, Wensheng	Arkema, Inc.
81	Hennessey, Barbara	U.S. Department of Transportation
82	Herring, Andy	Colorado School of Mines
83	Hirano, Shinichi	Ford Motor Company
84	Holladay, Jamie	Pacific Northwest National Laboratory
85	Houle, Frances A	Lawrence Berkeley National Laboratory
86	James, Brian	Strategic Analysis, Inc.
87	Jaramillo, Thomas	Stanford University
88	Jensen, Craig	University of Hawaii, Honolulu
89	Josefik, Nicholas	U.S. Army Corps of Engineers (USACE-DOD)
90	Junge, Axel	General Motors, Research & Development Center
91	Keller, Jay	Consultant (formerly Sandia National Laboratories)
92	Kim, Sangtae	University of California, Davis
93	Knights, Shanna	Ballard Power Systems
94	Kocha, Shyam	National Renewable Energy Laboratory
95	Kongkanand, Anusorn	General Motors Corporation
96	Kopasz, John	Argonne National Laboratory
97	Kraigsley, Alison	National Institutes of Health
98	Kurtz, Jennifer	National Renewable Energy Laboratory
99	Lakshmanan, Balsu	General Motors Corporation
100	Levy, Michael	Aaqius & Aaqius S. A.
101	Lewis, Michele	Argonne National Laboratory
102	Liu, Di-Jia	Argonne National Laboratory
103	Madden, Tom	Consultant
104	Maes, Miguel	National Aeronautics and Space Administration
105	Markovic, Nenad	Argonne National Laboratory
106	Maroni, Victor	Argonne National Laboratory
107	McGuire, Tim	Daimler AG
108	McKone, Thomas	Lawrence Berkeley National Laboratory
109	McWhorter, Scott	Savannah River National Laboratory
110	Melaina, Marc	National Renewable Energy Laboratory
111	Mergel, Jürgen	Forschungszentrum Jülich GmbH
112	Merritt, James	U.S. Department of Transportation
113	Miller, James	Argonne National Laboratory
114	Minh, Nguyen	GE Global Research Center
115	Mittelsteadt, Cortney	Giner, Inc.
116	Mohtadi, Rana	Toyota Engineering and Manufacturing America
117	Moulthrop, Larry	Proton OnSite
118	Mukerjee, Sanjeev	Northeastern University
119	Mukundan, Rangachary	Los Alamos National Laboratory
120	Myers, Charlie	Trenergi Corporation
121	Myers, Deborah	Argonne National Laboratory

No.	Name	Organization
122	Nicholas, Mike	University of California, Davis
123	O'Brien, James	Idaho National Laboratory
124	Ohma, Atsushi	Nissan (Japan)
125	Olson, Gregory	Consultant – SRA International, Inc.
126	O'Malley, Rachel	Johnson Matthey
127	Ott, Kevin	Los Alamos National Laboratory (retired)
128	Owejan, Jon	State University of New York, Alfred State
129	Pallasch, Johannes	NOW GmbH
130	Parks, George	FuelScience LLC / Phillips 66
131	Patel, Pinakin	FuelCell Energy, Inc.
132	Penev, Michael	National Renewable Energy Laboratory
133	Perret, Robert	Nevada Technical Services LLC
134	Perry, Mike	United Technologies Research Center
135	Petrovic, John	Petrovic and Associates
136	Pietrasz, Patrick	Ford Motor Company
137	Pivovar, Bryan	National Renewable Energy Laboratory
138	Podolski, Walt	Argonne National Laboratory
139	Polevaya, Olga	Nuvera Fuel Cells, Inc.
140	Ramsden, Todd	National Renewable Energy Laboratory
141	Resende, William	BMW
142	Richards, Mark	FuelCell Energy, Inc.
143	Rinebold, Joel	Connecticut Center for Advanced Technology, Inc.
144	Rorrer, Greg	National Science Foundation
145	Rufael, Tecle	Chevron
146	Sandrock, Gary	Oak Ridge National Laboratory
147	Schlasner, Steven	University of North Dakota, EERC
148	Shaffer, Brendan	University of California, Irvine
149	Shaw, Suzanne	European Commission, Fuel Cells and Hydrogen Joint Undertaking
150	Shenoy, Dev	U.S. Department of Energy, Advanced Manufacturing Office
151	Siegel, Don	University of Michigan, Ann Arbor
152	Sievers, Robert	Teledyne Energy Systems
153	Simnick, James	BP America
154	Simpson, Lin	National Renewable Energy Laboratory
155	Skolnik, Ed	Energetics Incorporated
156	Sofronis, Petros	University of Illinois, Urbana-Champaign
157	Soto, Herie	Shell Hydrogen LLC
158	Stamenkovic, Vojislav	Argonne National Laboratory
159	Steen, Marc	European Commission, Joint Research Centre
160	Steinbach, Andy	3M
161	St-Pierre, Jean	University of Hawaii, Manoa
162	Swider-Lyons, Karen	U.S. Navy, Naval Research Laboratory
163	Tamhankar, Satish	Linde
164	Thomas, C.E. (Sandy)	Clean Car Options
165	Trabold, Tom	Rochester Institute of Technology
166	Trocciola, John	SRA International, Inc.
167	Turner, John	National Renewable Energy Laboratory
168	Valdez, Thomas	National Aeronautics and Space Administration, Jet Propulsion Laboratory
169	van der Vliet, Dennis	3M
170	Veenstra, Mike	Ford Motor Company
171	Verduzco, Laura	Chevron LLC

No.	Name	Organization
172	Wagner, Frederick T.	General Motors Corporation (retired)
173	Waldecker, James	Ford Motor Company
174	Walk, Alex	SGL Group
175	Wang, Conghua	TreadStone Technologies, Inc.
176	Warren, Dave	Oak Ridge National Laboratory
177	Weber, Adam	Lawrence Berkeley National Laboratory
178	Wegrzyn, Jim	Brookhaven National Laboratory
179	Wei, Max	Lawrence Berkeley National Laboratory
180	Wen, Jennifer	University of Warwick
181	Wessel, Silvia	Ballard Power Systems
182	Wheeler, Douglas	DJW Technology LLC
183	Williams, Mark	National Energy Technology Laboratory
184	Woods, Stephen	National Aeronautics and Space Administration
185	Xu, Qiang	National Institute of Advanced Industrial Science and Technology (AIST)
186	Zelenay, Piotr	Los Alamos National Laboratory
187	Zhao, Ji-Cheng	U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy

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 sub-program area. Comments about sub-program management are provided in Appendix B.

Analysis Methodology

A total of **100** FCTO projects were reviewed at the meeting. As shown in Table 1, **187** review panel members participated in the AMR process, providing a total of **664** project evaluations. These reviewers were asked to provide numeric scores (on a scale of 1–4, including half-point intervals, 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 not reviewed, is provided in Appendix D.

For the Hydrogen Production and Delivery; Hydrogen Storage; Fuel Cells; Manufacturing R&D; Safety, Codes and Standards; and Systems Analysis sub-programs, 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.

For the Market Transformation and Technology Validation sub-programs, scores were based on the following five criteria and weights:

Score 1: Relevance/potential impact on DOE Program goals and RD&D objectives (15%)
Score 2: Strategy for technical validation and/or deployment (20%)
Score 3: Accomplishments and progress toward overall project and DOE goals (45%)
Score 4: Collaboration and coordination with other institutions (10%)
Score 5: Proposed future work (10%)

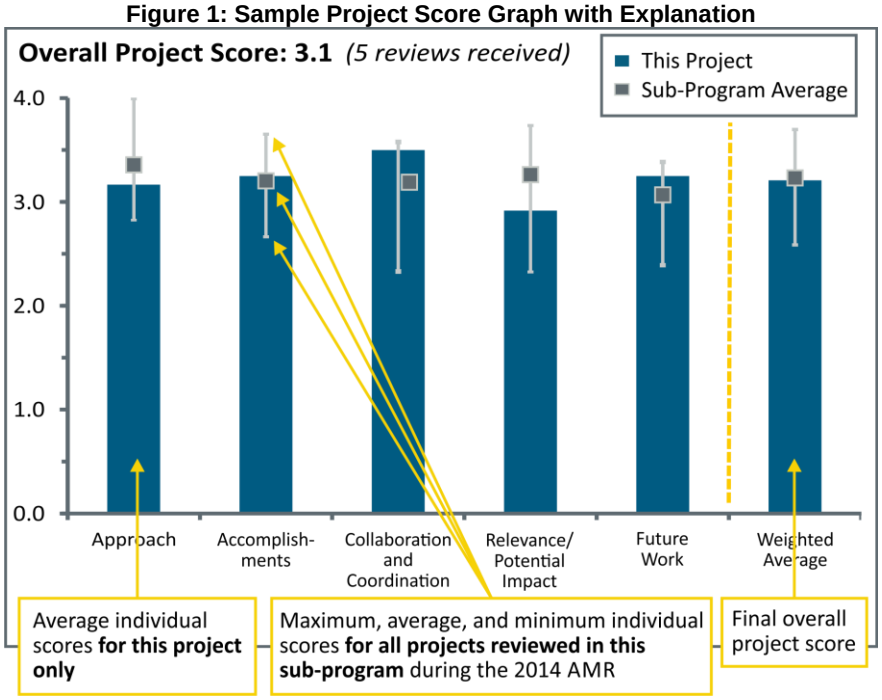
For all sub-programs, reviewers were also asked to provide qualitative comments regarding the five criteria, specific strengths and weaknesses of the project, and any recommendations relating to the work scope. These comments were also entered into the online, private database for easy retrieval and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

Organization of the Report

The project comments and scores are grouped by sub-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 R&D or other activity being conducted. Next are the results of the reviews of each project presented at the 2014 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 sub-program area. A sample graph is provided in Figure 1.

Projects are compared based on a consistent set of criteria. Each project report includes 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 sub-program.

Figure 1: Sample Project Score Graph with Explanation



For clarification, consider a hypothetical review in which only five projects were presented and reviewed in a sub-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 sub-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