Introduction

The fiscal year (FY) 2012 U.S. Department of Energy (DOE) Hydrogen and Fuel Cells Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting (AMR) was held from May 14–18, 2012, at the Crystal City Marriott and Crystal Gateway Marriott in Arlington, Virginia. 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. DOE uses the results of this merit review and peer evaluation, along with additional review processes, to make funding decisions for upcoming FYs.

The objectives of this meeting include the following:
- Review and evaluate FY 2012 accomplishments and FY 2013 plans for DOE laboratory programs; industry/university cooperative agreements; and related research, development, and demonstration (RD&D) efforts
- Provide an opportunity for program 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 of the *Peer Review Guide* developed by EERE. The peer review panel members, listed in Table 1, provided comments on 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	Ayers, Katherine	Proton OnSite
2	Barbier, Francoise	Air Liquide
3	Baturina, Olga	U.S. Naval Research Laboratory (former)
4	Beattie, Paul	Ballard Power Systems, Inc.
5	Benard, Pierre	Universite du Quebec a Trois-Rivieres
6	Bender, Guido	National Renewable Energy Laboratory
7	Benjamin, Thomas	Argonne National Laboratory
8	Bennett, Kristin	KB Science LLC
9	Birdsall, Jackie	California Fuel Cell Partnership
10	Blair, Larry	Consultant, U.S. Department of Energy
11	Blanchet, Scott	Nuvera Fuel Cells, Inc.
12	Borup, Rod	Los Alamos National Laboratory
13	Bouwkamp, Nico	California Fuel Cell Partnership
14	Bowden, Mark	Pacific Northwest National Laboratory
15	Bowman, Robert	Oak Ridge National Laboratory
16	Boyd, Robert	Boyd Hydrogen, LLC
17	Brosha, Eric	Los Alamos National Laboratory
18	Brown, Craig	National Institute of Standards and Technology
19	Buchner, John	University of Maryland, College Park
20	Burgunder, Albert	Praxair, Inc.
21	Cai, Mei	General Motors, Research and Development Center
22	Cairns, Julie	CSA Group
23	Campbell, Stephen	Automotive Fuel Cell Cooperation
24	Carlstrom, Chuck	H2 Pump LLC
25	Chahine, Richard	Hydrogen Research Institute
26	Choudhury, Biswajit	DuPont Fuel Cells
27	Christensen, John	Consultant, U.S. Department of Energy/National Renewable Energy Laboratory

No.	Name	Organization
28	Cole, Brian	U.S. Army Night Vision Laboratory
29	Cole, James Vernon	CFD Research Corporation
30	Collins, William	UTC Power
31	Conti, Amedeo	Nuvera Fuel Cells, Inc.
32	Cox, Phillip	University of North Florida
33	Curry-Nkansah, Maria	Imago Energy LLC
34	Davis, Benjamin	Los Alamos National Laboratory
35	De Castro, Emory	BASF Fuel Cell, Inc.
36	Debe, Mark	3M
37	Dedrick, Daniel	Sandia National Laboratories
38	DelPlancke, Jean-Luc	European Commission, Fuel Cells and Hydrogen Joint Undertaking
39	Dinh, Huyen	National Renewable Energy Laboratory
40	Dixon, David	The University of Alabama
41	Dross, Robert	Nuvera Fuel Cells, Inc.
42	Ehlers, Peter	CSA Group
43	Eisman, Glenn	H2Pump LLC
44	Elrick, William	California Fuel Cell Partnership
45	Erdle, Erich	Erdle Fuel Cell & Energy Consulting
46	Ernst, William	EnerSys Innovation
47	Ewan, Mitch	Hawaii Natural Energy Institute (HNEI)
48	Fan, Chinbay	Gas Technology Institute
49	Felter, Tom	Sandia National Laboratories
50	Fenske, George	Argonne National Laboratory
51	Fisher, Allison	Energizer Battery-Specialty Power
52	Fletcher, James	University of North Florida
53	Funk, Stuart	LMI
54	Gangi, Jennifer	Breakthrough Technologies Institute
55	Garland, Roxanne	DOE (retired)
56	Garzon, Fernando	Los Alamos National Laboratory
57	Gennett, Thomas	National Renewable Energy Laboratory
58	Gervasio, Don	University of Arizona
59	Gittleman, Craig	General Motors Corporation
60	Glass, Robert	Lawrence Livermore National Laboratory
61	Graetz, Jason	Brookhaven National Laboratory
62	Grassilli, Leo	Consultant, Office of Naval Research
63	Gross, Karl	H2 Technology Consulting, LLC
64	Gross, Tom	Electricore
65	Gupta, Ram	National Science Foundation
66	Hamilton, Jennifer	California Fuel Cell Partnership
67	Hardis, Jonathan	National Institute of Standards and Technology
68	Harris, Aaron	Sandia National Laboratories
69	Haugen, Greg	3M
70	Hays, Charles	California Institute of Technology
71	Hennessey, Barbara	U.S. Department of Transportation
72	Herbert, Thorsten	NOW GmbH
73	Herring, Andy	Colorado School of Mines
74	Hershkowitz, Frank	ExxonMobil, Research and Engineering Company
75	Hirano, Shinichi	Ford Motor Company
76	Holladay, Jamie	Pacific Northwest National Laboratory
77	Imam, Ashraf	U.S. Navy, Naval Research Laboratory
78	James, Brian	Strategic Analysis Inc.
79	James, Charles (Will)	Savannah River National Laboratory
80	Jarvi, Tom	Sun Catalytix Corp
81	Jensen, Craig	University of Hawaii at Manoa
82	Jorgensen, Scott	General Motors, Research and Development Center
83	Josefik, Nicholas	U.S. Army Corps of Engineers
84	Kasab, John	Ricardo

No.	Name	Organization
85	Keller, Jay	Sandia National Laboratories, retired/SRA International
86	Kerr, John	Lawrence Berkeley National Laboratory
87	Kienitz, Brian	W.L. Gore & Associates, Inc.
88	King, David	Pacific Northwest National Laboratory
89	Knights, Shanna	Ballard Power Systems
90	Kocha, Shyam	National Renewable Energy Laboratory
91	Kopasz, John	Argonne National Laboratory
92	Krause, Theodore	Argonne National Laboratory
93	Kumar, Romesh	Argonne National Laboratory
94	Kunze, Klaas	BMW AG
95	Kurtz, Jennifer	National Renewable Energy Laboratory
96	Lakshmanan, Balsu	General Motors Corporation
97	Lear, William	University of Florida
98	Lewis, Michele	Consultant
99	Lieberman, Robert	Intelligent Optical Systems
100	Linkous, Clovis	Youngstown State University
101	Lipp, Ludwig	FuelCell Energy, Inc.
102	Madden, Tom	Sun Catalytix
103	Maes, Miguel	National Aeronautics and Space Administration
104	Markovic, Nenad	Argonne National Laboratory
105	Maroni, Victor	Argonne National Laboratory
106	McLean, Gail	U.S. Department of Energy, Office of Science
107	McWhorter, Scott	U.S. Department of Energy
108	Medeiros, Maria	U.S. Navy, Office of Naval Research
109	Melis, Tasios	University of California, Berkeley
110	Mergel, Jürgen	Forschungszentrum Jülich GmbH
111	Merritt, James	U.S. Department of Transportation
112	Miller, James	Argonne National Laboratory
113	Minh, Nguyen	Center for Energy Research, University of California, San Diego
114	Mittelsteadt, Cortney	Giner Electrochemical Systems, LLC
115	Mohtadi, Rana	Toyota Research Institute of North America
116	More, Karren	Oak Ridge National Laboratory
117	Moreland, Gregory	SRA International, Inc.
118	Morgan, Jason	Ballard Material Products
119	Mountz, David	Arkema, Inc.
120	Mukerjee, Sanjeev	Northeastern University
121	Mukundan, Rangachary	Los Alamos National Laboratory
122	Myers, Deborah	Argonne National Laboratory
123	Ohi, Jim	H2O-E
124	Ohma, Atsushi	Nissan Motor Company
125	Olson, Gregory	SRA International
126	Ott, Kevin	Los Alamos National Laboratory
127	Owejan, Jon	GM Electrochemical Energy Research Laboratory
128	Padro, Catherine	Los Alamos National Laboratory
129	Parks, George	FuelScience LLC
130	Paster, Mark	Consultant
131	Penev, Michael	National Renewable Energy Laboratory
132	Perret, Robert	Nevada Technical Services LLC
133	Perry, Mike	United Technologies Research Center
134	Petrovic, John	Los Alamos National Laboratory, retired/Petrovic and Associates
135	Pietrasz, Patrick	Ford Motor Company
136	Pintauro, Peter	Vanderbilt University
137	Pivovar, Bryan	National Renewable Energy Laboratory
138	Podolski, Walt	Argonne National Laboratory
139	Ramani, Vijay	Illinois Institute of Technology
140	Rambach, Glenn	Trulite, Inc.

No.	Name	Organization
141	Richards, Mark	Versa Power Systems
142	Ricker, Rick	National Institute of Standards and Technology
143	Rinebold, Joel	Connecticut Center for Advanced Technology, Inc.
144	Roan, Vernon	University of Florida
145	Roger, Chris	Arkema Inc.
146	Rossmeissl, Neil	U.S. Department of Energy, Biomass Program
147	Rufael, Tecle	Chevron Energy Technology Company
148	Sandrock, Gary	Sandia National Laboratories
149	Schlasner, Steven	University of North Dakota, Energy & Environmental Research Center
150	Schneider, Jesse	Consultant
151	Serfass, Patrick	Technology Transition Corporation
152	Siegel, Don	University of Michigan, Ann Arbor
153	Sievers, Robert	Teledyne Energy Systems
154	Silverman, Linda	U.S. Department of Energy, Education and Workforce Development
155	Simnick, James	BP America
156	Simpson, Lin	National Renewable Energy Laboratory
157	Sofronis, Petros	Consultant
158	Soto, Herie	Shell
159	Spendelow, Jacob	Los Alamos National Laboratory
160	Stanfield, Eric	National Institute of Standards and Technology
161	Stanic, Vesna	EnerFuel, Inc.
162	Steele, Eugene	Steele Consulting
163	Steen, Marc	European Commission, Joint Research Centre
164	Steenberg, Thomas	Danish Power Systems
165	Stolten, Detlef	Forschungszentrum Jülich GmbH
166	Sutherland, Ian	General Motors Corporation
167	Swider-Lyons, Karen	U.S. Navy, Naval Research Laboratory
168	Thomas, C.E. (Sandy)	Consultant
169	Tran, Thanh	U.S. Navy, Naval Surface Warfare Center, Carderock Division
170	Trocciola, John	FuelCell Perspectives
171	Ulsh, Michael	National Renewable Energy Laboratory
172	Vanderborgh, Nicholas	Consultant
173	Veenstra, Mike	Ford Motor Company
174	Vernstrom, George	3M
175	Wachsman, Eric	University of Maryland
176	Wagner, Frederick	General Motors Corporation
177	Wainright, Jesse	Case Western Reserve University
178	Waldecker, James	Ford Motor Company
179	Walk, Alex	Consultant
180	Warner, James	Fuel Cell and Hydrogen Energy Association
181	Weber, Adam	Lawrence Berkeley National Laboratory
182	Weil, K. Scott	Pacific Northwest National Laboratory
183	Wheeler, Douglas	DJW Technology LLC
184	White, Chris	California Fuel Cell Partnership
185	Williams, Mark	URS Corporation
186	Wipke, Keith	National Renewable Energy Laboratory
187	Wolak, Frank	FuelCell Energy, Inc.
188	Wolverton, Christopher	Northwestern University
189	Woods, Stephen	National Aeronautics and Space Administration
190	Yuzugullu, Elvin	SRA International, Inc.
191	Zelenay, Piotr	Los Alamos National Laboratory
192	Zheng, Jinyang	Zhejiang University
193	Zhu, Yimin	Nanosys, Inc.

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 on sub-program management are provided in Appendix B.

Analysis Methodology

A total of **145** projects were reviewed at the meeting. As shown in Table 1, **193** review panel members participated in the AMR process, providing a total of **853** 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. Sample evaluation forms are provided in Appendix C. Scores and comments were submitted using laptops (provided onsite) 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 (for all projects except American Recovery and Reinvestment Act [Recovery 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 and 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, 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 0.20] + [Score 3 x 0.40] + [Score 4 x 0.10] + [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.

Reviewers of American Reinvestment and Recovery Act 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 Recovery Act project strengths and weaknesses and 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 Research and Development [R&D]; Technology Validation; Safety, Codes and Standards; Education; Systems Analysis; and Recovery Act activities) in order to align with the Program 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 2012 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 universal 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 line bars 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: Project Score Graph with Explanation
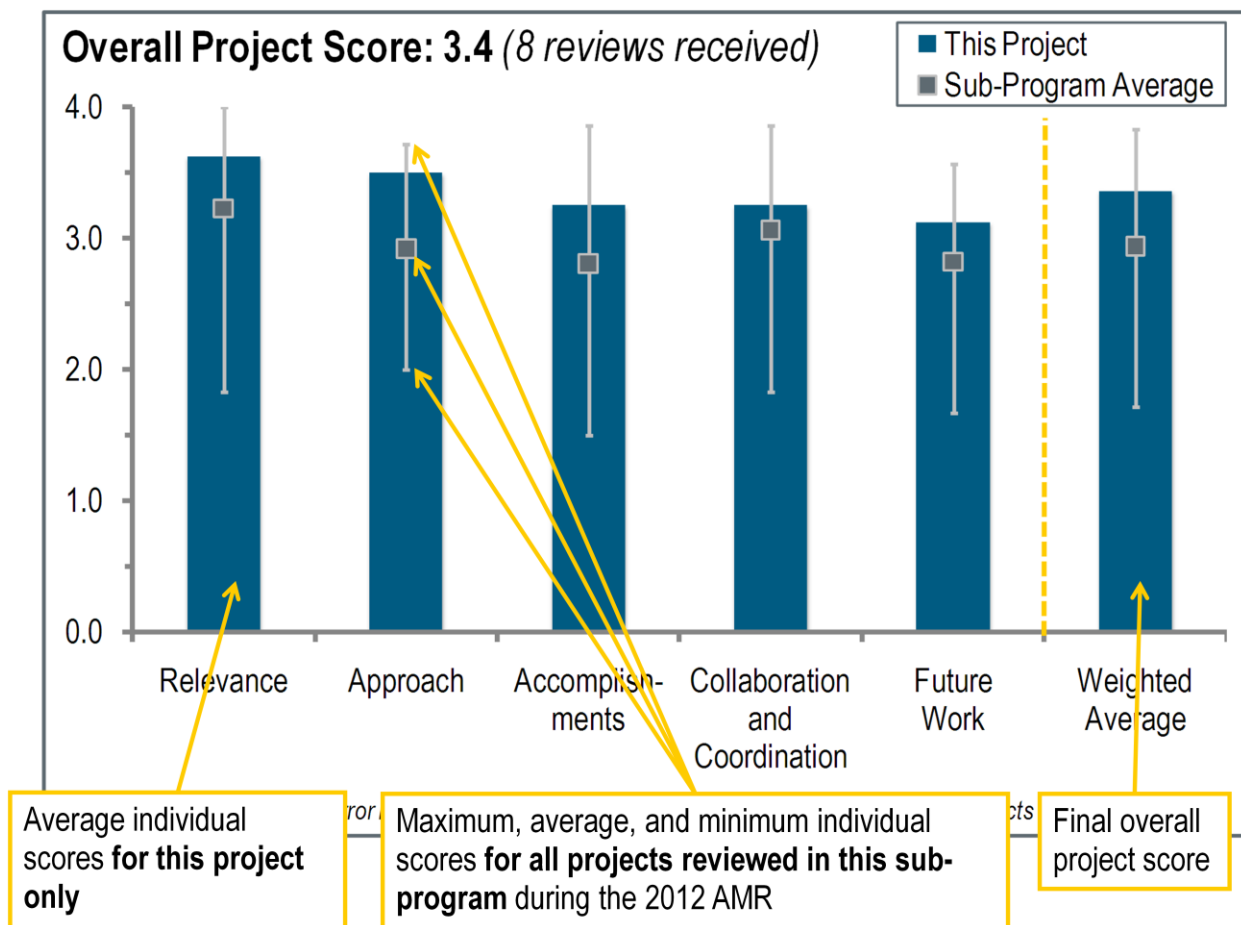
For clarification, consider a hypothetical review in which only five projects were presented and reviewed in a sub-program. Table 2 displays the average scores for each project according to the five rated criteria.

Table 2: Sample Project Scores

	Relevance (20%)	Approach (20%)	Accomplish-ments (40%)	Collaboration and 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
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 line bar 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 0.20] + [3.3 x 0.40] + [3.2 x 0.10] + [3.1 x 0.10] = 3.3

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