Prologue

Dear Colleague:

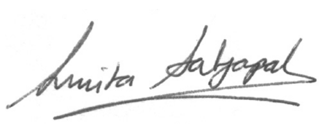
This document summarizes peer review comments and scores for the fiscal year (FY) 2018 U.S. Department of Energy (DOE) Hydrogen and Fuel Cells Program Annual Merit Review and Peer Evaluation Meeting (AMR), held June 13–15, 2018, in Washington, DC. In response to direction from various stakeholders, including the National Academies, this review process provides project- and program-level evaluations of DOE-funded early-stage research, development, and analysis of hydrogen and fuel cell technologies.

This year's AMR featured a number of new sessions and events, including a dedicated three-day track on the DOE Office of Fossil Energy's Solid Oxide Fuel Cell Program, a one-day session on interagency and state-level activities, and a fuel cell car ride-and-learn. The AMR kicked off with an opening plenary panel discussion with members of the Hydrogen Council, a global industry partnership of more than 40 companies committing to hydrogen infrastructure. The plenary session also featured keynote remarks by Daniel Simmons, Principal Deputy Assistant Secretary from the Office of Energy Efficiency and Renewable Energy (EERE), and program and sub-program overview presentations. The AMR was attended by more than 800 participants, including 176 reviewers who reviewed 116 projects.

DOE values the transparent public process of soliciting technical input on its projects and overall programs from relevant experts with depth and breadth of knowledge across a number of broad areas. The reviewers' recommendations are taken into consideration by DOE technology managers in generating future work plans. The table in this report lists the projects presented at the review and the overall evaluation score for each project. The individual reports present the reviewer comments to be considered during the upcoming fiscal year (October 1, 2018–September 30, 2019). The projects have been grouped according to sub-program and reviewed according to the appropriate evaluation criteria. To furnish principal investigators (PIs) with direct feedback, all of the evaluations and comments are provided to each presenter; however, the authors of the individual comments remain anonymous. DOE instructs the PIs to fully consider these summary evaluation comments, along with any other comments by DOE managers, in their FY 2019 plans. In addition, DOE managers contact each PI individually and discuss the comments and recommendations as future plans are developed.

In addition to thanking all participants in the AMR, I would like to express my sincere appreciation to the reviewers for your strong commitment, expertise, and dedication in advancing hydrogen and fuel cell technologies. You make this report possible, and we rely on your comments, along with other management processes, to help make project decisions for the new fiscal year. We look forward to your participation in the FY 2019 AMR, which is scheduled for April 29–May 1, 2019, in Washington, DC. Thank you for participating in the FY 2018 AMR.

Sincerely,



Sunita Satyapal
Director
Hydrogen and Fuel Cells Program
U.S. Department of Energy

Hydrogen Fuel R&D

Hydrogen Production and Delivery R&D

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
PD-025	Fatigue Performance of High-Strength Pipeline Steels and Their Welds in Hydrogen Gas Service *Joe Ronevich; Sandia National Laboratories*	3.4			X
PD-100	700 bar Hydrogen Dispenser Hose Reliability Improvement *Kevin Harrison; National Renewable Energy Laboratory*	3.5	X		
PD-108	Hydrogen Compression Application of the Linear Motor Reciprocating Compressor *Eugene Broerman; Southwest Research Institute*	2.8	X		
PD-131	Magnetocaloric Hydrogen Liquefaction *Jamie Holladay; Pacific Northwest National Laboratory*	3.1	X		
PD-135	Liquid Hydrogen Infrastructure Analysis *Guillaume Petitpas; Lawrence Livermore National Laboratory*	3.4			X
PD-136	Electrochemical Compression *Monjid Hamdan; Giner ELX, Inc.*	3.5	X		
PD-137	Hybrid Electrochemical–Metal Hydride Compression *Scott Greenway; Greenway Energy, Inc.*	3.1	X		
PD-138	Metal Hydride Compression *Terry Johnson; Sandia National Laboratories*	3.6	X		
PD-140	Dispenser Reliability *Michael Peters; National Renewable Energy Laboratory*	3.2	X		
PD-143	High-Temperature Alkaline Water Electrolysis *Hui Xu; Giner, Inc.*	3.4	X		
PD-146	Advancing Hydrogen Dispenser Technology by Using Innovative Intelligent Networks *Darryl Pollica; Ivys Inc.*	3.4	X		
PD-149	Hydrogen Dispensing Hose *Jennifer Lalli; NanoSonic, Inc.*	3.2	X		
PD-150	Coatings for Compressor Seals *Shannan O'Shaughnessy; GVD Corporation*	3.3	X		
PD-151	New Approaches to Improved Polymer Electrolyte Membrane Electrolyzer Ion-Exchange Membranes *Earl Wagener; Tetramer Technologies, LLC*	3.1	X		

Hydrogen Production and Delivery R&D: HydroGEN Seedling

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
PD-148	HydroGEN Overview: A Consortium on Advanced Water-Splitting Materials *Huyen Dinh; National Renewable Energy Laboratory*	3.6	X*		
PD-152	Proton-Conducting Solid Oxide Electrolysis Cells for Large-Scale Hydrogen Production at Intermediate Temperatures *Prabhakar Singh; University of Connecticut*	3.3	X*		
PD-153	Degradation Characterization and Modeling of a New Solid Oxide Electrolysis Cell Utilizing Accelerated Life Testing *Scott Barnett; Northwestern University*	3.4	X*		
PD-154	Thin-Film, Metal-Supported High-Performance and Durable Proton–Solid Oxide Electrolyzer Cell *Tianli Zhu; United Technologies Research Center*	3.2	X*		
PD-155	High-Efficiency Polymer Electrolyte Membrane Water Electrolysis Enabled by Advanced Catalysts, Membranes, and Processes *Kathy Ayers; Proton OnSite*	3.3	X*		
PD-156	Developing Novel Platinum-Group-Metal-Free Catalysts for Alkaline Hydrogen and Oxygen Evolution Reactions *Sanjeev Mukerjee; Northeastern University*	3.3	X*		
PD-157	Platinum-Group-Metal-Free Oxygen Evolution Reaction Catalysts for Polymer Electrolyte Membrane Electrolyzer *Di-Jia Liu; Argonne National Laboratory*	3.5	X*		
PD-158	High-Performance Ultralow-Cost Non-Precious-Metal Catalyst System for Anion-Exchange Membrane Electrolyzer *Hoon Chung; Los Alamos National Laboratory*	3.2	X*		
PD-159	Scalable Elastomeric Membranes for Alkaline Water Electrolysis *Yu Seung Kim; Los Alamos National Laboratory*	3.4	X*		
PD-160	Best-in-Class Platinum-Group-Metal-Free Catalyst Integrated Tandem Junction Photoelectrochemical Water-Splitting Devices *Charles Dismukes; Rutgers University*	3.6	X*		
PD-161	Protective Catalyst Systems on III-V and Silicon-Based Semiconductors for Efficient, Durable Photoelectrochemical Water-Splitting Devices *Thomas Jaramillo; Stanford University*	3.7	X*		

* HydroGEN seedling projects marked "Continue" are on track, but project continuation is contingent on passing a go/no-go decision.

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
PD-162	Novel Chalcopyrites For Advanced Photoelectrochemical Water Splitting *Nicolas Gaillard; University of Hawaii*	3.6	X*		
PD-163	Monolithically Integrated Thin-Film/Silicon Tandem Photoelectrodes for High-Efficiency and Stable Photoelectrochemical Water Splitting *Zetian Mi; University of Michigan*	3.3	X*		
PD-164	Efficient Solar Water Splitting with 5,000-Hour Stability Using Earth-Abundant Catalysts and Durable Layered Two-Dimensional Perovskites *Aditya Mohite; Los Alamos National Laboratory*	3.7	X*		
PD-165	Accelerated Discovery of Solar Thermochemical Hydrogen Production Materials via High-Throughput Computational and Experimental Methods *Ryan O'Hayre; Colorado School of Mines*	3.3	X*		
PD-166	Computationally Accelerated Discovery and Experimental Demonstration of High-Performance Materials for Advanced Solar Thermochemical Hydrogen Production *Charles Musgrave; University of Colorado Boulder*	3.6	X*		
PD-167	Transformative Materials for High-Efficiency Thermochemical Production of Solar Fuels *Chris Wolverton; Northwestern University*	2.9	X*		
PD-168	Mixed Ionic Electronic Conducting Quaternary Perovskites: Materials by Design for Solar Thermochemical Hydrogen *Ellen Stechel; Arizona State University*	3.4	X*		
PD-169	High-Temperature Reactor Catalyst Material Development for Low-Cost and Efficient Solar-Driven Sulfur-Based Processes *Claudio Corgnale; Greenway Energy*	3.2	X*		

* HydroGEN seedling projects marked "Continue" are on track, but project continuation is contingent on passing a go/no-go decision.

Hydrogen Storage R&D

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
ST-001	System-Level Analysis of Hydrogen Storage Options *Rajesh Ahluwalia; Argonne National Laboratory*	3.4	X		
ST-008	Hydrogen Storage System Modeling: Public Access, Maintenance, and Enhancements *Matt Thornton; National Renewable Energy Laboratory*	3.4	X		
ST-100	Hydrogen Storage Cost Analysis *Brian James; Strategic Analysis, Inc.*	3.1	X		
ST-122	Hydrogen Adsorbents with High Volumetric Density: New Materials and System Projections *Don Siegel; University of Michigan*	3.3			X
ST-127	Hydrogen Materials—Advanced Research Consortium (HyMARC): A Consortium for Advancing Hydrogen Storage Materials *Mark Allendorf; Sandia National Laboratories*	3.5	X		
ST-128	Hydrogen Materials—Advanced Research Consortium (HyMARC): Sandia National Laboratories Technical Activities *Mark Allendorf; Sandia National Laboratories*	3.5	X		
ST-129	Hydrogen Materials—Advanced Research Consortium (HyMARC): Lawrence Livermore National Laboratory Technical Activities *Brandon Wood; Lawrence Livermore National Laboratory*	3.6	X		
ST-130	Hydrogen Materials—Advanced Research Consortium (HyMARC): Lawrence Berkeley National Laboratory Technical Activities *Jeffrey Urban; Lawrence Berkeley National Laboratory*	3.3	X		
ST-131	Hydrogen Materials—Advanced Research Consortium (HyMARC): National Renewable Energy Laboratory Technical Activities *Thomas Gennett; National Renewable Energy Laboratory*	3.5	X		
ST-132	Hydrogen Materials—Advanced Research Consortium (HyMARC): Pacific Northwest National Laboratory Technical Activities *Tom Autrey; Pacific Northwest National Laboratory*	3.5	X		
ST-133	Hydrogen Materials—Advanced Research Consortium (HyMARC): Lawrence Berkeley National Laboratory Technical Activities *Jeffrey Long; Lawrence Berkeley National Laboratory*	3.4	X		

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
ST-138	Hydrogen Materials—Advanced Research Consortium (HyMARC) Seedling: Development of Magnesium Boride Etherates as Hydrogen Storage Materials *Godwin Severa; University of Hawaii*	3.5	X		

Fuel Cell R&D

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
FC-017	Fuel Cell System Modeling and Analysis *Rajesh Ahluwalia; Argonne National Laboratory*	3.4	X		
FC-117	Fiscal Year 2015 Small Business Innovation Research (Phase II Release 2): Ionomer Dispersion Impact on Polymer Electrolyte Membrane Fuel Cell and Electrolyzer Durability *Hui Xu; Giner, Inc.*	3.0	X		
FC-128	Facilitated Direct Liquid Fuel Cells with High-Temperature Membrane Electrode Assemblies *Emory DeCastro; Advent Technologies, Inc.*	3.0	X		
FC-135	Fuel Cell Consortium for Performance and Durability *Rod Borup; Los Alamos National Laboratory*	3.4	X		
FC-140	Tailored High-Performance Low-Platinum-Group-Metal Alloy Cathode Catalysts *Vojislav Stamenkovic; Argonne National Laboratory*	3.4	X		
FC-141	Platinum Monolayer Electrocatalysts *Jia Wang; Brookhaven National Laboratory*	3.4	X		
FC-142	Extended Surface Electrocatalyst Development *Bryan Pivovar; National Renewable Energy Laboratory*	3.1	X		
FC-143	Highly Active, Durable, and Ultralow-Platinum-Group-Metal Nanostructured Thin-Film Oxygen Reduction Reaction Catalysts and Supports *Andrew Steinbach; 3M*	3.1	X		
FC-144	Highly Accessible Catalysts for Durable High-Power Performance *Anusorn Kongkanand; General Motors*	3.5	X		
FC-145	Corrosion-Resistant Non-Carbon Electrocatalyst Supports for Proton Exchange Fuel Cells *Vijay Ramani; Washington University*	3.0	X		
FC-146	Advanced Materials for Fully Integrated Membrane Electrode Assemblies in Anion-Exchange Membrane Fuel Cells *Yu Seung Kim; Los Alamos National Laboratory*	3.3	X		
FC-147	Advanced Ionomers and Membrane Electrode Assemblies for Alkaline Membrane Fuel Cells *Bryan Pivovar; National Renewable Energy Laboratory*	3.2	X		
FC-154	Fiscal Year 2016 Small Business Innovation Research (Phase II Release 1): Regenerative Fuel Cell System *Paul Matter; pH Matter LLC*	2.9			X

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
FC-155	Novel Ionomers and Electrode Structures for Improved Polymer Electrolyte Membrane Fuel Cell Electrode Performance at Low-Platinum-Group-Metal Loadings *Andrew Haug; 3M*	3.2	X		
FC-156	Durable High-Power Membrane Electrode Assemblies with Low Platinum Loading *Swami Kumaraguru; General Motors*	3.2	X		
FC-157	High-Performance Polymer Electrolyte Fuel Cell Electrode Structures *Mike Perry; United Technologies Research Center*	2.9		X	
FC-158	Fuel Cell Membrane Electrode Assemblies with Ultralow-Platinum Nanofiber Electrodes *Peter Pintauro; Vanderbilt University*	3.3	X		
FC-160	ElectroCat (Electrocatalysis Consortium) *Deborah Myers (Argonne National Laboratory) and Piotr Zelenay (Los Alamos National Laboratory); Los Alamos National Laboratory*	3.2	X		
FC-161	Advanced Electrocatalysts through Crystallographic Enhancement *Jacob Spendelow; Los Alamos National Laboratory*	3.2	X		
FC-162	Vapor Deposition Process for Engineering of Dispersed Polymer Electrolyte Membrane Fuel Cell Oxygen Reduction Reaction Pt/NbO_x/C Catalysts *Jim Waldecker; Ford Motor Company*	3.2	X		
FC-163	Fuel Cell Systems Analysis *Brian James; Strategic Analysis, Inc.*	3.4	X		
FC-170	ElectroCat: Durable Manganese-Based Platinum-Group-Metal-Free Catalysts for Polymer Electrolyte Membrane Fuel Cells *Hui Xu; Giner, Inc.*	3.0	X		
FC-171	ElectroCat: Advanced Platinum-Group-Metal-Free Cathode Engineering for High Power Density and Durability *Shawn Litster; Carnegie Mellon University*	3.3	X		
FC-172	ElectroCat: Highly Active and Durable Platinum-Group-Metal-Free Oxygen Reduction Reaction Electrocatalysts through the Synergy of Active Sites *Yuyan Shao; Pacific Northwest National Laboratory*	2.9		X	
FC-173	ElectroCat: Platinum-Group-Metal-Free Engineered Framework Nanostructure Catalysts *Prabhu Ganesan; Greenway Energy, LLC*	2.9		X	

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
FC-174	Highly Efficient and Durable Cathode Catalyst with Ultralow Platinum Loading through Synergetic Platinum/ Platinum-Group-Metal-Free Catalytic Interaction *Di-Jia Liu; Argonne National Laboratory*	3.3	X		
FC-175	Polymer-Based Fuel Cells That Operate from 80°C–220°C *Yu Seung Kim; Los Alamos National Laboratory*	3.1	X		
FC-176	Fiscal Year 2017 Small Business Innovation Research (Phase II Release 1): Novel Hydrocarbon Ionomers for Durable Polymer Electrolyte Membranes *William Harrison; Nanosonic, Inc.*	2.8		X	

Technology Acceleration and Hydrogen Infrastructure R&D

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
MN-001	Fuel Cell Membrane Electrode Assembly Manufacturing Research and Development *Michael Ulsh; National Renewable Energy Laboratory*	3.4	X		
MN-015	Continuous Fiber Composite Electrofusion Coupler *Brett Kimball; Automated Dynamics*	2.6	X		
MN-016	In-Line Quality Control of Polymer Electrolyte Membrane Materials *Paul Yelvington; Mainstream*	3.2	X		
MN-017	Manufacturing Competitiveness Analysis for Hydrogen Refueling Stations *Margaret Mann; National Renewable Energy Laboratory*	3.1			X
MN-018	Roll-to-Roll Advanced Materials Manufacturing Lab Consortium *Claus Daniel; Oak Ridge National Laboratory*	3.2	X		
MT-008	Hydrogen Energy Systems as a Grid Management Tool *Mitch Ewan; Hawaii Natural Energy Institute*	3.3		X	
MT-011	Fuel-Cell-Powered Airport Ground Support Equipment Deployment *Larry Pitts; Plug Power*	3.3	X		
MT-013	Maritime Fuel Cell Generator Project *Lennie Klebanoff; Sandia National Laboratories*	3.3	X		
MT-014	Demonstration of Fuel Cell Auxiliary Power Unit to Power Truck Refrigeration Units in Refrigerated Trucks *Kriston Brooks; Pacific Northwest National Laboratory*	3.1			X
MT-017	FedEx Express Hydrogen Fuel Cell Extended-Range Battery Electric Vehicles *Phillip Galbach; FedEx Express*	3.2	X		
MT-021	Northeast Demonstration and Deployment of FCRx200 *Abas Goodarzi; US Hybrid*	3.0	X		
TV-001	Fuel Cell Electric Vehicle Evaluation *Jennifer Kurtz; National Renewable Energy Laboratory*	3.5	X		
TV-008	Fuel Cell Bus Evaluations *Leslie Eudy; National Renewable Energy Laboratory*	3.9	X		
TV-017	Hydrogen Station Data Collection and Analysis *Sam Sprik; National Renewable Energy Laboratory*	3.4	X		
TV-029	Performance and Durability Testing of Volumetrically Efficient Cryogenic Vessels and High-Pressure Liquid Hydrogen Pump *Salvador Aceves; Lawrence Livermore National Laboratory*	2.9			X

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
TV-031	Dynamic Modeling and Validation of Electrolyzers in Real-Time Grid Simulation *Rob Hovsapian; Idaho National Laboratory*	3.7	X		
TV-034	Fuel Cell Hybrid Electric Delivery Van *Jason Hanlin; Center for Transportation and the Environment*	3.2	X		
TV-039	Innovative Advanced Hydrogen Mobile Fueler *Sara Odom; Electricore*	3.5		X	
TV-040	High-Temperature Electrolysis Test Stand *Richard Boardman; Idaho National Laboratory*	3.7	X		
TV-041	Modular Solid Oxide Electrolyzer Cell System for Efficient Hydrogen Production at High Current Density *Hossein Ghezel-Ayagh; FuelCell Energy*	3.5	X		
TV-042	Optimal Stationary Fuel Cell Integration and Control (Energy Dispatch Controller) *Genevieve Saur; National Renewable Energy Laboratory*	3.3	X		
TV-043	Integrated Systems Modeling of the Interactions between Stationary Hydrogen, Vehicle, and Grid Resources *Samveg Saxena; Lawrence Berkeley National Laboratory*	3.2	X		
TV-045	H2@Scale Analysis *Mark Ruth; National Renewable Energy Laboratory*	3.6	X		
TV-146	H2@Scale: Experimental Characterization of Durability of Advanced Electrolyzer Concepts in Dynamic Loading *Shaun Alia; National Renewable Energy Laboratory*	3.7	X		
TV-148	Hydrogen Stations for Urban Sites *Brian Ehrhart; National Renewable Energy Laboratory/ Sandia National Laboratories*	3.2	X		
TV-149	Mirai Testing *Henning Lohse-Busch; Argonne National Laboratory*	3.7			X
TV-150	Analysis of Fuel Cells for Trucks *Ram Vijayagopal; Argonne National Laboratory*	3.2	X		

Safety, Codes and Standards

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
SCS-001	National Codes and Standards Deployment and Outreach *Carl Rivkin; National Renewable Energy Laboratory*	3.6	X		
SCS-005	Research and Development for Safety, Codes and Standards: Materials and Component Compatibility *Chris San Marchi; Sandia National Laboratories*	3.8	X		
SCS-007	Fuel Quality Assurance Research and Development and Impurity Testing in Support of Codes and Standards *Tommy Rockward; Los Alamos National Laboratory*	3.4	X		
SCS-010	Research and Development for Safety, Codes and Standards: Hydrogen Behavior *Ethan Hecht; Sandia National Laboratories*	3.5	X		
SCS-011	Hydrogen Quantitative Risk Assessment *Alice Muna; Sandia National Laboratories*	3.4	X		
SCS-019	Hydrogen Safety Panel, Safety Knowledge Tools, and First Responder Training Resources *Nick Barilo; Pacific Northwest National Laboratory*	3.7	X		
SCS-021	National Renewable Energy Laboratory Hydrogen Sensor Testing Laboratory *William Buttner; National Renewable Energy Laboratory*	3.4	X		
SCS-025	Enabling Hydrogen Infrastructure through Science-Based Codes and Standards *Chris LaFleur; Sandia National Laboratories*	3.6	X		
SCS-026	Compatibility of Polymeric Materials Used in the Hydrogen Infrastructure *Kevin Simmons; Pacific Northwest National Laboratory*	3.5			X
SCS-030	Advancing Fuel Cell Electric Vehicles in San Francisco and Beyond *Jessie Denver; City and County of San Francisco*	3.0	X		

Systems Analysis

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
SA-039	Regional Water Stress Analysis with Hydrogen Production at Scale *Amgad Elgowainy; Argonne National Laboratory*	3.4		X	
SA-044	Cost–Benefit Analysis of Technology Improvement in Light-Duty Fuel Cell Vehicles *Aymeric Rousseau; Argonne National Laboratory*	3.5	X		
SA-059	Sustainability Analysis: Hydrogen Regional Sustainability *Elizabeth Connelly; National Renewable Energy Laboratory*	3.2			X
SA-063	Regional Supply of Hydrogen *Michael Penev; National Renewable Energy Laboratory*	3.3	X		
SA-169	Market Segmentation Analysis of Medium- and Heavy-Duty Trucks with a Fuel Cell Emphasis *Chad Hunter; National Renewable Energy Laboratory*	3.0	X		
SA-170	Analysis of Cost Impacts of Integrating Advanced Onboard Storage Systems with Hydrogen Delivery *Amgad Elgowainy; Argonne National Laboratory*	3.2	X		