Prologue

Dear Colleague:

The Fiscal Year (FY) 2024 U.S. Department of Energy (DOE) Hydrogen Program Annual Merit Review and Peer Evaluation Meeting (AMR) was held May 6–9, 2024, in Arlington, Virginia. I am pleased to present this summary of the peer review comments and scores that we received during this important event, which plays a significant role in government accountability and ensures taxpayer dollars are being used effectively. In response to direction from various stakeholders, including the National Academies, this review process provides project- and program-level evaluations of DOE-funded activities to advance hydrogen and fuel cell technologies.

This year's AMR kicked off with opening remarks on U.S. clean hydrogen priorities from Deputy Secretary of Energy David Turk, followed by a panel discussion with representatives from the Hydrogen Interagency Task Force (HIT). Leaders from the U.S. Departments of Agriculture, Transportation, Commerce, and the U.S. Small Business Administration discussed their agencies' actions related to executing the national hydrogen strategy and the opportunities presented by the HIT's whole-of-government approach to advancing clean hydrogen. This was followed by remarks from Alejandro Moreno, associate principal deputy assistant secretary for the Office of Energy Efficiency and Renewable Energy, and Shalanda Baker, director of the Office of Energy Justice and Equity. I then provided an overview of the DOE Hydrogen Program. Following my overview presentation, a second panel highlighted the Program's approach to agency-wide collaboration and coordination, with perspectives from six representatives of DOE offices involved in the Program. In the final panel, program managers from the Hydrogen and Fuel Cell Technologies Office (HFTO) provided perspectives on their teams' work.

The AMR technical session included tracks on each of HFTO's subprograms: Hydrogen Production Technologies; Hydrogen Infrastructure Technologies; Fuel Cell Technologies; Systems Development and Integration; and Analysis, Codes and Standards. It also included a two-day track with updates from nine DOE offices plus the Advanced Research Projects Agency–Energy, along with six other offices within the Office of Energy Efficiency and Renewable Energy.

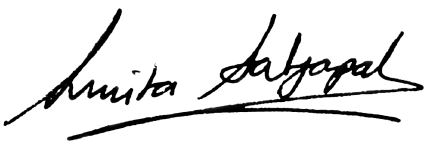
Our AMR this year also featured a one-day track on interagency activities. Other federal agencies presented on the hydrogen activities they supported; presenters represented the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, NASA, and the Departments of Defense, Transportation, and Agriculture. A separate HIT panel highlighted key activities from HIT working groups and crosscutting teams focused on supply and demand; infrastructure, siting, and permitting; analysis and global competitiveness; and workforce and energy justice. The closing AMR session was dedicated to presentations from each of the seven Regional Clean Hydrogen Hubs announced in October 2023.

The AMR was attended by more than 1,000 people, including more than 130 reviewers who reviewed more than 100 projects funded by HFTO and 20 reviewers who provided feedback on the overall Program and its subprograms. We at DOE highly value this transparent public process, wherein we solicit technical input on our projects and programs from experts with deep technical knowledge. DOE technology managers consider the reviewers' recommendations when generating future work plans and improving program effectiveness.

The summary table on the following pages lists the projects presented at the review and the overall evaluation score for each project, and Appendix A provides the scores and comments from the Program reviewers. The projects have been grouped according to subprogram and reviewed according to the appropriate evaluation criteria. The individual reports for each project present the reviewer comments to be considered during the upcoming fiscal year (October 1, 2024–September 30, 2025). The scores and comments are provided to each project's principal investigators (PIs) so that they receive direct feedback (with the authors of the individual comments remaining anonymous). DOE instructs the PIs to consider these summary evaluations fully—along with any comments from DOE managers—in their FY 2025 plans.

On behalf of the DOE Hydrogen Program, I would like to express my sincere appreciation to all the 2024 AMR participants—especially the reviewers, researchers, and presenters—for your strong commitment, expertise, and dedication to advancing hydrogen and fuel cell technologies and addressing our nation's critical energy, economic, and environmental needs. 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 and improve overall program effectiveness. We look forward to your participation in the next AMR, which is scheduled for April 27–May 1, 2026.

Sincerely,



Dr. Sunita Satyapal
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DOE Hydrogen Program Coordinator
U.S. Department of Energy

Hydrogen Production Technologies

Hydrogen Production

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
ELY-BIL001	Megawatt-Scale Low Temperature Electrolyzer Research Capability *Daniel Leighton, National Renewable Energy Laboratory*	3.4	X		
P-148	HydroGEN Overview: A Consortium on Advanced Water-Splitting Materials *Huyen Dinh, National Renewable Energy Laboratory*	3.5	X		
P-170	Benchmarking Advanced Water-Splitting Technologies: Best Practices in Materials Characterization *Olga Marina, Pacific Northwest National Laboratory*	3.7	X		
P-179	BioHydrogen (BioH2) Consortium to Advance Fermentative Hydrogen Production *Katherine Chou, National Renewable Energy Laboratory*	3.2	X		
P-196	H2NEW Consortium: Hydrogen from Next-Generation Electrolyzers of Water *Bryan Pivovar, National Renewable Energy Laboratory, and Richard Boardman, Idaho National Laboratory*	3.5	X		
P-200	Low-Cost Manufacturing of High-Temperature Electrolysis Stacks *Scott Swartz, Nextech Materials, Ltd.*	3.6	X		
P-202	Novel Microbial Electrolysis Cell Design for Efficient Hydrogen Generation from Wastewaters *Bruce Logan, The Pennsylvania State University*	3.1	X		
P-203	Novel Microbial Electrolysis System for Conversion of Biowastes into Low-Cost Renewable Hydrogen *Noah Meeks, Southern Company Services, Inc.*	3.2	X		
P-204	Hydrogen Production Cost and Performance Analysis *Brian James, Strategic Analysis, Inc.*	3.4	X		
P-205	Metal-Organic Framework-Based Heterostructure Electrocatalysts with Tailored Electron Density Distribution for Cost-Effective and Durable Fuel Cells and Electrolyzers *Sreeprasad Sreenivasan, University of Texas, El Paso*	3.1	X		
P-206	Single-Walled Carbon Nanotubes with Confined Chalcogens as the Catalysts and Electrodes for Oxygen Reduction Reaction in Fuel Cells *Juchen Guo, University of California, Riverside*	2.7	X		

Hydrogen Production: HydroGEN Seedling[1]

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
P-208	Non-Intermittent, Solar-Thermal Processing to Split Water Continuously via a Near-Isothermal, Pressure-Swing Redox Cycle *Alan Weimer, University of Colorado, Boulder*	3.4	X		
P-209	Gallium-Nitride-Protected Tandem Photoelectrodes for High-Efficiency, Low-Cost, and Stable Solar Water Splitting *Zetian Mi, University of Michigan*	3.3	X		
P-211	Inverse Design of Perovskite Materials for Solar Thermochemical Water Splitting *Christopher Muhich, Arizona State University*	3.6	X		
P-212	Ca-Ce-Ti-Mn-O-Based Perovskites for Two-Step Solar Thermochemical Hydrogen Production Cycles *Robert Wexler, Washington University in St. Louis*	3.4	X		
P-213	>200 cm^2 Type 3 Photoelectrochemical Water-Splitting Prototype Using Bandgap-Tunable Perovskite Tandem and Molecular-Scale Designer Coatings *Shu Hu, Yale University*	3.2	X		
P-214	Demonstration of a Robust, Compact Photoelectrochemical Hydrogen Generator *Joel Haber, California Institute of Technology*	3.2	X		
P-215	Semi-Monolithic Devices for Photoelectrochemical Hydrogen Production *Nicolas Gaillard, University of Hawaii at Manoa*	3.3	X		
P-216	Scalable Halide Perovskite Photoelectrochemical Cell Modules with 20% Solar-to-Hydrogen Efficiency and 1,000 Hours of Diurnal Durability *Aditya D. Mohite, Rice University*	3.2	X		
P-217	Scalable Solar Fuel Production in a Reactor Train System by Thermochemical Redox Cycling of Novel Nonstoichiometric Perovskites *Xin Qian, Saint-Gobain*	3.6	X		
P-218	All-Perovskite Tandem Photoelectrodes for Low-Cost Solar Hydrogen Fuel Production from Water Splitting *Yanfa Yan, University of Toledo*	3.1	X		

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

Hydrogen Infrastructure Technologies

Hydrogen Infrastructure

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
H2-041	H2@Scale Cooperative Research and Development Agreement: California Research Consortium (Reference Station, Fueling Performance Test Device, Station Cap Model) *Sam Sprik, National Renewable Energy Laboratory*	3.3			X
IN-001a	Hydrogen Materials Compatibility Consortium (H-Mat) Overview: Metals *Chris San Marchi, Sandia National Laboratories*	3.5	X		
IN-001b	Hydrogen Materials Compatibility Consortium (H-Mat) Overview: Polymers *Kevin Simmons, Pacific Northwest National Laboratory*	3.4	X		
IN-015	Optimizing the Heisenberg Vortex Tube for Hydrogen Cooling *Jacob Leachman, Washington State University*	3.2			X
IN-019	Ultra-Cryopump for High-Demand Transportation Fueling *Kyle Gross, RotoFlow*	2.8			X
IN-025	Hydrogen Delivery Technologies Analysis *Amgad Elgowainy, Argonne National Laboratory*	3.5	X		
IN-034	HyBlend: Pipeline Cooperative Research and Development Agreement (CRADA) Cost and Emissions Analysis *Mark Chung, National Renewable Energy Laboratory*	3.4	X		
IN-035	HyBlend: Pipeline Cooperative Research and Development Agreement (CRADA) Materials Research and Development *Chris San Marchi, Sandia National Laboratories*	3.6	X		
IN-036	Cost-Effective Pre-Cooling for High-Flow Hydrogen Fueling *Devin Halliday, GTI Energy*	2.9			X
IN-039	Analytic Framework for Optimal Sizing of Hydrogen Fueling Stations for Heavy-Duty Vehicles at Ports *Todd Wall, Pacific Northwest National Laboratory*	3.3			X
IN-040	The HyRIGHT Project: 700 bar Hydrogen Refueling Interface for Gaseous Heavy-Duty Trucks *Will James, Savannah River National Laboratory*	3.2			X
IN-043	Detection System Comprising Inexpensive Printed Sensor Arrays for Hydrogen Gas Emission Monitoring and Reporting *Rahul Pandey, Palo Alto Research Center*	2.9	X		

Hydrogen Storage

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
ST-001	System-Level Analysis of Hydrogen Storage Options *Rajesh Ahluwalia, Argonne National Laboratory*	3.3	X		
ST-127	Hydrogen Materials Advanced Research Consortium (HyMARC) Overview *Mark Allendorf, Sandia National Laboratories*	3.6	X		
ST-209	HyMARC Seedling: Theory-Guided Design and Discovery of Materials for Reversible Methane and Hydrogen Storage *Omar Farha, Northwestern University*	3.2	X		
ST-212	HyMARC Seedling: Methane and Hydrogen Storage with Porous Cage-Based Composite Materials *Eric Bloch, Indiana University*	3.7	X		
ST-217	HyMARC Seedling: A Reversible Liquid Hydrogen Carrier System Based on Ammonium Formate and Captured Carbon Dioxide *Hongfei Lin, Washington State University*	3.5	X		
ST-218	HyMARC Seedling: High-Capacity Step-Shaped Hydrogen Adsorption in Robust, Pore-Gating Zeolitic Imidazolate Frameworks *Michael McGuirk, Colorado School of Mines*	3.6			X
ST-234	Development of Magnesium Borane Containing Solutions of Furans and Pyroles as Reversible Liquid Hydrogen Carriers *Craig Jensen, University of Hawaii*	3.2	X		
ST-235	Hydrogen Storage Cost and Performance Analysis *Cassidy Houchins, Strategic Analysis, Inc.*	3.3	X		
ST-237	Carbon Composite Optimization Reducing Tank Cost *Duane Byerly, Hexagon R&D*	3.1	X		
ST-241	First Demonstration of a Commercial-Scale Liquid Hydrogen Storage Tank Design for International Trade Applications *Ed Holgate, Shell*	3.3	X		
ST-242	Dimethyl Ether as a Renewable Hydrogen Carrier: Innovative Approach to Renewable Hydrogen Production *Michael Heidlage, Los Alamos National Laboratory*	3.4	X		
ST-243	FueL Additives for Solid Hydrogen (FLASH) Carriers for Electric Aviation *Noemi Leick, National Renewable Energy Laboratory*	2.7			X

Fuel Cell Technologies

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
FC-160	ElectroCat 2.0 (Electrocatalysis Consortium) *Deborah Myers, Argonne National Laboratory, and Piotr Zelenay, Los Alamos National Laboratory*	3.4	X		
FC-336	A Systematic Approach to Developing Durable, Conductive Membranes for Operation at 120°C *Tom Zawodzinski, University of Tennessee, Knoxville*	3.0	X		
FC-337	Cummins Proton Exchange Membrane Fuel Cell System for Heavy-Duty Applications *Jean St-Pierre, Cummins Inc.*	2.9	x		
FC-338	Domestically Manufactured Fuel Cells for Heavy-Duty Applications *Cynthia Rice, Plug Power Inc.*	3.2	x		
FC-339	M2FCT: Million Mile Fuel Cell Truck Consortium *Rod Borup, Los Alamos National Laboratory, and Adam Weber, Lawrence Berkeley National Laboratory*	3.7	X		
FC-344	Low-Cost Corrosion-Resistant Coated Aluminum Bipolar Plates by Elevated Temperature Formation and Diffusion Bonding *Tianli Zhu, Raytheon Technologies Research Center*	2.7	X		
FC-345	Development and Manufacturing for Precious-Metal-Free Metal Bipolar Plate Coatings for Proton Exchange Membrane Fuel Cells *CH Wang, Treadstone Technologies, Inc.*	2.7	X		
FC-346	Fully Unitized Fuel Cell Manufactured by a Continuous Process *Jon Owejan, Plug Power Inc.*	3.3	X		
FC-347	Development of Low-Cost, Thin Flexible Graphite Bipolar Plates for Heavy-Duty Fuel Cell Applications *David Chadderdon, NeoGraf Solutions, LLC*	3.1	X		
FC-348	Fuel Cell Bipolar Plate Technology Development for Heavy-Duty Applications *Siguang Xu, General Motors LLC*	3.5	X		
FC-349	Foil-Bearing-Supported Compressor–Expander *Giri Agrawal, R&D Dynamics Corporation*	3.1	X		
FC-350	High-Efficiency and Transient Air Systems for Affordable Load-Following Heavy-Duty Truck Fuel Cells *Doug Hughes, Eaton Corporation*	3.3	X		
FC-351	Durable and Efficient Centrifugal Compressor-Based Filtered Air Management System and Optimized Balance of Plant *Mike Bunce, MAHLE Powertrain, LLC*	3.4	X		

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
FC-352	Leveraging Internal Combustion Engine Air System Technology for Fuel Cell System Cost Reduction *Paul Wang, Caterpillar Inc.*	3.3	X		
FC-353	Fuel Cell Cost and Performance Analysis *Brian James, Strategic Analysis, Inc.*	3.4	X		
FC-354	L'Innovator Program *Emory De Castro, Advent Technologies*	3.3	X		
FC-363	Advanced Fuel Cell Vehicle DC-DC Converter Development *Vivek Sujan, Oak Ridge National Laboratory*	3.4	X		
MNF-BIL001	R2R: Roll to Roll Consortium *Scott Mauger, National Renewable Energy Laboratory*	3.1	X		

Systems Development and Integration

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
SDI-001	Integrated Modeling, Techno-Economic Analysis, and Reference Design for Renewable Hydrogen to Green Steel and Ammonia – Greenheart *Jennifer King, National Renewable Energy Laboratory*	3.1	X		
SDI-002	Hydrogen Microgrid in Underserved Communities *Kumaraguru Prabakar, National Renewable Energy Laboratory*	2.7		X	
SDI-006	High Temperature Electrolyzer Megawatt-Scale Test Facility *Richard Boardman, Idaho National Laboratory*	3.6	X		
TA-001	Membrane Electrode Assembly Manufacturing Research and Development *Peter Rupnowski, National Renewable Energy Laboratory*	3.2			X
TA-016	Fuel Cell Hybrid Electric Delivery Van *Steve Clermont, Center for Transportation and the Environment*	3.0			X
TA-018	High-Temperature Electrolysis, Stack, and Systems Testing *Micah Casteel, Idaho National Laboratory*	3.7	X		
TA-029	Autonomous Hydrogen Fueling Station *Keith Brown, Plug Power Inc.*	2.6		X	
TA-030	Demonstration of Integrated Hydrogen Production and Consumption for Improved Utility Operations *Paul Brooker, Orlando Utilities Commission*	2.9	X		

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
TA-037	Demonstration and Framework for H2@Scale in Texas and Beyond *Rich Myhre, Frontier Energy, Inc.*	3.5	X		
TA-039	Solid Oxide Electrolysis System Demonstration *Hossein Ghezel-Ayagh, FuelCell Energy, Inc.*	3.5	X		
TA-044	System Demonstration for Supplying Clean, Reliable, and Affordable Electric Power to Data Centers Using Hydrogen Fuel *Paul Wang, Caterpillar Inc.*	3.4			X
TA-048	Advanced Research on Integrated Energy Systems (ARIES)/Flatirons Facility – Hydrogen System Capability Buildout *Daniel Leighton, National Renewable Energy Laboratory*	3.4			X
TA-052	Solid Oxide Electrolysis Cells Integrated with Direct Reduced Iron Plants for Producing Green Steel *Jack Brouwer, University of California, Irvine*	3.3	X		
TA-053	Grid-Interactive Steelmaking with Hydrogen (GISH) *Ronald O'Malley, Missouri University of Science and Technology*	3.4			X
TA-056	Ultra-Efficient Long-Haul Hydrogen Fuel Cell Tractor *Darek Villeneuve, Daimler Trucks North America*	3.5	X		
TA-057	High-Efficiency Fuel Cell Application for Medium-Duty Truck Vocations *Stan Bower, Ford Motor Company*	3.6	X		
TA-058	Freight Emissions Reduction via Medium-Duty Battery Electric and Hydrogen Fuel Cell Trucks with Green Hydrogen Production via a New Electrolyzer Design and Electrical Utility Grid Coupling *Jacob Lozier, General Motors LLC*	3.5	X		
TA-059	Identifying Medium- and Heavy-Duty Applications for Fuel Cell Electric Trucks *Ram Vijayagopal, Argonne National Laboratory*	3.4	X		
TA-060	Offshore Wind to Hydrogen – Modeling, Analysis, Testing, and International Collaboration Work *Genevieve Saur, National Renewable Energy Laboratory*	3.4			X
TA-062	Validation of Interconnection and Interoperability of Grid-Forming Inverters Sourced by Hydrogen Technologies in View of 100% Renewable Microgrids *Kumaraguru Prabakar, National Renewable Energy Laboratory*	3.2	X		
TA-063	High-Efficacy Validation of Hydride Mega Tanks at the ARIES Lab (HEVHY METAL) *Katherine Hurst, National Renewable Energy Laboratory*	3.3	X		
TA-064	Hydrogen Production, Grid Integration, and Scaling for the Future *Sam Sprik, National Renewable Energy Laboratory*	3.1	X		

Project Number	Project Title *Principal Investigator Name & Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
TA-065	Total Cost of Ownership Analysis of Hydrogen Fuel Cells in Off-Road Heavy-Duty Applications – Preliminary Results *Rajesh Ahluwalia, Argonne National Laboratory*	3.4			X

Analysis, Codes and Standards

Systems Analysis

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
SA-178	Cradle-to-Grave Transportation Analysis *Amgad Elgowainy, Argonne National Laboratory*	3.6			X
SA-181	Global Change Analysis Model Expansion – Hydrogen Pathways *Page Kyle, Pacific Northwest National Laboratory*	3.4	X		
SA-187	Heavy-Duty Hydrogen Fueling Station Corridors *Mark Chung, National Renewable Energy Laboratory*	3.3			X
SA-188	Sustainability Criteria for Hydrogen Deployments *Mark Chung, National Renewable Energy Laboratory*	3.1			X

Safety, Codes and Standards

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
SCS-001	Component Failure Research and Development *Genevieve Saur, National Renewable Energy Laboratory*	3.4	X		
SCS-005	Research and Development for Safety, Codes and Standards: Material and Component Compatibility *Joe Ronevich, Sandia National Laboratories*	3.3	X		

Project Number	Project Title *Principal Investigator Name and Organization*	Final Score	Continue	Discontinue/ Further Review	Completed
SCS-010	Research and Development for Safety, Codes and Standards: Hydrogen Behavior *Ethan Hecht, Sandia National Laboratories*	3.6	X		
SCS-011	Hydrogen Quantitative Risk Assessment *Brian Ehrhart, Sandia National Laboratories*	3.5	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*	3.6	X		
SCS-022	Fuel Cell and Hydrogen Energy Association Codes and Standards Support *Karen Quackenbush, Fuel Cell and Hydrogen Energy Association*	2.9	X		
SCS-028	Hydrogen Education for a Decarbonized Global Economy (H2EDGE) *Eladio Knipping, Electric Power Research Institute*	3.4	X		
SCS-030	MC Formula Protocol for H35HF Fueling *Taichi Kuroki, National Renewable Energy Laboratory*	3.5			X
SCS-031	Assessment of Heavy-Duty Fueling Methods and Components *Shaun Onorato, National Renewable Energy Laboratory*	3.7	X		
SCS-032	Smart Hydrogen Wide Area Monitoring for Outdoor H2@Scale Demonstration Sites and Enclosure *David Peaslee, National Renewable Energy Laboratory*	3.4	X		
SCS-033	Risk Assessments of Design and Refueling for Hydrogen Locomotive and Tender *Brian Ehrhart, Sandia National Laboratories*	2.9			X
SCS-034	Large-Scale Hydrogen Storage – Risk Assessment Seattle City Light and Port of Seattle *Arun Veeramany, Pacific Northwest National Laboratory*	3.5			X
SCS-035	Modeling and Risk Assessment of Hydrogen–Natural-Gas Blends Austin Glover, Sandia National Laboratories	3.0			X
SCS-036	Electrical Hydrogen Sensor Technology with a Sub-Minute Response Time and a Part-Per-Billion Detection Limit for Hydrogen Environmental Monitoring *Tho Nguyen, University of Georgia*	3.1	X		
SCS-037	Sensing Hydrogen Losses at One-Part-Per-Billion Level for Hydrogen-Blending Natural Gas Pipelines *Shan Hu, Iowa State University*	2.8	X		