XVI. Project Listings by Organization

3M Company
V.A.7 Highly Active, Durable, and Ultra-low PGM NSTF Thin Film ORR Catalysts and Supports
V.A.8 Highly-Accessible Catalysts for Durable High-Power Performance
V.B.4 FC-PAD: Ionomer, GDLs, Interfaces
V.C.1 New Fuel Cell Membranes with Improved Durability and Performance
V.C.2 Advanced Hybrid Membranes for Next Generation PEMFC Automotive Applications
V.C.7 Advanced Ionomers and MEAs for Alkaline Membrane Fuel Cells
V.D.1 High Performance, Durable, Low Cost Membrane Electrode Assemblies for Transportation Applications
VI.1 Fuel Cell Membrane Electrode Assembly Manufacturing R&D

AccerlorMittal
III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

ACI Services
III.4 Hydrogen Compression Application of the Linear Motor Reciprocating Compressor (LMRC)

Adaptive Intelligent Systems LLC
III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

Adherent Technologies, Inc.
IV.D.5 Optimizing the Cost and Performance of Composite Cylinders for H₂ Storage using a Graded Construction

Advent Technologies Inc.
V.D.5 Facilitated Direct Liquid Fuel Cells with High Temperature Membrane Electrode Assemblies

Air Liquide
III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage
VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Air Products and Chemicals, Inc.
VII.B.3 Validation of an Advanced High Pressure PEM Electrolyzer and Composite Hydrogen Storage, with Data Reporting, for SunHydro Stations
VII.C.3 Advanced Hydrogen Fueling Station Supply: Tube Trailers
VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

ALD Nanosolutions
V.A.6 Extended Surface Electrocatalyst Development

Ames Laboratory
IV.C.6 High-capacity Hydrogen Storage Systems via Mechanochemistry

Amsen Technologies LLC
V.C.9 Low-Cost Proton Conducting Membranes for PEM Fuel Cells

Anderson Burton
VII.B.5 Brentwood Case Study
### AOC, LLC
- IV.D.1 Enhanced Materials and Design Parameters for Reducing the Cost of Hydrogen Storage Tanks

### Ardica Technologies, Inc.
- IV.C.12 Low-Cost $\alpha$-Alane for Hydrogen Storage

### Argonne National Laboratory
- III.1 Hydrogen Delivery Infrastructure Analysis
- III.13 Hydrogen Fueling Station Precooling Analysis
- IV.A.1 System Analysis of Physical and Materials-Based Hydrogen Storage
- IV.C.9 High-Capacity and Low-Cost Hydrogen-Storage Sorbents for Automotive Applications
- V.A.4 Tailored High Performance Low-PGM Alloy Cathode Catalysts
- V.A.7 Highly Active, Durable, and Ultra-low PGM NSTF Thin Film ORR Catalysts and Supports
- V.B.1 Fuel Cell-Performance and Durability (FC-PAD) Consortium Overview
- V.B.2 FC-PAD Fuel Cell-Performance and Durability Electro catalysts and Supports
- V.B.3 FC-PAD: Electrode Layer Integration
- V.B.4 FC-PAD: Ionomer, GDLs, Interfaces
- V.B.5 FC-PAD: Modeling, Evaluation, Characterization
- V.C.6 Advanced Materials for Fully-Integrated MEAs in AEMFCs
- V.D.1 High Performance, Durable, Low Cost Membrane Electrode Assemblies for Transportation Applications
- V.D.3 Rationally Designed Catalyst Layers for PEMFC Performance Optimization
- V.F.5 Performance and Durability of Advanced Automotive Fuel Cell Stacks and Systems with Nanostructured Thin Film Catalyst Based Membrane Electrode Assemblies
- VII.A.3 Fuel Cell Electric Truck (FCET) Component Sizing
- IX.1 Employment Impacts of Hydrogen and Fuel Cell Technologies
- IX.2 Life-Cycle Analysis of Water Consumption for Hydrogen Production
- IX.3 Impact of Fuel Cell and H₂ Storage Improvements on FCEVs
- IX.5 Life Cycle Analysis of Emerging Hydrogen Production Technologies

### Arizona State University
- II.C.1 High Efficiency Solar Thermochemical Reactor for Hydrogen Production

### ASTM International
- VIII.3 Hydrogen Fuel Quality

### Automated Dynamics
- VI.5 Continuous Fiber Composite Electrofusion Coupler

### A.V. Tchouvelev & Associates
- VIII.1 National Codes and Standards Deployment and Outreach

### Ballard Power Systems
- VB.7 The Effect of Airborne Contaminants on Fuel Cell Performance and Durability
- X.4 Demonstration of Fuel Cell Auxiliary Power Units (APUs) to Power Transport Refrigeration Units (TRUs) in Refrigerated Trucks

### Battelle
- V.F.7 Stationary and Emerging Market Fuel Cell System Cost Analysis—Primary Power and Combined Heat and Power Applications
XVI. Project Listings by Organization

Becht Engineering
   VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Ben C. Gerwick, Inc.
   III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage

Bevilacqua Knight Inc.
   III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

Birch Studio
   VI.3 Fuel Cell and Hydrogen Opportunity Center, www.hfcnexus.com

Bki
   VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Bloomfield Automation
   VIII.7 NREL Hydrogen Sensor Testing Laboratory

BMW
   IV.D.2 Thermomechanical Cycling of Thin Liner High Fiber Fraction Cryogenic Pressure Vessels Rapidly Refueled by Liquid Hydrogen Pump to 700 bar

Bowen Liu
   VI.4 U.S. Clean Energy Hydrogen and Fuel Cell Technologies: A Competitiveness Analysis

Branded by Media
   VIII.1 National Codes and Standards Deployment and Outreach

Breakthrough Technologies Institute
   VI.3 Fuel Cell and Hydrogen Opportunity Center, www.hfcnexus.com

Brookhaven National Laboratory
   V.A.5 Platinum Monolayer Electrocatalysts
   V.G.1 Structure and Function in Electrocatalysis of Reactions for Direct Energy Conversion
   V.G.2 Catalysis and Electrocatalysis for Advanced Fuel Synthesis: Hydrogen Production and the Water-Gas Shift

Bucknell University
   II.C.1 High Efficiency Solar Thermochemical Reactor for Hydrogen Production

California Fuel Cell Partnership
   VII.C.6 Station Operational Status System (SOSS) 3.0 Implementation, SOSS 3.1 Upgrade, and Station Map Upgrade Project

California Institute of Technology
   I.D.3 Tandem Particle-Slurry Batch Reactors for Solar Water Splitting
   IV.B.1 Hydrogen Storage Engineering Center of Excellence
   IV.C.8 Design and Synthesis of Materials with High Capacities for Hydrogen Physisorption

California State University, Los Angeles
   VII.B.4 CSULA Hydrogen Refueling Facility Performance Evaluation and Optimization
Carnegie Mellon University
  V.A.1 Non-Precious Metal Fuel Cell Cathodes: Catalyst Development and Electrode Structure Design
  V.A.8 Highly-Accessible Catalysts for Durable High-Power Performance

Center for Transportation and the Environment
  IV.D.3 Conformable Hydrogen Storage Pressure Vessel Project
  VII.A.4 Fuel Cell Hybrid Electric Delivery Van Project

Central Michigan University
  V.G.14 Element Specific Atomic Arrangement of Binary and Ternary Alloy Nanosized Catalysts in As-Prepared and Active State

City of Santa Fe Springs
  VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Colorado School of Mines
  II.C.1 High Efficiency Solar Thermochemical Reactor for Hydrogen Production
  III.2 Fatigue Performance of High-Strength Pipeline Steels and Their Welds in Hydrogen Gas Service
  V.A.6 Extended Surface Electrocatalyst Development
  V.B.4 FC-PAD: Ionomer, GDLs, Interfaces
  V.C.2 Advanced Hybrid Membranes for Next Generation PEMFC Automotive Applications
  V.C.7 Advanced Ionomers and MEAs for Alkaline Membrane Fuel Cells
  VI.1 Fuel Cell Membrane Electrode Assembly Manufacturing R&D

Commissariat a l’energie atomique et aux energies alternatives
  VIII.3 Hydrogen Fuel Quality

Composite Technology Development, Inc.
  IV.D.5 Optimizing the Cost and Performance of Composite Cylinders for H₂ Storage using a Graded Construction

Connecticut Center for Advanced Technology
  VI.2 Clean Energy Supply Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cell Technologies

Cornell University
  V.A.8 Highly-Accessible Catalysts for Durable High-Power Performance

CP Industries
  III.6 Low Cost Hydrogen Storage at 875 bar Using Steel Liner and Steel Wire Wrap

CSA Group
  VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Dason Technology
  II.F.1 Monolithic Piston-Type Reactor for Hydrogen Production through Rapid Swing of Reforming/Combustion Reactions

DJW Technology, LLC
  VI.2 Clean Energy Supply Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cell Technologies
  VI.4 U.S. Clean Energy Hydrogen and Fuel Cell Technologies: A Competitiveness Analysis
Drexel University
  V.A.8 Highly-Accessible Catalysts for Durable High-Power Performance

e4tech
  VI.4 U.S. Clean Energy Hydrogen and Fuel Cell Technologies: A Competitiveness Analysis

ElectroChem, Inc.
  V.C.11 Novel Nanocomposite Polymer Electrolyte Membranes for Fuel Cells

Element One
  VIII.7 NREL Hydrogen Sensor Testing Laboratory

Emerald Energy NW LLC
  III.10 Magnetocaloric Hydrogen Liquefaction

Energetics, Inc.
  IX.1 Employment Impacts of Hydrogen and Fuel Cell Technologies

Excelsior Design, Inc.
  VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Federal Express Corporation
  X.5 FedEx Express Hydrogen Fuel Cell Extended-Range Battery Electric Vehicles

Firexplo
  VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Florida State University
  VII.D.3 Dynamic Modeling and Validation of Electrolyzers in Real Time Grid Simulation

Fluer, Inc.
  VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Ford Motor Company
  IV.B.1 Hydrogen Storage Engineering Center of Excellence
  IV.C.10 Hydrogen Adsorbents with High Volumetric Density: New Materials and System Projections
  IV.D.1 Enhanced Materials and Design Parameters for Reducing the Cost of Hydrogen Storage Tanks
  VIII.9 Compatibility of Polymeric Materials Used in the Hydrogen Infrastructure

Forterra Water Pipe
  III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

Fuel Cell & Hydrogen Energy Association
  VIII.8 Fuel Cell & Hydrogen Energy Association Codes and Standards Support

FuelCell Energy
  II.B.5 Solid Oxide Based Electrolysis and Stack Technology with Ultra-High Electrolysis Current Density (>3 A/cm²) and Efficiency
  II.F.2 Reformer-Electrolyzer-Purifier (REP) for Production of Hydrogen [CO₂ Pump]
  V.A.3 Innovative Non-PGM Catalysts for High-Temperature PEMFCs
  V.C.3 Smart Matrix Development for Direct Carbonate Fuel Cell
Gas Technology Institute
   III.7 Compressor-Less Hydrogen Refueling Station Using Thermal Compression
   VII.B.2 Performance Evaluation of Delivered Hydrogen Fueling Stations

General Motors Company
   IV.B.1 Hydrogen Storage Engineering Center of Excellence
   V.A.1 Non-Precious Metal Fuel Cell Cathodes: Catalyst Development and Electrode Structure Design
   V.A.8 Highly-Accessible Catalysts for Durable High-Power Performance
   V.C.1 New Fuel Cell Membranes with Improved Durability and Performance
   V.D.1 High Performance, Durable, Low Cost Membrane Electrode Assemblies for Transportation Applications
   VI.1 Fuel Cell Membrane Electrode Assembly Manufacturing R&D

Georgia Institute of Technology
   II.B.6 Economical Production of Hydrogen Through Development of Novel, High Efficiency Electrocatalysts for Alkaline Membrane Electrolysis
   V.G.10 Atomic-Scale Design of Metal and Alloy Catalysts: A Combined Theoretical and Experimental Approach
   VI.1 Fuel Cell Membrane Electrode Assembly Manufacturing R&D

Giner, Inc.
   II.B.2 High-Performance, Long-Lifetime Catalysts for Proton Exchange Membrane Electrolysis
   II.B.4 High Temperature, High Pressure Electrolysis
   V.C.4 Ionomer Dispersion Impact on Fuel Cell and Electrolyzer Performance and Durability
   V.C.8 Dimensionally Stable High Performance Membranes
   V.D.6 Advanced Catalysts and Membrane Electrode Assemblies (MEAs) for Reversible Alkaline Membrane Fuel Cells
   V.E.1 Regenerative Fuel Cell System

Global Engineering and Technology, LLC
   III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage
   III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

GLWN, Westside Industrial Retention & Expansion Network
   VI.4 U.S. Clean Energy Hydrogen and Fuel Cell Technologies: A Competitiveness Analysis

GVD Corporation
   III.8 Advanced Barrier Coatings for Harsh Environments

GWS Solutions of Tolland, LLC
   VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Hanson Pressure Pipe
   III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage

Harris Thermal Transfer Products
   III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage

Hawaii Natural Energy Institute
   V.B.7 The Effect of Airborne Contaminants on Fuel Cell Performance and Durability
   X.1 Hydrogen Energy Systems as a Grid Management Tool
XVI. Project Listings by Organization

Hexagon Lincoln
- IV.B.1 Hydrogen Storage Engineering Center of Excellence
- IV.D.1 Enhanced Materials and Design Parameters for Reducing the Cost of Hydrogen Storage Tanks
- IV.D.6 Achieving Hydrogen Storage Goals through High-Strength Fiber Glass

High Energy Coil Reservoirs, LLC
- IV.D.3 Conformable Hydrogen Storage Pressure Vessel Project

Humboldt State University
- VII.D.3 Dynamic Modeling and Validation of Electrolyzers in Real Time Grid Simulation

Hydrogenics
- VII.A.4 Fuel Cell Hybrid Electric Delivery Van Project
- VII.B.4 CSULA Hydrogen Refueling Facility Performance Evaluation and Optimization
- X.3 Maritime Fuel Cell Generator Project

Hy-Performance Materials Testing, LLC
- III.6 Low Cost Hydrogen Storage at 875 bar Using Steel Liner and Steel Wire Wrap
- IV.D.8 Innovative Development, Selection and Testing to Reduce Cost and Weight of Materials for BOP Components

Idaho National Laboratory
- VII.D.3 Dynamic Modeling and Validation of Electrolyzers in Real Time Grid Simulation

Illinois Institute of Technology
- V.A.9 Corrosion-Resistant Non-Carbon Electrocatalyst Supports for PEFCs
- V.C.3 Smart Matrix Development for Direct Carbonate Fuel Cell

Indiana University-Purdue University Indianapolis
- V.D.3 Rationally Designed Catalyst Layers for PEMFC Performance Optimization

IRD Fuel Cells
- V.A.1 Non-Precious Metal Fuel Cell Cathodes: Catalyst Development and Electrode Structure Design
- V.A.2 Development of PGM-free Catalysts for Hydrogen Oxidation Reaction in Alkaline Media

Japan Automotive Research Institute
- VIII.3 Hydrogen Fuel Quality

Jet Propulsion Laboratory
- IV.B.1 Hydrogen Storage Engineering Center of Excellence

Johns Hopkins University
- V.A.7 Highly Active, Durable, and Ultra-low PGM NSTF Thin Film ORR Catalysts and Supports
- V.D.1 High Performance, Durable, Low Cost Membrane Electrode Assemblies for Transportation Applications
- V.G.3 Control of Reactivity in Nanoporous Metal/Ionic Liquid Composite Catalysts

Johnson Matthey Fuel Cells
- V.D.3 Rationally Designed Catalyst Layers for PEMFC Performance Optimization

Kobe Steel, LTD.
- III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage
Lawrence Berkeley National Laboratory
II.D.3 Tandem Particle-Slurry Batch Reactors for Solar Water Splitting
II.E.1 Biomass to Hydrogen
IV.C.4 HyMARC: A Consortium for Advancing Solid-State Hydrogen Storage Materials
IV.C.7 H₂ Storage Characterization and Optimization Research Efforts
V.A.4 Tailored High Performance Low-PGM Alloy Cathode Catalysts
V.B.1 Fuel Cell-Performance and Durability (FC-PAD) Consortium Overview
V.B.3 FC-PAD: Electrode Layer Integration
V.B.4 FC-PAD: Ionomer, GDLs, Interfaces
V.B.5 FC-PAD: Modeling, Evaluation, Characterization
V.B.6 Multiscale Modeling of Fuel Cell Membranes
V.C.7 Advanced Ionomers and MEAs for Alkaline Membrane Fuel Cells
V.D.1 High Performance, Durable, Low Cost Membrane Electrode Assemblies for Transportation Applications
V.F.8 A Total Cost of Ownership Model for Design and Manufacturing Optimization of Fuel Cells in Stationary and Emerging Market Applications
VI.1 Fuel Cell Membrane Electrode Assembly Manufacturing R&D

Lawrence Livermore National Laboratory
II.D.2 Wide Bandgap Chalcopyrite Photoelectrodes for Direct Solar Water Splitting
III.15 Cryo-Compressed Pathway Analysis (2016)
IV.C.3 HyMARC: Hydrogen Storage Materials Advanced Research Consortium (LLNL Effort)
IV.C.4 HyMARC: A Consortium for Advancing Solid-State Hydrogen Storage Materials
IV.C.5 Improving the Kinetics and Thermodynamics of Mg(BH₄)₂ for Hydrogen Storage
IV.C.8 Design and Synthesis of Materials with High Capacities for Hydrogen Physisorption
IV.D.2 Thermomechanical Cycling of Thin Liner High Fiber Fraction Cryogenic Pressure Vessels Rapidly Refueled by Liquid Hydrogen Pump to 700 bar
VII.C.4 Performance and Durability Testing of Volumetrically Efficient Cryogenic Vessels and High Pressure Liquid Hydrogen Pump

Lexidyne, LLC
IX.11 National FCEV and Hydrogen Refueling Station Scenarios

LightSail
III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

Linde LLC
IV.D.2 Thermomechanical Cycling of Thin Liner High Fiber Fraction Cryogenic Pressure Vessels Rapidly Refueled by LH₂ Pump to 700 bar
VII.B.2 Performance Evaluation of Delivered Hydrogen Fueling Stations
VII.C.4 Performance and Durability Testing of Volumetrically Efficient Cryogenic Vessels and High Pressure Liquid Hydrogen Pump

Los Alamos National Laboratory
IV.B.1 Hydrogen Storage Engineering Center of Excellence
V.A.1 Non-Precious Metal Fuel Cell Cathodes: Catalyst Development and Electrode Structure Design
V.A.2 Development of PGM-free Catalysts for Hydrogen Oxidation Reaction in Alkaline Media
V.A.4 Tailored High Performance Low-PGM Alloy Cathode Catalysts
Los Alamos National Laboratory (Continued)
V.A.5 Platinum Monolayer Electrocatalysts
V.B.1 Fuel Cell-Performance and Durability (FC-PAD) Consortium Overview
V.B.2 FC-PAD Fuel Cell-Performance and Durability Electrocatalysts and Supports
V.B.3 FC-PAD: Electrode Layer Integration
V.B.4 FC-PAD: Ionomer, GDLs, Interfaces
V.B.5 FC-PAD: Modeling, Evaluation, Characterization
V.C.4 Ionomer Dispersion Impact on Fuel Cell and Electrolizer Performance and Durability
V.C.6 Advanced Materials for Fully-Integrated MEAs in AEMFCs
V.D.1 High Performance, Durable, Low Cost Membrane Electrode Assemblies for Transportation Applications
V.D.5 Facilitated Direct Liquid Fuel Cells with High Temperature Membrane Electrode Assemblies
V.F.3 Technical Assistance to Developers
VIII.3 Hydrogen Fuel Quality

Mainstream Engineering
VI.1 Fuel Cell Membrane Electrode Assembly Manufacturing R&D
VI.6 In-line Quality Control of PEM Materials

Materia, Inc.
IV.D.4 Next Generation Hydrogen Storage Vessels Enabled by Carbon Fiber Infusion with a Low Viscosity, High Toughness System

MegaStir Technologies LLC
III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage
III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

Michigan Technological University
V.D.1 High Performance, Durable, Low Cost Membrane Electrode Assemblies for Transportation Applications

Montana State University
IV.D.4 Next Generation Hydrogen Storage Vessels Enabled by Carbon Fiber Infusion with a Low Viscosity, High Toughness System

N&R Engineering
III.6 Low Cost Hydrogen Storage at 875 bar Using Steel Liner and Steel Wire Wrap

NanoSonic, Inc.
III.12 Cryogenically Flexible, Low Permeability H₂ Delivery Hose
V.C.10 Novel Hydrocarbon Ionomers for Durable Proton Exchange Membranes

National Fuel Cell Research Center
VI.2 Clean Energy Supply Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cell Technologies

National Institute of Standards and Technology
III.2 Fatigue Performance of High-Strength Pipeline Steels and Their Welds in Hydrogen Gas Service
IV.C.7 H₂ Storage Characterization and Optimization Research Efforts
V.F.2 Neutron Imaging Study of the Water Transport in Operating Fuel Cells
National Renewable Energy Laboratory

II.B.1 Renewable Electrolysis Integrated System Development and Testing
II.B.2 High-Performance, Long-Lifetime Catalysts for Proton Exchange Membrane Electrolysis
II.C.2 Flowing Particle Bed Solarthermal RedOx Process to Split Water
II.D.1 High-Efficiency Tandem Absorbers for Economical Solar Hydrogen Production
II.D.2 Wide Bandgap Chalcopyrite Photoelectrodes for Direct Solar Water Splitting
II.E.1 Biomass to Hydrogen
III.9 Improved Hydrogen Liquefaction through Heisenberg Vortex Separation of Para- and Orthohydrogen
III.11 700 bar Hydrogen Dispenser Hose Reliability Improvement
III.12 Cryogenically Flexible, Low Permeability H₂ Delivery Hose
III.14 H₂FIRST—Consolidation
IV.B.1 Hydrogen Storage Engineering Center of Excellence
IV.B.2 Hydrogen Storage System Modeling: Public Access, Maintenance, and Enhancements
IV.C.7 H₂ Storage Characterization and Optimization Research Efforts
V.A.6 Extended Surface Electrocatalyst Development
V.A.8 Highly-Accessible Catalysts for Durable High-Power Performance
V.B.1 Fuel Cell-Performance and Durability (FC-PAD) Consortium Overview
V.B.2 FC-PAD Fuel Cell-Performance and Durability Electrocatalysts and Supports
V.B.3 FC-PAD: Electrode Layer Integration
V.B.4 FC-PAD: Ionomer, GDLs, Interfaces
V.B.5 FC-PAD: Modeling, Evaluation, Characterization
V.C.2 Advanced Hybrid Membranes for Next Generation PEMFC Automotive Applications
V.C.5 Highly Stable Anion-Exchange Membranes for High-Voltage Redox-Flow Batteries
V.C.7 Advanced Ionomers and MEAs for Alkaline Membrane Fuel Cells
V.D.6 Advanced Catalysts and Membrane Electrode Assemblies (MEAs) for Reversible Alkaline Membrane Fuel Cells
V.E.1 Regenerative Fuel Cell System
V.F.4 Fuel Cell Technology Status: Degradation
V.G.17 Hydroxide Conductors for Energy Conversion Devices
VI.1 Fuel Cell Membrane Electrode Assembly Manufacturing R&D
VI.2 Clean Energy Supply Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cell Technologies
VI.6 In-line Quality Control of PEM Materials
VI.7 Manufacturing Competitiveness Analysis for Hydrogen Refueling Stations
VII.A.1 Fuel Cell Electric Vehicle Evaluation
VII.A.2 Technology Validation: Fuel Cell Bus Evaluations
VII.B.1 Hydrogen Station Data Collection and Analysis
VII.B.5 Brentwood Case Study
VII.C.1 Hydrogen Component Validation
VII.C.5 Hydrogen Meter Benchmark Testing
VII.D.1 Stationary Fuel Cell Evaluation
VII.D.2 Material Handling Equipment Data Collection and Analysis
VIII.1 National Codes and Standards Deployment and Outreach
VIII.7 NREL Hydrogen Sensor Testing Laboratory
IX.7 Sustainability Analysis of Hydrogen Supply and Stationary Fuel Cell Systems Using the Hydrogen Regional Sustainability (HyReS) Framework
National Renewable Energy Laboratory (Continued)
   IX.8 Evaluation of Technology Status Compared to Program Targets
   IX.9 Expanded Capabilities for the Hydrogen Financial Analysis Scenario Tool
   IX.11 National FCEV and Hydrogen Refueling Station Scenarios

NEI Corporation
   V.C.11 Novel Nanocomposite Polymer Electrolyte Membranes for Fuel Cells

New England Wire Technologies, Inc.
   III.12 Cryogenically Flexible, Low Permeability H₂ Delivery Hose

Nissan Technical Center, North America
   V.A.9 Corrosion-Resistant Non-Carbon Electrocatalyst Supports for PEFCs
   V.C.2 Advanced Hybrid Membranes for Next Generation PEMFC Automotive Applications

Northeastern University
   II.B.3 High Performance Platinum Group Metal Free Membrane Electrode Assemblies through Control of Interfacial Processes
   V.A.3 Innovative Non-PGM Catalysts for High-Temperature PEMFCs

Northwestern University
   II.C.1 High Efficiency Solar Thermochemical Reactor for Hydrogen Production

NOV Fiberglass Systems
   VI.5 Continuous Fiber Composite Electrofusion Coupler

Nuvera Fuel Cells
   X.4 Demonstration of Fuel Cell Auxiliary Power Units (APUs) to Power Transport Refrigeration Units (TRUs) in Refrigerated Trucks

Oak Ridge National Laboratory
   III.2 Fatigue Performance of High-Strength Pipeline Steels and Their Welds in Hydrogen Gas Service
   III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage
   III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage
   III.6 Low Cost Hydrogen Storage at 875 bar Using Steel Liner and Steel Wire Wrap
   IV.D.5 Optimizing the Cost and Performance of Composite Cylinders for H₂ Storage using a Graded Construction
   IV.D.7 Melt Processable PAN Precursor for High Strength, Low-Cost Carbon Fibers (Phase II)
   V.A.1 Non-Precious Metal Fuel Cell Cathodes: Catalyst Development and Electrode Structure Design
   V.A.4 Tailored High Performance Low-PGM Alloy Cathode Catalysts
   V.A.7 Highly Active, Durable, and Ultra-low PGM NSTF Thin Film ORR Catalysts and Supports
   V.B.1 Fuel Cell-Performance and Durability (FC-PAD) Consortium Overview
   V.B.2 FC-PAD Fuel Cell-Performance and Durability Electrocatalysts and Supports
   V.B.3 FC-PAD: Electrode Layer Integration
   V.B.4 FC-PAD: Ionomer, GDLs, Interfaces
   V.B.5 FC-PAD: Modeling, Evaluation, Characterization
   V.C.7 Advanced Ionomers and MEAs for Alkaline Membrane Fuel Cells
   V.F.1 New Fuel Cell Materials: Characterization and Method Development
   V.G.12 Fundamentals of Catalysis and Chemical Transformations
Ohio Fuel Cell Coalition

VI.2 Clean Energy Supply Chain and Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cell Technologies

Oregon State University

II.E.3 Novel Hybrid Microbial Electrochemical System for Efficient Hydrogen Generation from Biomass
IV.B.1 Hydrogen Storage Engineering Center of Excellence

Pacific Northwest National Laboratory

II.E.3 Novel Hybrid Microbial Electrochemical System for Efficient Hydrogen Generation from Biomass
II.F.1 Monolithic Piston-Type Reactor for Hydrogen Production through Rapid Swing of Reforming/Combustion Reactions
III.10 Magnetocaloric Hydrogen Liquefaction
IV.B.1 Hydrogen Storage Engineering Center of Excellence
IV.B.2 Hydrogen Storage System Modeling: Public Access, Maintenance, and Enhancements
IV.C.7 \( \text{H}_2 \) Storage Characterization and Optimization Research Efforts
IV.D.1 Enhanced Materials and Design Parameters for Reducing the Cost of Hydrogen Storage Tanks
IV.D.6 Achieving Hydrogen Storage Goals through High-Strength Fiber Glass
V.G.4 Multifunctional Catalysis to Synthesize and Utilize Energy Carriers
VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources
VIII.9 Compatibility of Polymeric Materials Used in the Hydrogen Infrastructure
X.4 Demonstration of Fuel Cell Auxiliary Power Units (APUs) to Power Transport Refrigeration Units (TRUs) in Refrigerated Trucks

Pajarito Powder

II.B.6 Economical Production of Hydrogen through Development of Novel, High Efficiency Electrocatalysts for Alkaline Membrane Electrolysis
V.A.2 Development of PGM-free Catalysts for Hydrogen Oxidation Reaction in Alkaline Media
V.A.3 Innovative Non-PGM Catalysts for High-Temperature PEMFCs

Paul Scherrer Institute

V.B.4 FC-PAD: Ionomer, GDLs, Interfaces

PDC Machines

III.14 H2FIRST—Consolidation

The Pennsylvania State University

II.B.3 High Performance Platinum Group Metal Free Membrane Electrode Assemblies through Control of Interfacial Processes
II.E.1 Biomass to Hydrogen

pH Matter, LLC

V.E.1 Regenerative Fuel Cell System

Plug Power

X.2 Ground Support Equipment Demonstration
X.5 FedEx Express Hydrogen Fuel Cell Extended-Range Battery Electric Vehicles

POSCO

III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage
XVI. Project Listings by Organization

Powertech
VII.C.2 Development of the Hydrogen Station Equipment Performance (HyStEP) Device

PPG Industries
IV.D.6 Achieving Hydrogen Storage Goals through High-Strength Fiber Glass

Proton OnSite
II.B.3 High Performance Platinum Group Metal Free Membrane Electrode Assemblies through Control of Interfacial Processes
II.B.6 Economical Production of Hydrogen through Development of Novel, High Efficiency Electrocatalysts for Alkaline Membrane Electrolysis
II.B.7 New Approaches to Improved PEM Electrolyzer Ion Exchange Membranes
VII.B.3 Validation of an Advanced High Pressure PEM Electrolyzer and Composite Hydrogen Storage, with Data Reporting, for SunHydro Stations
VII.B.5 Brentwood Case Study
VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Purdue University
V.A.7 Highly Active, Durable, and Ultra-low PGM NSTF Thin Film ORR Catalysts and Supports

RCF Economic and Financial Consulting, Inc.
IX.1 Employment Impacts of Hydrogen and Fuel Cell Technologies

Redox Power Systems
V.D.4 Affordable, High Performance, Intermediate Temperature Solid Oxide Fuel Cells

Rensselaer Polytechnic University
V.C.6 Advanced Materials for Fully-Integrated MEAs in AEMFCs
V.C.8 Dimensionally Stable High Performance Membranes

SAE International
VIII.3 Hydrogen Fuel Quality

Sandia National Laboratories
II.C.1 High Efficiency Solar Thermochemical Reactor for Hydrogen Production
II.E.1 Biomass to Hydrogen
III.2 Fatigue Performance of High-Strength Pipeline Steels and Their Welds in Hydrogen Gas Service
IV.C.1 HyMARC: A Consortium for ADVancing SOLID-State Hydrogen Storage Materials
IV.C.2 Hydrogen Storage Materials Advanced Research Consortium: Sandia Effort
IV.C.4 HyMARC: A Consortium for ADVancing SOLID-State Hydrogen Storage Materials
IV.C.5 Improving the Kinetics and Thermodynamics of Mg(BH$_4$)$_2$ for Hydrogen Storage
IV.D.8 Innovative Development, Selection and Testing to Reduce Cost and Weight of Materials for BOP Components
V.C.6 Advanced Materials for Fully-Integrated MEAs in AEMFCs
VII.C.2 Development of the Hydrogen Station Equipment Performance (HyStEP) Device
VIII.2 R&D for Safety, Codes and Standards: Materials and Components Compatibility
VIII.4 R&D for Safety, Codes and Standards: Hydrogen Behavior
VIII.5 Hydrogen Quantitative Risk Assessment
VIII.10 Enabling Hydrogen Infrastructure Through Science-Based Codes and Standards
IX.4 Hydrogen Analysis with the Sandia ParaChoice Model
X.3 Maritime Fuel Cell Generator Project
Savannah River Consulting LLC
  II.C.3 Electrolyzer Component Development for the HyS Thermochemical Cycle
  IV.B.3 Investigation of Metal and Chemical Hydrides for Hydrogen Storage in Novel Fuel Cell Systems

Savannah River National Laboratory
  II.C.3 Electrolyzer Component Development for the HyS Thermochemical Cycle
  IV.B.1 Hydrogen Storage Engineering Center of Excellence
  IV.B.2 Hydrogen Storage System Modeling: Public Access, Maintenance, and Enhancements
  IV.B.3 Investigation of Metal and Chemical Hydrides for Hydrogen Storage in Novel Fuel Cell Systems
  IV.C.11 Electrochemical Reversible Formation of Alane
  VI.5 Continuous Fiber Composite Electrofusion Coupler

Smart Chemistry
  VIII.3 Hydrogen Fuel Quality

Southwest Research Institute®
  III.4 Hydrogen Compression Application of the Linear Motor Reciprocating Compressor (LMRC)

Spectrum Automation Controls
  II.B.1 Renewable Electrolysis Integrated System Development and Testing
  III.11 700 bar Hydrogen Dispenser Hose Reliability Improvement
  VII.C.1 Hydrogen Component Validation
  VII.C.5 Hydrogen Meter Benchmark Testing

Spencer Composites Corporation
  IV.D.2 Thermomechanical Cycling of Thin Liner High Fiber Fraction Cryogenic Pressure Vessels Rapidly Refueled by Liquid Hydrogen Pump to 700 bar
  IV.D.4 Next Generation Hydrogen Storage Vessels Enabled by Carbon Fiber Infusion with a Low Viscosity, High Toughness System
  VII.C.4 Performance and Durability Testing of Volumetrically Efficient Cryogenic Vessels and High Pressure Liquid Hydrogen Pump

SRI International
  IV.C.12 Low-Cost α-Alane for Hydrogen Storage

Stanford University
  II.C.1 High Efficiency Solar Thermochemical Reactor for Hydrogen Production
  II.D.2 Wide Bandgap Chalcopyrite Photoelectrodes for Direct Solar Water Splitting

Strategic Analysis, Inc.
  II.A.1 Hydrogen Pathways Analysis for Hydrogen Production via a Monolithic Piston Reforming Reactor and Reformer-Electrolyzer-Purifier Technology
  IV.A.2 Hydrogen Storage Cost Analysis
  V.F.6 Fuel Cell Vehicle and Bus Cost Analysis
  V.F.8 A Total Cost of Ownership Model for Design and Manufacturing Optimization of Fuel Cells in Stationary and Emerging Market Applications
  VI.4 U.S. Clean Energy Hydrogen and Fuel Cell Technologies: A Competitiveness Analysis

Structural Integrity Associates, Inc.
  III.6 Low Cost Hydrogen Storage at 875 bar Using Steel Liner and Steel Wire Wrap
SunHydro LLC
   VII.B.3 Validation of an Advanced High Pressure PEM Electrolyzer and Composite Hydrogen Storage, with Data Reporting, for SunHydro Stations

Sustain X
   III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

Swagelok
   III.12 Cryogenically Flexible, Low Permeability H₂ Delivery Hose

Temple University
   III.3 Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage
   III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage

Tetramer Technologies, LLC
   II.B.7 New Approaches to Improved PEM Electrolyzer Ion Exchange Membranes

Texas A&M University
   IV.C.9 High-Capacity and Low-Cost Hydrogen-Storage Sorbents for Automotive Applications
   V.G.5 Modeling Catalyzed Growth of Single Walled Carbon Nanotubes

Toray Composites America
   IV.D.1 Enhanced Materials and Design Parameters for Reducing the Cost of Hydrogen Storage Tanks

TreadStone Technologies, Inc.
   V.D.2 Novel Structured Metal Bipolar Plates for Low Cost Manufacturing

Tufts University
   V.B.4 FC-PAD: Ionomer, GDLs, Interfaces

Unique Electric Solutions
   VII.A.4 Fuel Cell Hybrid Electric Delivery Van Project

United Parcel Services
   VII.A.4 Fuel Cell Hybrid Electric Delivery Van Project

United Technologies Research Center
   IV.B.1 Hydrogen Storage Engineering Center of Excellence
   V.D.3 Rationally Designed Catalyst Layers for PEMFC Performance Optimization

Université du Québec à Trois-Rivières
   IV.B.1 Hydrogen Storage Engineering Center of Excellence

University at Buffalo-SUNY
   V.D.6 Advanced Catalysts and Membrane Electrode Assemblies (MEAs) for Reversible Alkaline Membrane Fuel Cells

University of California, Berkeley
   V.F.8 A Total Cost of Ownership Model for Design and Manufacturing Optimization of Fuel Cells in Stationary and Emerging Market Applications
University of California, Irvine
II.D.3  Tandem Particle-Slurry Batch Reactors for Solar Water Splitting
II.F.2  Reformer-Electrolyzer-Purifier (REP) for Production of Hydrogen [CO₂ Pump]

University of Chicago
V.G.16  Computer Simulation of Proton Transport in Fuel Cell Membranes
IX.10  The Business Case for Hydrogen-powered Passenger Cars: Competition and Solving the Infrastructure Puzzle

University of Colorado Boulder
II.C.2  Flowing Particle Bed Solarthermal RedOx Process to Split Water
V.A.6  Extended Surface Electrocatalyst Development
V.G.8  Analysis of the Mechanisms of Electrochemical Oxygen Reduction and Development of Ag-alloy and Pt-alloy Electrocatalysis for Low Temperature Fuel Cells

University of Connecticut
V.B.7  The Effect of Airborne Contaminants on Fuel Cell Performance and Durability
V.C.3  Smart Matrix Development for Direct Carbonate Fuel Cell
V.G.6  Room Temperature Electrochemical Upgrading of Methane to Oxygenate Fuels

University of Delaware
V.A.6  Extended Surface Electrocatalyst Development
V.B.4  FC-PAD: Ionomer, GDLs, Interfaces
V.C.5  Highly Stable Anion-Exchange Membranes for High-Voltage Redox-Flow Batteries

University of Georgia
II.E.2  Sweet Hydrogen: High-Yield Production of Hydrogen from Biomass Sugars Catalyzed by in vitro Synthetic Biosystems

University of Hawaii
II.D.1  High-Efficiency Tandem Absorbers for Economical Solar Hydrogen Production
II.D.2  Wide Bandgap Chalcopyrite Photoelectrodes for Direct Solar Water Splitting
IV.C.7  H₂ Storage Characterization and Optimization Research Efforts
V.D.2  Novel Structured Metal Bipolar Plates for Low Cost Manufacturing

University of Houston
V.G.11  Dual Site Requirements for Hydrogenoxygenation of Model Biomass Compounds

University of Maryland
V.D.4  Affordable, High Performance, Intermediate Temperature Solid Oxide Fuel Cells

University of Massachusetts Amherst
V.G.9  Computational Design of Graphene-Nanoparticle Catalysts

University of Michigan
IV.B.1  Hydrogen Storage Engineering Center of Excellence
IV.C.5  Improving the Kinetics and Thermodynamics of Mg(BH₄)₂ for Hydrogen Storage
IV.C.10  Hydrogen Adsorbents with High Volumetric Density: New Materials and System Projections
University of Michigan (Continued)

V.G.8 Analysis of the Mechanisms of Electrochemical Oxygen Reduction and Development of Ag-alloy and Pt-alloy Electrocatalysis for Low Temperature Fuel Cells

University of Missouri

IV.C.6 High-capacity Hydrogen Storage Systems via Mechanochemistry

University of Nevada

II.D.1 High-Efficiency Tandem Absorbers for Economical Solar Hydrogen Production
II.D.2 Wide Bandgap Chalcopyrite Photoelectrodes for Direct Solar Water Splitting

University of New Mexico

II.B.3 High Performance Platinum Group Metal Free Membrane Electrode Assemblies through Control of Interfacial Processes
V.A.2 Development of PGM-free Catalysts for Hydrogen Oxidation Reaction in Alkaline Media
V.A.3 Innovative Non-PGM Catalysts for High-Temperature PEMFCs
V.A.9 Corrosion-Resistant Non-Carbon Electrocatalyst Supports for PEFCs
V.G.13 Sub Nanometer Sized Clusters for Heterogeneous Catalysis

University of Rochester

V.A.1 Non-Precious Metal Fuel Cell Cathodes: Catalyst Development and Electrode Structure Design

University of Tennessee

IX.6 Policies to Promote Alternative Fuel Vehicles

University of Texas at Austin

IV.D.3 Conformable Hydrogen Storage Pressure Vessel Project
V.D.3 Rationally Designed Catalyst Layers for PEMFC Performance Optimization
VII.A.4 Fuel Cell Hybrid Electric Delivery Van Project

University of Utah

V.G.15 Thermodynamic, Kinetic and Electrochemical Studies on Mixed Proton, Oxygen Ion and Electron (Hole) Conductors

University of Waterloo

V.A.1 Non-Precious Metal Fuel Cell Cathodes: Catalyst Development and Electrode Structure Design

University of Wisconsin-Madison

V.G.10 Atomic-Scale Design of Metal and Alloy Catalysts: A Combined Theoretical and Experimental Approach

Valence Technology

VII.A.4 Fuel Cell Hybrid Electric Delivery Van Project

Vanderbilt University

V.C.1 New Fuel Cell Membranes with Improved Durability and Performance

Versa Power Systems, Ltd.

II.B.5 Solid Oxide Based Electrolysis and Stack Technology with Ultra-High Electrolysis Current Density (>3 A/cm²) and Efficiency
Virginia Clean Cities at James Madison University

VI.3 Fuel Cell and Hydrogen Opportunity Center, www.hfcnexus.com

Virginia Polytechnic Institute and State University

II.B.4 High Temperature, High Pressure Electrolysis
II.E.2 Sweet Hydrogen: High-Yield Production of Hydrogen from Biomass Sugars Catalyzed by in vitro Synthetic Biosystems
IV.D.7 Melt Processable PAN Precursor for High Strength, Low-Cost Carbon Fibers (Phase II)
V.G.8 Analysis of the Mechanisms of Electrochemical Oxygen Reduction and Development of Ag-alloy and Pt-alloy Electrocatalysis for Low Temperature Fuel Cells

VTT

VIII.3 Hydrogen Fuel Quality

Washington State University

II.F.1 Monolithic Piston-Type Reactor for Hydrogen Production through Rapid Swing of Reforming/Combustion Reactions
III.9 Improved Hydrogen Liquefaction through Heisenberg Vortex Separation of Para- and Orthohydrogen
V.G.13 Sub Nanometer Sized Clusters for Heterogeneous Catalysis

Washington University

II.B.6 Economical Production of Hydrogen through Development of Novel, High Efficiency Electrocatalysts for Alkaline Membrane Electrolysis

Wayne State University

V.G.7 Nanostructured, Targeted Layered Metal Oxides as Active and Selective Heterogeneous Electrocatalysts for Oxygen Evolution

Werken

VII.B.5 Brentwood Case Study

Wiretough Cylinders

III.5 Steel Concrete Composite Vessel for 875 bar Stationary Hydrogen Storage
III.6 Low Cost Hydrogen Storage at 875 bar Using Steel Liner and Steel Wire Wrap

Witte Engineered Gases

VIII.6 Hydrogen Safety Panel, Safety Knowledge Tools and First Responder Training Resources

Workhorse Technologies Inc.

X.5 FedEx Express Hydrogen Fuel Cell Extended-Range Battery Electric Vehicles

Worthington Cylinder Corporation

VII.C.3 Advanced Hydrogen Fueling Station Supply: Tube Trailers

WPCSOL

V.B.7 The Effect of Airborne Contaminants on Fuel Cell Performance and Durability