



INTERNATIONAL PARTNERSHIP FOR HYDROGEN AND FUEL CELLS IN THE ECONOMY

IPHE Country Update April, 2017: United States

Name	Sunita Satyapal/Mike Mills
Contact Information	sunita.satyapal@ee.doe.gov , 202 586-2336 michael.mills@ee.doe.gov
Covered Period	April 2017 to Nov 2017

1. New Policy Initiatives on Hydrogen and Fuel Cell

Policy Decisions since last meeting:

- White House budget proposal language for FY2018:
 - Increased reliance on the private sector to fund later-stage research, development, and commercialization
 - Focuses resources toward early-stage research and development
- FY18 FCTO Budget to be determined (\$45M - \$101M)
- Federal government currently operating under a continuing resolution until Dec 8
- Organizational changes:
 - On August 7, 2017, Mr. Dan Brouillette was sworn in as the Deputy Secretary of the U.S. Department of Energy. Most recently he was the Senior Vice President and head of public policy for USAA. Before joining USAA, Mr. Brouillette was a Vice President of Ford Motor Company, where he led the automaker's domestic policy teams and served on its North American Operating Committee.

New Publications since last meeting:

- DOE publishes approximately 100 publications, including newsletters, success stories, news alerts, and blogs every year.
- The [**State of the States: Fuel Cells in America 2017**](#), released in November 2017, highlights California, Connecticut, and New York as the top three states and Massachusetts, Colorado, Hawaii, New Jersey, and Ohio as rising stars in the hydrogen and fuel cell industry.
- The [**Pathways to Commercial Success Report**](#), released in October 2017, highlights R&D efforts funded by FCTO have resulted in more than 650 patents, more than 30 technologies in the market, and 75 technologies that are projected to enter the market within three to five years.
- The [**2016 Fuel Cell Technologies Market Report**](#) position stationary power, backup power, and material handling equipment as some of the largest markets and transportation and energy storage as emerging sectors for hydrogen and fuel cells with approximately 62,000 fuel cells and 500 MW in fuel cell power shipped



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worldwide in 2016, representing more than double the capacity of shipments in megawatts compared to 2014.

- The [2016 Business Case for Fuel Cells](#), released in June 2017, illustrates how top American companies are using fuel cells in their business operations to advance their sustainability goals, save millions of dollars in electricity costs, and reduce emissions by hundreds of thousands of metric tons per year.
- [2017 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development](#) released in August 2017 by California's Air Resources Board highlights California's recent accomplishments, provides status updates and gives recommendations to the Energy Commission.
- [National Hydrogen Scenarios](#) was released in October 2017 by the H2USA Locations Roadmap Working Group. It provides context and offers insight to stakeholders involved in the development of national hydrogen refueling networks by examining the quantity, location, and deployment schedule of stations to satisfy consumer demand for FCEVs.

2. Hydrogen and Fuel Cell R&D Update

- Buses have achieved a 25,000 hr durability for the fuel cell power plant, exceeding the 2016 and ultimate targets.
- Fuel cell buses have surpassed 17 million passengers
- Fuel cell forklifts have gone through approximately 16 million hydrogen refuelling
- More than 235 MW installed capacity for fuel cell stationary power systems and 8,000 backup power systems deployed or on order
- Cut the cost of electrolyzers by 80% since 2002
- Cut the cost of automotive fuel cells (at high volume) by 80% since 2002 to \$45/KW today
- Quadrupled the lifetime of a fuel cell since 2006 to over 120,000 miles or 4,100 hours
- Two catalysts were developed in FY17 which surpassed our 2020 technical target for specific power output (8.0 kW/gPGM at the $Q/\Delta T$ stipulated of 1.45 kW/°C).
- Through the use of innovative coatings, permeation for hydrogen compressor seals was reduced by nearly 60%.

3. Demonstration and Deployments Update

- Progress continues towards 100 stations in California. By November 2017, 31 retail stations and 3 non-retail stations had opened in California and an additional 13 are in process. California has awarded funding for a total of 65 stations to date. Also, 15 retail stations are currently planned for the Northeast U.S. Over 1,600 miles of hydrogen pipeline are in place.



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- Demand for FCEVs continues to increase rapidly. Through September 2017, more than 2,800 FCEVs had been purchased or leased. (In August, 2017, there were 1,600 fuel cell vehicles registered in California.)
- [Hydrogen Safety Training Resource](#): FCTO and Federal Energy Management Program (FEMP) are developing a hydrogen training resource focused on FCEV technology and how it can be utilized for federal fleets. Fueling infrastructure options and safety considerations are also included in the training.

4. Events and Solicitations

- **National Hydrogen and Fuel Cell Day:** During the week of October 8, 2017, thousands of scientists and engineers across the country celebrated National Hydrogen and Fuel Cell Day with a week full of activities and announcements across the country. Activities at the Energy Department included a range of media activities such as a press release and video of Secretary Perry driving a fuel cell car (seen by nearly 70,000 people), the launch of an “Increase your H2IQ” training resource for the general public with nearly 100 downloads in the first week of launch, and fuel cell car and technology displays at the Smithsonian’s National Air and Space museum in Washington D.C. and at the Solar Decathlon in Denver, Colorado, with a combined attendance of nearly 500 people. The week continued with multiple ride-and-drives and numerous media announcements on inter-agency and international collaboration.
- [2017 Fuel Cell Seminar & Energy Exposition](#): The annual conference brings together stakeholders from start-up, universities, government, and industry to showcase progress, share research, and build partnerships. November 2017
- **H2@Scale Workshop:** Held in California before the Fuel Cell Seminar, this event will identify regional and near-term opportunities to leverage stranded resources for hydrogen production and efficient use in industrial applications. November 2017
- **2018 Hydrogen and Fuel Cell Technology Showcase:** This event will showcase the latest new and emerging hydrogen and fuel cell technologies for transportation, stationary power generation, and energy storage applications. Will be held in Washington, D.C. on June 11 – 12.
- **U.S. DOE Hydrogen and Fuel Cells Program 2018 Annual Merit Review, Peer Evaluation Meeting:** Hydrogen and fuel cell projects funded by DOE will be presented and reviewed for their merit. Will be held in Washington, D.C. on June 13 – 15.
- **Hydrogen and Fuel Cell Technical Advisory Committee (HTAC):** The next biannual meeting will take place in May in Washington, D.C. Finalized dates TBD.



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- **2018 International Infrastructure Workshop:** This event is being organized in collaboration with Germany and Japan to identify and align early-stage R&D efforts in hydrogen fueling infrastructure across industry and governments. Will be held in Boston, MA in March.
- **RFI on Reducing Regulatory Barriers to Hydrogen Infrastructure** (planned): RFI will cover transportation topics and interagency cooperation needs as well as the barriers relating to H2@Scale.

5. Investments: Government and Collaborative Hydrogen and Fuel Cell Funding

- [H2@Scale Laboratory CRADA Call](#) - The National Renewable Energy Laboratory issued a request for proposals for qualified partners to participate in cooperative research and development agreement (CRADA) projects with the Hydrogen at Scale (H2@Scale) national laboratories consortium. Through this CRADA call, FCTO seeks to double the impact of its applied research funding to accelerate technology advancement in support of the H2@Scale objectives and to increase industrial and stakeholder engagement in H2@Scale. Up to \$6 million in FCTO funding is available for collaborative projects to address key challenges associated with wide-scale production and use of hydrogen to address critical issues such as enabling grid resiliency, energy security, domestic job creation, and leadership in innovation. As of November, 22 selections have been made.
- [FY 2017 Fuel Cell Technologies Office Annual Funding Opportunity Announcement Selections](#) - Over 30 awards (\$15.8M in funding) have been announced. The FOA topics include:
 - Topic 1: PGM-free Catalyst and Electrode R&D –leverages the Electrocatalysis Consortium (ElectroCat) to accelerate the development of catalysts made without platinum group metals (PGM-free) for use in fuel cells for transportation.
 - Topic 2: Advanced Water Splitting Materials –leverages the HydroGEN Consortium to accelerate the development of advanced water splitting materials for hydrogen production, with an initial focus on advanced electrolytic, photoelectrochemical, and solar thermochemical pathways.
 - Topic 3: Hydrogen Storage Materials Discovery – leverages the Hydrogen Materials—Advanced Research Consortium (HyMARC) to address unsolved scientific challenges in the development of viable solid-state materials for hydrogen storage onboard fuel cell electric vehicles (FCEVs).
 - Topic 4: Precursor Development for Low-Cost, High-Strength Carbon Fiber for Use in Composite Overwrapped Pressure Vessel Applications – aims to reduce the cost of onboard hydrogen storage necessary for FCEVs. Applicants for this topic



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will be encouraged to collaborate with LightMAT, a consortium launched by the DOE Vehicle Technologies Office to enable light-weighting of vehicles through the development of high-strength steels and carbon fiber.

6. Regulations, Codes & Standards Update

- NFPA 2: Hydrogen Technologies Code is currently undergoing revisions
- Phase II of the Global Technical Regulation under the UN ECE WP 29 has kicked off



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Summary Country Update November 2017: U.S.

Transportation	Target Number	Current Status	Partnerships, Strategic Approach	Policy Support
Fuel Cell Vehicles ¹	No target	As of 9/2017, 2,748 (purchased or leased)	<ul style="list-style-type: none"> Partnering with California Air Resources Board (CARB) and California Energy Commission (CEC) 	<ul style="list-style-type: none"> ZEV state mandate (e.g. CA); state subsidies (rebates in CA, MA, CT etc.) The target is 4.5% of sales in 2018 and increases to 22% in 2025 \$5,000 rebate for FCEVs for qualified income applicants: https://cleanvehiclerebate.org/eng
FC Bus	No target	~26 (in service) 20 funded for CA in 2018	Federal Transit Authority (Department of Transportation); CARB; CEC, State of CA	
Fuel Cell Trucks	No target	Prototype testing	TBD	<ul style="list-style-type: none"> ZEV state mandate (e.g. CA)
Forklifts	No target	As of 5/2017, >16,000 (including on order, preliminary analysis)	Early market applications strategy	
H ₂ Refueling Stations	Target Number	Current Status	Partnerships, Strategic Approach	Policy Support
70 MPa On-Site Production	No Target	~ 80 stations as of 11/17 (open,	State partnerships	

¹ Includes Fuel Cell Electric Vehicles with Range Extenders



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70 MPa Delivered	No Target	constructed, or planned) 31 open public retail in CA		<ul style="list-style-type: none"> California - \$100M to 2023 or until 100 stations are built (includes O&M grants) ZEV mandate
35 MPa On-Site Production	No Target	2 as of 5/2016 (bus only stations). 70 MPa stations include 35 MPa	2 stations for bus refuelling (California)	
35 MPa Delivered				
Stationary	Target Number ²	Current Status	Partnerships, Strategic Approach	Policy Support
Small ³	No Target	Negligible	-N/A	
Medium ⁴	No Target	As of 5/2016, system capacity installed ~555 kW		
Large ⁵	No Target	Overall more than 235 MW of large stationary		

² Targets can be units installed and/or total installed capacity in the size range indicated

³ <5 kW (e.g., Residential Use)

⁴ 5kW – <100 kW (e.g., Distributed Residential Use) By March, 26 retail stations and 5 non-retail stations had opened in California and an additional 15 are in process. 12-25 retail stations are planned for the Northeast U.S

⁵ 0.1MW – <10 MW (e.g., Industrial Use)



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		(100 kW to multi-megawatt) fuel cells currently operating in the U.S. ⁶		
District Grid ⁷	No Target	As of 5/2016, system capacity installed ~25 MW		
Regional Grid ⁸	No Target	As of 10/23/2015, system capacity installed 30 MW		
Telecom backup	No target	As of 5/2017 >8,000 (including on order)		
H ₂ Production	Target ⁹	Current Status	Partnerships, Strategic Approach	Policy Support
Fossil Fuels ¹⁰	\$4/kg (produced, delivered, dispensed)	~\$5/kg to \$7.5 (at high volume from distributed natural gas)	Limited govt partnerships (commercial/industry focused)	• Limited

⁶ https://energy.gov/sites/prod/files/2016/11/f34/fcto_state_of_states_2016_0.pdf

⁷ 10MW – <30 MW (e.g., Grid Stability, Ancillary Services)

⁸ 30MW plus (e.g., Grid Storage and Systems Management)

⁹ Target can be by quantity (Nm³, kg, t) and by percentage of total production; also, reference to efficiency capabilities can be a target

¹⁰ Hydrogen produced by reforming processes



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		\$13-\$16/kg (low volume)		
Water Electrolysis ¹¹ (PEM, Alkaline, SOEC)	44 kWh/kg	~50 to 55 kWh/kg	Continued govt funding/cost share	<ul style="list-style-type: none"> Limited (e.g. state dependent; e.g. 33% renewables in CA)
By-product H ₂	N/A			
Energy Storage from Renewables	Target¹²	Current Status	Partnership, Strategic Approach	Policy Support
Power to Power ¹³ Capacity	N/A		In process	
Power to Gas ¹⁴ Capacity	N/A	60-kW demonstration at UC Irvine began in 2016	In process	<ul style="list-style-type: none"> California Low Carbon Fuel Standard creates credits for use of low-carbon fuels. Blends of H₂ and

¹¹ Please indicate if targets relate to a specific technology (PEM, Alkaline, SOEC)

¹² Can be expressed in MW of Installed Capacity to use the electricity from renewable energy generation, and Annual MWh of stored energy capacity

¹³ Operator has an obligation to return the electricity stored through the use of hydrogen back to electricity

¹⁴ Operator has the opportunity to provide the stored energy in the form of hydrogen back to the energy system through multiple channels (e.g., merchant product, enriched natural gas, synthetic methane for transportation, heating, electricity)



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				natural gas could receive credits under this regulation.
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