INTERNATIONAL PARTNERSHIP FOR
HYDROGEN AND FUEL CELLS IN THE ECONOMY

IPHE Country Update November 2016: United States

The IPHE Secretariat requests each IPHE member submit a one-page narrative update on hydrogen and fuel cell (HFC) activities. Please only report actions and developments since the last Country Update and leave Sections blank if there have been no new developments.

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Covered Period	2016

1. New Policy Initiatives on Hydrogen and Fuel Cell

Policy Decisions since last meeting:

The President's FY17 Budget Request for the Fuel Cell Technologies Office is $105.5M. The new Technology Acceleration Key Activity shown in the chart is comprised of Manufacturing R&D, Technology Validation, and Market Transformation. The FCTO is currently operating on the FY16 funding level until December 2016, at which time Congress is expected to approve an FY17 budget for the Department of Energy.

Key Activity	FY 15 ($ in thousands) Approp.	FY 16 ($ in thousands) Approp.	FY17 ($ in thousands) Request
Fuel Cell R&D	33,000	35,000	35,000
Hydrogen Fuel R&D[1]	35,200	41,050	44,500
Manufacturing R&D	3,000	3,000	3,000
Systems Analysis	3,000	3,000	3,000
Technology Validation	11,000	7,000	7,000
Safety, Codes and Standards	7,000	7,000	10,000
Market Transformation	3,000	3,000	3,000
Technology Acceleration	0	0	13,000
NREL Site-wide Facilities Support	1,800	1,900	N/A
Total	97,000	100,950	105,500

The President's Budget request includes:

- Increasing investments for clean energy research and development to $5.9 billion in discretionary funds supporting **Mission Innovation** - the landmark commitment to accelerate public and private global clean energy innovation announced at the start of the Paris climate negotiations. The U.S. is seeking to double clean energy R&D funding in five years and the Department's investment is about 76 percent of the $7.7 billion government-wide FY 2017 contribution toward this pledge.

- Investing nearly $1.5 billion in mandatory funding in FY 2017 for clean energy technology development and deployment and $1.3 billion for advanced clean transportation ($11.3 billion over ten years).

- Organizational changes:
  - David Friedman, former member of the Hydrogen Technical Advisory Committee, joined EERE as Principal Deputy Assistant Secretary in July 2015 and is now serving as Acting Assistant Secretary for EERE (David Danielson left EERE in May 2016).

New Publications since last meeting:

- DOE released the 2016 Revolution Now Report which highlights the dramatic growth and decreasing costs of five clean energy technologies: wind turbines, photovoltaic (PV) solar modules for both utility-scale plants and distributed systems, electric vehicles (EVs), and light-emitting diodes (LEDs). For full report, download using this link: http://energy.gov/sites/prod/files/2016/09/f33/Revolutiona%CC%82%E2%82%ACNow%202016%20Report_2.pdf
- California's Air Resources Board released the report: "2016 Annual Evaluation of Hydrogen Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development". It offers a summary of the activities and lessons from the past year of station installations. For the full report, download using this link:https://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_2016.pdf
- DOE released the 2015 Fuel Cell Technologies Market report in October, 2016. The report documents the global growth of the fuel cell market, with more than 60,000 fuel cells, totaling over 300 MW, shipped worldwide in 2015. The number of megawatts (MW) shipped grew substantially – by more than 65% – over 2014. The increase in total megawatts shipped in 2015 could be attributed to several factors, including growth in both the stationary and transportation sectors. For the full

report, download using this link:
http://energy.gov/sites/prod/files/2016/10/f33/fcto_2015_market_report.pdf

- The California Hydrogen Business Council released the report on its "Financing the 101st" workshop held on June 14-15. The report provides insights on financeable business models for building hydrogen fueling stations beyond the 100 covered by the $100M investment from CA. For the executive summary of the report, use this link: https://californiahydrogen.org/content/chbc-releases-report-private-financing-hydrogen-fueling-stations

2. Hydrogen and Fuel Cell R&D Update

- The DOE ultimate durability target for fuel cell systems was increased to 8,000 hours to allow for 150,000 miles of driving on a lower average speed drive-cycle.
- Fuel cell cost has been cut in half since 2007, still projected at $53/kW (modeled cost based on lab technology projected for high volume manufacturing of 500,000 units/year and $59/kW at 100,000 units/year)
- 2016 fuel cell system durability status: 4100 hours (automotive); 23,000 (bus maximum lifetime exceeding DOE 2016 interim target of 18000 hours
- Storage modeled cost is $15/kWh (at high volume)
- Lab Big Idea Summit – H2 @ Scale initiative approved
    - Enables green processes and increased renewable penetration that can decrease all U.S. carbon by ~half by 2050

3. Demonstration and Deployments Update

- Progress continues towards 100 stations in California and 12-25 retail stations are planned for the Northeast U.S. In California there are 28 hydrogen stations that are open (22 retail and 6 non retail) as of Oct, 2016.

- As July 2016, there are 331 fuel cell electric vehicles registered in CA – twice the number of cars registered last year at around the same time. (https://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_2016.pdf)

- Approximately 18,000 additional fuel cell forklifts and backup power units (combined) deployed or on order by industry (without DOE funding).

    - For BUP deployments see Program Record 16013 at https://www.hydrogen.energy.gov/pdfs/16013_industry_deployed_fc_bup.pdf

    - For fuel cell forklift deployments, see Program Record 16012 at https://www.hydrogen.energy.gov/pdfs/16012_industry_deployed_fc_powered_lift_trucks.pdf

- In July, DOE, in partnership with the Department of Interior's National Park Service launched a new technology demonstration hydrogen refuelling station in Washington D.C. Though not a public station, this station will showcase cutting-edge hydrogen generation technology and provide opportunities to demonstrate FCEVs at federal agencies and throughout the surrounding region. This happened in conjunction with the incorporation of the world's first commercially available fuel cell electric vehicles into the U.S. Department of Energy (DOE) and U.S Department of Interior (DOI) fleets through a no-cost loan and test program for technology demonstration and education & outreach purposes.

4. Events and Solicitations

Provide information on upcoming hydrogen-related events that will include international participants. Also, please provide any information regarding solicitations[1] that can lead to collaboration among IPHE members.

- **National Hydrogen and Fuel Cell Day Celebration:** DOE celebrated Hydrogen and Fuel Cell Day (10/8) with a several education and outreach activities during the weeks leading up to and after 10/8. Activities included celebratory events at the National Press Club Building in Washington DC with the participation of Assistant Secretary David Friedman, Deputy Assistant Secretary Reuben Sarkar, Former Senator Byron Dorgan and representatives from FCEV automakers and H2 suppliers. Other activities included tweets from DOE and Secretary Moniz's twitter, Facebook Live with Fuel Cell Technologies Office Director Sunita Satyapal and the release of several blogs on the DOE website. In addition to DOE activities, industry and national lab stakeholders participated in the celebration with different activities of their own. For a full list of the activities from non-DOE stakeholders, visit www.hydrogenandfuelcellday.org.

- **U.S. Department of Energy Hydrogen and Fuel Cells Program 2016 Annual Merit Review and Peer Evaluation Meeting:** Hydrogen and fuel cell projects funded by DOE were presented and reviewed for their merit fro June 6-10, 2016. http://www.annualmeritreview.energy.gov/
    - Former Senator Dorgan offered keynote address

[1] Can include *Requests for Information* and *Calls for Proposals* and other requests that may or may not involve funding support but looks to address issues that may be of interest to IPHE members

- **Hydrogen and Fuel Cell Technical Advisory Committee (HTAC):** Upcoming biannual meeting will take place December 6-7, 2016 in Washington, D.C. https://www.hydrogen.energy.gov/htac_meeting_dec16.html
    - HTAC biennial report will soon be published: *Response to Findings and Recommendations of the Hydrogen and Fuel Cell Technical Advisory Committee: Fifth Biennial Report to Congress*
- **Sustainable Transportation Summit:** was held on July 11-12, 2016, at the Washington, D.C. Convention Center and will bring together shareholders from Fuel Cell, Vehicle, and Bioenergy Offices

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

- In December 2015, DOE announced up to $35 million to support hydrogen production, delivery, and storage research and development; demonstration and deployment of infrastructure components; consortia topics for fuel cell performance and durability and advanced hydrogen storage materials research; and cost and performance analysis for hydrogen production, storage, and fuel cells. Below is the detailed breakdown of topics that will be covered:
    - **Research and Development (R&D)**
        - Hydrogen Production R&D: Advanced High-Temperature Water Splitting
        - Advanced Compression
        - Advanced Vacuum Insulation for Automotive Applications
    - **Demonstration and Deployments**
        - Component Manufacturing and Standardization for Hydrogen Infrastructure (e.g., hose/piping, dispenser/station technologies)
        - Crosscutting: America's Climate Communities of Excellence
    - **Consortia Topics**
        - Fuel Cell – Performance and Durability (FC-PAD)
        - Hydrogen Storage Materials – Advanced Research Consortium (HyMARC)
    - **Analysis**
        - Cost and Performance Analysis for Fuel Cells; Hydrogen Storage; Hydrogen Production and Delivery

    This solicitation has closed and review of proposals is ongoing.

- In February 2016, the Energy Materials Network (EMN), a National Laboratory-led initiative leveraging $40M in federal funding that will assist American entrepreneurs and manufacturers pursue clean energy, was launched at an event at the White House. Each EMN consortium will bring together National Labs, industry, and academia to focus on specific classes of materials aligned with industry's most pressing challenges related to materials for clean energy technologies. For example:

  - Electrolysis Consortium (ElectroCat) - dedicated to finding new ways to replace the rare and costly platinum group metals currently used in hydrogen fuel cells
  - Advanced Water Splitting Materials - accelerate the research, development, and deployment of advanced water splitting technologies for renewable hydrogen production

- In March, the Small Business Vouchers Pilot program awarded vouchers to 7 fuel cell companies. The project duration is 12 months and value of the award is between $100,000 and $200,000.

- In Oct 2016, the DOE announced a notice of intent (NOI) to invest $30 million, subject to appropriations, to advance fuel cell and hydrogen technologies. These projects will leverage national lab consortia launched under DOE's Energy Materials Network (EMN) this past year, and will support the President's Materials Genome Initiative and advanced manufacturing priorities. National lab consortia that will be leveraged include:
  - Electrocatalysis Consortium (ElectroCat)–this consortium will accelerate the development of catalysts made without platinum group metals (PGM-free) for use in transportation fuel cell applications.
  - HydroGEN Consortium (HydroGEN)–this consortium will accelerate the development of advanced water splitting materials for hydrogen production, with an initial focus on advanced electrolytic, photoelectrochemical, and solar thermochemical pathways..
  - Hydrogen Materials—Advanced Research Consortium (HyMARC)–this consortium aims to address unsolved scientific challenges in the development of viable solid-state materials for storage of hydrogen onboard vehicles.

  Text of NOI: https://eere-exchange.energy.gov/#FoaIdf7d62876-8a95-481d-9a2c-4ea1d5f4f1f2

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Summary Country Update November 2016: U.S.

Transportation	Target Number	Current Status	Partnerships, Strategic Approach	Policy Support
Fuel Cell Vehicles[2]	No target	As of 7/2016, 331 (purchased or leased)	• 2015 vehicle roll-out in California • Partnering with California Air Resources Board (CARB) and California Energy Commission (CEC)	• ZEV state mandate (e.g. CA); state subsidies (rebates in CA, MA, CT etc.) http://www.zevfacts.com/zev-mandate.html
FC Bus	No target	~33 (in service)	Federal Transit Authority (Department of Transportation); CARB; CEC	• ZEV state mandate (e.g. CA)
Fuel Cell Trucks	No target	In development	TBD	• ZEV state mandate (e.g. CA)
Forklifts	No target	As of 10/2016, >18,000 (including on order, preliminary analysis)	Early market applications strategy	• Investment Tax Credit (lower of 30% or $3,000/kW, December 31, 2016 expiration) http://energy.gov/savings/business-energy-investment-tax-credit-itc
H_2 Refueling Stations	**Target Number**	**Current Status**	**Partnerships, Strategic Approach**	**Policy Support**
70 MPa On-Site Production	No Target	~ 65 stations as of 5/16 (open,	State partnerships	

[2] Includes Fuel Cell Electric Vehicles with Range Extenders

70 MPa Delivered	No Target	constructed, or planned) 22 public retail		• California - $100M to 2023 or until 100 stations are built (includes O&M grants) • ZEV mandate
35 MPa On-Site Production 35 MPa Delivered	No Target	2 as of 5/2016 (bus only stations). 70 MPa stations include 35 MPa	2 stations for bus refuelling (California)	
Stationary	**Target Number[3]**	**Current Status**	**Partnerships, Strategic Approach**	**Policy Support**
Small[4]	No Target	Negligible	-N/A	• Investment Tax Credit (lower of 30% or $3,000/kW, 2016 expiration)
Medium[5]	No Target	As of 5/2016, system capacity installed ~555 kW	-Commercial (limited govt involvement beyond tax credit)	• Investment Tax Credit (lower of 30% or $3,000/kW, 2016 expiration)

[3] Targets can be units installed and/or total installed capacity in the size range indicated
[4] <5 kW (e.g., Residential Use)
[5] 5kW – <100 kW (e.g., Distributed Residential Use)

Large[6]	No Target	As of 5/2016, system capacity installed ~170 MW	--Commercial (limited govt involvement beyond tax credit)	• Investment Tax Credit (lower of 30% or $3,000/kW, 2016 expiration)
District Grid[7]	No Target	As of 5/2016, system capacity installed ~25 MW	--Commercial (limited govt involvement beyond tax credit)	• Investment Tax Credit (lower of 30% or $3,000/kW, 2016 expiration)
Regional Grid[8]	No Target	As of 10/23/2015, system capacity installed 30 MW	-Limited govt involvement beyond tax credit)	• Investment Tax Credit (lower of 30% or $3,000/kW, 2016 expiration)
Telecom backup	No target	~7,800 (including on order, preliminary analysis)	-Commercial (limited govt involvement beyond tax credit)	• Investment Tax Credit (lower of 30% or $3,000/kW, 2016 expiration)
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] 0.1MW –<10 MW (e.g., Industrial Use)
[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 (Nm^3, kg, t) and by percentage of total production; also, reference to efficiency capabilities can be a target
[10] Hydrogen produced by reforming processes

		$13-$16/kg (low volume)		
Water Electrolysis[11] (PEM, Alkaline, SOEC)	44 kWh/kg	~50 to 55 kWh/kg	Continued govt funding/cost share	• Limited (e.g. state dependent; e.g. 33% renewables in CA)
By-product H_2	N/A			
Energy Storage from Renewables	**Target[12]**	**Current Status**	**Partnership, Strategic Approach**	**Policy Support**
Power to Power[13] Capacity	N/A		In process	
Power to Gas[14] Capacity	N/A		In process	

[11] Please indicate if targets relate to a specific technology (PEM, Alkiline, 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 el ectricity
[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, el ectricity)

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