



INTERNATIONAL PARTNERSHIP FOR HYDROGEN AND FUEL CELLS IN THE ECONOMY

IPHE Country Update May 2016: U.S.

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Covered Period	2015

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.

Key Activity	FY 15	FY 16	FY 17
	(\$ in thousands)		
	Approp.	Approp.	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.



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- 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 Danielson, Assistant Secretary of Energy Efficiency and Renewable Energy (EERE) since 2012, will be leaving the DOE on May 31
 - David Friedman, former member of the Hydrogen Technical Advisory Committee, joined EERE as Principal Deputy Assistant Secretary in July 2015. He will be acting Assistant Secretary for EERE beginning June 1.
- ***New Publications since last meeting:***
 - **The California Energy Commission and the California Air Resources Board** released the Joint Agency Staff Report on Assembly Bill 8: Assessment of Time and Cost Needed to Attain 100 Hydrogen Refuelling Stations in California, in December 2015. The report concludes that California will attain the 100-hydrogen-refueling-station milestone goal between 2020 and 2024 (consistent with the timeline for AB 8, which expires in 2023).
<http://www.energy.ca.gov/2015publications/CEC-600-2015-016/CEC-600-2015-016.pdf>
 - **H2FIRST Reference Station Design Task Report** published April 2015, presents near-term station cost results and discusses cost trends of different station types. This work presents the hydrogen community with a uniform, cost-optimal formula for designing and building hydrogen stations. Phase 2 of the project is ongoing. <http://energy.gov/eere/fuelcells/downloads/h2first-reference-station-design-task-project-deliverable-2-2>
 - **The California Sustainable Freight Action Plan** examines the transition of California's freight transport system to support the State's economic competitiveness in coming decades while reducing harmful pollution affecting many California communities.
http://dot.ca.gov/hq/tpp/offices/ogm/cs_freight_action_plan/main.html

2. Hydrogen and Fuel Cell R&D Update

- Automotive fuel cell cost updated to \$53/kW (at high volume)
- Storage modelled cost updated to \$15/kWh (at high volume)
- Lab Big Idea Summit – H2 @ Scale initiative proposed
 - 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 privately funded stations in the Northeast U.S. ~ 65 stations as of 5/5/2016 (open, constructed, or planned), ~17 public retail stations.
- Over 19,000 fuel cell forklifts and backup power units (combined) deployed or on order (preliminary analysis)



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- Medium Duty Parcel Delivery project with FedEx and UPS launched in May 2016

4. Events and Solicitations

- **International Hydrogen Infrastructure Workshops:** DOE, NOW and NEDO organized the 3rd H₂ Infrastructure Workshop to enable international information exchange on hydrogen infrastructure challenges in four key areas—metering, fuel quality, fuel protocol validation, and station hardware reliability & performance. Collaboration continues - FCHJU has offered to host the 4th in June 2016 in the Netherlands.
- **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 are presented and reviewed for their merit.
<http://www.annualmeritreview.energy.gov/>
 - June 6-10, 2016 in Washington, D.C.
 - Former Senator Dorgan is confirmed keynote speaker
- **SAE 2016 Range extenders for Electric Vehicle Symposium:** Event will focus on powertrain and fuel opportunities and challenges, policy and regulation driving designs, infrastructure and the advances in range extender technology and will include a session on fuel cell electric vehicles. <http://www.sae.org/events/rex/>
 - November 2-3, 2016 in Knoxville, Tennessee
- **Hydrogen and Fuel Cell Technical Advisory Committee (HTAC):** Upcoming biannual meeting will take place September 20-21, 2016 in Washington, D.C.
https://www.hydrogen.energy.gov/htac_meeting_sep16.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*
- **Hydrogen Technology Showcase & Training (HyTEST) Request for Information:** RFI seeking feedback regarding construction and benefits of a HyTEST facility will be announced soon.
- **Advanced Water Splitting Materials Workshop:** held on April 14-15, 2016, in Stanford, California. <http://energy.gov/eere/fuelcells/downloads/advanced-water-splitting-materials-workshop>
- **Sustainable Transportation Summit:** will be 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



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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.



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Summary Country Update May 2016: U.S.

Transportation	Target Number	Current Status	Partnerships, Strategic Approach	Policy Support
Fuel Cell Vehicles ¹	No target	As of 4/2016, >300 (purchased or leased)	<ul style="list-style-type: none"> • 2015 vehicle roll-out in California • 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.) http://www.zevfacts.com/zev-mandate.html
FC Bus	No target	~33 (in service)	Federal Transit Authority (Department of Transportation); CARB; CEC	<ul style="list-style-type: none"> • ZEV state mandate (e.g. CA)
Fuel Cell Trucks	No target	In development	TBD	<ul style="list-style-type: none"> • ZEV state mandate (e.g. CA)
Forklifts	No target	As of 5/2016, >11,600 (including on order, preliminary analysis)	Early market applications strategy	<ul style="list-style-type: none"> • 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, constructed, or planned) ~ 17 public retail	State partnerships	<ul style="list-style-type: none"> • California - \$100M to 2023 or until 100 stations are built (includes O&M grants) • ZEV mandate
70 MPa Delivered	No Target			

¹ Includes Fuel Cell Electric Vehicles with Range Extenders



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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	<ul style="list-style-type: none"> Investment Tax Credit (lower of 30% or \$3,000/kW, 2016 expiration)
Medium ⁴	No Target	As of 5/2016, system capacity installed ~555 kW	-Commercial (limited govt involvement beyond tax credit)	<ul style="list-style-type: none"> Investment Tax Credit (lower of 30% or \$3,000/kW, 2016 expiration)
Large ⁵	No Target	As of 5/2016, system capacity installed ~170 MW	--Commercial (limited govt involvement beyond tax credit)	<ul style="list-style-type: none"> Investment Tax Credit (lower of 30% or \$3,000/kW, 2016 expiration)
District Grid ⁶	No Target	As of 5/2016, system capacity installed ~25 MW	--Commercial (limited govt involvement beyond tax credit)	<ul style="list-style-type: none"> Investment Tax Credit (lower of 30% or \$3,000/kW, 2016 expiration)

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)

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

⁶ 10MW – <30 MW (e.g., Grid Stability, Ancillary Services)



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Regional Grid ⁷	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)
H₂ Production	Target⁸	Current Status	Partnerships, Strategic Approach	Policy Support
Fossil Fuels ⁹	\$4/kg (produced, delivered, dispensed)	~\$5/kg to \$7.5 (at high volume from distributed natural gas) \$13-\$16/kg (low volume)	Limited govt partnerships (commercial/industry focused)	• Limited
Water Electrolysis ¹⁰ (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	Target¹¹	Current Status	Partnership, Strategic Approach	Policy Support

⁷ 30MW plus (e.g., Grid Storage and Systems Management)

⁸ Target can be by quantity (Nm³, kg, t) and by percentage of total production; also, reference to efficiency capabilities can be a target

⁹ Hydrogen produced by reforming processes

¹⁰ Please indicate if targets relate to a specific technology (PEM, Alkaline, SOEC)

¹¹ Can be expressed in MW of Installed Capacity to use the electricity from renewable energy generation, and Annual MWh of stored energy capacity



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Power to Power ¹² Capacity	N/A		In process	
Power to Gas ¹³ Capacity	N/A		In process	

¹² Operator has an obligation to return the electricity stored through the use of hydrogen back to electricity

¹³ 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)