INTERNATIONAL PARTNERSHIP FOR
HYDROGEN AND FUEL CELLS IN THE ECONOMY

IPHE Country Update April 2019[1]: United States

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Covered Period	December 2018 to April 2019

1. New Initiatives, Programs, and Policies on Hydrogen and Fuel Cells

- The 2019 budget for the U.S. Department of Energy's (DOE's) Fuel Cell Technologies Office (FCTO) is $120 million. An additional $30 million was appropriated for solid oxide fuel cells which is under the purview of DOE's Office of Fossil Energy.
- Several states are ramping up plans for activities relevant to hydrogen and fuel cells including energy storage, vehicles and fuels. Examples include:
    - Colorado introduced an executive order to adopt a zero emission vehicle (ZEV) mandate that would increase the percentage of ZEVs, including fuel cell cars, sold in the state.
    - Arizona announced it would pursue 80% clean energy by 2050 and 3,000 MW of energy storage by 2030.
    - California increased the carbon intensity reduction requirement under the Low Carbon Fuel Standard to 20% by 2030. The previous requirement was a 10% reduction in carbon intensity by 2020. The state defines carbon intensity as the amount of carbon emitted throughout a fuel's entire life cycle, from extraction or production to combustion. Hydrogen qualifies as a low-carbon fuel.
- Congress reinstated the Section 48 and Section 25D Investment Tax Credit for fuel cells for businesses and residential installations. The reinstatement established a tiered phase-out of the credit through 2023, based on when construction commences, allowing owners of stationary and material handling fuel cell systems to claim up to 30% of total system equipment and installation costs.
- Daniel Simmons was officially sworn in as the Assistant Secretary for Energy Efficiency and Renewable Energy (EERE) at the U.S. DOE. FCTO is one of the areas he oversees within the EERE portfolio.

2. Hydrogen and Fuel Cell R&D Update

- The U.S. DOE FCTO updated and published the current status of hydrogen delivery and dispensing (excluding production) cost to $12-$13/kg. The cost reflects hydrogen delivery from centralized production to fuelling stations, and dispensing into fuel cell cars in current U.S. markets.
- The U.S. DOE FCTO launched the H-Mat Consortium to address cross-cutting research and development (R&D) on hydrogen materials compatibility. Through this consortium, various DOE national laboratories work collaboratively with industry, universities and

[1] This document reflects examples of key activities and program updates related to hydrogen and fuel cells since the previous IPHE Steering Committee meeting. It is not intended to be a comprehensive country overview.

other relevant stakeholders to improve the reliability of materials, reduce the costs of materials, and inform codes and standards that guide development and use of hydrogen technologies.

3. Demonstration, Deployments, and Workforce Development Update

- 3 retail hydrogen stations opened in California since Dec 2018. The total number of retail stations is approximately 40.
- Nearly 1,000 fuel cell cars entered the market since Dec 2018. The total number of fuel cell cars on the road is over 6,500.
- 5 fuel cell buses exceeded the U.S. DOE and Department of Transportation (DOT) target of 25,000 hours. These buses are part of an effort from the U.S. Department of Transportation along with FCTO and DOE's National Renewable Energy Laboratory to track and demonstrate the performance of fuel cell buses currently in operation in various states in the U.S.
- Since November 2018, there have been announcements from industry to build new hydrogen liquefaction plants in the U.S. Examples of locations where the proposed plants will be built include Louisiana, Texas, California and a region in the West. Air Liquide, Air Products and Praxair are examples of the companies investing in these plants.

4. Events

- The 2019 U.S. DOE Annual Merit Review and Peer Evaluation Meeting will be April 29 to May 1, 2019 in Crystal City, Virginia.
- The U.S. DOE FCTO is planning various workshops to enable the H2@Scale initiative. These workshops will focus on specific applications where hydrogen and fuel cells can add value. Recent and upcoming workshops under this effort include:
    - Hydrogen and Fuel Cell R&D for Data Center Applications Workshop on March 20 in Seattle, WA
    - H2@Rail on March 26-27 in Lansing, MI
    - H2@Ports on September 9-11 in San Francisco, CA
- The official launch of the Center for Hydrogen Safety (CHS) will take place during the American Institute of Chemical Engineers (AIChE) spring meeting on April 1-2. This is being launched by AIChE with numerous global partners and DOE plans to be a partner aligned with promoting safety information sharing.

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

- The U.S. DOE announced approximately $50 million in funding for research and development (R&D) on heavy and medium-duty transportation, including about $15M to cover hydrogen and fuel cell topics such as advanced storage for gaseous fuels, hydrogen fuelling components and durable fuel cell membranes with low platinum content.
- The U.S. DOE also announced approximately $30 million in funding to advance hydrogen production, storage and fuel cells R&D to enable the agency's H2@Scale initiative. The focus of H2@Scale is to enable affordable and reliable large-scale hydrogen generation, transport, storage, and utilization in the U.S. across multiple sectors.
- The U.S. DOE announced the signing of a Memorandum of Understanding (MOU) with the Michigan Economic Development Corporation (MEDC) to enhance collaboration on

hydrogen and fuel cell R&D with the state of Michigan to promote private investment and domestic job creation.

6. Regulations, Codes & Standards, and Safety Update

- AIChE and the U.S. DOE's Pacific Northwest National Laboratory announced a new partnership - the Center for Hydrogen Safety (CHS). CHS is a global oriented non-profit dedicated to promoting hydrogen safety and best practices worldwide with access to 60,000 members in 110 countries. The CHS will hold its official launch during the American Institute of Chemical Engineers (AIChE) spring meeting on April 1-2.
- The U.S. DOE continues to support R&D to enable reduced liquid hydrogen station footprint and to address the restriction in certain regions of the use of fuel cell vehicles in tunnels.
- UN Global Technical Regulation 13 Phase II work is ongoing. The next meeting of the working group was held in Vancouver, BC in March and included reporting on the progress of the five task groups. The task group topics include medium- and heavy-duty vehicles and buses, fueling receptacles, recommendations for test procedures, and other topics.
- The 2020 edition National Fire Protection Association 2 has been voted on and is expected to be released in early summer 2019.

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Summary Country Update April 2019: United States

Transportation	Target Number	Current Status	Partnerships, Strategic Approach	Support Mechanism
Fuel Cell Vehicles[2]	1,000,000 by 2030 (CA goal)	Over 6,500 as of March 2019	Multiple state efforts and industry stakeholders	ZEV state mandate (currently implemented in CA, CT, MA, ME, MD, NJ, NY, OR, RI, and VT); state subsidies (rebates in CA, MA, CT etc.)
FC Buses[3]	No target	35 active, 39 in development in OH, CA, CT, HI, IL, & NY (Nov 2018)	Federal Transit Authority (Department of Transportation); CARB; CEC, and multiple states	
Fuel Cell Trucks	No target	Prototype testing	CTE, FedEx Express, UPS, CEC, SCAQMD, Nikola	ZEV state mandate (e.g., CA)
Forklifts	No target	>25,000	Early market applications strategy	
H_2 Refueling Stations	**Target Number**	**Current Status**	**Partnerships, Strategic Approach**	**Support Mechanism**
70 MPa On-Site Production	200 by 2025 in CA	~40 open public retail in	State and private sector partnerships	

[2] https://cafcp.org/by_the_numbers. Includes Fuel Cell Electric Vehicles with Range Extenders
[3] https://www.nrel.gov/hydrogen/assets/docs/us-fcb-projects-2018.xlsx

70 MPa Delivered	12-25 in Northeast	California, 25 under development[4] 6 built in Northeast, 11 under development. 1 open in Hawaii		• California - $2.5 billion to build ZEV charging/refueling stations including 200 hydrogen stations (includes O&M grants) • ZEV mandate
35 MPa On-Site Production	No target	2 as of 11/2018 (bus only stations). 70 MPa stations include 35 MPa	2 stations for bus refuelling (California)	Solicitations from state and local agencies (e.g., South Coast Air Quality Management District, Air Quality Standards Attainment Program in California)
35 MPa Delivered	No target			
Stationary	**Target Number[5]**	**Current Status**	**Partnerships, Strategic Approach**	**Support Mechanism**
Small[6]	$1,000/kW for backup units running directly on hydrogen	Negligible	Industry-led	State/regional

[4] https://cafcp.org/by_the_numbers
[5] Targets can be units installed and/or total installed capacity in the size range indicated
[6] <5 kW (e.g., Residential Use)

	$1,500/kW for combined heat and power units running on natural gas			
Medium[7]	$1,000/kW for combined heat and power units running on natural gas	As of 5/2016, system capacity installed ~555 kW	Industry-led	State/regional
Large[8]	No target	Overall, more than 240 MW of large stationary (100 kW to multi-megawatt) fuel cells in the U.S.	Industry-led	State/regional
District Grid[9]	No target	As of 5/2016, system capacity installed ~25 MW	Industry-led	State/regional

[7] 5kW – 400 kW (e.g., Distributed Residential Use)
[8] 0.3MW – 10 MW (e.g., Industrial Use)
[9] 1MW – 30 MW (e.g., Grid Stability, Ancillary Services)

Regional Grid[10]	No target	As of 10/23/2015, system capacity installed 30 MW	Industry-led	State/regional
Telecom backup	No target	As of 5/2017 >8,000 (including on order)	Industry-led	State/regional
H_2 Production and Delivery	**Target[11]**	**Current Status**	**Partnerships, Strategic Approach**	**Support Mechanism**
Overall[12]	$4/kg (produced, delivered, dispensed) ultimately $7/kg by 2025, to supply early markets	~$5/kg-$10/kg (if state-of-the-art technologies were manufactured at high volume) $13-$16/kg (current price of hydrogen fuel in California, sourced primarily from	Limited government partnerships (commercial/industry focused)	State/regional funding and regulations (e.g., 33% of fuel sold from stations that are government-funded must be renewable in CA)

[10] 30MW plus (e.g., Grid Storage and Systems Management)
[11] Target can be by quantity (Nm^3, kg, t) and by percentage of total production; also, reference to efficiency capabilities can be a target
[12] Hydrogen produced by reforming processes

		natural gas reforming)[13]		
Water Electrolysis[14] (PEM, Alkaline, SOEC)	<$2/kg produced	Data collection in process	Continued government funding/cost share	State/regional (e.g., 33% renewables in CA)
By-product H_2	N/A	Not tracked		
Energy Storage from Renewables	**Target[15]**	**Current Status**	**Partnership, Strategic Approach**	**Support Mechanism**
Power to Power[16] Capacity	N/A	N/A	N/A	N/A
Power to Gas[17] Capacity	N/A	60-kW demonstration at UC Irvine began in 2016	In process	California Low Carbon Fuel Standard creates credits for use of low-carbon fuels. Blends of H_2 and natural gas could receive credits under this regulation.

[13] https://www.hydrogen.energy.gov/pdfs/review18/h2f01_miller_2018_o.pdf
[14] Please indicate if targets relate to a specific technology (PEM, Alkaline, SOEC)
[15] Can be expressed in MW of Installed Capacity to use the electricity from renewable energy generation, and Annual MWh of stored energy capacity
[16] Operator has an obligation to return the electricity stored through the use of hydrogen back to electricity
[17] 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)