INTERNATIONAL PARTNERSHIP FOR
HYDROGEN AND FUEL CELLS IN THE ECONOMY

IPHE Country Update April 2022: United States

Name	Sunita Satyapal
Contact Information	Sunita.Satyapal@ee.doe.gov Gregory.Kleen@ee.doe.gov Vanessa.Arjona@ee.doe.gov
Covered Period	December 2021 to April 2022

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

- On November 15, 2021, U.S. President Joseph Biden signed into law the bipartisan Infrastructure Investment and Jobs Act (Bipartisan Infrastructure Law, BIL) which includes funding for the US Department of Energy (DOE) to deliver a more equitable clean energy future. The BIL includes $8 billion for Regional Clean Hydrogen Hubs, $1 billion for a Clean Hydrogen Electrolysis Program, and $500 million for Clean Hydrogen Manufacturing and Recycling Initiatives.
- The BIL also requires the Department of Energy to develop a National Clean Hydrogen Strategy and Roadmap to facilitate widescale production, processing, delivery, storage, and use of clean hydrogen; and to work with the Environmental Protection Agency to develop a clean hydrogen standard.
- In December 2021, DOE announced the establishment of the Office of Clean Energy Demonstrations. This new office will support clean energy technology demonstration projects in areas including clean hydrogen, carbon capture, grid-scale energy storage, and small modular reactors.
- On February 9, 2022, DOE announced an organizational realignment that would strengthen the Department's ability to effectively implement the clean energy investments in the Bipartisan Infrastructure Law (BIL) and the Energy Act of 2020. Two new offices have been established which will support the DOE's ongoing work to achieve carbon-free electricity in the US by 2035 and a net zero economy by 2050.
- Programs and activities in states and various regions continue. For example, in December 2021, New Mexico state announced up to $7.6 million in available funding for diesel emission reduction projects, with a preference for hydrogen fuel cell electric freight and drayage trucks, buses and locomotives.

2. Hydrogen and Fuel Cell R&D Update

- DOE released a comprehensive Supply Chain Report which contains seven deep-dive assessments on the challenges and opportunities to build domestic supply chains for clean energy technologies. Each of the seven assessments focused on a specific technology. Water electrolyzers and fuel cells was one of the technologies assessed.
- DOE published the Advanced Liquid Alkaline Electrolysis Experts Meeting report documenting the status and challenges of commercially available liquid

alkaline (LA) water electrolyzers, as well as the research and development (R&D) opportunities for LA electrolyzers.

- In February 2022, DOE released two Requests for Information (RFIs), one of which is related to BIL hydrogen provisions on clean hydrogen manufacturing and recycling research, and electrolysis R&D. The information gathered from the RFI will inform R&D strategies on hydrogen-related manufacturing, recycling, and electrolysis programs.
- DOE published a report capturing the outcomes of a Roundtable on Foundational Science for Carbon-Neutral Hydrogen Technologies held in August 2022. The report identified priority research opportunities to address the underlying scientific and technical hydrogen challenges.

3. Demonstration, Deployments, and Workforce Developments Update

- On November 10, 2021, DOE helped launch the Clean Energy Ministerial's H2 Twin Cities Initiative which seeks to accelerate global hydrogen deployments by pairing communities around the world to collaborate, share ideas, learn from each other, and accelerate progress.
- In February 2022, DOE launched the H2 Matchmaker map. H2 Matchmaker is a resource helping clean hydrogen producers, end-users, and others find opportunities to develop networks of production, storage, and transportation infrastructure.
- In April 2022, DOE's Hydrogen and Fuel Cell Technologies Office (HFTO) announced $2 million in funding to build a talent pipeline from Historically Black Colleges and Universities and Other Minority Institutions (HBCU-OMIs) to help bridge the gap in clean hydrogen workforce development.

4. Events and Solicitations

- DOE hosted multiple virtual workshops promoting hydrogen and fuel cell technologies, including the:
  - H2-PACE: Power And Control Electronics for Hydrogen Technologies Meeting on December 2–3, 2021. This meeting focused on the opportunities for electronics-based technology advancement, product development, and cost reductions for growing electrolyzer and fuel cell industries.
  - Advanced Liquid Alkaline Electrolysis Experts Meeting on January 26-27, 2022. This meeting brought together leading experts in liquid alkaline electrolysis from academia, national laboratories, and industry to discuss R&D opportunities in novel materials, system designs, component integration, manufacturing, and more, to achieve cost targets of $2/kg hydrogen by 2026 and $1/kg hydrogen by 2030.
  - Bulk Storage of Gaseous Hydrogen Workshop on February 10–11, 2022. This workshop connected industry, end users, and government with stakeholders in bulk gaseous storage to discuss surface and subsurface storage and improve understanding about the challenges and opportunities in meeting the future energy storage demand.
  - Liquid Hydrogen Technologies Workshop on February 22–23, 2022, in collaboration with the U.S. National Aeronautics and Space Administration (NASA). This workshop addressed development needs

for low-cost, energy-efficient, scalable, and safe liquid hydrogen generation, dispensing, and end-use.
    - High-Temperature Electrolysis Manufacturing Workshop on March 8–9, 2022, in support of the Hydrogen Energy Earthshot to reduce the cost of clean hydrogen by 80% and the Clean Hydrogen Electrolysis Program established under the Bipartisan Infrastructure Law.
    - Advanced Materials for Proton Exchange Membrane (PEM) Electrolyzers Workshop (H2-AMP) on March 30–31, 2022. This meeting, which supported the DOE's Hydrogen Energy Earthshot, brought together leading PEM electrolyzer experts from academia, national laboratories, and industry to present on R&D opportunities in novel materials, industry needs, and more, to achieve future cost targets.
    - Expert Workshop on the Environmental Impacts of Hydrogen on March 31 & April 1, 2022, in collaboration with the European Commission's Clean Hydrogen Joint Undertaking. The workshop provided insight on the current/available knowledge on the environmental impacts of hydrogen, shared evidence-based information on human-made hydrogen releases, and highlighted key research, development and demonstration (RD&D) gaps.
- DOE held various H2IQ hours, including one in March 2022 which focused on the compatibility of pipeline materials with hydrogen and blends of hydrogen and natural gas.
- On February 15, DOE announced two Requests for Information (RFI) to collect feedback from stakeholders to inform the implementation and design of the Bipartisan Infrastructure Law's Regional Hydrogen Hub and the Electrolysis and Clean Hydrogen Manufacturing and Recycling Programs. The requests will help accelerate progress, reduce technology cost, and ramp up the use of hydrogen as a clean energy carrier.
- The 2022 DOE Hydrogen Program Annual Merit Review and Peer Evaluation Meeting will be held virtually, June 6 to 8, 2022. Hydrogen and fuel cell projects funded by DOE will be presented, and projects and programs reviewed for their merit. Attendance is free but registration is required.

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

- DOE Fossil Energy and Carbon Management Office (FECM) announced funding for several projects supporting hydrogen and fuel cell technologies including:
    - $4 million in funding to advance the development of ceramic-based materials to improve the efficiency of hydrogen-fueled turbines that may one day be used in clean power plants.
    - $2.4 million in funding for three (3) projects to advance novel thermal and hydrogen energy storage technologies toward increased duration, reliability and affordability.
    - $28 million in funding for research and development and front-end engineering design projects that will advance clean hydrogen as a carbon-free fuel for transportation, industrial use and electricity production.

- In March 2022, the US Department of Transportation announced $409 million in funding to modernize the nation's transit bus fleet, including $30 million in funding to purchase fuel cell electric buses and the supporting infrastructure and equipment.

6. Regulations, Codes & Standards, and Safety Update

- Revised separation distance requirements for bulk liquid hydrogen storage systems have been accepted by the National Fire Protection Association (NFPA) 2 Hydrogen Technologies Code Technical Committee. The formal vote will be balloted in May to officially incorporate these changes into the 2023 edition of NFPA 2.

Summary Country Update April 2022: United States

Transportation	Target Number	Current Status	Partnerships, Strategic Approach	Support Mechanism
Fuel Cell Vehicles[1]	1,000,000 by 2030 in CA	>13,000	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.)
Fuel Cell Buses	No target	~70	Federal Transit Authority (Department of Transportation); CARB; CEC, and multiple states	
Fuel Cell Trucks[2]	$80/kW by 2030 (Interim) $60 k/W (Ultimate)	As of June 2021, 5 of 10 Toyota/Kenworth Class trucks have been deployed out of the Port of LA	CTE, FedEx Express, UPS, CEC, SCAQMD, Nikola	ZEV MOU and taskforce in place between California, Colorado, Connecticut, District of Columbia, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, and Washington to support the deployment of medium- and heavy-duty ZEVs
Forklifts	No target	>50,000	Early market applications strategy	

[1] Includes Fuel Cell Electric Vehicles with Range Extenders

[2] https://www.hydrogen.energy.gov/pdfs/19006_hydrogen_class8_long_haul_truck_targets.pdf

H_2 Refueling Stations	Target Number	Current Status	Partnerships, Strategic Approach	Support Mechanism
70 MPa On-Site Production	1,000 by 2030 in CA 12-20 in Northeast	>50 open retail stations	State and private sector partnerships	California - $2.5 billion to build ZEV charging/refueling stations including 200 hydrogen stations (includes O&M grants) ZEV mandate
70 MPa Delivered				
35 MPa On-Site Production	No target	N/A	2 stations for bus refuelling (California)	Solicitations from state and local agencies (e.g., South Coast Air Quality Management District, Air Quality Standards Attainment U.S. DOE in California)
35 MPa Delivered	No target			
Stationary	**Target Number[3]**	**Current Status**	**Partnerships, Strategic Approach**	**Support Mechanism**
Small[4]	$1,000/kW for backup units running directly on hydrogen $1,500/kW for combined heat and power units running on natural gas	Installed stationary power (including large, medium and small units) is over 500 MW.	Industry-led	State/regional

[3] Targets can be units installed and/or total installed capacity in the size range indicated

[4] <5 kW (e.g., Residential Use)

Medium[5]	$1,000/kW for combined heat and power units running on natural gas		Industry-led	State/regional
Large[6]	No target	N/A	Industry-led	State/regional
District Grid[7]	No target	N/A	Industry-led	State/regional
Regional Grid[8]	No target	N/A	Industry-led	State/regional
Telecom backup	No target	N/A	Industry-led	State/regional
H_2 Production	**Target[9]**	**Current Status**	**Partnerships, Strategic Approach**	**Support Mechanism**
Fossil Fuels[10]	$1/kg produced by 2030	$1.5/kg		
Water Electrolysis[11] (PEM, Alkaline, SOEC)	$1/kg produced by 2030	$5-$6/kg for low volume >172 MW PEM electrolyzer	Continued government funding/cost share	State/regional (e.g., 33% renewables in CA)

[5] 5kW – 400 kW (e.g., Distributed Residential Use)
[6] 0.3MW – 10 MW (e.g., Industrial Use)
[7] 1MW – 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
[11] Please indicate if targets relate to a specific technology (PEM, Alkaline, SOEC)

		capacity installed/underway		
By-product H_2	N/A	N/A		
Energy Storage from Renewables	**Target[12]**	**Current Status**	**Partnership, Strategic Approach**	**Support Mechanism**
Power to Power[13] Capacity	N/A	N/A		
Power to Gas[14] Capacity	N/A	Project in CA is injecting H2 into NG pipeline		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.

[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)