



INTERNATIONAL PARTNERSHIP FOR HYDROGEN AND FUEL CELLS IN THE ECONOMY

IPHE Country Update November 2021: United States

Name	Sunita Satyapal
Contact Information	Sunita.Satyapal@ee.doe.gov Gregory.Kleen@ee.doe.gov Vanessa.Arjona@ee.doe.gov
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1. New Initiatives, Programs, and Policies on Hydrogen and Fuel Cells

- On November 5, 2021 the US House of Representatives [passed](#) the Bipartisan Infrastructure Bill (BIB) which includes funding for the US Department of Energy (DOE) to deliver reliable, clean and affordable energy to communities across the US. The BIB includes \$8 billion for at least four regional clean hydrogen hubs and \$1.5 billion for electrolysis and clean hydrogen manufacturing and recycling research, development, and demonstration.
- On July 14, DOE [launched](#) the Long Duration Storage Energy Earthshot which seeks to reduce the cost of grid-scale energy storage by 90% for systems that deliver at least 10 hours of duration within the decade. DOE also [announced](#) the Carbon Negative Earthshot on November 5 at COP 26 in Glasgow, with the goal to remove carbon dioxide (CO₂) from the atmosphere and durably store it for less than \$100/ton of net CO₂-equivalent. These Energy Earthshots follow Hydrogen Shot, the first Energy Earthshot, which was announced on June 7, with the goal of \$1 for 1 kg of clean hydrogen in 1 decade.
- Programs and activities at the state level have increased with a growing number of regional coalitions and partnerships focused on hydrogen deployment. Examples of recent and state-level policy and initiatives include:
 - California state legislature [approved](#) \$3.9 billion in funding over three years to accelerate the zero-emission vehicle transition which includes the adoption of hydrogen fuel cell technologies for both light-duty and heavy-duty transportation applications.
 - The California Air Resources Board [announced](#) \$62 million in available funding that can be used to purchase medium- and heavy-duty trucks and buses utilizing clean technologies such as fuel cell electric.
 - New York state [signed](#) legislation that establishes goals of zero emissions for new passenger cars and trucks, and new off-road vehicles and equipment by 2035, and zero emissions for new medium-duty and heavy-duty vehicles by 2045. New York state also [announced](#) a collaboration with the US National Renewable Energy Laboratory (NREL) to study the role of green hydrogen in the state's decarbonization strategy. The state will provide \$12.5 million in funding for long duration energy storage technologies and demonstration projects that may include green hydrogen.
- Several bills were proposed by Congress that would include provisions for hydrogen and fuel cells such as production and investment tax credits.



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2. Hydrogen and Fuel Cell R&D Update

- DOE Office of Science held a Roundtable on Foundational Science for Carbon-Neutral Hydrogen Technologies in August 2021 to identify the basic science research gaps to help achieve Hydrogen Shot and accelerate progress in clean hydrogen. A [brochure](#) is available summarizing the results.
- DOE released a R&D program record [documenting](#) hydrogen production potential from nuclear power plants.
- DOE released [StoreFAST](#), a techno-economic tool that analyses both energy storage systems and flexible power generation systems on a side-by-side basis. Hydrogen systems are included in the model.

3. Demonstration, Deployments, and Workforce Developments Update

- DOE [announced](#) \$20 million in funding that will support the DOE's H2@Scale vision for clean hydrogen across multiple sectors and help meet the Department's Hydrogen Shot goal of \$1 per 1 kilogram in 1 decade. The project will demonstrate technology that can produce clean hydrogen energy from nuclear power.
- DOE [announced](#) approximately \$8 million in funding for nine cooperative projects that will complement existing H2@Scale efforts and support DOE's Hydrogen Shot goals. The selected projects will leverage the Advanced Research on Integrated Energy Systems (ARIES) platform to enable the integration of hydrogen technologies in future energy systems, including energy storage and a specific focus on safety and risk mitigation.
- DOE [launched](#) the Hydrogen Shot Fellowship to recruit diverse talent who can contribute to make Hydrogen Shot a reality. Hydrogen Shot Fellows will engage in Hydrogen Shot related work including hydrogen production, storage, infrastructure, utilization research, development and demonstration activities.

4. Events and Solicitations

- DOE [hosted](#) the virtual Hydrogen Shot Summit on August 31 and September 1, 2021. The Summit convened more than 3,200 stakeholders to initiate dialogue around what is needed to achieve Hydrogen Shot. Key themes included the need to collaborate across all sectors, to leverage clean hydrogen to lift-up communities in need, and to identify opportunities for scale as a way to bring costs down. Recordings and presentations are available online.
- DOE held a week-long [communications campaign](#) in commemoration of National Hydrogen and Fuel Cell Day (Oct 8). Activities included announcements on new projects, blogs about Hydrogen Shot and how to celebrate Hydrogen and Fuel Cells Day, a hydrogen and fuel cells quiz, multiple posts across DOE social media channels, as well as a symbolic 1.008 mile walk/run. Secretary Granholm posted a [tweet](#) with a [video](#) about the role of clean hydrogen to help decarbonize our economy, tackle the climate crisis and create good paying jobs.
- DOE [hosted](#) the virtual Advances in Liquid Hydrogen Storage Workshop on August 18, 2021 in collaboration with the U.S. National Aeronautics and Space Administration (NASA). The workshop covered DOE's liquid hydrogen related initiatives and outlook, and introduced recent advancements in large scale liquid hydrogen storage technologies and projects at NASA.
- DOE, in collaboration with Mission Innovation member countries, hosted the Hydrogen Fuel Cell Off-Road Equipment and Vehicles Virtual Workshop in September. This three-day workshop explored opportunities for cooperation and collaboration on



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hydrogen heavy-duty, off-road applications including fuel cells for agriculture, construction, and mining equipment.

- DOE held various [H2IQ hours](#), including one which highlighted efforts from DOE's Applied Energy Labs on hydrogen technology research, development, demonstration, and deployment activities.

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

- DOE [launched](#) the first ever Hydrogen Business Case Prize Competition during Hydrogen and Fuel Cell Week. The Prize challenges teams to develop user-friendly analysis tools that identify regional business cases where clean hydrogen can add value to specific sectors and technology applications.
- DOE announced funding for multiple projects supporting hydrogen and fuel cell technologies including:
 - [\\$52.5 million for 31 projects](#) that will advance next-generation clean hydrogen technologies and support the Hydrogen Shot initiative to reduce the cost and accelerate breakthroughs in the clean hydrogen sector.
 - [Approximately \\$200 million in funding for 25 projects](#) that will focus on reducing emissions from cars and trucks via electrification and alternative-fuel technologies, such as hydrogen fuel cells. Five (5) projects will be funded under the SuperTruck 3 Initiative which focuses on improving medium- and heavy-duty truck efficiencies and reducing emissions of freight transportation.
 - [\\$6.2M in funding for 8 projects](#) on hydrogen turbine R&D.
- DOE [launched](#) the Inclusive Energy Innovation Prize that will award up to \$2.5 million in cash prizes to groups and organizations that support entrepreneurship and innovation in communities historically underserved in climate and energy technology funding.

6. Regulations, Codes & Standards, and Safety Update

- DOE Sandia National Laboratories released a [report](#) reviewing the literature on leak behavior for hydrogen/natural gas blends. Of the literature reviewed, there was no directly observed separation of the hydrogen from the natural gas or methane blend during unignited dispersion. There are multiple literature sources that measured flame lengths and heat flux values, which are both relevant metrics to risk and hazard assessments.
- Version 4.0 of the Hydrogen Plus Other Alternative Fuels Risk Assessment Model (HyRAM+) tool was [released](#). This version of the toolkit introduces the capability to estimate hazards and calculate risk using pure methane or pure propane as other alternative fuels, in addition to pure hydrogen.



Summary Country Update November 2021: United States

Transportation	Target Number	Current Status	Partnerships, Strategic Approach	Support Mechanism
Fuel Cell Vehicles ¹	1,000,000 by 2030 in CA	>11,000	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.)
FC Bus	No target	>60	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	>45,000	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



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H ₂ Refueling Stations	Target Number	Current Status	Partnerships, Strategic Approach	Support Mechanism
70 MPa On-Site Production	1,000 by 2030 in CA	>47 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	12-20 in Northeast			
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)



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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	<u>\$5-\$6/kg</u> 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 (Nm³, 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)



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		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 H ₂ 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)