Clean Hydrogen Receives Major Boost as Key Element Towards Net-Zero by 2050

Incentives in the Inflation Reduction Act and funding from the 2021 Infrastructure Investment and Jobs Act will stimulate new markets for clean hydrogen.

Industry Insight

The hydrogen market is changing amid federal and state initiatives to harness the technology to support decarbonization. **Investing in clean hydrogen is viewed as a key component of efforts to progress towards the Biden administration's target of net-zero emissions by 2050.**

The U.S. Department of Energy (DOE) is actively pursuing efforts to implement the hydrogen-specific provisions in the 2021 Infrastructure Investment and Jobs Act (IIJA), which represents the largest investment in U.S. infrastructure. **IIJA contains $9.5 billion for clean hydrogen**, including $8 billion for the development of regional clean hydrogen hubs across the country. The law calls for the development of a roadmap and strategy to facilitate wide scale hydrogen use, as well as a clean hydrogen production standard.

In September, **DOE opened applications for a $7 billion funding opportunity for proposals to establish regional hubs across the country.** DOE has also issued a draft National Clean Hydrogen Strategy and Roadmap, providing an overview of the potential for hydrogen production and use, and outlining how clean hydrogen can contribute to decarbonization and economic development goals. Further, the agency has issued draft guidance for a clean hydrogen production standard.

The Inflation Reduction Act, signed into law in August 2022, provides **additional support through policies and incentives including a production tax credit (PTC)** that will facilitate a market for clean hydrogen in the U.S.

Through its Hydrogen Program Plan, DOE has been conducting research and development to accelerate the deployment of hydrogen technologies. **DOE activities encompass several offices and about $400 million in the fiscal year 2022** budget request compared to $285 million related to hydrogen in the prior year. Earlier this year, DOE announced the closing of a $504 million loan guarantee for a hydrogen storage project to be developed by Mitsubishi Power Americas and Magnum Development in Utah. The loan will be utilized to develop the largest clean hydrogen storage facility in the world.

States are working towards utilizing the $8 billion allocated for regional hydrogen hubs in the IIJA. New York has announced a multi-state agreement, including with a coalition of 40 hydrogen ecosystem partners, to develop a proposal for a regional hub. The New York-led consortium includes Connecticut, Massachusetts, and New Jersey. Further, Colorado, New Mexico, Utah, and Wyoming have signed a memorandum of understanding to coordinate the development of a clean hydrogen hub to meet infrastructure needs that may arise from expanding the use of hydrogen as a fuel source. Seven Midwestern states – Illinois, Indiana, Kentucky, Michigan, Minnesota, Ohio, and Wisconsin – have formed the Midwest Hydrogen Coalition to boost their decarbonization efforts.

California has enacted a suite of measures to advance hydrogen including establishing a hydrogen program to provide financial incentives to eligible in-state hydrogen projects and considering green electrolytic hydrogen as an eligible form of energy storage. The state's **Energy Commission has issued a study evaluating the viability and safety implications of injecting hydrogen into the natural gas system**, a critical step in considering renewable hydrogen as a component of the state's decarbonization strategy. Meanwhile, three of the state's utilities have proposed live hydrogen blending demonstration projects.

Among other state level activities, **Oklahoma has enacted a measure to create a hydrogen fuel production standard setting a goal of producing two million metric tons of hydrogen fuel using a low or zero carbon source of energy annually by 2028**. Arizona has called for a committee to investigate and evaluate existing laws and regulations and recommend legislation related to the production, distribution, and storage of hydrogen.

Key Takeaways

- States are working to compete for a portion of the $8 billion allocated for regional hydrogen hubs in the 2021 Infrastructure Investment and Jobs Act.
- The Inflation Reduction Act lays out a variety of tax credits for clean energy including the first hydrogen production tax credit estimated at $13 billion over 10 years.
- DOE has closed a $504 million loan guarantee for a hydrogen storage project in Utah, the largest clean hydrogen storage facility in the world.

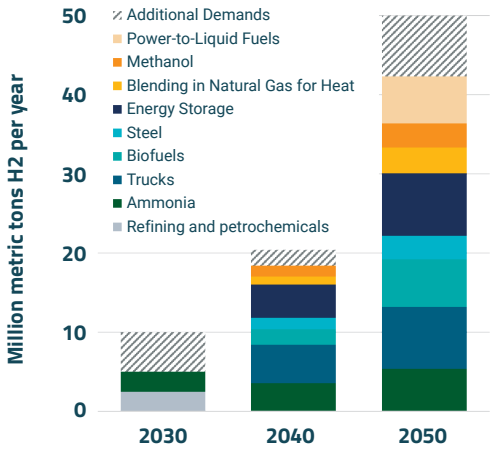
> IIJA calls for a roadmap and strategy to facilitate wide scale hydrogen use and includes $9.5 billion for clean hydrogen.

Key Statistics

More Demands

Deployments of clean hydrogen to decarbonize industry, transportation, and the power grid can enable 10 million metric tonnes (MMT) of demand annually by 2030, 20 MMT/year by 2040, and 50 MMT in 2050, according to DOE's draft National Hydrogen Strategy and Roadmap.

Projected annual demand for hydrogen by sector



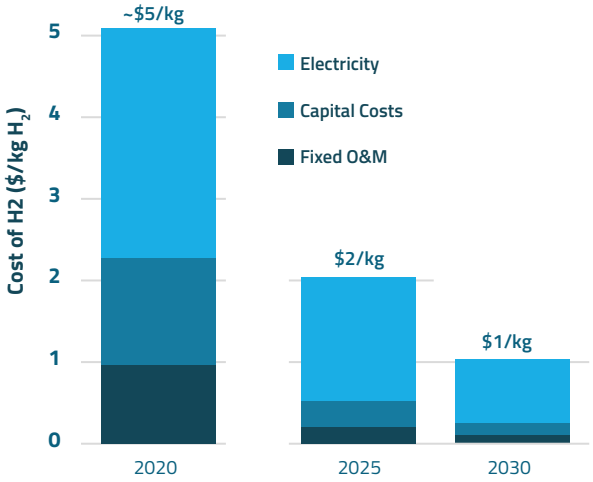
Sources: DOE, EnerKnol

Price Drop

To unlock the market potential for the technology, DOE's Hydrogen Shot initiative seeks to lower the cost of clean hydrogen by 80 percent to $1 per kilogram by 2030, down from the current level of $5 per kilogram.

Launched in June 2021, Hydrogen Shot is the first in a series of Energy Earthshots aimed at driving breakthroughs to cut costs of critical clean energy technologies by 2030. Achieving $1/kg using electrolyzers requires lower electricity cost, significantly lower capital costs, improvement in efficiency and durability, and higher utilization.

Cost of Clean H2 from Electrolysis



Sources: DOE, EnerKnol

Hydrogen-Specific Provisions in the 2021 Infrastructure Investments and Jobs Act (H.R. 3684)

Regional Clean Hydrogen Hubs: Provides $8 billion to enable the demonstration and development of networks of clean hydrogen producers, potential consumers, and connective infrastructure, in a bid to advance the production, processing, delivery, storage, and end-use, thereby enabling sustainable and equitable regional benefits as well as market uptake.

Clean Hydrogen Electrolysis Program: Provides $1 billion to improve the efficiency and cost-effectiveness of electrolysis technologies through research, development, and demonstration for commercialization and deployment to enable $2 per kg clean hydrogen from electrolysis by 2026.

Clean Hydrogen Manufacturing and Recycling: Provides $500 million to support U.S. manufacturing of clean hydrogen equipment, including projects that enhance efficiency and cost-effectiveness, and support domestic supply chains for key components.

National Clean Hydrogen Strategy and Roadmap: Requires DOE to develop a technologically and economically feasible national strategy and roadmap to facilitate wide scale production, processing, delivery, storage, and use of clean hydrogen, and update the report every three years.

Clean Hydrogen Production Standard: Calls for the development of a clean standard that is to be a point of reference for specified programs – not a regulatory standard – and is intended to serve as a guide to actions DOE takes under Title VIII of the 2005 Energy Policy Act including the regional hydrogen hubs and the research and development program that calls for technology cost goals oriented toward achieving the standard.

Tax provisions and funding opportunities in the 2022 Inflation Reduction Act (H.R. 5376)

Hydrogen Production Tax Credit: Creates a credit for the qualified production of clean hydrogen available during the facility's first 10 years of operation; applies for new facilities that begin construction before Jan. 1, 2033 and requires qualifying facilities to produce hydrogen through a process resulting in lifetime greenhouse gas emissions of no more than 4 kgs of CO2e per kg of hydrogen; sets a base credit amount of $0.60 per kg times the applicable percentage with credit amounts indexed for inflation and allows a bonus credit if prevailing wage and apprenticeship requirements are met.

DOE expects the act to support demand for clean hydrogen through additional programs, including:

- Grants and loans for auto manufacturing facilities involved in making clean vehicles, including fuel cell electric vehicles (FCEVs) and grants for clean heavy-duty vehicles, including FCEVs;
- A tax credit for producing sustainable aviation fuels, which can require hydrogen feedstock; and
- Grants to reduce emissions at ports, which could fund deployments of fuel cells.

Recent Actions: State-Level

CA California Utilities Propose Hydrogen Blending Demonstrations

Sept. 8, 2022 - The Southern California Gas Company, San Diego Gas and Electric Company, and Southwest Gas Corporation submitted (A.22-09-006) a joint application to the California Public Utilities Commission (CA PUC) for the creation of live hydrogen blending demonstration projects by each utility. The application outlines how the results would apply to all of the utilities pipeline networks and includes complete timelines, proposed budgets, and details about each project's components.

Independent Study Issued on Injecting Hydrogen Into Natural Gas Systems

July 21, 2022 - CA PUC issued (R1302008) a study evaluating the viability and safety implications of injecting hydrogen into the natural gas system, a critical step in considering renewable hydrogen as a component of the state's decarbonization strategy. The study explores the possibilities and limitations of California's pipeline infrastructure as the state explores zero-carbon energy options for hard to decarbonize applications. The commission conducted the study in response to SB 1369 and as part of the commission's rulemaking examining expansion of renewable hydrogen through standards and interconnection protocols for injecting hydrogen into natural gas pipelines. The study found that hydrogen blends of up to 5 percent in the natural gas system are generally safe, but higher blends would increase chances of leaks and embrittlement of steel pipelines, and also require modifications of appliances to avoid leaks and malfunction. The study concludes that additional examination and real-world demonstrations are required to determine the appropriate blend percentage.

CO NM UT WY Four States Plan Western Inter-State Hydrogen Hub

Feb. 24, 2022 - Colorado, New Mexico, Utah and Wyoming signed a memorandum of understanding to coordinate and develop a regional clean hydrogen hub. The states intend to work to compete for a portion of the $8 billion allocated in the IIJA to create a Western Inter-State Hydrogen Hub.

WV West Virginia Hydrogen Hub Coalition Engages Industry Leaders

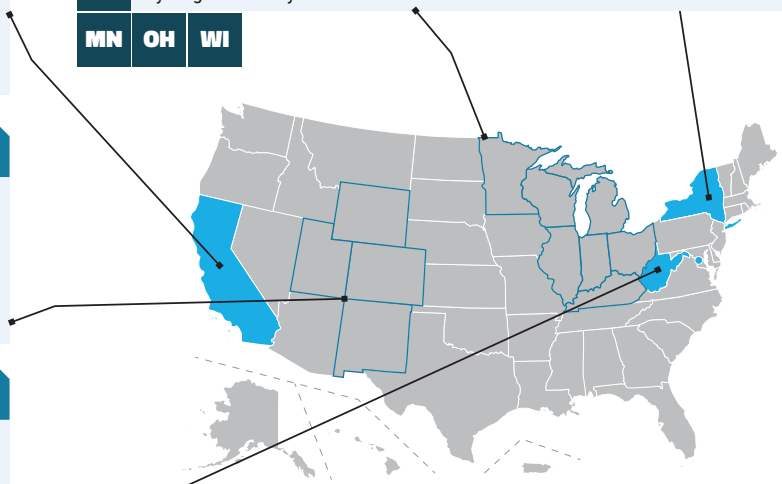
July 28, 2022 - The West Virginia hydrogen hub coalition engaged industry leaders to discuss next steps for establishing West Virginia as the new home of hydrogen energy production, taking advantage of the opportunity created by IIJA. The state possesses abundant energy sources and with its strong associations is in a unique position to develop an innovative hydrogen hub. The state is in a position to advance energy innovation by leveraging existing natural gas and coal resources for the development of hydrogen technologies.

NY Governor Announces Multi-State Agreement for a Clean Hydrogen Hub

Aug. 25, 2022 - New York Governor Kathy Hochul announced that Maine and Rhode Island have signed on to a New York-led multi-state agreement, linking with Connecticut, Massachusetts, and New Jersey to develop a proposal to become one of at least four regional clean hydrogen hubs designated through the federal Regional Clean Hydrogen Hubs program under IIJA. The announcement advances each state's leadership in clean hydrogen infrastructure deployment and supports New York's 2019 Climate Leadership and Community Protection Act goal to lower greenhouse gas emissions 85 percent by 2050.

IL IN KY MI MN OH WI Seven States Form Midwest Hydrogen Coalition

Sept. 19, 2022 – Seven Midwestern states – Illinois, Indiana, Kentucky, Michigan, Minnesota, Ohio, and Wisconsin – announced an agreement to form the Midwest Hydrogen Coalition to boost their decarbonization efforts. The coalition is intended to allow for a multi-state, multi-sector approach for leveraging each state's unique assets to facilitate the development of the hydrogen industry across the Midwest.



Recent Actions: Federal

DOE Releases Draft Guidance for Hydrogen Production Standard

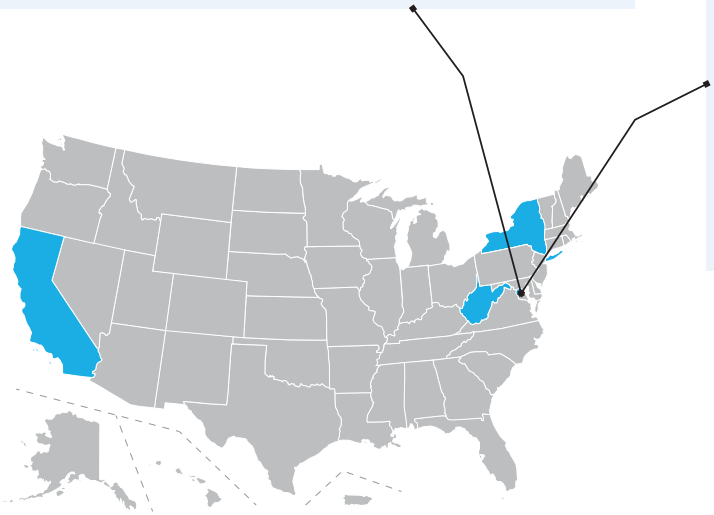
Sept. 22, 2022 - DOE released draft guidance for a Clean Hydrogen Production Standard (CHPS) to meet the requirements of IIJA. The initial proposal establishes a target of 4 kgCO2e/kgH2 for lifecycle or "well-to-gate," greenhouse emissions associated with hydrogen production, accounting for multiple requirements of the law. Under IIJA, DOE must develop an initial standard for the carbon intensity of clean hydrogen production and the standard must support production from specified sources including fossil fuels with carbon capture, hydrogen-carrier fuels, renewable energy resources including biomass, and nuclear energy. The law defines "clean hydrogen" to mean hydrogen produced with a carbon intensity equal to or less than 2 kgCO2e per kg of H2 produced at the site of production and takes into consideration technological and economic feasibility.

DOE Announces $7B Funding to Kick-Start U.S. Clean Hydrogen Economy

Sept. 22, 2022 - DOE announced a $7 billion funding opportunity for regional clean hydrogen hubs (H2Hubs) across the country, part of the $8 billion hydrogen hub program funded through IIJA. The department also issued its draft National Clean Hydrogen Strategy and Roadmap that provides a comprehensive overview of the potential for hydrogen production, transport, storage, and use in the U.S. and outlines how clean hydrogen can contribute to decarbonization and economic development goals. A final version is anticipated in the coming months and will be updated at least every three years. (EnerKnol Pulse)

DOE Invests $4.7 Million to Improve Hydrogen Turbine Performance

Sept. 13, 2022 - DOE's Office of Fossil Energy and Carbon Management announced around $4.7 million in funding for six projects to expand the expansion of ceramic-based materials to enhance the efficiency of hydrogen-fuelled turbines that could be used in clean power facilities. Electricity made from clean hydrogen, whether produced from renewable resources or from fossil fuels or carbon-based waste resources, coupled with pre-combustion carbon capture and storage will assist in accomplishing the Biden Administration's goal of a net zero emission in the U.S. electricity sector by 2035. Moreover, projects selected under this funding opportunity will concentrate on the research and development of ceramic matrix composite components, which allow hydrogen turbines to operate at higher working temperatures, in the long run improving cycle efficiency.



DOE Announces Funding for Nuclear-Coupled Hydrogen Production

Sept. 1, 2022 - DOE announced funding for projects in "Nuclear Coupled Hydrogen Production and Use" to support the development of nuclear plant thermal integration that would be required for high-temperature hydrogen production or hydrogen-coupled end uses for nuclear energy. These first-of-a-kind activities are expected to support and lead to a demonstration of thermal energy extraction, distribution, and control at thermal power levels of 20 to 300 megawatts thermal.

DOE Announces $60 Million for Hydrogen Research, Grid Modernization

Aug. 23, 2022 - DOE announced a $40 million funding opportunity announcement to advance the expansion and deployment of green hydrogen technologies. An additional $20 million will be made available to create a university research consortium on grid resilience to support the development of grid resilience programs across states, regions, tribes, and utilities. (EnerKnol Pulse)

DOE Announces $504M Loan Guarantee for Largest Hydrogen Storage

June 8, 2022 - DOE announced the closing of a $504.4 million loan guarantee for a hydrogen storage project to be developed by Mitsubishi Power Americas and Magnum Development in Utah. The loan will be utilized to develop the largest clean hydrogen storage facility in the world. This marks the department's first loan guarantee for a clean energy project in about a decade. The project, Advanced Clean Energy Storage Hub, is expected to enhance the employment ratio in the region of Utah by creating 400 jobs in construction and 25 in operations. (EnerKnol Pulse)

DOE Offers $28 Million in Funding for Clean Hydrogen Development

Feb. 7, 2022 - DOE announced that it is making $28 million available to fund the development of clean hydrogen by supporting research and development and front-end engineering design projects that will utilize clean hydrogen for transportation, electricity production, and industrial uses. The funding prospect will leverage advanced methods to make clean hydrogen at lesser costs from supplies that include community solid waste, legacy coal discard, scrap plastics, and biomass with carbon capture and storage. (EnerKnol Pulse)

DOE National Lab Researches Produceing Hydrogen From Fossil Resources

Jan. 24, 2022 - The National Energy Technology Laboratory announced that its Strategic Systems Analysis & Engineering, or SSAE, researchers are working towards using fossil energy resources to produce hydrogen by adopting advanced hydrogen production and carbon capture technologies. The new initiative is expected to expand the use of fossil-fuel derived hydrogen in decarbonizing the transportation sector, and offer hydrogen as a fuel for industrial applications. SSAE is evaluating possible technology and market scenarios to help achieve the goal of reducing greenhouse gas emissions while meeting the hydrogen production cost target. (EnerKnol Pulse)

Select Enacted State Legislation Related to Hydrogen

State	Bill Number	Date of Enactment	Description
California	SB 1010	16 Sep, 2022	Requires the Department of General Services, on and after January 1, 2024, to develop criteria to evaluate bidders, at least in part, based on the number of zero-emission vehicles or plug-in hybrid electric vehicles in their rental car fleet when seeking to award a contract for commercial rental car services; states that the installation of electric vehicle supply equipment or supporting electrical and hydrogen fueling infrastructure by state entities to support specified state fleet operations do not constitute gifts of public funds.
California	SB 1075	16 Sep, 2022	Requires the State Air Resources Board to prepare an evaluation posted to the state board's internet website by June 1, 2024, that includes specified information relative to the deployment, development, and use of hydrogen; requires the Energy Commission, as part of the 2023 and 2025 editions of the integrated energy policy report, to study and model potential growth for hydrogen and its role in decarbonizing the electrical and transportation sectors of the economy and helping to achieve specified goals, and to consider other potential uses of green electrolytic hydrogen specifically in all of their decarbonization strategies.
California	SB 1291	16 Sep, 2022	Directs the California Public Utilities Commission, State Air Resources Board, and Energy Commission to consider green electrolytic hydrogen an eligible form of energy storage, and other potential uses for green electrolytic hydrogen.
California	AB 209	6 Sep, 2022	Directs the Energy Commission to establish a Hydrogen Program to provide financial incentives to eligible in-state hydrogen projects for the demonstration or scale-up of the production, processing, delivery, storage, or end use of hydrogen; eligible projects include those that produce, process, deliver, store, or use hydrogen derived from water using eligible renewable energy resources.
Hawaii	SB 2283	27 Jun, 2022	Requires the Hawaii Natural Energy Institute to conduct a study to examine the potential for the production and use of renewable hydrogen in the state and the potential role of renewable hydrogen in achieving a local, affordable, reliable, and decarbonized energy system and economy; requires a report to the legislature.
Illinois	SB3613	10 Jun, 2022	Creates the Hydrogen Economy Task Force to establish a plan to create, support, develop or partner with a Hydrogen Hub in Illinois and determine how to maximize federal financial incentives to support hub development; directs the task force is to identify opportunities to integrate hydrogen in the transportation, energy, industrial, agricultural, and other sectors, and recommend government policies to incentivise the deployment of hydrogen in the state.
New Hampshire	SB440	8 Jun, 2022	Directs the Office of Offshore Wind Industry Development, Department of Energy to advise on the development of clean energy resources in the Gulf of Maine and the purchase of power by New Hampshire public utilities from these resources; requires the office to generate a report relative to the same including recommendations on the criteria for evaluating power purchase agreements for procurement of electricity or hydrogen produced by wind turbines in the Gulf of Maine.
Colorado	HB22-1381	2 Jun, 2022	Establishes the geothermal energy grant program in the Colardo energy office providing three types of grants: (1) a single structure geothermal grant, which is awarded to applicants that are assembling new buildings and that are installing a geothermal system as the main heating system for the building; (2) community district grant, which is granted to support ground source, water source or multisource thermal system that serve more than one building; and (3) geothermal electricity generation grant, which is allocated to support the development of geothermal electricity generation and hydrogen generation produced from geothermal energy.
Oklahoma	SB 1857	26 May, 2022	Modifies or extends tax years for which credit may be claimed for investment in certain qualified clean-burning motor vehicles and related assets; provides tax credit for hydrogen fuel cells and related assets.
Oklahoma	SB 1853	26 May, 2022	Creates a hydrogen fuel production standard in the state of Oklahoma setting a goal of producing two million metric tons of hydrogen fuel using a low or zero carbon source of energy annually by 2028; requires each hydrogen fuel production facility to report to the Corporation Commission by March 1 each year the amount of hydrogen fuel produced in the preceding calendar year and the low or zero carbon source used; zero-carbon resources that can be used for hydrogen fuel produced include wind, photovoltaic, hydropower, geothermal and biomass.
Connecticut	HB 05200	23 May, 2022	Establishes a task force to study hydrogen-fueled energy in the state's economy and energy infrastructure; requires the study to review regulations and legislation needed to achieve economies of scale for the hydrogen ecosystem; examine ways to take advantage of competitive incentives and programs created by IIJA; recommendations for workforce initiatives to prepare the state's workforce for hydrogen-fueled energy-related jobs; examine the sources of potential clean hydrogen, including, wind, solar, biogas and nuclear; and recommendations for funding and tax preferences for building hydrogen-fueled energy facilities at brownfield sites; among others.
Oklahoma	SB 1856	2 May, 2022	Requires the office of the Secretary of Energy and Environment to create and govern a grant program for entities utilizing sequestration of carbon captured from production of hydrogen from natural gas, determine the criteria for the program and establish a process for consideration of proposals.
Arizona	SB1396	11 Apr, 2022	Establishes the Hydrogen Study Committee to investigate and evaluate existing laws and regulations and recommend legislation related to the production, distribution, and storage of hydrogen; requires the committee to study the production of hydrogen from any fuel sources, consistent with the natural resources of this state, and review the safety standards regarding the production, transportation and use of hydrogen by state agencies.
Tennessee	SB 1959	18 Mar, 2022	Enacts the Tennessee Natural Gas Innovation Act and defines innovative natural gas source to include farm gas, biogas, renewable natural gas, hydrogen, carbon capture, qualified assets, renewable natural gas attributes, and energy efficiency resources; allows the utility commission to authorize a recovery mechanism, or adjust rates through a utility's existing annual review process to recover operational expenses or capital costs, or both, associated with the investment in natural gas innovation resources, including a return on the innovative natural gas resource capital investments.
Nebraska	LB 1099	16 Mar, 2022	Requires the Department of Economic Development to create the Nebraska Hydrogen Hub Industry Work Group to develop and outline a competitive proposal for submission to DOE, to be selected as one of the four regional clean hydrogen hubs authorized under IIJA; requires the work group shall also build a plan to make case for an agricultural-based clean hydrogen hub, expanding the existing eligible purposes.

Select Enacted State Legislation Related to Hydrogen

State	Bill Number	Date of Enactment	Description
Washington	SB 5910	28 Feb, 2022	Defines green electrolytic hydrogen as hydrogen produced through electrolysis, and does not include hydrogen manufactured using steam reforming or any other conversion technology that produces hydrogen from a fossil fuel feedstock; exempts green electrolytic hydrogen from certain taxes.
Washington	HB 1812	28 Feb, 2022	Establishes the Energy Facility Site Evaluation Council as an independent agency separate from the Utilities and Transportation Commission; authorizes clean energy product manufacturing facilities, storage facilities, renewable natural gas facilities, and renewable or green electrolytic hydrogen facilities to opt into the council's siting process.
Alabama	SB 36	16 Feb, 2022	Defines underground storage facilities further to include the storage of carbon dioxide, ammonia, hydrogen, nitrogen, and noble gases; authorizes the State Oil and Gas Board to regulate the operation and abandonment of underground storage facilities and adopt rules providing fees and charges to defray the expenses in such regulation.

Upcoming Events

Oct. 11, 2022 — DOE Nuclear-Coupled Hydrogen Production

DOE is due to receive applications for projects that support the development of nuclear plant thermal integration that would be required for high-temperature hydrogen production or hydrogen-coupled end uses for nuclear energy.

Oct. 20, 2022 — DOE Clean Hydrogen Production Standard

DOE is due to receive comments on its Clean Hydrogen Production Standard draft guidance, establishing a target for the lifecycle emissions intensity of hydrogen production.

Nov. 7, 2022 — DOE Regional Clean Hydrogen Hubs

DOE is due to receive concept papers for H2Hubs across the country. The department aims to select six to ten hubs for a combined total of up to $7 billion in federal funding. Complete applications are due by April 7, 2023.

Policy Monitors

DOE/EERE

Funding Opportunity Announcements

White House

Infrastructure Investment and Jobs Act - Related Documents

DOE

Loan Programs Office Press Releases