Pioneering Hydrogen:

Envisioning a Future Hydrogen Economy Through an Analysis of the DOE's Hydrogen Hubs

STEPTOE & JOHNSON PLLC

KeyState

March 20, 2024

Presenters

Benedict J. Kirchner
Steptoe & Johnson PLLC

Meadville, PA
(814) 333-4910
benedict.kirchner@steptoe-johnson.com

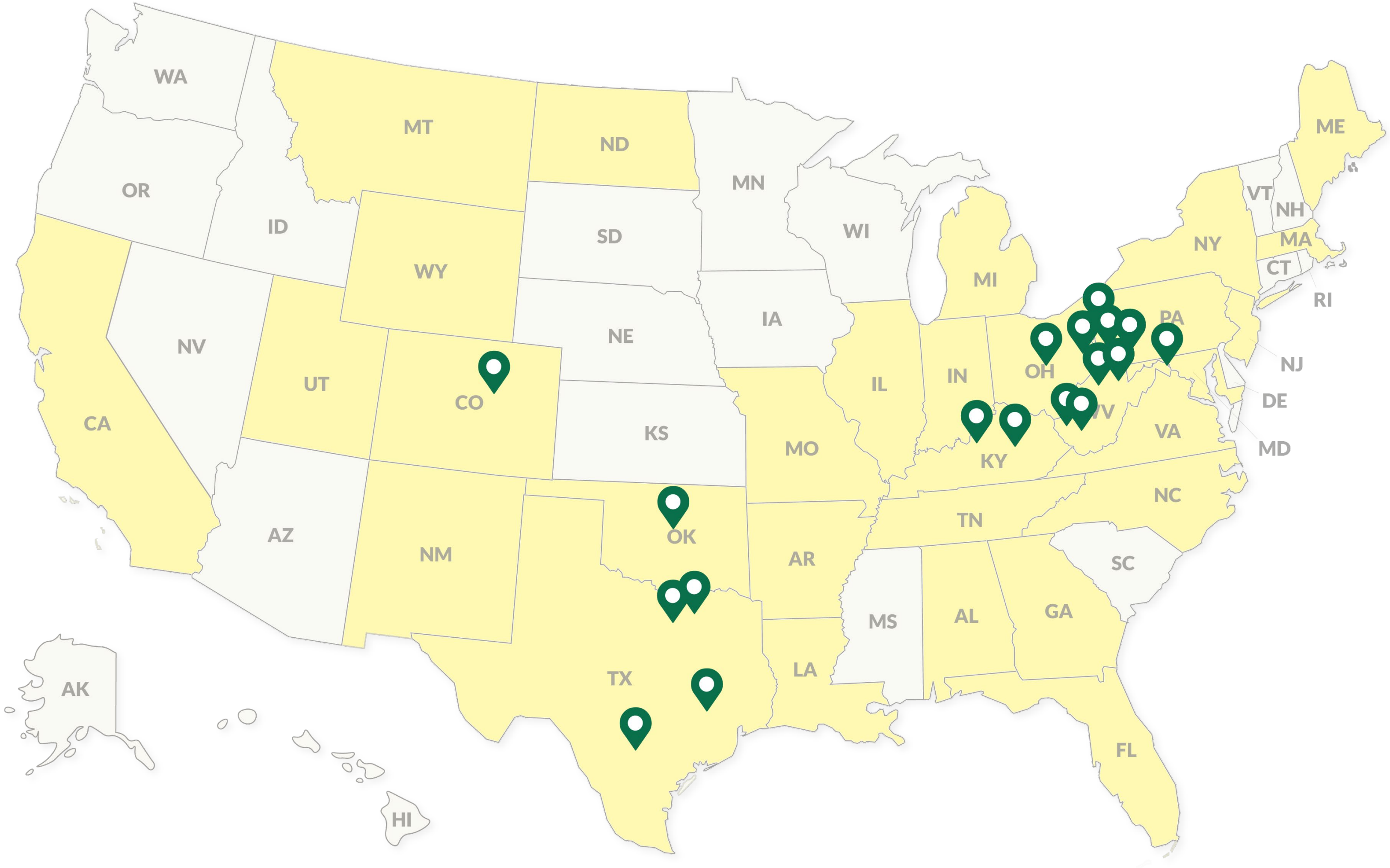
Braden L. Christopher
Steptoe & Johnson PLLC

Southpointe, PA
(724) 749-3181
benedict.kirchner@steptoe-johnson.com

Perry Babb
KeyState Energy

Bellefonte, PA
www.keystate.net

Office Locations & Attorney Licensure



Office Locations

- Bridgeport, WV
- Charleston, WV
- Collin County, TX
- Columbus, OH
- Dallas, TX
- Denver, CO
- Huntington, WV
- Lexington, KY
- Louisville, KY
- Martinsburg, WV
- Meadville, PA
- Morgantown, WV
- Oklahoma City, OK
- Pittsburgh, PA
- San Antonio, TX
- Southpointe, PA
- The Woodlands, TX
- Wheeling, WV

Attorney Licensure

STEPTOE & JOHNSON PLLC

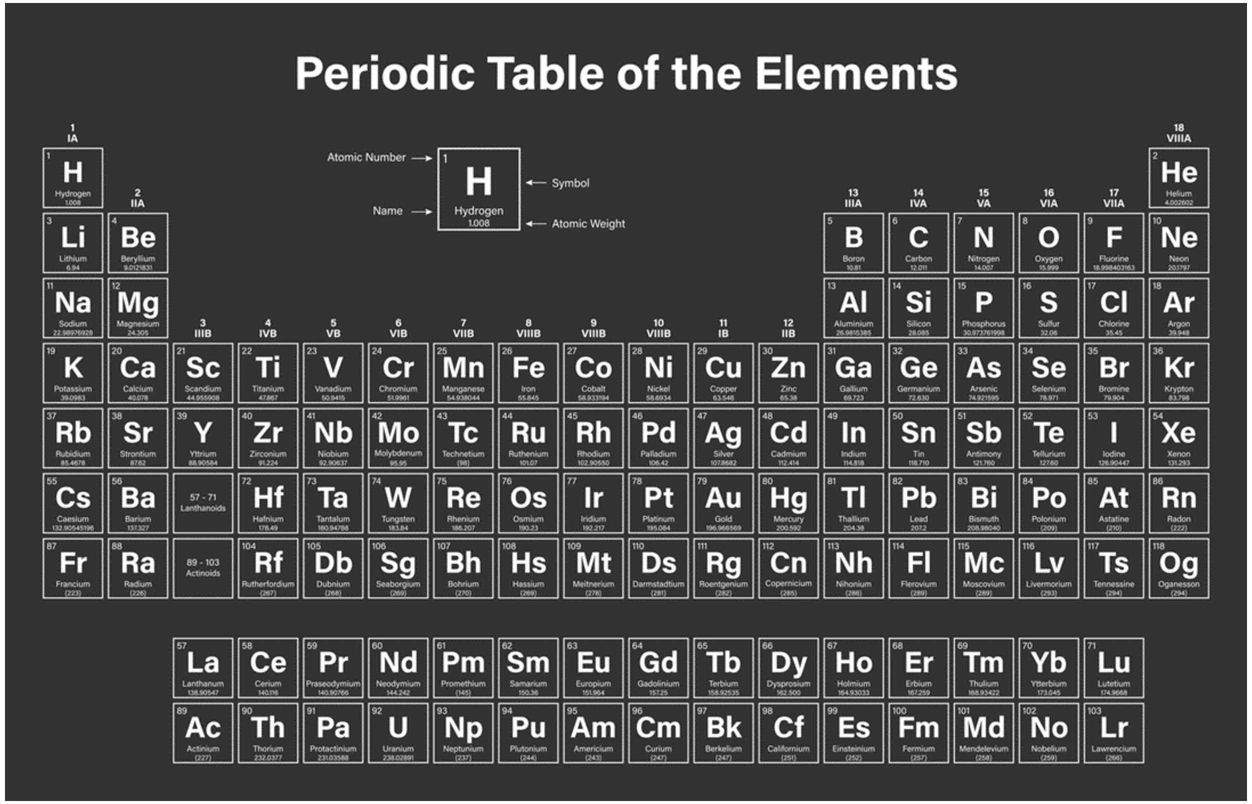
Agenda

- Introduction on Hydrogen
- Legal and Regulatory Landscape
- Overview of the Hydrogen Hubs
- Practical Perspective from KeyState Energy

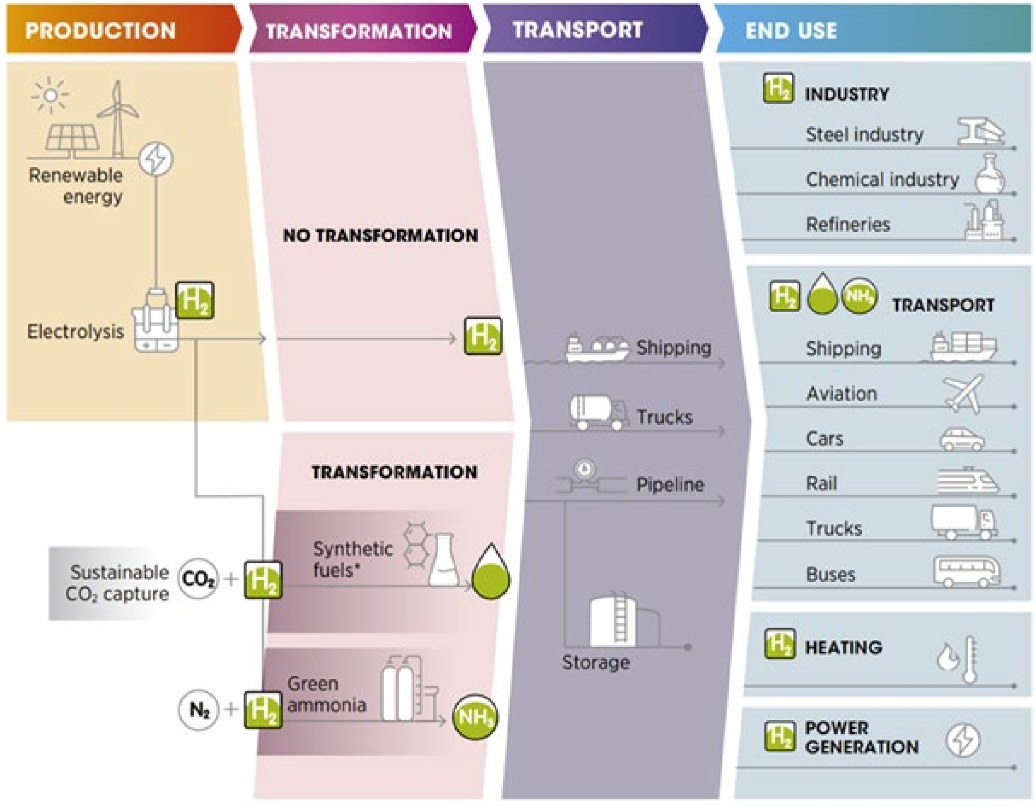
H_2 101

Why hydrogen?

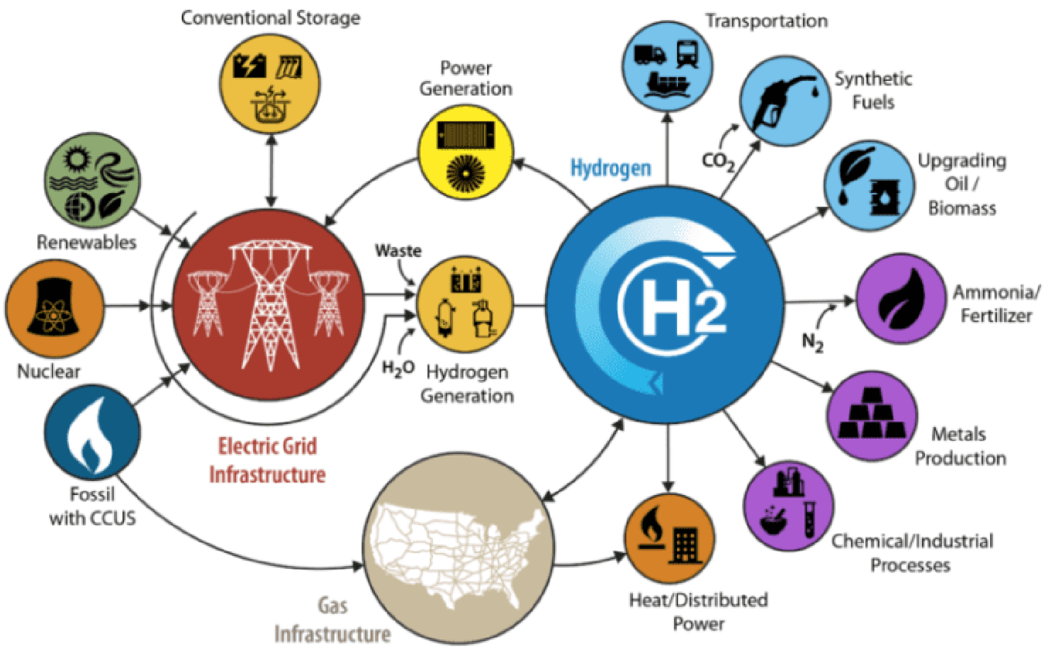
- Abundant
- Efficient
- Clean
- Applicability to heavy industry



H_2 101 – Uses

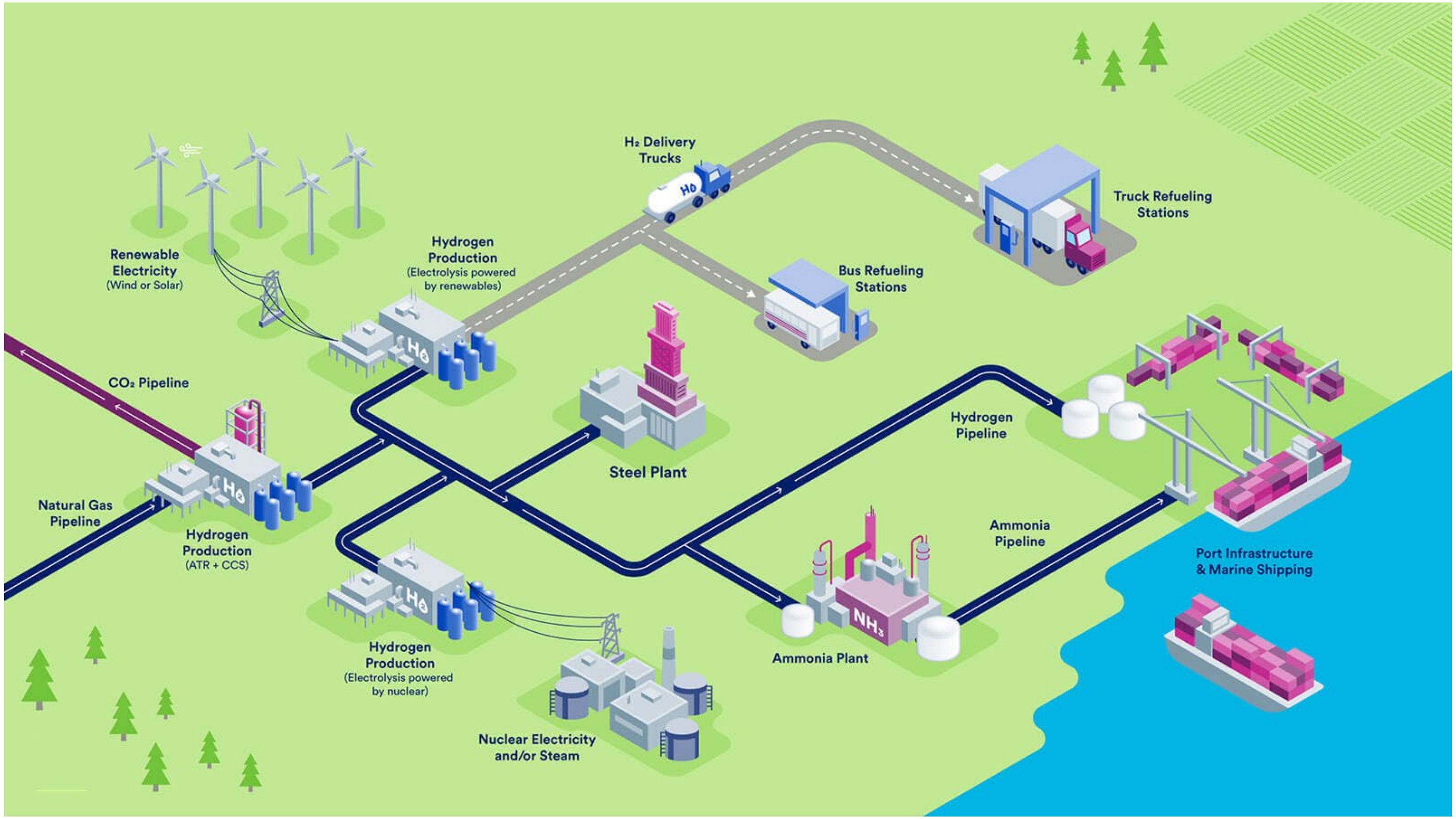


Source: IRENA.
* The term synthetic fuels refers here to a range of hydrogen-based fuels produced through chemical processes with a carbon source (CO and CO_2 captured from emission streams, biogenic sources or directly from the air). They include methanol, jet fuels, methane and other hydrocarbons. The main advantage of these fuels is that they can be used to replace their fossil fuel-based counterparts and in many cases be used as direct replacements – that is, as drop-in fuels. Synthetic fuels produce carbon emissions when combusted, but if their production process consumes the same amount of CO_2, in principle it allows them to have net-zero carbon emissions.



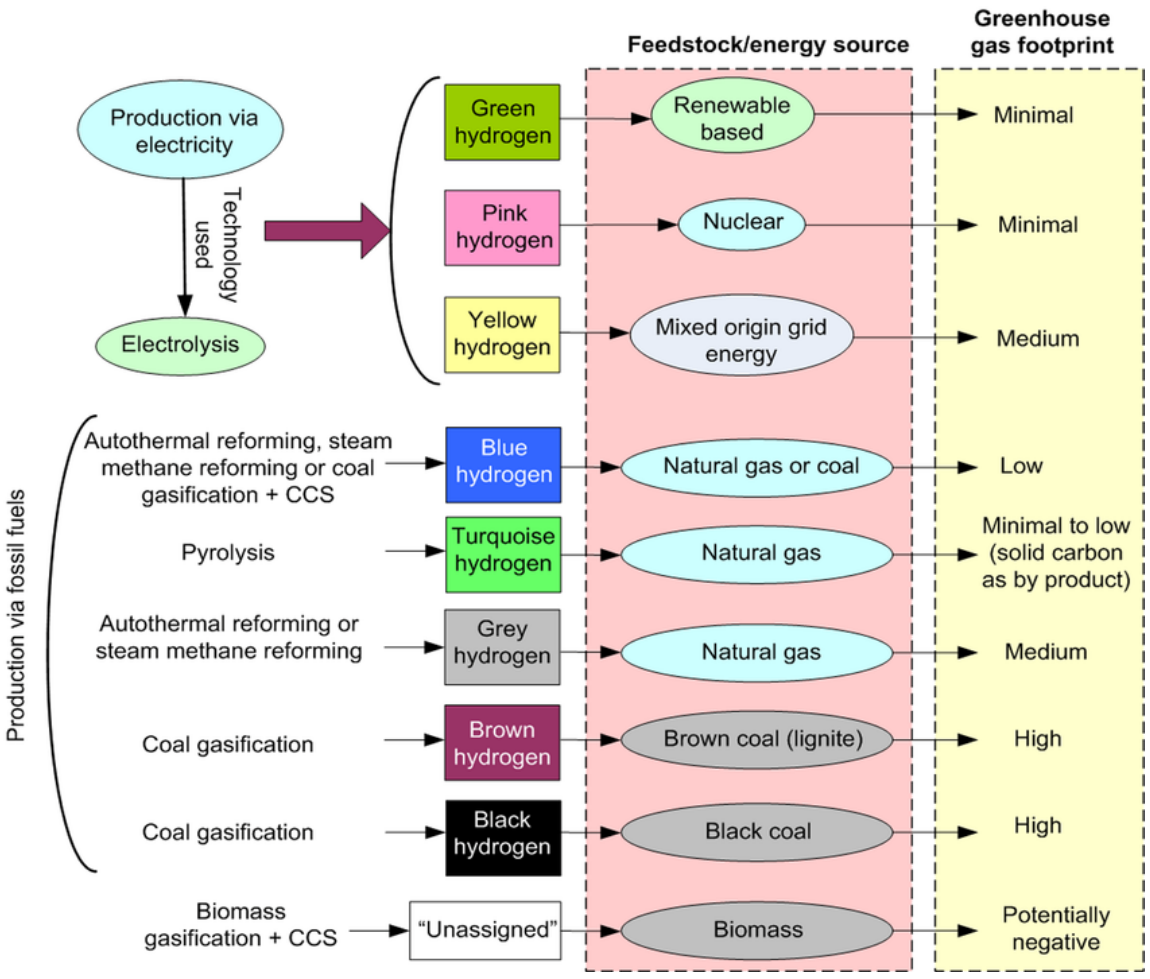
Sources: https://www.irena.org/Energy-Transition/Technology/Hydrogen and U.S. Department of Energy

H_2 101 – Uses



Source: https://www.catf.us/2023/04/us-hydrogen-hubs-what-comes-next/

H_2 101 – Types

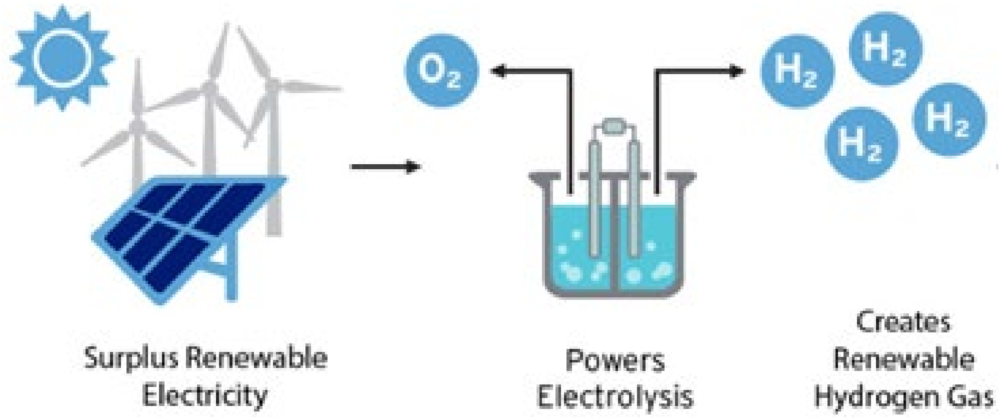


Sources: https://www.researchgate.net/figure/arious-types-of-hydrogen-production-with-greenhouse-footprint_fig1_366016700 and https://nacfe.org/news/nacfe-december-2020-newsletter/

H_2 101 – How

Green Hydrogen (Water + Renewable Energy)

- Electrolysis

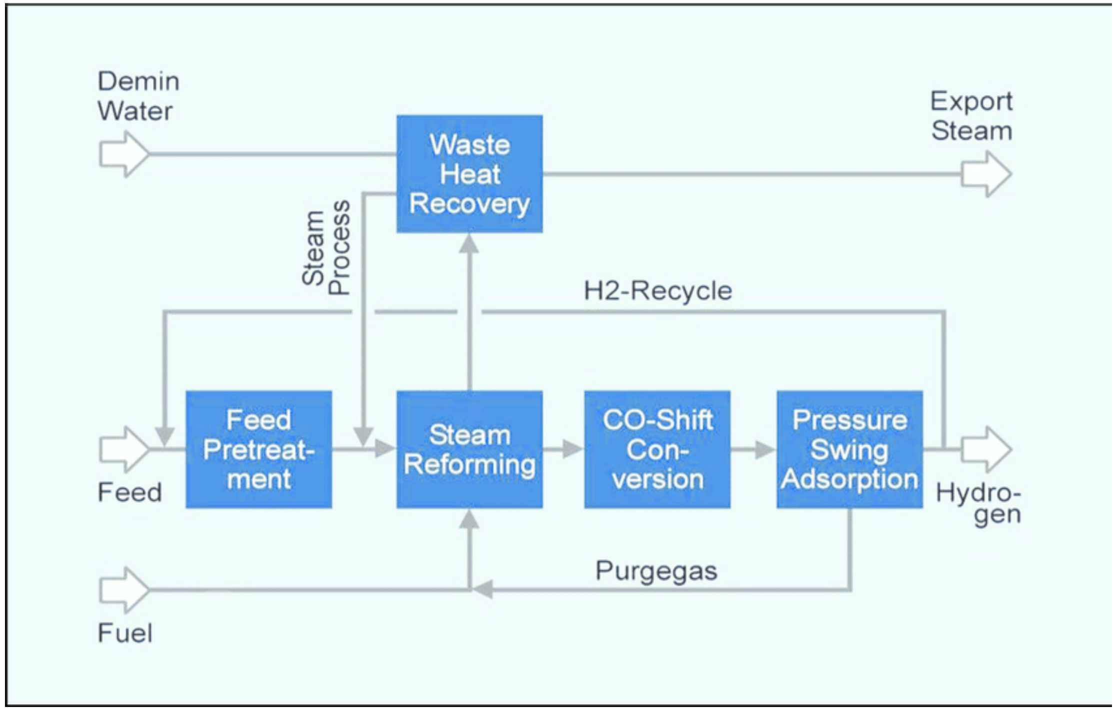


Source: https://www.haskel.com/en-kz/blog/green-hydrogen-and-windfarms

H_2 101 – How

Blue Hydrogen (Methane + Carbon Capture)

- Steam methane reforming or Auto thermal reforming



Source: https://www.researchgate.net/figure/Block-diagram-for-a-steam-methane-reformer-for-hydrogen-production_fig1_270955153

Regulatory Framework

- The good:
  - Most of the pipeline permits, other authorizations, and operation regulations are the same as, or similar to, those for oil and gas
- The bad:
  - No Natural Gas Act for interstate pipelines and FERC says it doesn't have jurisdiction
  - Need for permit reform
  - Need for additional legislation/regulation – federal, state and local

45V Proposed Rulemaking

- Announced December 2023
- Have not been finalized
- Current version does not adequately include Blue hydrogen
- Very difficult to comply with
- Comments were open until February; public hearing is scheduled for March 25^{th}
- Final version likely not out until the end of April at the earliest

Clean Hydrogen Standard Applied to 45V

- DOE Clean Hydrogen Production Standard (CHPS) (42 USC 16166)
  - Maximum of 4 kg CO2e / kg H2 measured well-to-gate (upstream through the point of production, including carbon capture)

- 45V Draft credits:

Emissions intensity (kgCO2e/kgH2)	Maximum tax credit ($/kgH2)
0-0.45	$3.00
0.45-1.5	$1.00
1.5-2.5	$0.75
2.5-4	$0.60

Challenges

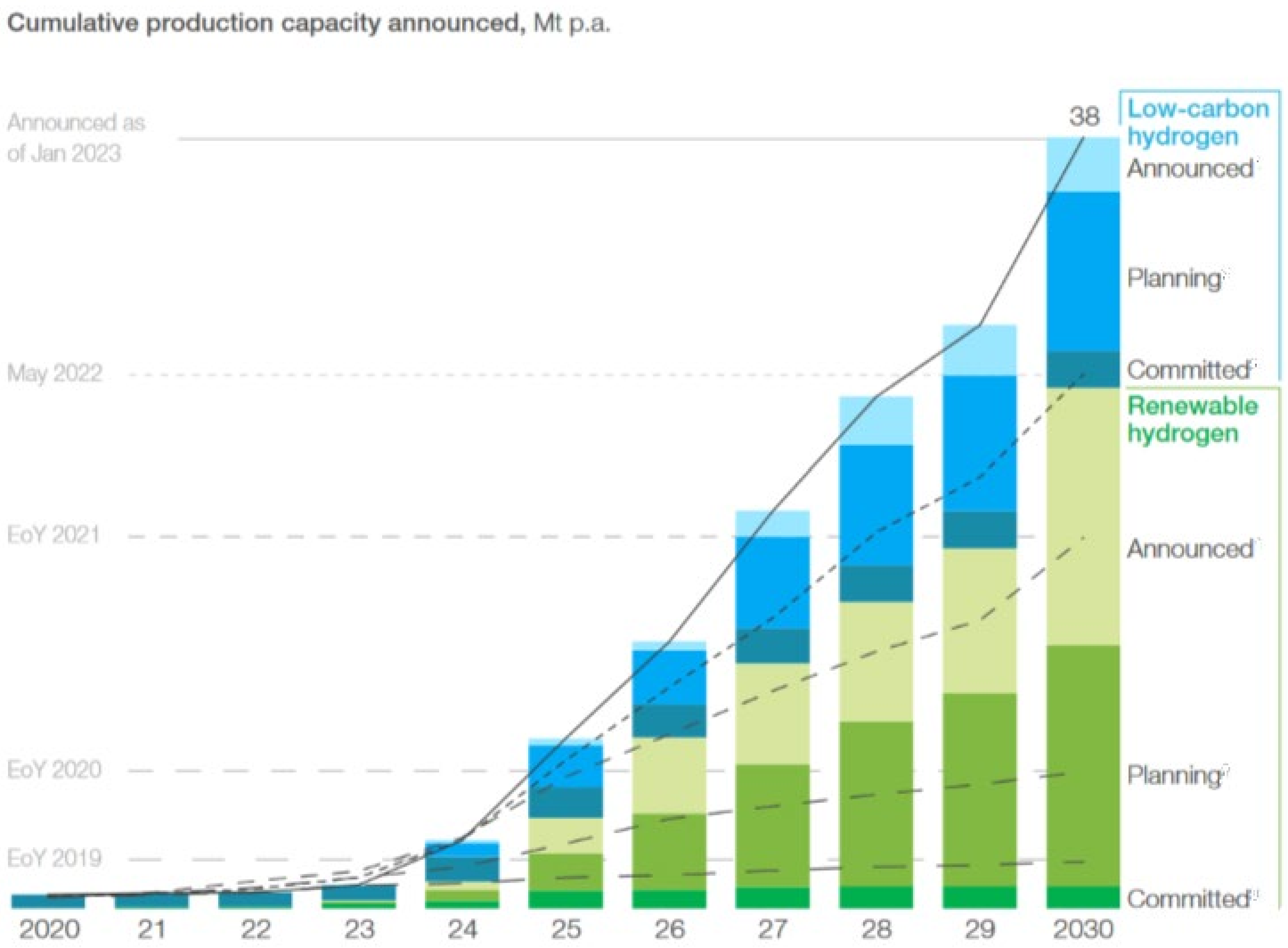
- Production inefficiency/loss of energy
- Cost
- Market
- Regulation (lack thereof)
- Midstream
- Emerging technology

Challenges in Focus: FERC Expresses Doubt About Hydrogen as Fuel

- "[H]ydrogen has a number of physical characteristics that make it **impractical** as a replacement for natural gas or other hydrocarbons in the economy, at least on a significant scale." "Hydrogen has **the highest energy content of any fuel by weight**…, but it has the lowest energy content by volume." This has serious implications for the practicality (and commercial viability) of transporting large volumes of hydrogen over substantial distances…. The opportunity cost of transporting a low energy density fuel, necessarily displacing higher energy density fuel in the process, would likely **raise the overall cost of energy** significantly."
- Also, "it takes **more energy to produce hydrogen** (by separating it from other elements in molecules) than hydrogen provides when it is converted to useful energy." This raises profound questions about the practicality of producing the quantities of hydrogen that would be needed for a "hydrogen economy." **A vast amount of surplus energy would be needed to supply enough hydrogen to replace natural gas.**

Source: FERC August 9, 2023 written responses to House subcommittee

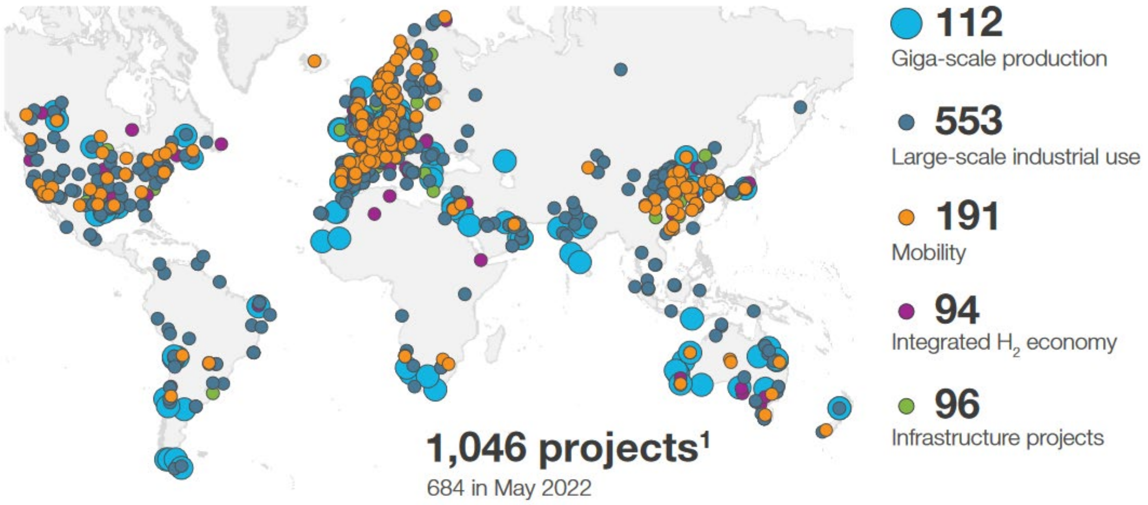
Level Setting

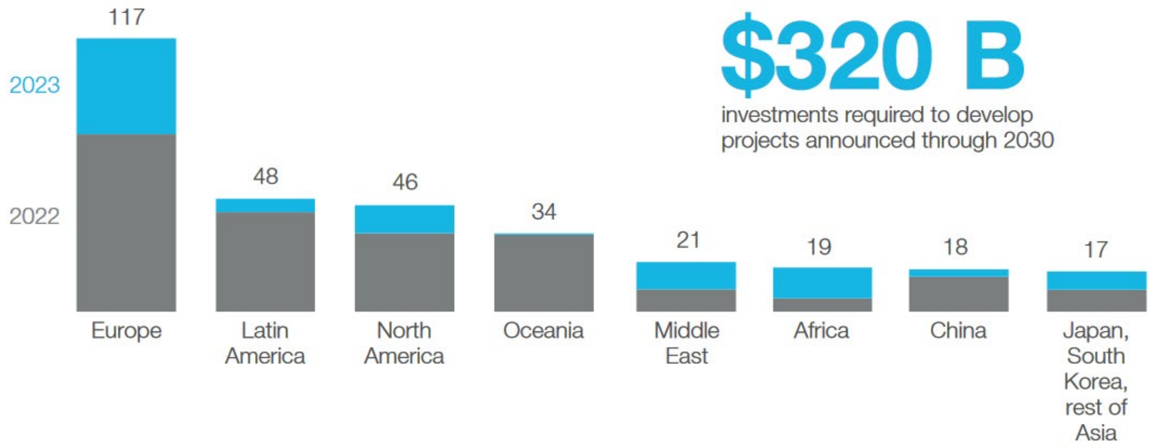


Source: https://hydrogencouncil.com

Road Map of Projects

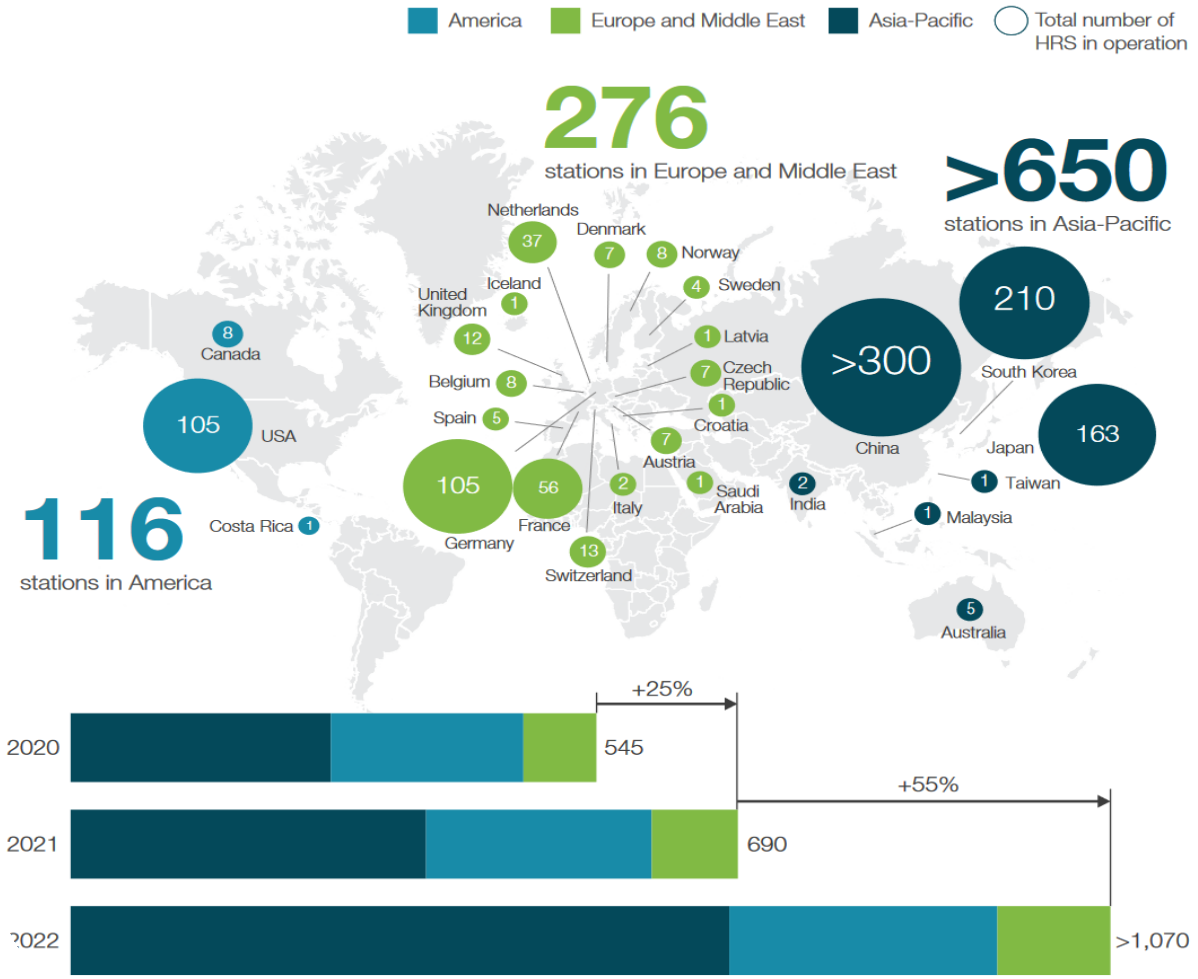
- Only $29B of announced projects have achieved Final Investment Decision (FID) so far
- Over $3B invested in US H_2 Storage projects
- U.S. Hydrogen Hub project will account for $15B ($7B public funding for infrastructure, $7B private funding for infrastructure, and $1B public fund for demand side projects





Sources: https://hydrogencouncil.com, https://www.law360.com/articles/1694185/print?section=capitalmarkets, and https://www.thehydrogenmap.com/ (Pillsbury)

Hydrogen Fuel Stations



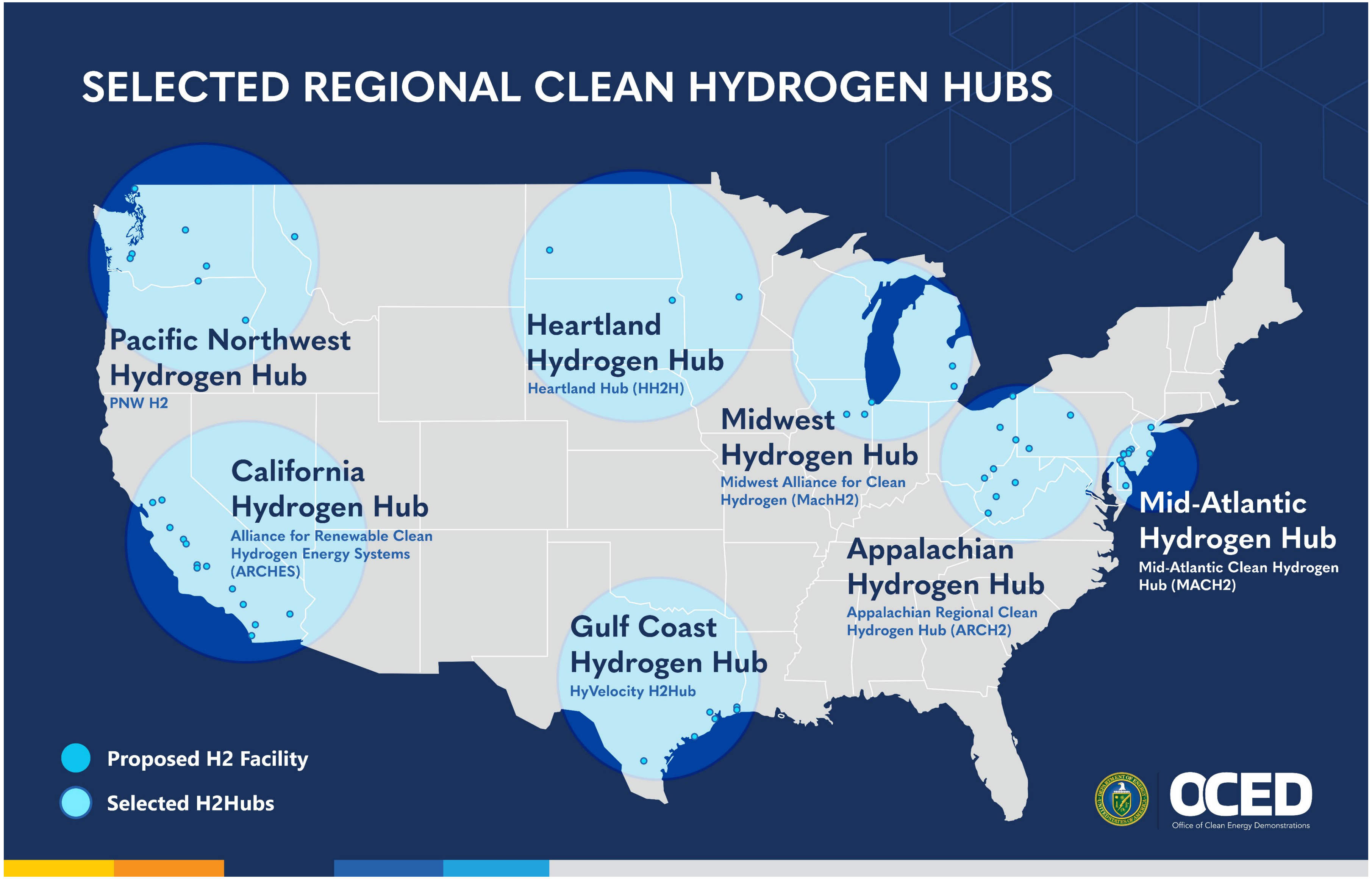
Source: https://hydrogencouncil.com and https://www.h2stations.org/

Overview of Hydrogen Hubs

Infrastructure Investment and Jobs Act (Infrastructure Bill)

- Signed into law in November 2021
- Significant provisions relating to the development of clean hydrogen – produced with a carbon intensity equal to or less than 2kg of CO2 per kg of hydrogen
- $8 Billion in funding to establish at least 4 regional clean hydrogen hubs
- DOE's Hydrogen Shot: 1 decade to reach $1 per kilogram of clean hydrogen
- Focuses on hydrogen production, storage, transport, and utilization technologies. It encourages collaboration across government, private sector, academic institutions, and national labs. 42 U.S.C. § § 16151-16166.
- Hydrogen from diverse sources, including renewable energy, nuclear power, and fossil fuels with CCUS
- 7 hubs selected in October 2023 for potential funding

Source: https://www.energy.gov/articles/biden-harris-administration-announces-7-billion-americas-first-clean-hydrogen-hubs-driving



Source: https://www.energy.gov/sites/default/files/2023-10/Selected%20Regional%20Clean%20Hydrogen%20Hubs%20Map%20Blue_0.png

Hub Name	Location	Focus	Direct Jobs	Funding
Mid-Atlantic Hydrogen Hub (MACH2)	Pennsylvania, Delaware, New Jersey	Decarbonizing with renewable and nuclear electricity, repurposing historic oil infrastructure	20,800	Up to $750 million
Appalachian Hydrogen Hub (ARCH2)	West Virginia, Ohio, Pennsylvania	Utilizing low-cost natural gas, supporting ammonia production, and hydrogen refueling stations	Over 21,000	Up to $925 million
California Hydrogen Hub (ARCHES)	California	Green hydrogen from renewable energy and biomass for transportation and industrial decarbonization	220,000	Up to $1.2 billion
Gulf Coast Hydrogen Hub (HyVelocity)	Texas	Large-scale production through natural gas with CCS and renewable-powered electrolysis	Approximately 45,000	Up to $1.2 billion
Heartland Hydrogen Hub	Minnesota, North Dakota, South Dakota	Decarbonizing agriculture, enhancing clean hydrogen use in power and heating	Upwards of 3,880	Up to $925 million
Midwest Hydrogen Hub (MachH2)	Illinois, Indiana, Michigan	Supporting decarbonization in manufacturing, refining, and heavy-duty transportation	13,600	Up to $1 billion
Pacific Northwest Hydrogen Hub (PNW H2)	Washington, Oregon, Montana	Renewable resource-based hydrogen for transportation, energy storage, and agriculture	More than 10,000	Up to $1 billion

Source: https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/13/biden-harris-administration-announces-regional-clean-hydrogen-hubs-to-drive-clean-manufacturing-and-jobs/

Gulf Coast Hydrogen Hub (HyVelocity)

Partnerships and Leadership: Collaboration among AES Corporation, Air Liquide, Chevron, ExxonMobil, Mitsubishi Power Americas, Ørsted, and Sempra Infrastructure, administered by GTI Energy. Boasts over 90 supporting partners from various sectors.

Energy Assets

- Broad base of industrial energy customers across multiple demand segments
- Welcoming environment for infrastructure development
- 33% of U.S. hydrogen production capacity
- Highly skilled energy workforce (11% of U.S. energy jobs)
- Large concentration of academic and industry-driven energy innovation: major research universities and a new innovation campus
- Largest energy manufacturing cluster (7000+ establishments)

Production capacity

- Largest renewable energy market in the nation (36 GW wind, 15 GW solar)
- 2.4 billion tons of CO_2 storage capacity (10,000x Houston's current CO_2 emissions)
- Access to abundant low-cost natural gas (11.2 Tcf natural gas produced in 2022)

Transportation & storage

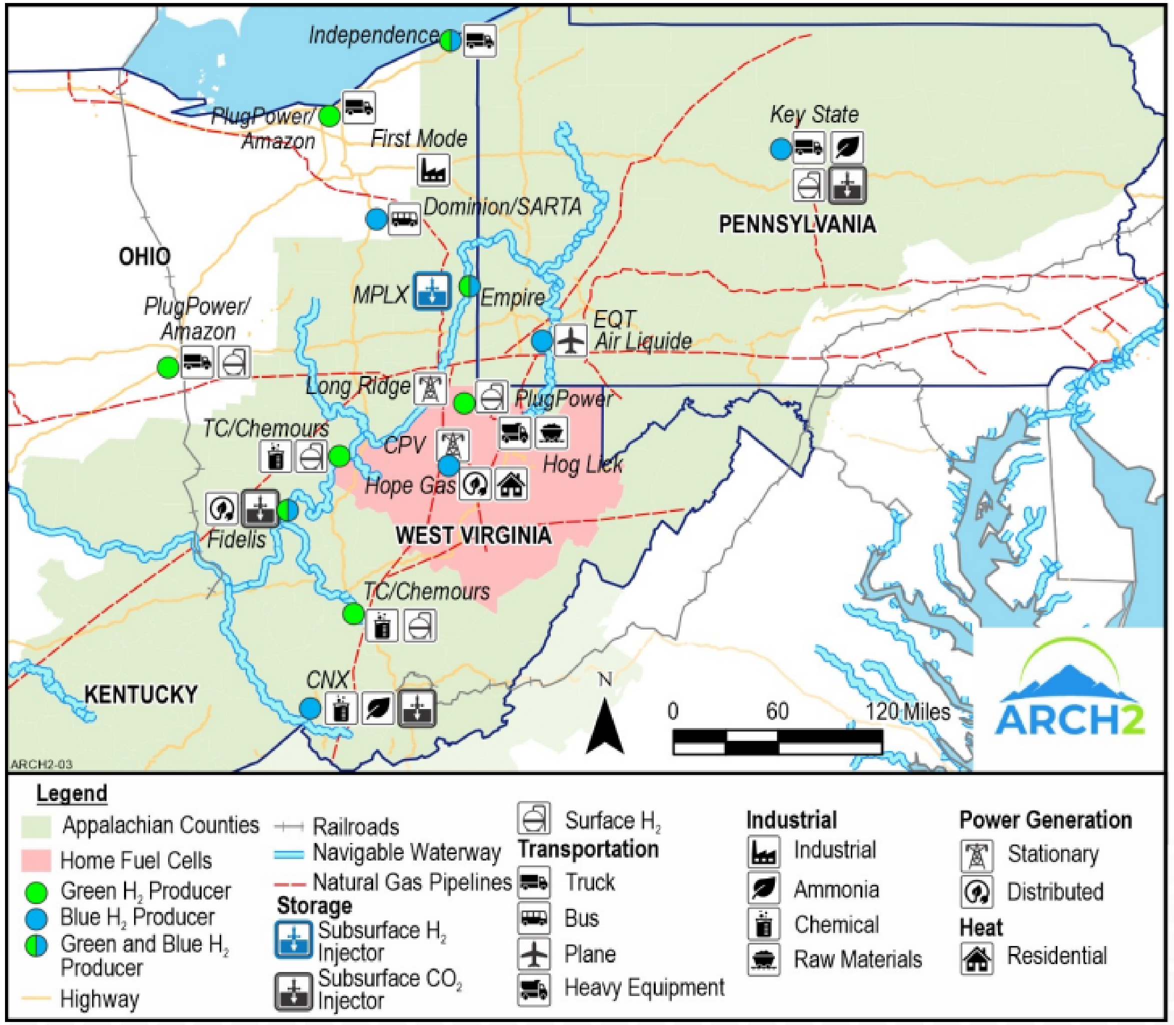
- 1,000+ miles of hydrogen pipeline – largest networks in the nation
- 3 of the six hydrogen storage caverns in the world

Source: McKinsey and CHF Gulf Coast Hydrogen Roadmap . 2022 US DOE Energy and Employment Report

1

Source: https://www.hyvelocityhub.com/#:~:text=Supply%20and%20Demand-,HyVelocity%20Hub%3A%20Rapidly%20Scaling%20Clean%20Hydrogen%20Supply%20and%20Demand,along%20the%20U.S.%20Gulf%20Coast

Appalachian Regional Clean Hydrogen Hub (ARCH2)



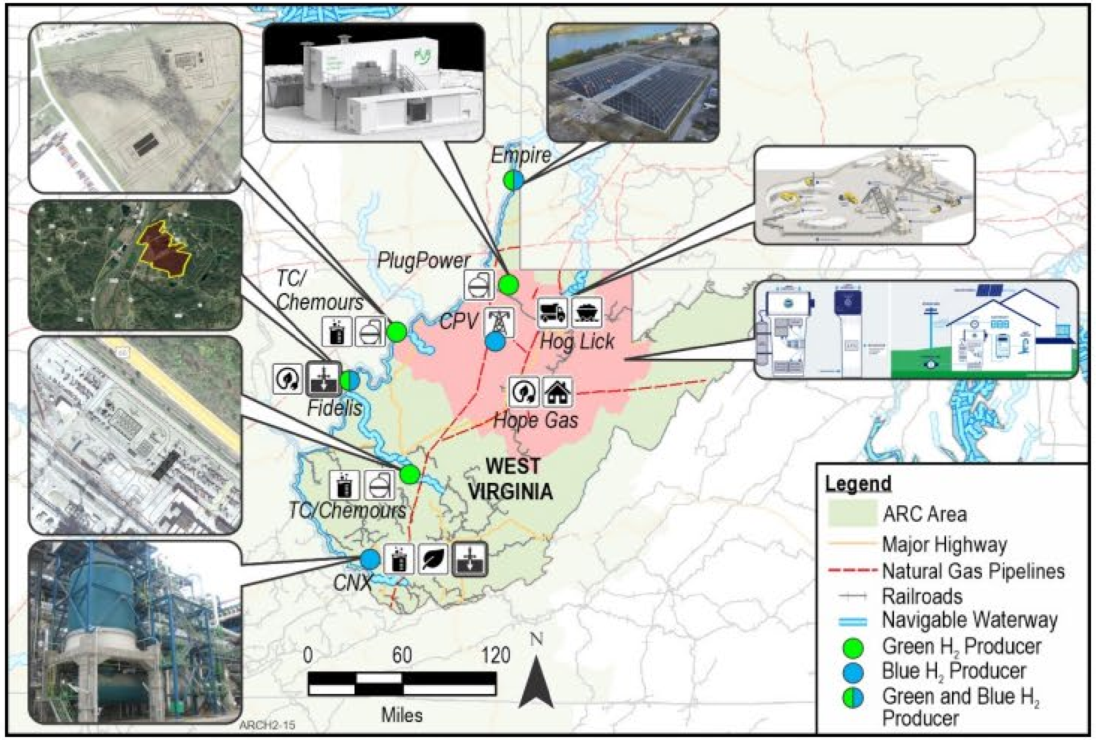
Note: Proposed project locations based on preliminary siting are subject to change during the detailed planning phase (phase 1).

Source: https://www.energy.gov/sites/default/files/2023-10/H2Hubs_Appalachian_Community_Briefing.pdf

STEPTOE & JOHNSON PLLC

ARCH2 Project Summaries

- **CNX/ TransGas:** Low-CI ammonia production
- **TC Energy/ Chemours**: Electrolysis-based H2 production in two chemical facilities
- **Fidelis / Mountaineer GigaSystem**: NG + biomass to produce Low CI H2 for datacenters, other off-takers.
- **HLA:** H2 off-taker: H2 use as fuel for off-site aggregate delivery trucks and on-site haul trucks/equipment.
- **Hope Gas/ WATT Fuel Cell Corp / EQT**: Produce clean H2 from NG for blending in Hope local distribution system and residential fuel cells.
- **Empire Diversified Energy**: Anaerobically digested food waste based H2 production for industrial and transportation fuel.
- **Plug Power/ Amazon:** Green H2 production facility in northern WV.



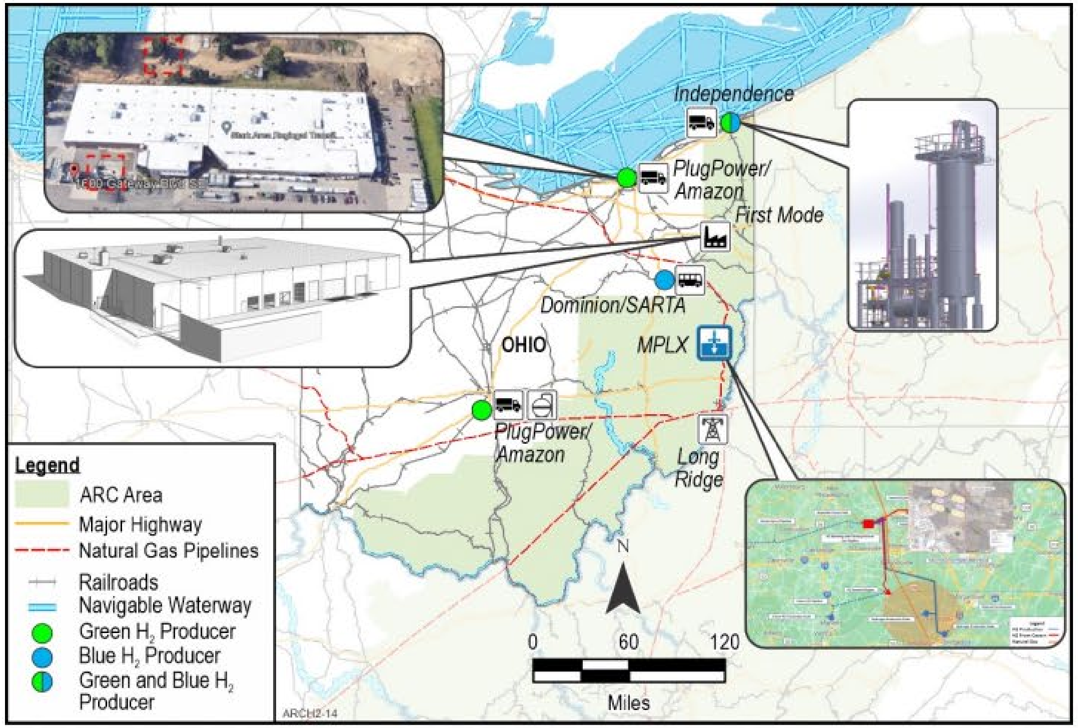
Note: Proposed project locations based on preliminary siting are subject to change during the detailed planning phase (phase 1).

Source: https://www.energy.gov/sites/default/files/2023-10/H2Hubs_Appalachian_Community_Briefing.pdf

STEPTOE & JOHNSON PLLC

ARCH2 Project Summaries

- **MPLX:** H_2 storage facility development with connective infrastructure to support ARCH2 producers, storage, and end-users
- **Dominion Energy Ohio**: H2 production with CO_2 capture to supply H_2 to regional transit (e.g., SARTA)
- **Plug Power/ Amazon:** One distribution center with H_2 fueling MHE; fueling station FCEV delivery trucks.
- **First Mode:** H_2 end-user: Manufacturing facility for retrofitting mining trucks with H_2 fuel cell power system.
- **Independence Hydrogen:** H2 production facility using industrial off-gas as feedstock in Ashtabula, Ohio to provide clean hydrogen for material handling equipment at distribution centers.

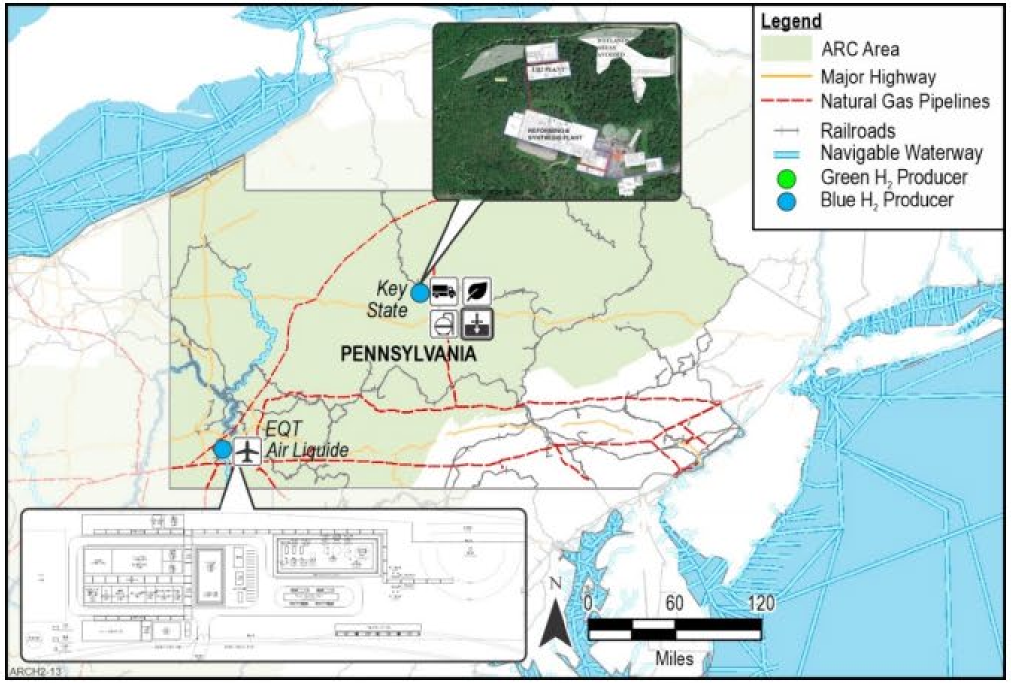


Note: Proposed project locations based on preliminary siting are subject to change during the detailed planning phase (phase 1).

Source: https://www.energy.gov/sites/default/files/2023-10/H2Hubs_Appalachian_Community_Briefing.pdf

ARCH2 Project Summaries

- **EQT-GTL:** Low-carbon NG and renewable natural gas (RNG) (as required) to produce low-carbon aviation fuel.
- **Air Liquide -** Liquified H2 facility in southwest PA to serve as an offtake for EQT's excess hydrogen to be used in the mobility sector.
- **KeyState:** H_2 production plus other products (NH3, urea/diesel exhaust fluid (DEF))



Note: Proposed project locations based on preliminary siting are subject to change during the detailed planning phase (phase 1).

Source: https://www.energy.gov/sites/default/files/2023-10/H2Hubs_Appalachian_Community_Briefing.pdf

Perry Babb, CEO

KeyState Energy

Overview of Projects and Discussion

Source: https://keystate.net/projects/pa/

PRESS ROOM

KeyState's Clean Hydrogen and Carbon Storage Project Secures Funding through the Appalachian Regional Clean Hydrogen Hub (ARCH2) $925 Million Federal Grant

Pennsylvania, US, October 31, 2023 – the US Department of Energy made a significant announcement, selecting the Appalachian Regional Clean Hydrogen Hub (ARCH2) as one of seven regional hubs to receive federal grants totaling $7 billion for the advancement of the clean hydrogen economy. ARCH2 was granted $925 million.

KeyState Natural Gas Synthesis ("Keystate"), a portfolio company of specialist decarbonization investor, Climate Investment, serves as a Principal Project of ARCH2 and is a recipient of these grants. In response to this transformational development, Perry Babb, President of KeyState Energy, and the project's developer, stated, "With this announcement, KeyState will receive substantial grant funding over the coming years to undergird the much larger private sector investment required to develop KeyState's Clean Hydrogen and Carbon Storage Complex in North Central Pennsylvania."

KeyState's pioneering approach encompasses on-site natural gas extraction, methane conversion into hydrogen and carbon, and the underground storage of CO_2, powered by zero-carbon sources. This innovative process enables large-scale, high-quality hydrogen production that meets the most stringent requirements for Qualified Clean Hydrogen under the Federal Hydrogen Production Tax Credit.

The produced clean hydrogen will be directed toward serving the hydrogen fuel cell heavy truck market and supporting the production of ammonia and urea for diverse industries, including agriculture, medicine, and transportation.

KeyState's project is poised to capture and store over 500,000 tons of CO_2 annually while concurrently contributing to historic emissions reduction and job creation in the Appalachian region.

During the construction phase, KeyState is expected to generate more than 1,000 jobs, and its impact will extend to workforce development initiatives across numerous school districts, vocational schools, and two- and four-year colleges. This economic influence will be felt across a multicounty region spanning Clinton, Clearfield, Cameron, and Centre counties.

Pennsylvania, with its history of energy transitions spanning over 300 years, is well-prepared to lead the global hydrogen sector. The state's abundant reserves of low-cost natural gas, substantial geological storage potential, and a legacy of energy innovation position Pennsylvania and Appalachia as emerging global hydrogen leaders for the next 30 years.

Source: https://keystate.net/arch2/

Questions?

Benedict J. Kirchner
Steptoe & Johnson PLLC

Meadville, PA
(814) 333-4910
benedict.kirchner@steptoe-johnson.com

Braden L. Christopher
Steptoe & Johnson PLLC

Southpointe, PA
(724) 749-3181
benedict.kirchner@steptoe-johnson.com

Perry Babb
KeyState Energy

Bellefonte, PA
www.keystate.net

Disclaimer

These materials are public information and have been prepared solely for educational purposes. These materials reflect only the personal views of the authors and are not individualized legal advice. It is understood that each case and/or matter is fact-specific, and that the appropriate solution in any case and/or matter will vary. Therefore, these materials may or may not be relevant to any particular situation. Thus, the presenters and Steptoe & Johnson PLLC cannot be bound either philosophically or as representatives of their various present and future clients to the comments expressed in these materials. The presentation of these materials does not establish any form of attorney-client relationship with the authors or Steptoe & Johnson PLLC. While every attempt was made to ensure that these materials are accurate, errors or omissions may be contained therein, for which any liability is disclaimed.


SJ
STEPTOE
&JOHNSON
PLLC