

Hydrogen

an ideal alternative
energy source for the rail

Hydrogen Power

Will It Work In Colorado?



graphic courtesy of Alstom

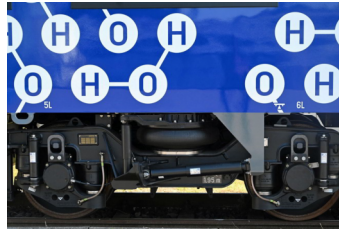
Headlines

20 October 2022 12:11 GMT

'Will no longer be considered' | Hydrogen trains up to 80% more expensive than electric options, German state finds

Study commissioned by Baden-Württemberg concludes that line electrification or battery hybrid trains would be far cheaper over 30 years

On the Westfrankenbahn line, the TCO (total cost of ownership) of a hydrogen-powered operation would be €849m (\$833m), compared to €506m for a battery hybrid and €588m for conventional electric trains.



5 April 2023 13:28 GMT

Italy allocates €300m to new hydrogen trains and associated green H2 projects

Ministry of Infrastructure and Transport assigns €24m for new rolling stock and €276m for the production, storage and supply of renewable hydrogen

16 June 2023 14:10 GMT

World first as Chinese company converts diesel locomotive to run on hydrogen fuel cells

CRRC says its Ningdong locomotive can hold 270kg of H₂, allowing it to operate continuously for up to 190 hours

3 August 2023 12:50 GMT

No more hydrogen trains | Rail company that launched world's first H2 line last year opts for all-electric future

State-owned LNVG to buy 102 battery trains and 27 catenary-connected models in order to phase out diesel, says Lower Saxony government



Headlines

6 February 2023 13:44 GMT

Indian Railways will spend \$335m on 35 new hydrogen trains – making it the world's biggest H2 rail operator

State railway firm to spend \$9.7m per train across narrow-gauge 'heritage' routes — giving it more than twice as many hydrogen locomotives as the next largest operator in Germany

Oct 12, 2023

Arriving Soon in California: First Intercity Zero-Emission, Hydrogen Passenger Trains in North America

Caltrans today signed a historic, \$80 million contract with Stadler Rail, Inc. to deliver the first zero-emission, hydrogen intercity passenger trains in North America, furthering California's standing as a world leader in clean transportation.



7 June 2023 8:01 GMT

The 'misery' line | World's largest hydrogen train fleet still not fully operational six months after service began

German transport authority will provide free travel for two months to compensate fed-up passengers for the 'incredible amount of bad public transport'

Oct. 11, 2023

Alstom releases results of North America's first demonstration of hydrogen-powered trains

The Coradia iLint carried more than 10,000 passengers, over 130 trips spanning 10,660 kilometers in Quebec this summer from mid-June to the end of September.

Headlines

13 October 2023 9:59 GMT

US reveals the seven regional Hydrogen Hubs to receive \$7bn of government funding

White House says the clean H2 developments will 'catalyze more than \$40bn in private investments'

Mid-Atlantic Hydrogen Hub (Mid-Atlantic Clean Hydrogen Hub (MACH2); Pennsylvania, Delaware, New Jersey) — (Amount: up to \$750m)

Appalachian Hydrogen Hub (Appalachian Regional Clean Hydrogen Hub (ARCH2); West Virginia, Ohio, Pennsylvania) — (Amount: up to \$925m)

California Hydrogen Hub (Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES); California) — (Amount: up to \$1.2bn)

Gulf Coast Hydrogen Hub (HyVelocity Hydrogen Hub; Texas) — (Amount: up to \$1.2bn)

Heartland Hydrogen Hub (Minnesota, North Dakota, South Dakota) — (Amount: up to \$925m)

Midwest Hydrogen Hub (Midwest Alliance for Clean Hydrogen (MachH2); Illinois, Indiana, Michigan) — (Amount: up to \$1bn).

Pacific Northwest Hydrogen Hub (PNW H2; Washington, Oregon, Montana) — (Amount: up to \$1bn)

In the end, 22 proposals publicly announced that they were applying in full, but 15 of those are now unlikely to move forward without the generous subsidies.



25 September 2023 12:07 GMT

Cost of green hydrogen unlikely to fall 'dramatically' in coming years, admit developers

Renewable H2 costs are actually increasing in the short term due to increased capex and shortages in electrolyser manufacturing capacity; cost of regulation

The biggest factor behind the rise in cost is simply that the upstream renewables for hydrogen production are highly exposed to increases in the cost of capital.

19 October 2023 7:59 GMT

Green hydrogen price in Europe unlikely to fall below €5/kg by 2030, putting off potential offtakers: analyst

The previous consensus figure of €3/kg will not be reached due to ongoing economic challenges, but policymakers can still do a lot to reduce costs, says BCG



Hydrogen Manufacture “Typology”



Projected Impact from ARCH2
Project Benefits

Appalachian Regional Clean Hydrogen Hub

West Virginia, Ohio, Pennsylvania

blue hydrogen derived from natural gas with associated CO₂ emissions captured and permanently stored; includes **hydrogen pipelines** and **multiple H₂ refueling stations**

<https://www.arch2hub.com/>



Mid-Atlantic Hydrogen Hub

Pennsylvania, Delaware, New Jersey

green and **pink** hydrogen via electrolyzers, and seems to be led by the three state governments; 15 “anchor partners”, including industrial gases giant **Air Liquide**, electrolyser and fuel-cell manufacturer Bloom Energy and **power companies PSEG and Chesapeake Utilities**

<https://www.midatlantichydrogenhub.com/>



Alliance for Renewable Clean Hydrogen Energy Systems

California

green hydrogen from renewables and biomass that will be primarily used to decarbonise public transport, heavy-duty trucking and port operations; There are 203 partners in the project

<https://archesh2.org/>



HyVelocity Hydrogen Hub

Texas

both **green** and **blue** hydrogen; describes itself as an “industry-led hydrogen hub” that includes seven core partners

<https://www.hyvelocityhub.com/>



Hydrogen Manufacture “Typology”

Heartland Hydrogen Hub

Minnesota, North Dakota, South Dakota

blue hydrogen that will utilize natural gas that would otherwise be flared; project partners are Minneapolis-based power and gas utility Xcel Energy; oil refiner Marathon Petroleum; and Canadian energy infrastructure company TC Energy, in collaboration with the University of North Dakota



Midwest Alliance for Clean Hydrogen

Illinois, Indiana, Michigan

green, blue and pink hydrogen (from nuclear energy); the hub will employ electrolysis technology to split the hydrogen and oxygen molecules in water.

MachH2 will use existing and new clean generation resources including nuclear, renewables, and blue hydrogen utilizing carbon capture and sequestration.

<https://machh2.com/>

NOT SELECTED

Western Inter-States Hydrogen Hub

Colorado, New Mexico, Utah, Wyoming

Opportunities for Low-Carbon Hydrogen in Colorado: A Roadmap discusses the feasibility for such an action in Colorado and identifies types of production but does not identify partners, nor a specific production methodology nor an implementation plan.

<https://energyoffice.colorado.gov/climate-energy/western-inter-states-hydrogen-hub>



Pacific Northwest Hydrogen Hub

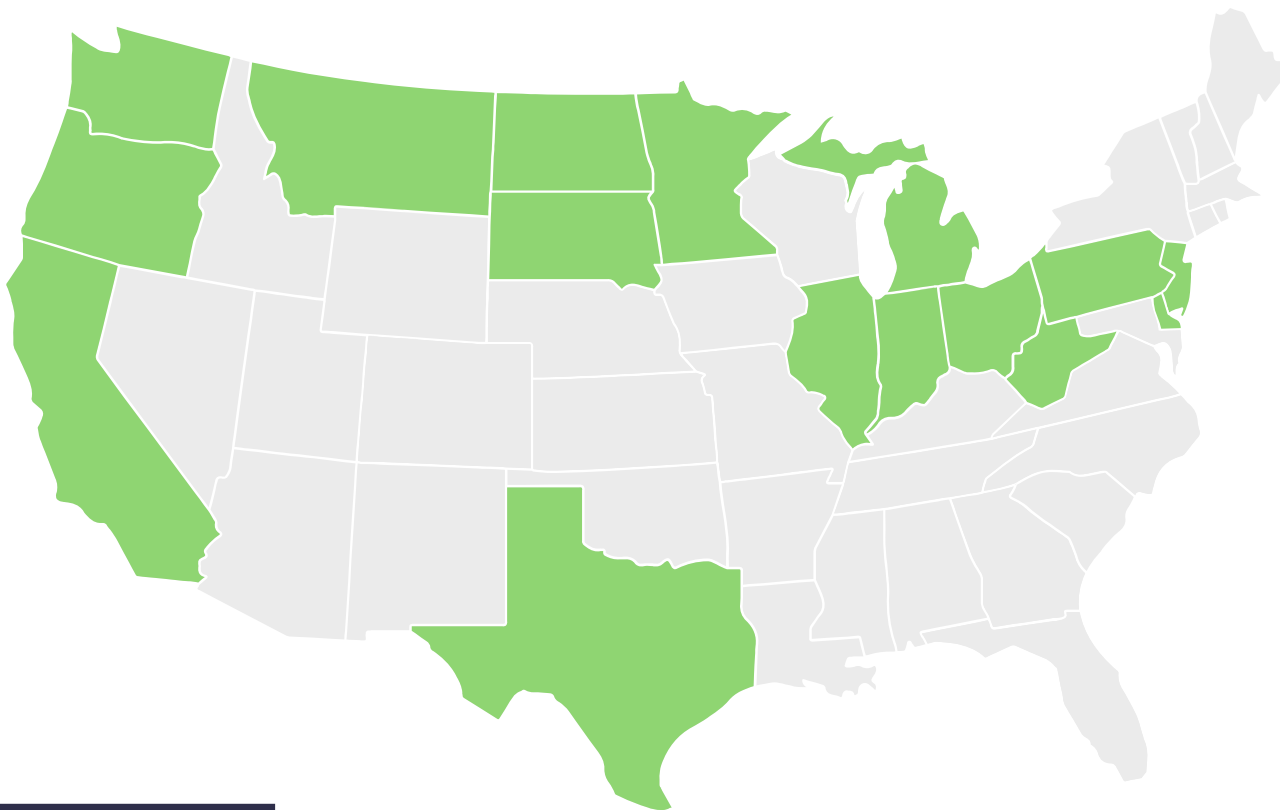
Washington, Oregon, Montana

green hydrogen scheme that includes proposed projects from 17 companies, which source most of their power from hydroelectric dams

<https://pnwh2.com/>



Service Focused Map



Hydrogen Hub States

White House says the clean H2 developments will 'catalyze more than \$40bn in private investments'

The White House says that the projects in the Regional Clean Hydrogen Hubs programme will produce more than three million tonnes of clean hydrogen annually — almost a third of the national goal of ten million tonnes a year by 2030.



Educate

a

b

Communicate

What's Next for Hydrogen Power in Colorado

c

Advocate

Presentation Title



Questions?



graphic courtesy of Alstom