Atlantic Council
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# Hydrogen Policy Brief 3: Hydrogen Transportation and Storage

by Cynthia Quarterman

## TAKEAWAYS

- The United States already has over 1,600 miles of hydrogen pipelines, one of the most extensive hydrogen pipeline networks in the world.[1] It also has the world's largest transportation and storage network for fossil fuels. The existing transportation and storage infrastructure in the United States makes it physically ready to lead the world in hydrogen development.

- For the transition to hydrogen to be successful, it will be necessary, at least initially, to create regional hydrogen clusters that can scale clean hydrogen production and host demand centers without requiring a major buildout of long-distance hydrogen transportation infrastructure. For long-term success, those regional centers must eventually grow to form an interconnected national network. The existing fossil fuel transportation and storage hubs in the United States could easily host regional hydrogen clusters that quickly evolve into a national network.

- Despite all of its advantages—from existing infrastructure to resources for production—the United States will have to embrace hydrogen usage more affirmatively, especially in the realm of policy, in order to make hydrogen a viable alternative energy option. The first step forward would be to identify all potentially interested stakeholders from the public and private sectors and host a planning summit to set forth a strategic hydrogen vision, including identifying potential regional hydrogen hubs and associated transportation and storage options.

1 "Hydrogen Pipelines," Hydrogen and Fuel Cell Technologies Office, US Department of Energy, accessed June 29, 2021, https://www.energy.gov/eere/fuelcells/hydrogen-pipelines.

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# Opportunities and Challenges for Hydrogen Transportation and Storage

Hydrogen is the lightest gas and the smallest, most abundant element. It is neither toxic nor corrosive. When burned, it releases only energy and water. Hydrogen's energy content is the greatest by weight of any fuel. Its availability, energy potential, and limited environmental effects should make it a strong contender as a potential future fuel alternative. However, hydrogen's characteristics also create challenges for its transportation and storage.

Hydrogen presents unique technical and safety challenges to transportation and storage. As the lightest gas, hydrogen can escape containment and permeate materials more easily than methane and many other transported gases. It also requires more compression than traditional gases to increase its energy density. To remain in a liquid form, hydrogen must be super-cooled to -253 degrees Celsius at atmospheric pressure, since it reverts to its gaseous state above that temperature, which complicates its storage and transportation.[1]

As a gas, hydrogen is very flammable when mixed with air and is easily ignitable due to its broad combustible range. The only gas known to condense hydrogen, thereby suppressing ignition, is helium, which is not widely available. Even once it is ignited, hydrogen has a barely visible flame, requiring specialized detectors. Hydrogen can also embrittle certain metals and other materials, causing their expedited deterioration and cracking.

These challenges, while beyond those related to natural gas, are not insurmountable, and, in fact, have already been addressed in existing hydrogen transportation and storage.

# Existing Transportation and Storage Infrastructure

Hydrogen is already used in the United States today in industrial settings, so the technology and knowledge needed to transport and store hydrogen exist. In order to transport or store hydrogen efficiently, it is necessary to significantly compress the gas to increase its energy density, cool it into a cryogenic liquid, or bond it to another chemical carrier (e.g., sorption materials, liquid hydrocarbons, chemical hydrides, or metal hydrides). Compressed hydrogen gas is transported by truck in tube trailers or by pipeline, similar to the transport of natural gas. Liquid hydrogen is moved in super-insulated liquid tanker trucks. When pipelines are unavailable, tanker trucks are often used to transport liquid hydrogen longer distances because they can carry a much greater volume than gas tube trailers. A pipeline itself serves as a storage vessel of sorts. As with hydrogen's transportation, its storage facilities must either be capable of storing cryogenic or compressed hydrogen in vessels such as insulated liquid tanks (dewars) or gaseous storage cylinders. For long-term storage, geologic bulk underground storage caverns, similar to those used for natural gas, are necessary.

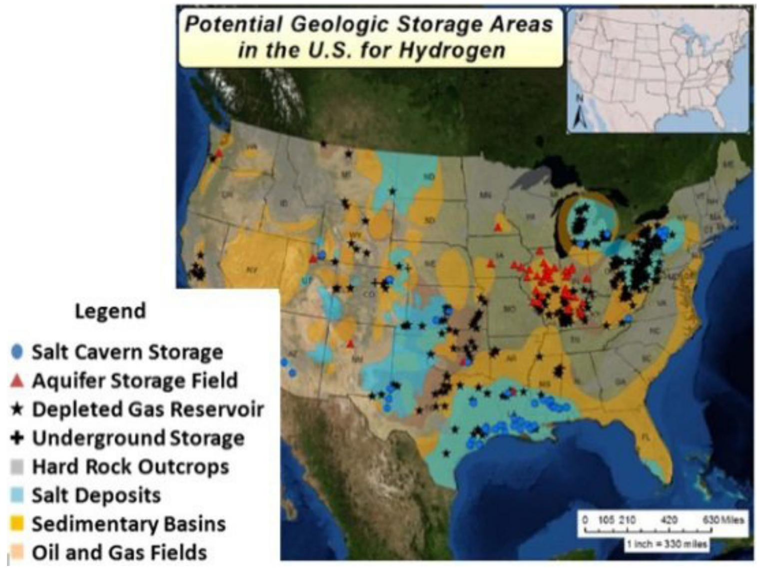
## Existing Pipeline and Storage Infrastructure

There are approximately 1,600 miles of hydrogen pipelines in the United States. The vast majority of those pipelines are located on the Gulf Coast and in Farm Belt regions. Today, hydrogen being transported by pipeline serves as a feedstock to nearby refineries and ammonia production plants. Several shorter hydrogen pipelines are located throughout the country;[2] for example, Hawaii Gas currently transports a synthetic gas that contains approximately 12 percent hydrogen. There were also some early movements of hydrogen gas mixtures by pipeline. Historically, pipelines transporting "town gas," which was used in the 1800s to early 1950s, contained several gases, including hydrogen.[3]

There are currently three underground hydrogen storage facilities in the United States. The Chevron Phillips Clemens Terminal has stored hydrogen in a salt mine since the 1980s. In 2017, the team at Lane Power & Energy Solutions, Inc. began building what was then the largest hydrogen storage facility in the world in Beaumont, Texas for Air Liquide. There is currently an Advanced Clean Energy Storage project in process to store 1,000 megawatts (MW) of hydrogen in underground salt caverns being

2 US Pipeline and Hazardous Materials Safety Administration Annual Report 2020, US Department of Transportation, 2020, https://portal.phmsa.dot.gov/analytics/sax.dll?Portalpages&PortalPath=%2Fshared%2FPDM%20Public%20Website%2F_portal%2FPublic%20Reports&Page=Infrastructure.

3 Paul W. Parfomak, Pipeline Transportation of Hydrogen: Regulation, Research, and Policy, Congressional Research Service Report R46700, March 2, 2021, https://www.everycrsreport.com/files/2021-03-02_R46700_294547743ff4516b1d562f7c4dae166186f1833e.pdf.




"Potential Geologic Storage Areas in the U.S. for Hydrogen," US Department of Energy, Hydrogen and Fuel Cell Technologies Office, Accessed July 6, 2021.

built by Mitsubishi Power and Magnum Development in Delta, Utah.[4]

In addition to hydrogen pipeline and storage facilities, the United States has more than 2.8 million miles of natural gas and hazardous liquid pipelines throughout the country, at least some of which could be repurposed to transport hydrogen. As of 2020, the United States had approximately 2.3 million miles of gas distribution, 0.3 million miles of gas transmission, and 0.2 million miles of liquid pipelines.[5] There are also more than four hundred natural gas underground storage locations in the United States using depleted wells, aquifers, or salt caverns.[6] As energy-producing areas have changed over time, pipelines have been retrofitted to transport different commodities. Most notably, the recent increase in fracked natural gas led to the conversion of some hazardous liquid lines into gas service. Similarly, two crude oil pipelines in Texas were converted in the 1990s to hydrogen service.[7]

There has been global interest in converting natural gas pipelines to hydrogen service. In July 2020, a group of eleven European gas infrastructure companies published a roadmap to create a dedicated European Hydrogen Backbone primarily from repurposing existing gas pipeline infrastructure.[8] That initiative has grown further, and as of April 2021, it now includes twenty-three natural gas infrastructure companies and twenty-one countries, using 69 percent repurposed and 31 percent new pipelines.[9]

The primary technical and technological challenges for converting existing pipeline infrastructure to hydrogen service are as follows: (1) identifying the materials used in existing pipeline facilities; (2) ensuring the integrity of those facilities; (3) determining the effects of hydrogen on existing pipeline materials, including fittings, control valves, welds, membranes, gaskets, seals, shut-off valves, pressure regulators, meters, and other components; (4) retrofitting or replacing materials as appropriate to withstand the lighter, more embrittling gas; (5) ensur-

4 For technical-related challenges for hydrogen storage facilities, see S. Foh, E. Rockar, P.Randolph, Underground hydrogen storage. Final report. [Salt caverns, excavated caverns, aquifers and depleted fields], US Department of Energy, December 1, 1979, https://doi.org/10.2172/6536941; H.B.J. Stone, I. Veldhuis, R.N. Richardson, Underground hydrogen storage in the UK, Geologic Society of London, January 1, 2009, https://doi.org/10.1144/SP313.13 ; A.S. Lord, P.H. Kobos, & D.J. Borns, Geologic Storage of Hydrogen, Sandia National Labs, slides, May 21, 2009; Germany, as a part of its HyCavMobil (hydrogen cavern for mobility) has begun construction of a test cavern for large-scale underground hydrogen storage, B. Haight, "Germany To Study Underground Hydrogen Storage," ESG Newswire, April 14, 2021, https://esgreview.net/2021/04/14/germany-to-study-underground-hydrogen-storage/; The National Hydrogen Strategy, German Federal Ministry for Economic Affairs and Energy, June 2020, https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/the-national-hydrogen-strategy.pdf?__blob=publicationFile&v=6.

5 US Pipeline and Hazardous Materials Safety Administration Annual Report 2020.

6 Ensuring Safe and Reliable Underground Natural Gas Storage, Interagency Task Force on Natural Gas Storage Safety, October 2016, https://www.energy.gov/sites/prod/files/2016/10/f33/Ensuring%20Safe%20and%20Reliable%20Underground%20Natural%20Gas%20Storage%20-%20Final%20Report.pdf; US Pipeline and Hazardous Materials Safety Administration Annual Report 2020.

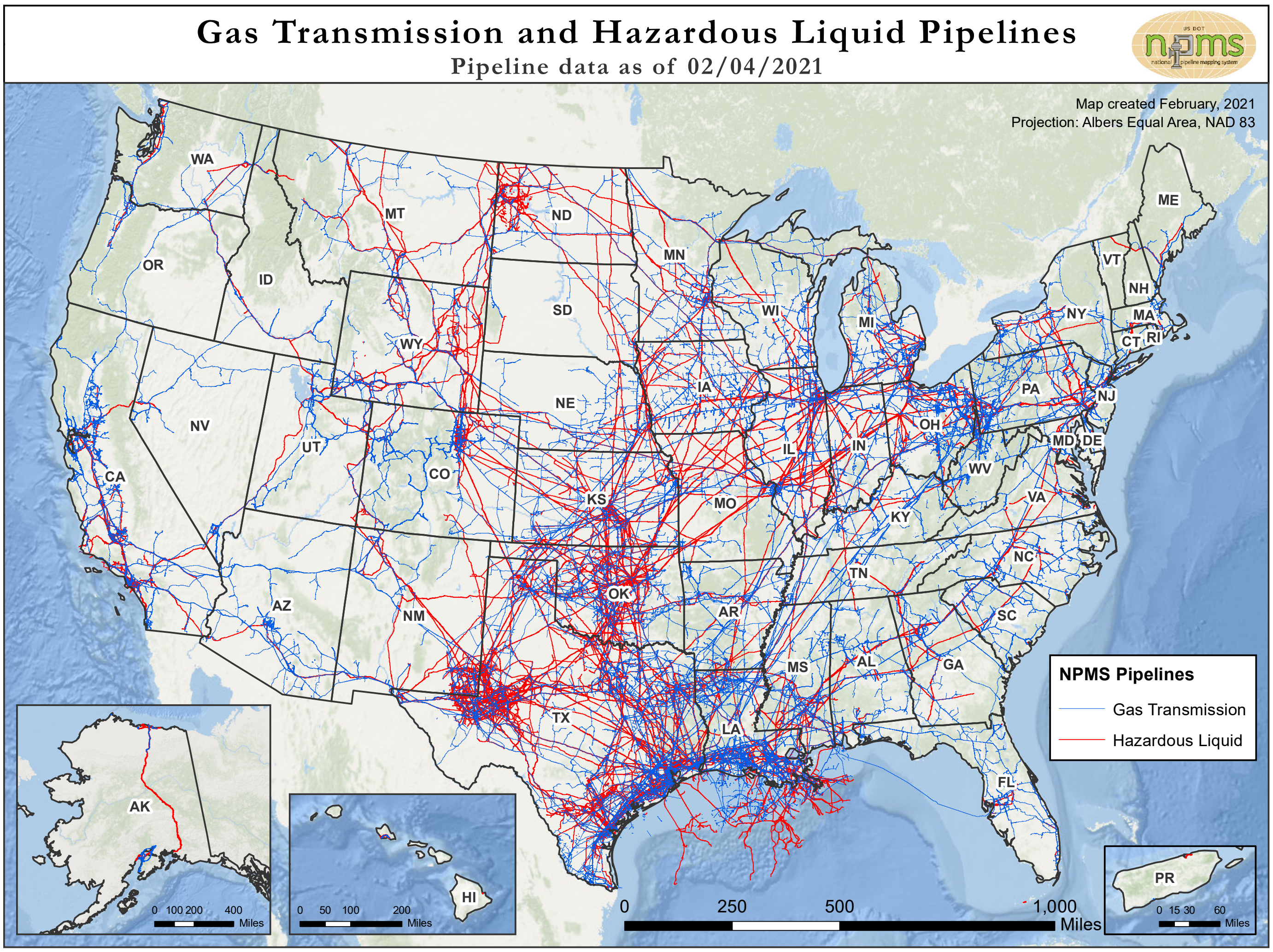
7 Jim Campbell, "Questions and Issues on Hydrogen Pipelines," Air Liquide, Slides presented at Department of Energy Hydrogen Pipeline Working Group Meeting, August 31, 2005, https://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/hpwgw_questissues_campbell.pdf.

8 "European Hydrogen Backbone," Gas for Climate: A path to 2050, https://gasforclimate2050.eu/ehb/.

9 Extending the European Hydrogen Backbone: A European Hydrogen Infrastructure Vision Covering 21 Countries, *Gas for Climate 2050*, April 2021, https://gasforclimate2050.eu/wp-content/uploads/2021/06/European-Hydrogen-Backbone_April-2021_V3.pdf; P. Adam et al, Hydrogen infrastructure - the pillar of energy transition, Whitepaper in the Press Conference of the European Commission, August 7, 2020 https://assets.siemens-energy.com/siemens/assets/api/uuid:3d4339dc-434e-4692-81a0-a55adbcaa92e/200915-whitepaper-h2-infrastructure-en.pdf.

ing a system exists to monitor pipeline integrity for embrittlement, cracking, fatigue, and other abnormalities; (6) ensuring an adequate leak detection and containment program is in place; (7) increasing pipeline compressor and turbines to support higher compression and drive power; and (8) updating pipeline control and measurement systems.[10] Any additional safety risks associated with the unique aspects of hydrogen would also need to be assessed and addressed.[11] Storage facilities would have to address similar issues as well as those related to fluid flow and geochemical, biotic, and geo-mechanical reactions to hydrogen underground.[12]

It is not necessary to completely convert existing natural gas pipelines into hydrogen service, however. As many examples show, it is also possible to transport hydrogen mixed into existing natural gas pipelines. Such mixed gas pipelines would decrease current greenhouse gas emissions associated with using natural gas alone and could also serve as a transition to eventual full hydrogen pipeline transportation.[13] Previous studies have pointed to hydrogen mixtures of between 5-20 percent that would require minimal changes to existing infrastructure.[14] Italian pipeline operator Snam has already demonstrated the viability of a 10 percent hydrogen blend with natural gas through a segment of its pipeline network in Italy, as a part of the broader European hydrogen strategy..[15]




"Gas Transmission and Hazardous Liquid Pipelines," National Pipeline Mapping System, data as of February 2021.

10 J.L. Gillette and R.L. Kolpa, Overview of Interstate Hydrogen Pipeline Systems, Argonne National Laboratory, Environmental Science Division, ANL/EVS/TM/08-2, November 2007, https://publications.anl.gov/anlpubs/2008/02/61012.pdf; "Hydrogen Pipeline Systems," Asia Industrial Gases Association (AIGA) AIGA 033/14, http://www.asiaiga.org/uploaded_docs/AIGA%20033_14%20Hydrogen%20pipeline%20systems.pdf.

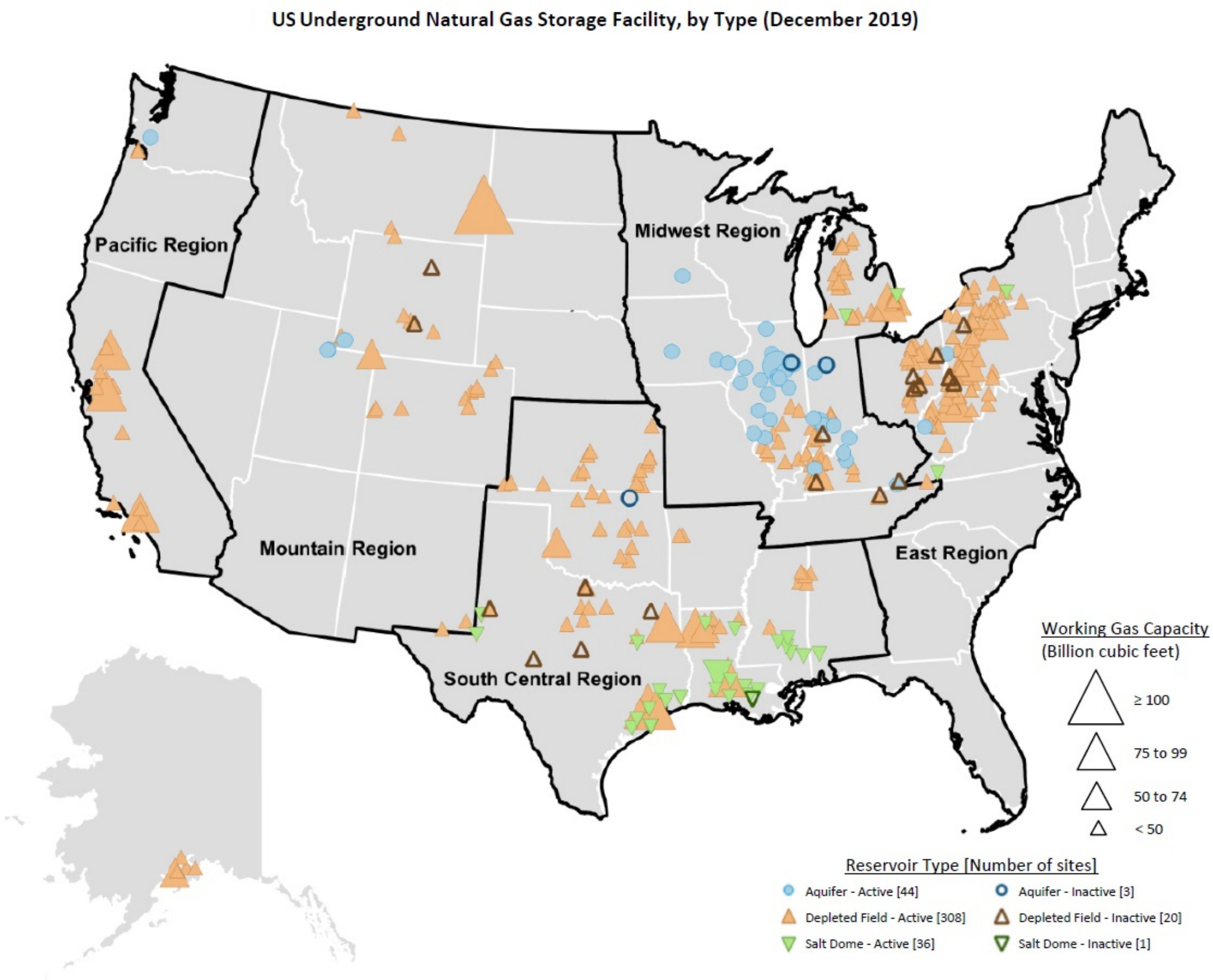
11 Campbell, "Questions and Issues on Hydrogen Pipelines," 23.

12 N. Heinemann et al, "Enabling large-scale hydrogen storage in porous media—the scientific challenges," Energy & Environmental Science 2 (2021), https://pubs.rsc.org/en/content/articlelanding/2021/ee/d0ee03536j#!divAbstract.

13 M.W. Melania, O. Antonia, and M. Penev, Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues, National Renewable Energy Laboratory, March 2013, https://www.nrel.gov/docs/fy13osti/51995.pdf.

14 J.L. Gillette and R.L. Kolpa, Overview of Interstate Hydrogen Pipeline Systems, citing F. Oney, T.N. Veziroglu and Z. Dulger, "Evaluation of Pipeline Transportation of Hydrogen and Natural Gas Mixtures," International Journal of Hydrogen Energy 19 (10) (October 1994): 813-22, https://www.sciencedirect.com/science/article/abs/pii/0360319994901988.

15 "Snam and Baker Hughes Test World's First Hydrogen Blend Turbine for Gas Network," Snam, July 20, 2020, https://www.snam.it/en/media/press-releases/2020/snam_baker_hughes_test_first_hydrogen_blend_turbine.html.




"US Underground Natural Gas Storage Facility," US Energy Information Administration, December 2019.

Whether new or retrofitted pipelines are used to transport hydrogen, pipelines will be integral to creating a national hydrogen network because of their relative cost and safety compared to transportation by other modes. Fortunately, there are already several analyses identifying the costs of those options.[16]

## Transport by Existing Rail Infrastructure

The United States has an equally extensive freight rail network, rivaling that of any country in the world. That network covers 137,000 interconnected route miles upon which approximately 57 tons of goods move per American per year.[17] A substantial amount of energy products currently move by rail. According to the American Association of Railroads (AAR), 70 percent of US coal and ethanol was transported by rail in 2020.[18] During the same period, 3.2 percent of US crude production moved by rail, down from a high of 11 percent in 2014.[19]

In addition to those energy commodities, the United States Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) recently published rules to allow bulk transport of "methane, refrigerated liquid" commonly known as liquefied natural gas (LNG) in rail tank cars.[20] Some in industry see that development as a possible precursor to bulk shipments of liquefied hydrogen by rail.[21] However, the rule was immediately challenged in court, and Transportation Secretary Pete Buttigieg has suggested that rule is one

16 Wade A. Amos, "Costs of Storing and Transporting Hydrogen," National Renewable Energy Laboratory, November 1998, https://www.nrel.gov/docs/fy99osti/25106.pdf; "Hydrogen Delivery Technical Roadmap," US DRIVE Partnership document, July 2017, https://www.energy.gov/sites/default/files/2017/08/f36/hdtt_roadmap_July2017.pdf.

17 "Freight Rail Facts and Figures," Association of American Railroads, accessed June 29, 2021, https://www.aar.org/facts-figures/.

18 "Freight Rail & Energy: Safely Moving Coal, Ethanol & Crude Oil," Association of American Railroads, accessed June 29, 2021, https://www.aar.org/issue/freight-rail-energy-industry/.

19 "What Railroads Haul: Crude Oil," Association of American Railroads, April 2021, https://www.aar.org/wp-content/uploads/2020/07/AAR-Crude-Oil-Fact-Sheet.pdf.

20 85 FR 44994, Hazardous Materials: Liquefied Natural Gas by Rail, Federal Register, August 24, 2020.

21 "LNG on the Rails—Precursor to LH2 on the Rails?" Chart Industries, Inc., slide presentation given at US Department of Energy workshop, 2018, https://www.energy.gov/sites/prod/files/2019/04/f62/fcto-h2-at-rail-workshop-2019-nason-larson.pdf.

the Biden-Harris administration will closely scrutinize.[22] In total, 2.3 million carloads and millions of tons of chemicals—many of them hazardous—were transported by rail in the United States in 2020.[23] Rail intermodal hubs exist throughout the United States in major markets (e.g., Chicago, IL; Long Beach/Los Angeles, CA; Atlanta, GA; Dallas/Ft Worth, TX; Seattle, WA; Newark, NJ; Memphis, TN; Kansas City, MO; Harrisburg, PA; Stockton, CA; Jacksonville, FL; Norfolk, VA; Detroit, MI; Toledo, OH; Houston, TX; and Columbus, OH), creating potentially ideal locations for future hydrogen transport hubs. The transportation of hydrogen by rail would probably be limited because the costs and safety risks exceed those of pipeline transportation.

### Existing Ports and Shipping Infrastructure

The United States has approximately 360 commercial shipping seaports. It is second only to China in its container port traffic, with five of the top fifty ports in the world. To the extent hydrogen is shipped over water today, it moves on barges in compressed tube trailers, which could expand to traverse the country's vast inland waterways. In order to transport large quantities of hydrogen by ship, it would be necessary to use cryogenic storage vessels. In 2019, Japan launched the world's first liquid hydrogen tanker, the Suiso Frontier, to transport liquid hydrogen from Australia to Japan.[24] The existence of such a tanker opens up the possibility for large movements of hydrogen around the globe.

### Existing Trucking and Road Infrastructure

The United States also has an extensive interstate national highway system of approximately 160,000 miles, connecting urban and rural areas. The larger network of approximately 4 million miles of federal, state and local highways and roadways accommodates extensive freight traffic. According to the American Trucking Association, trucks moved approximately 72.5 percent of the US freight by weight in 2019, using 36.9 million registered trucks that traveled more than 3 trillion miles.[25] More than 96,000 carriers transport hazardous materials. The US trucking industry is well prepared to transport hydrogen around the country.

## Future Hydrogen Infrastructure

An efficient and effective hydrogen-based energy transportation and storage system would ideally build upon the existing fossil fuel infrastructure. As the safest, most economical means of transporting hydrogen, new or retrofitted pipelines would be used to move large quantities of hydrogen across the country from areas of high production to those of high demand. Large-scale associated storage facilities would be integrated into that pipeline system. In high production or demand areas where pipelines were not yet available, rail transportation could be used as a means of temporary long-haul movement. For hydrogen distribution near production, demand, or pipeline offload points, truck transportation would continue to be used. Where cryogenic conversion was available, liquefied hydrogen tankers would be used for longer hauls, and compressed hydrogen tube trailers would be used for short movements. In addition to truck transportation, compressed hydrogen vessels could be transported by rail for those users farther away with smaller needs.

In certain circumstances and, in particular, for overseas shipping, the most viable solution may be to transport the hydrogen as ammonia rather than as pure hydrogen. Ammonia is far less volatile and easier to store and transport than pure liquid or gaseous hydrogen, and ammonia is already traded and shipped at global scale in support of various chemical and agricultural industries. Across applications, the decision to transport hydrogen or ammonia will be dictated by the energy and capital efficiency of ammonia conversion (particularly if the hydrogen needs to be separated at the point of consumption or if ammonia itself could be used as the fuel), the availability of extent infrastructure (several major ammonia pipelines already connect Midwestern farm states with ammonia production centers), and the ease of hydrogen infrastructure construction between production and consumption points.

For clean hydrogen production pathways that rely upon electrolysis, an alternative transportation strategy may be to use long-distance transmission lines to supply clean electricity to electrolyzers near demand centers, rather than transporting hydrogen fuel. For certain contexts, moving electrons over long distances may be less expensive and more efficient than transporting hydrogen fuel through the above pathways.

22 State of Maryland v. DOT, No. 20-1318 (D.C. Cir. 2020); Senate Testimony of Pete Buttigieg at Confirmation Hearing on Jan. 21, 2021.

23 "What Railroads Haul: Chemicals," Association of American Railroads, April 2021, https://www.aar.org/wp-content/uploads/2020/07/AAR-Chemicals-Fact-Sheet.pdf.

24 "World first for liquid hydrogen transportation," Lloyd's Register, October 23, 2020, https://www.lr.org/en/insights/articles/world-first-for-liquid-hydrogen-transportation/.

25 "Economics and Industry Data," American Trucking Associations, accessed June 29, 2021, https://www.trucking.org/economics-and-industry-data.

# The Role of Policy

The Biden-Harris administration has already embraced the use of hydrogen as an energy alternative to address climate change. However, more than a subtle embrace will be necessary to move the United States and its energy transportation and storage sectors toward creating a path forward for hydrogen use. As mentioned above, the European Union and the United Kingdom have charted a deliberate course to transition their fossil fuel transportation and storage infrastructure to a hydrogen-centric future.[26]

By comparison, over the past decade, the United States has had an on-again, off-again dalliance with hydrogen, funding some exploratory research and pilot projects but never fully committing to its energy use. Without some greater sense of urgency and unwavering national commitment, the US energy market will undoubtedly continue to support the readily available, cheapest, and most familiar fuel options to the detriment of the environment.

# A Path Forward

In order to chart a course to a hydrogen-rich energy future, a transportation and storage network to support future regional hydrogen production and demand centers must be carefully planned to be economically and technologically viable. Private industry working alone will probably not achieve that goal without the support and abiding interest of the federal government convening interested private entities, relevant government agencies, and other parties to advance hydrogen. The United States should take the following policy steps to advance hydrogen transportation and storage at scale:

1. **Spearhead a public-private planning effort to begin identifying potential regional hydrogen hubs and associated transportation and storage options to create a roadmap for a hydrogen future.** The first step forward would be to identify all potentially interested stakeholders and host a planning summit to set forth a strategic hydrogen vision, including identifying potential regional hydrogen hubs and associated transportation and storage options. Using this effort as a springboard for public-private partnerships for hydrogen-related transportation and storage can also minimize risk of failure and help to identify transition pathways.

2. **Study existing resources to identify and address critical research and infrastructure gaps.** The next step would be to survey existing hydrogen transportation and storage data and resources to identify gaps in knowledge and technology. A plan should then be devised to fill those gaps with research, technical and technology-related projects that are funded by private industry, government, or both.[27] Where data independence is important, the United States government through its national labs and other government-funded research programs can conduct research and test projects on its own.

3. **Incentivize private hydrogen transportation and storage innovation and investments.** The US government should also support private hydrogen-related industry efforts through tax incentives, grant programs, loan programs, or other incentives to help decrease the risk associated with new technologies, and encourage innovation and investment.

4. **Fund more hydrogen transportation and storage research projects as well as related large-scale pilots.** Large-scale public-private pilot projects (perhaps through the actual creation of a regional hydrogen hub with all modes of transportation and storage represented) will be necessary to jump-start the hydrogen energy transition.[28]

5. **Begin drafting guidelines for a common hydrogen legislative and regulatory framework to be used nationally.** It is not too early to begin planning an appropriate statutory and regulatory framework for a safe, environmentally, and financially sound hydrogen transportation and storage network, including by anticipating possible siting controversies, safety failures, and interstate and interagency turf battles. While there are existing regulations addressing safety, economics, security, and other issues relating to hydrogen, none of them imagine an extensive hydrogen transportation and storage network.[29]

To build successful hydrogen transportation and storage infrastructure at scale in the United States will require the deliberative steps set forth above at a bare minimum. Taking those key steps should set the course for the United States to expedite its movement towards a hydrogen energy transition. Given its vast existing fossil fuel infrastructure, the United States—though late to embracing hydrogen energy—can still learn from the lessons of other nations and join them in leading the way to a hydrogen energy-rich future.

26 Extending the European Hydrogen Backbone: A European Hydrogen Infrastructure Vision Covering 21 Countries.

27 The National Renewable Energy Laboratory is leading a collaborative research and development project with six national labs and twenty industry and academic partners known as HyBlend to address technical issues in blending hydrogen with natural gas, which could assist with this effort. "HyBlend Project To Accelerate Potential for Blending Hydrogen in Natural Gas Pipelines," National Renewable Energy Laboratory, November 18, 2020, https://www.nrel.gov/news/program/2020/hyblend-project-to-accelerate-potential-for-blending-hydrogen-in-natural-gas-pipelines.html.

28 A good example of how this might work is the Department of Energy's work in collaboration with GTI, Frontier Energy, SoCal Gas, and the University of Texas to create the first dedicated renewable hydrogen infrastructure network known as H2@scale.

29 One likely dispute will be the social cost of pipeline construction or conversion: will a national hydrogen pipeline network be met with the same skepticism as the existing pipeline network and other infrastructure projects, and, if so, how will that skepticism be addressed?

## About the Author

Cynthia Quarterman is a distinguished fellow with the Atlantic Council Global Energy Center. Quarterman served as the administrator of the US Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), from 2009 until 2014. She has been a key policymaker in energy development, safety, and transportation since the Clinton administration, when she served as the director of the former Minerals Management Service.

Throughout her extensive handling of complicated issues, including deep-water oil and gas exploration and production, royalty collection, liquefied national gas (LNG) facilities, and the truck, rail, and pipeline transportation of the nation's new energy bounty, Quarterman has been a steadfast advocate for responsible energy development and prudent regulations. She has also served in numerous other capacities within the Department of the Interior and was a member of the Obama administration transition team at the Department of Energy. In addition to extensive experience within the federal government, Quarterman was also previously a partner in the Washington office of Steptoe and Johnson LLP, where her practice focused on issues related to transportation and energy.