

EXECUTIVE SUMMARY

Regional Hydrogen Pipeline Costs for US-REGEN Model

To fully leverage the potential of hydrogen as a path to decarbonization, the development of robust and extensive hydrogen pipeline infrastructure is crucial. In addition to usual challenges faced by other energy infrastructure, such as natural gas pipelines or electric transmission lines, hydrogen pipelines present unique concerns including embrittlement and higher operating pressure. This project seeks to leverage the existing research on natural gas and hydrogen transportation and studies on regional differences in infrastructure project costs to develop assumptions and cost estimates of new hydrogen pipelines.

Material costs for new hydrogen pipelines may be 10% higher than for new natural gas pipelines, which would result in a 1.4–4.6% difference in total cost per unit inch-mile. Due to hydrogen's lower energy density, capital costs would be 14%–16% higher per unit energy flow rate for hydrogen compared to natural gas. These estimates for pipeline costs likely understate the difference because the scope did not include the compressor stations along the pipeline route, which are expected to have higher capital and operating costs for hydrogen pipelines than natural gas pipelines.

KEY RESEARCH QUESTION

- What are the capital costs of building new hydrogen pipelines?
- How do the costs vary across different regions in the United States?



RESEARCH OVERVIEW

The research methodology incorporates established research on natural gas pipeline costs. The findings are benchmarked against the EIA natural gas pipeline cost dataset and adjustment factors are applied to determine hydrogen pipeline costs. The findings and results are summarized in this report.

KEY FINDINGS

- Though hydrogen pipelines were estimated to cost only 1.4%–4.6% per unit inch-mile more than natural gas pipelines, hydrogen exhibits faster flow and lower volumetric density than natural gas, resulting in a region-dependent average net increase of 14%–16% in capital cost per unit energy flow rate for hydrogen versus natural gas transportation through pipelines.
- The capital costs of building hydrogen pipelines vary significantly across the United States, with New England exhibiting the highest costs and the Great Plains & Rocky Mountain region displaying the lowest cost for hydrogen pipelines.
- There is substantial variation in labor costs across the country, while material costs show the least variation between regions.
- Obtaining right-of-way for pipelines is comparatively less costly than the other three components including material, labor, and miscellaneous cost as defined in Oil and Gas Journal data. However, overcoming institutional barriers to obtain ROW can pose significant challenges.
- This study does not include the capital and operating costs of compressor stations. Including these costs would likely result in a greater difference between natural gas and hydrogen pipeline projects because hydrogen compressor stations are expected to have higher capital costs and energy demands.
 - This topic is covered in detail in the LCRI report, *Economic Cost, Limitations, Challenges and Opportunities of Utilizing Existing Natural Gas Compressor Systems for Transport of Hydrogen and Hydrogen Blends*, [3002028177](#).

WHY THIS MATTERS

The estimated costs for hydrogen pipelines are important inputs in economy-wide energy system models given hydrogen's role as a zero-carbon energy carrier with the potential to decarbonize all energy sectors. Accurately assessing the cost of hydrogen pipeline and the variation of cost across different regions is vital for conducting thorough techno-economic analyses of its potential applications in these sectors.

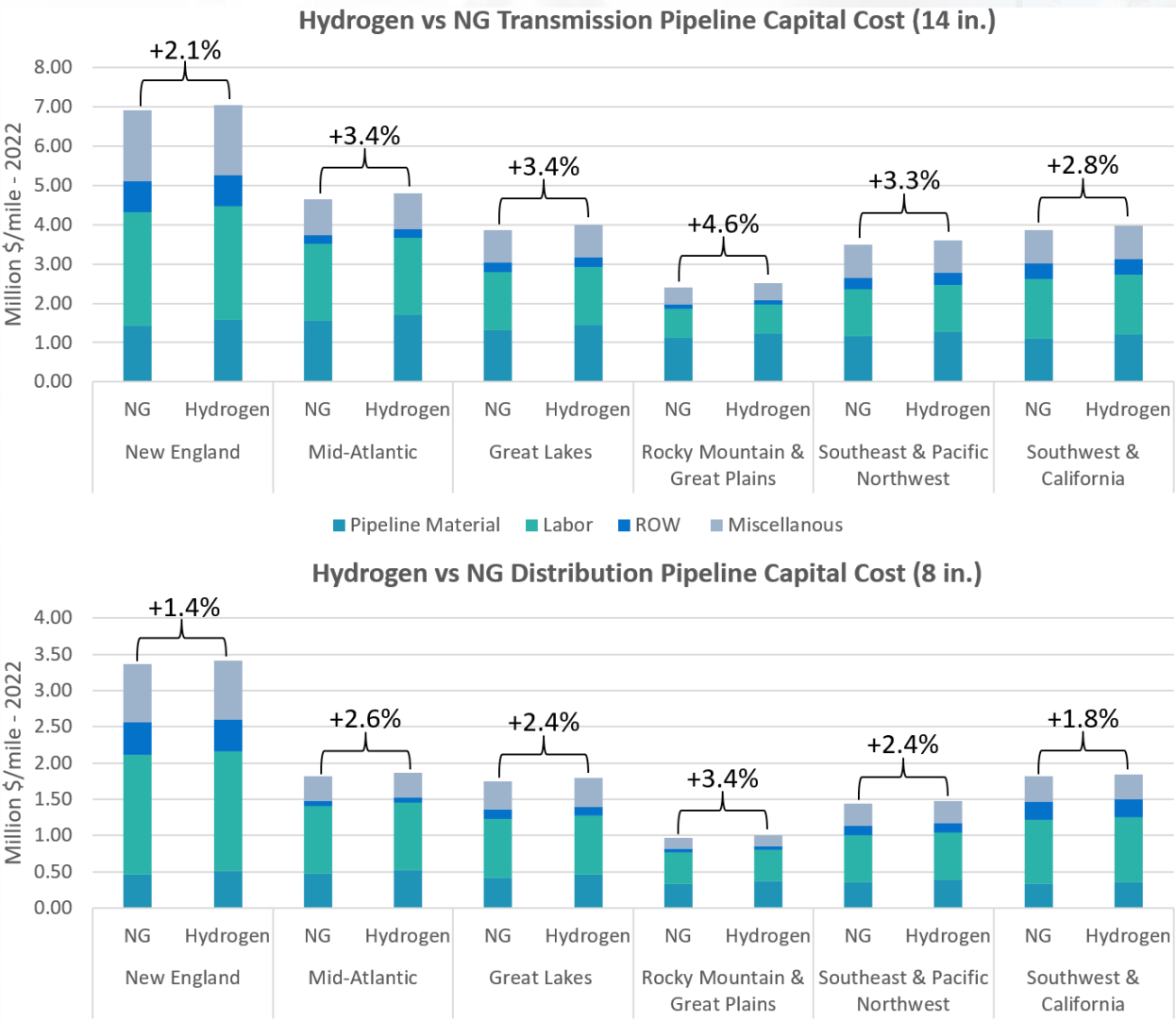
HOW TO APPLY RESULTS

The data tables in the full report can be exported and used in internal analyses. The report also contains high-level takeaways to consider in techno-economic analysis of hydrogen transportation.

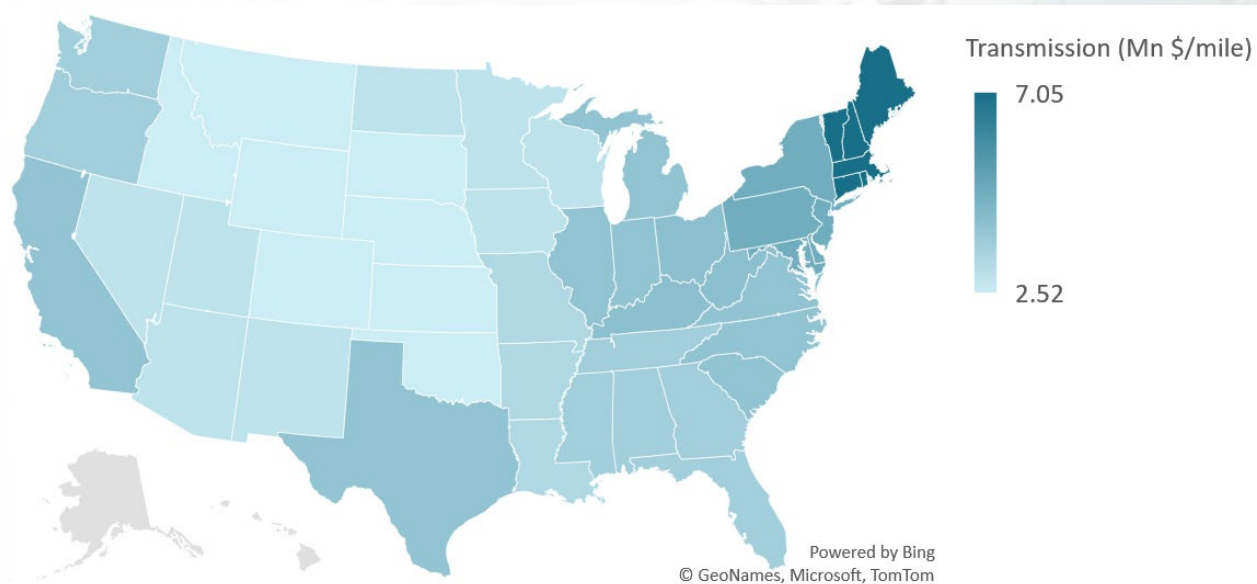
LEARNING AND ENGAGEMENT OPPORTUNITIES

- More information on the LCRI Technical Subcommittee on Integrated Energy System Analysis and the LCRI US-REGEN model can be found at the website: lcri-vision.epri.com/content/portfolio-modeling-analysis.html.

The following graphs depict the estimated costs for transmission and distribution pipelines for natural gas and hydrogen of the same diameter, with the estimated capital expense premium for hydrogen pipelines superimposed.



The geographic variation is also shown on this map of hydrogen transmission pipeline costs by region.



The full report contains greater detail on the methodology and the full final data set of regional costs.



THE LOW-CARBON RESOURCES INITIATIVE

This report was published under the Low-Carbon Resources Initiative (LCRI), a joint effort of EPRI and GTI Energy addressing the need to accelerate development and deployment of low- and zero-carbon energy technologies. The LCRI is targeting advances in the production, distribution, and application of low-carbon energy carriers and the cross-cutting technologies that enable their integration at scale. These energy carriers, which include hydrogen, ammonia, synthetic fuels, and biofuels, are needed to enable affordable pathways to economy-wide decarbonization by mid-century. For more information, visit www.LowCarbonLCRI.com.

LCRI CONTACT

ANAND KUMAR

Project Manager, LCRI Technical Subcommittee on Integrated Energy System Analysis
650.855.1038
akumar@epri.com

About EPRI

Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.

GTI Energy is a leading research and training organization. Our trusted team works to scale impactful solutions that shape energy transitions by leveraging gases, liquids, infrastructure, and efficiency. We embrace systems thinking, open learning, and collaboration to develop, scale, and deploy the technologies needed for low-carbon, low-cost energy systems. www.gti.energy

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

THIS DOCUMENT WAS PREPARED BY THE ORGANIZATION(S) NAMED BELOW AS AN ACCOUNT OF WORK SPONSORED OR COSPONSORED BY THE ELECTRIC POWER RESEARCH INSTITUTE, INC. (EPRI). NEITHER EPRI, ANY MEMBER OF EPRI, ANY COSPONSOR, THE ORGANIZATION(S) BELOW, NOR ANY PERSON ACTING ON BEHALF OF ANY OF THEM:

(A) MAKES ANY WARRANTY OR REPRESENTATION WHATSOEVER, EXPRESS OR IMPLIED, (I) WITH RESPECT TO THE USE OF ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, OR (II) THAT SUCH USE DOES NOT INFRINGE ON OR INTERFERE WITH PRIVATELY OWNED RIGHTS, INCLUDING ANY PARTY'S INTELLECTUAL PROPERTY, OR (III) THAT THIS DOCUMENT IS SUITABLE TO ANY PARTICULAR USER'S CIRCUMSTANCE; OR

(B) ASSUMES RESPONSIBILITY FOR ANY DAMAGES OR OTHER LIABILITY WHATSOEVER (INCLUDING ANY CONSEQUENTIAL DAMAGES, EVEN IF EPRI OR ANY EPRI REPRESENTATIVE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES) RESULTING FROM YOUR SELECTION OR USE OF THIS DOCUMENT OR ANY INFORMATION, APPARATUS, METHOD, PROCESS, OR SIMILAR ITEM DISCLOSED IN THIS DOCUMENT.

REFERENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCESS, OR SERVICE BY ITS TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE, DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY EPRI.

EPRI PREPARED THIS REPORT UNDER THE LOW-CARBON RESOURCES INITIATIVE (LCRI), WHICH IS JOINTLY LED BY EPRI AND GTI ENERGY.

EXPORT CONTROL RESTRICTIONS

Access to and use of this EPRI product is granted with the specific understanding and requirement that responsibility for ensuring full compliance with all Applicable U.S. and foreign export laws and regulations is being undertaken by you and your company. This includes an obligation to ensure that any individual receiving access hereunder who is not a U.S. citizen or U.S. permanent resident is permitted access under applicable U.S. and foreign export laws and regulations.

In the event you are uncertain whether you or your company may lawfully obtain access to this EPRI product, you acknowledge that it is your obligation to consult with your company's legal counsel to determine whether this access is lawful. Although EPRI may make available on a case-by-case basis an informal assessment of the applicable U.S. export classification for specific EPRI products, you and your company acknowledge that this assessment is solely for informational purposes and not for reliance purposes.

Your obligations regarding U.S. export control requirements apply during and after you and your company's engagement with EPRI. To be clear, the obligations continue after your retirement or other departure from your company, and include any knowledge retained after gaining access to EPRI products.

You and your company understand and acknowledge your obligations to make a prompt report to EPRI and the appropriate authorities regarding any access to or use of this EPRI product hereunder that may be in violation of applicable U.S. or foreign export laws or regulations.

For more information, contact:

EPRI Customer Assistance Center
800.313.3774 • askepri@epri.com



3002028847

April 2024

EPRI

3420 Hillview Avenue, Palo Alto, California 94304-1338 USA • 650.855.2121 • www.epri.com

© 2024 Electric Power Research Institute (EPRI), Inc. All rights reserved. Electric Power Research Institute, EPRI, and TOGETHER...SHAPING THE FUTURE OF ENERGY are registered marks of the Electric Power Research Institute, Inc. in the U.S. and worldwide.