Hydrogen: The New Fuel Facing Growing Pains

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This executive briefing on trade examines how hydrogen is produced, its current and potential uses in industry, the factors that limit its cross-border trade, and recent developments in the global hydrogen industry. Despite growing global interest in the use of hydrogen, international trade remains limited due to high cost of production and transportation, significant challenges associated with its storage, and the lack of necessary infrastructure.

How Hydrogen is Produced

Pure hydrogen rarely occurs naturally on earth; hydrogen for industrial use is primarily produced via steam-methane reforming (SMR) or electrolysis. SMR is the dominant and most cost-effective method in commercial hydrogen production. It works by reacting high-temperature steam with methane—typically sourced from natural gas—under high pressure to separate hydrogen atoms from carbon. The second production method, electrolysis, splits hydrogen from water using an electric current. While electrolysis is still a less common production method, it is viewed as a lower-emissions alternative, especially when powered by renewable energy sources or nuclear power.[1]

Hydrogen's Importance and Applications in Industry

Currently, nearly all hydrogen consumption in the United States takes place in petroleum refining and chemical production, with petroleum refining accounting for 68 percent of usage, as hydrogen is essential for producing the higher quality low-sulfur, or "sweet", petroleum.[2] Additionally, the chemical industry uses hydrogen primarily in the synthesis of ammonia for fertilizers, representing around 21 percent of current domestic demand. Hard-to-decarbonize sectors such as heavy industry and transportation have increasingly viewed hydrogen as a low-carbon alternative fuel source. Looking forward, reports indicate that hydrogen is set to expand into emerging applications, such as in the steel industry as a low-carbon alternative to natural gas, and in the transportation sector. This transition is being bolstered by public[3] and private research and development grants aimed at commercializing hydrogen solutions in hard-to-decarbonize sectors.

Challenges in International Hydrogen Trade

Despite growing interest in uses for hydrogen, international trade in pure hydrogen remains relatively minimal (approximately $207 million in 2024), with most hydrogen produced and consumed locally.[4] Limited cross-border trade exists via short pipelines[5], trucking, rail, or maritime shipping within a few hundred kilometers, and there is international trade in hydrogen-derived products like ammonia. However, a number of technical and economic barriers continue to restrict hydrogen's global movement.

One of the most pressing challenges is transport and storage, due to hydrogen's low volumetric energy density. To make long-distance transport viable, hydrogen must either be compressed (350 to 700 bar pressure), liquefied (requiring

[1] Electrolysis generates only hydrogen and oxygen as outputs, making it a zero-emission process when clean electricity is used.

[2] High sulfur petroleum is referred to as "sour" petroleum (over 0.5 percent sulfur content) which is a less valuable form of petroleum as compared to "sweet" petroleum (less than 0.5 percent sulfur content). The sulfur content in "sour" petroleum is commonly reduced through hydrodesulfurization, or the adding of hydrogen gas to react with the sulfur in the petroleum which is removed as hydrogen sulfide.

[3] As part of the 2021 Infrastructure Investment and Jobs Act, the U.S. Department of Energy announced $7 billion of funding for clean hydrogen hubs across the United States. The 2025 One Big Beautiful Bill Act (OBBBA) included the clean hydrogen tax credit (section 45V) introduced in the Inflation Reduction Act, but the OBBBA moved the cutoff date of new projects forward by five years.

[4] Global hydrogen production reached 100 million metric tons in 2024.

[5] There are currently no hydrogen specific pipelines linking the United States with Canada or Mexico. Hydrogen is typically traded in the form of ammonia throughout North America.

chilling to –253°C), or chemically converted into carriers such as ammonia or liquid organic hydrogen carriers. Each of these approaches is highly energy-intensive, costly, and technologically demanding. The situation is further complicated by a severe infrastructure gap: globally, there are fewer than 5,000 kilometers of hydrogen pipelines, compared to approximately 1.3 million kilometers of natural gas pipelines. For maritime trade, the industry lacks the necessary specialized liquefied hydrogen carriers and port terminals, with only a handful of projects and vessels currently in use or in development.[6] These constraints collectively explain why global hydrogen trade is still in its infancy despite increasing policy support and private sector interest.

Due to its physical and chemical properties—such as its small molecular size—pure hydrogen cannot use existing oil or natural gas infrastructure without significant modifications.[7] Where hydrogen-specific pipelines do exist, they are typically confined to industrial clusters or short regional connections, such as the SoutH2 Corridor which connects Algeria to Italy, Austria, and Germany. Hydrogen-compatible refueling stations, port terminals, storage tanks, and liquefication facilities are also limited, restricting cross-border or long-distance trade. Building out this infrastructure would require years of permitting, financing, and coordination between governments and the private sector.

Production costs remain a major hurdle for hydrogen to become competitive with fossil fuels. Producing hydrogen through the SMR pathway is relatively low-cost as compared to electrolysis but still costs around $1.8 to $2.2 per kilogram when carbon capture is used. Hydrogen produced via electrolysis can cost from $5 to $7 per kilogram, depending on electricity prices. This makes hydrogen three to five times more expensive per British thermal unit than natural gas production, and this gap would need to narrow for hydrogen to compete with natural gas in most industrial applications. In addition, the need to liquefy hydrogen or convert it to ammonia for transportation and storage can double or even triple the delivered price.

Several economies—including Saudi Arabia, India, China, and the European Union—have announced pilot projects to build the infrastructure needed for international trade in hydrogen and hydrogen-based fuels. Moving forward, international trade in hydrogen is likely to remain limited unless major infrastructure investments and cost reductions are realized.

Sources: American Chemistry Council, "Hydrogen and the Chemical Industry," 10/5/23; Atlantic Council, "Quick takeaways on the United States' historic investment in clean hydrogen hubs," 10/19/23; Bhuiyan et al., "Hydrogen as an alternative fuel: A comprehensive review of challenges and opportunities in production, storage, and transportation," 1/14/25; Chen et al., "A review on ports' readiness to facilitate international hydrogen trade," 2/9/23; Clifford Chance, "One Big Beautiful Bill Act," 11/25; CSIS, "Understanding 45V and Clean Hydrogen's Importance to U.S. Energy Leadership," 4/23/25; DOE, "Hydrogen Delivery," accessed 8/20/25; EIA, "Crude oils have different quality characteristics," 7/16/25; EIA, "Hydrogen explained," accessed 7/1/25; Haruna et al., "Sulfur removal technologies from fuel oil for safe and sustainable environment," 7/28/22; IDTechEx, "Bridging the gap: Storage & distribution in the hydrogen value chain," 8/15/23; IEA, "Global Hydrogen Review 2024," 10/24; IEA, "Global Hydrogen Review 2025," 9/12/25; Jordan et al. "The Role of Hydrogen in Decarbonizing U.S. Iron and Steel Production," 3/6/25; Michaels Energy, "Colors and costs of hydrogen vs. natural gas," 4/1/24; NGHI Son Refinery and Petrochemical LLC, "Sour crude oil and sweet crude oil," accessed 8/20/25; NREL, "Hydrogen Blending into Natural Gas Pipeline Infrastructure: Review of the State of Technology," 10/22; Offshore technology, "North America has the highest oil and gas pipeline length globally," 12/4/19; SoutH2Corridor, "Initiative," accessed 8/25/25; S&P, GTA Database, general imports, HS subheading 280410, accessed 11/19/25; WTO, "International trade and green hydrogen," 10/9/23.

[6] The three largest importers of hydrogen (excluding ammonia or other liquid organic hydrogen carriers) are the United States ($56.8 million), the Netherlands ($52.3 million), and Singapore ($18.2 million). Each primarily sources hydrogen from nearby trade partners: the United States from Canada (99 percent), the Netherlands from Belgium (96 percent), and Singapore from Taiwan (85 percent).

[7] Though not a wide-spread practice, some companies have tested blending small amounts of hydrogen into natural gas to transport hydrogen using existing natural gas pipelines.