NBR

CLEAN EDGE ASIA PROJECT

Lessons from Hydrogen Strategy in Vietnam and the United States

BY NGUYEN DUC TUYEN
CLEAN EDGE ASIA FELLOW

As more countries pursue deep decarbonization strategies, hydrogen will play a critical role in global energy transitions. The significance of hydrogen will be best observed in harder-to-abate sectors, such as those involving steel, chemicals, long-haul or heavy-duty transport, shipping, and aviation. However, to decrease emissions, the hydrogen utilized must be low-carbon from the outset—often referred to as green hydrogen. As a result, a growing number of countries now have a national hydrogen roadmap or strategy, and funds have been dedicated to the acceleration of domestic hydrogen development, especially green hydrogen.

The significance of hydrogen was highlighted at the 2021 United Nations Climate Change Conference in Glasgow. Delegates from 32 countries and the European Union agreed to work together to accelerate the development and deployment of clean hydrogen and ensure that "affordable, renewable, and low-carbon hydrogen is globally available by 2030."[1]

Although hydrogen is the most abundant element in the universe, it must be separated from other elements before it can be utilized. There are three typical methods to produce hydrogen: (1) gray hydrogen, which involves separation from hydrocarbon compounds CxHx and often emits CO_2 (around 90% of hydrogen is produced mainly from this method), (2) blue hydrogen, which uses hydrocarbon methods, but combined with CO_2 collection and storage technology, and (3) green hydrogen, which electrolyzes water into hydrogen and oxygen without any other byproducts. Hydrogen has been a matter of interest in the past without significant impact, but some factors make this time different:

- Governments worldwide have set a target of zero emissions by 2050, and hydrogen is the critical option for reducing emissions.[2]

- The decreasing costs of renewable energy (RE) and high-efficiency electrolyzers at an industrial scale are improving the economic attractiveness of green hydrogen. Accelerating transitions to RE resources mean greater variability, which has created a demand for more long-term energy storage. Due to its unique characteristics to serve as a medium for energy storage, hydrogen can resolve the strains created by RE variability, as well as assist with energy transport.
- Historically, electrolysis has required so much electricity that producing hydrogen did not make sense because the total cost was too high, and the efficiency was low. Recently, the excess electricity from RE is significant for the grid and can be used to electrolyze water, storing electricity in the form of hydrogen.

As a result of these factors, hydrogen and hydrogen-based fuels are now projected to meet a sizable share of final energy demand in 2050, up from virtually nothing today. To make this target possible, the following challenges need to be solved:

- Electrolyzer, storage, and energy costs for the liquefaction of hydrogen must continue to be reduced to an affordable level.
- Storage, transportation, and distribution infrastructure for hydrogen must be developed.
- The hydrogen industry must have a global supply chain.

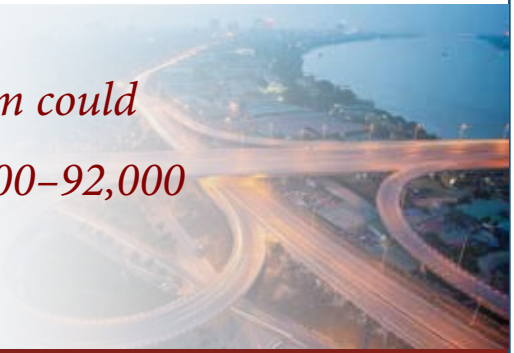
This essay will examine the hydrogen scenario in Vietnam, which is at an early stage, as well as in the United States, which has a more developed hydrogen industry. It will then conclude by considering policy options for accelerating the hydrogen industry in Vietnam based on the key lessons from the United States.

Hydrogen in Vietnam

The hydrogen market in Vietnam could reach $100 billion in 2035 and $1,200 billion in 2050, while demand could reach 22 million tons per year in 2050.[3] By replacing fossil fuels with hydrogen, Vietnam could reduce CO_2 emissions by 5.4% and create 62,000–92,000 jobs every year. To realize this scenario, domestic policy, as well as participation from foreign corporations, becomes increasingly critical for the hydrogen energy market in Vietnam.

According to other countries' experiences, a hydrogen development roadmap is crucial to realize the future of hydrogen in Vietnam. This roadmap must forecast the demand in its domestic market as well as in the foreign market until 2050 (together with the plan for achieving net zero by 2050).[4] Aside from the efforts by the Vietnamese government, foreign aid will also play a key role. The main German development agency GIZ has sponsored hydrogen policy adviser units in Vietnam through the domestic consulting department, which is the Institute of Energy (in cooperation with professional consultants from Ireland). Several offshore wind and hydrogen companies from England, such as OWC, also set up a representative office in Vietnam to construct a hydrogen development strategy.

By replacing fossil fuels with hydrogen, Vietnam could reduce CO_2 emissions by 5.4% and create 62,000–92,000 jobs every year.



Furthermore, international enterprises are actively involved in hydrogen-related activities in Vietnam. In October 2022, the Vietnam Initiative for Energy Transition conducted research and held a workshop to explore the potential of the domestic hydrogen industry. To enhance grid flexibility in high-renewable energy systems, innovative technologies like flexible operating generator systems were introduced. In November 2022, Wärtsilä, a Finnish manufacturing company, introduced an internal combustion engine capable of burning hydrogen and natural gas simultaneously, contributing up to 10% of power generation in simple-cycle, natural gas turbine (SCGT) factories. An event hosted by the Visionary Private Equity Group in November 2022 also featured presentations from hydrogen producers on co-burning systems.

Constructing a hydrogen demand market in Vietnam is crucial for affordable, large-scale production. At the moment, the price for electricity generation via hydrogen is much more expensive than the traditional method. However, by utilizing surplus renewable energy to generate hydrogen for serving as an energy carrier, the production cost can be lowered to a more reasonable price. A GIZ-supported project evaluated the hydrogen cost in Vietnam, projecting it to be 1.25–1.50 euros per kilogram (kg) by 2050, a significant improvement over the current cost of 2.76–4.60 euros per kg. Vietnam possesses advantages such as a high ratio of renewable energy, low financial risk, and the potential for establishing sales relationships with neighboring markets. It has the potential to compete as an exporter of hydrogen to large markets such as Japan or South Korea.

Demand for hydrogen in Vietnam. Vietnam currently has a small market for hydrogen due to its prohibitively high cost and difficulty in transporting. Hydrogen is produced and used onsite at oil refineries and fertilizer plants with a total capacity of 500 kilotons per annum.[5] Small amounts of hydrogen are used for the steel, glass, electronics, and food industries. Hydrogen-related industries include oil refining, fertilizer production, power generation, transportation, steel, and cement.

Blue hydrogen is limited in development in Vietnam due to gas scarcity, while green hydrogen is encouraged to develop widespread gas transportation infrastructure that can be used for transporting hydrogen in Vietnam. According to PetroVietnam (PVN), by 2025 the cost of producing blue hydrogen and green hydrogen in Vietnam will still be 1.3 and 2.1 times as high as gray hydrogen. Most of the hydrogen stock is being used in the refinery and petrochemical industries, and a minor amount (0.5%) of Vietnam's total hydrogen demand is used in steel, electronics, and food factories.[6] According to Vietnam's Hydrogen Energy Development Strategy, the country's green hydrogen production and utilization will aim to achieve the following objectives:

- Increase green and blue hydrogen production by 100,000–500,000 tons/year in 2030 and 10–20 million tons/year in 2050.
- Increase the application of hydrogen across all industries (electricity, cement, chemical, and steel production), as well as transportation (integrating fuel cells).

Vietnam's green hydrogen policy. As mentioned earlier, Vietnam currently has a small market for hydrogen. However, after realizing the importance of hydrogen for the future, the government has proposed a more structured orientation for the country's hydrogen transition. It has forecasted that the total energy demand for hydrogen will reach 152 tonnes of oil equivalent (TOE) in 2035 and 11,661 TOE in 2050 within the high scenario.[7]

To maintain the power balance, Vietnam will promote hydrogen to replace fossil fuels steadily over time. The coal industry will also produce hydrogen with the carbon capture method instead of the traditional process. Moreover, to achieve zero carbon emissions in 2050, Vietnam is planning to use biomass, ammonia, and hydrogen as energy sources along with traditional fossil fuel sources in 2028, steadily raising green energy use and finally attaining the target in 2035.

To realize this development plan for energy, the government has proposed several hydrogen factory projects. For example, the Green Solutions Group decided to invest 19,500 billion Vietnamese dong in Ben Tre's green hydrogen factory, which is the first green hydrogen factory in Vietnam that will be operational in 2024.[8] Another project that has been proposed is the construction of a green hydrogen center in Quang Tri with a total of 75,600 billion Vietnamese dong in investment. This center consists of several source production factories, such as solar, wind, and hydrogen/ammonia.[9]

Aside from investing in hydrogen facilities, the Vietnamese government is also focused on promoting the development of hydrogen technology. It has launched long-term research programs for improving hydrogen production, storage, transportation, distribution, and consumption. One project entails research cooperation between the Vietnam Petroleum Institute and the consulting and solutions corporation GIGON from Germany for producing green hydrogen from offshore wind farms.

Regarding the policy framework, the Vietnamese government promulgates resolutions supporting the development and application of hydrogen, such as carrying out technological research and developing a number of experimental projects; prioritizing several cutting-edge technologies for development investment, including hydrogen energy technology; developing and implementing a roadmap for transitioning to clean fuels for vehicles; and creating legal corridors strong enough to support research into green fuel technologies such as green hydrogen, ammonia, and biofuels. Vietnam's Hydrogen Energy Development Strategy approved by the prime minister in February 2024 aims to develop hydrogen energy production, infrastructure, and usage across various sectors to ensure energy security, reduce greenhouse gas emissions, and promote a green economy.

Hydrogen development orientation to 2030. By implementing its commitments from the 26th United Nations Climate Change Conference (COP26), the Vietnamese government has gradually developed the following policy orientations:

- Increasing R&D for renewable energy, including hydrogen in the transportation and energy sectors.
- Replacing fossil fuel with green hydrogen in various industries such as transportation.
- Adding a scenario that heavily utilizes hydrogen to meet Vietnam's net emission reduction target from COP26 in the Master Power Plan 8 and the National Energy Plan.

Hydrogen development orientation from 2030 to 2050. The needs and goals of hydrogen development are clearer in some of the following documents. The first document is the "Draft National Strategy on Climate Change." In the period to 2050, energy demand is expected to increase from 2030 to 2035 through the following developments:

- Hydrogen replaces the powdered anthracite coal sprayed into blast furnaces. Hydrogen will replace coal by 100% by 2050.
- Hydrogen begins to be used to replace coal in steel production.
- Hydrogen begins to be used instead of diesel oil and natural gas in industries (except in

brick, cement, iron, and steel). The percentage of hydrogen replacements will increase to 100% by 2050.

- Hydrogen begins to be used as an alternative measure for fossil fuels such as diesel oil in passenger transport by road, rail, and inland waterways; fuel oil in sea transport; and jet gasoline in air transport. The rate of alternative hydrogen use will increase to 100% by 2050.

The second document is the "Power Planning VIII":

- In 2050, the majority of thermal power station fuels will be changing into biomass, ammonia, and hydrogen.
- The fuel of coal-fired and thermal power plants will be converted: (1) all coal-fired power plants will steadily change to biomass and ammonia aside from coal after twenty operating years, and will be replaced completely in 2050, (2) all gas power plants are expected to begin using hydrogen along with coal, or switching to 100% hydrogen if the cost of the hydrogen production becomes more affordable, and (3) green hydrogen and ammonia produced by renewable energy demand for replacing coal are forecast to reach 23 million tons in 2050.
- The development of renewable energy for self-consumption will be prioritized over selling to the main grid (e.g., producing green hydrogen, ammonia, and chemicals).
- Renewable energy sources will be prioritized for unlimited development based on ensuring national defense and energy security and bringing about high economic efficiency.

In conclusion, although Vietnam does not currently have a solid policy for hydrogen, it has shown great interest in developing domestic hydrogen resources and believes that hydrogen will play a significant role in the energy storage market in the future. To promote the development of hydrogen, the government has adopted various measures, including investment in hydrogen-producing facilities and the deployment of research programs as effective methods for hydrogen production, storage, transportation, distribution, and consumption.

Hydrogen Policies in the United States

The United States is among the leading countries in researching and developing hydrogen energy. The U.S. Department of Energy's funding for hydrogen and fuel cells has increased from $100 million to $280 million per year, with approximately $150 million per year since 2017.[10] The funding is required for more research, development, demonstration, and deployment of hydrogen technologies, as well as to improve competitiveness and performance. Directing capital to hydrogen is key to enabling its growth in the United States.

The United States has a clear vision for its domestic hydrogen economy, which could generate an estimated $140 billion per year in revenue and create 700,000 total jobs by 2030. By 2050, it could increase to $750 billion per year in revenue and support 3.4 million jobs.[11] Moreover, hydrogen in the United States could provide significant environmental benefits and improve air quality. Hydrogen has already been widely deployed across various U.S. sectors, including transportation, building, industrial processes, power storage, and power systems.

In the U.S. government's ambitious scenario, hydrogen demand could reach 17 million metric tons by 2030 and 63 million metric tons by 2050. As a result, the Department of Energy created the Hydrogen Program to provide R&D strategies for hydrogen and related technologies.[12] In June 2021, it also launched the Hydrogen Shot program, which invests in emerging clean hydrogen technologies.[13] The goal of this program is to make the cost of hydrogen $1 for 1 kg for industrial and stationary power generation applications in the next decade.

The program addresses key challenges to achieve these targets, such as reducing costs and improving the performance of hydrogen production, delivery, and storage, thereby overcoming the technology and market barriers that reduce the opportunities for exporting hydrogen.

More broadly, the U.S. hydrogen roadmap is divided into three phases: 2023–25, 2026–30, and beyond 2030.

- *2023–25.* The target of this phase is developing large-scale hydrogen production while reducing cost. The first large-scale hydrogen production plant will use water electrolysis from renewables and gas reforming with renewable natural gas. As a result, the production costs will fall, enabling new applications. At the end of 2025, total hydrogen demand could reach 13 million metric tons across applications.
- *2026–30.* In this phase, hydrogen use across the United States will increase in transportation and backup power while decreasing in infrastructure. By the end of this phase, hydrogen demand is expected to top 17 million metric tons across applications. To reach the target, the annual investment is estimated to increase to $8 billion by 2030.
- *Beyond 2030.* After 2030, the U.S. government forecasts that the cost of hydrogen will be equal to fossil fuel prices across domestic regions and industries. The United States will have the highest revenue for hydrogen globally, and the U.S. hydrogen industry could reach $750 billion per year by 2050, including demand for 63 million metric tons.

Numerous countries have developed national strategies on hydrogen, including plans to develop and build green hydrogen value chains (production, compression, storage, and transportation), as in the U.S. case analyzed above. To realize its ambitions for hydrogen and achieve the goal of zero carbon emissions, the government and enterprises in Vietnam should consider the following policy options.

- *Roadmap.* Launch a national hydrogen development project or program; set long-term goal about green hydrogen to lower the financial risk of investors; and scout strategic partners in exporting green hydrogen.
- *Incentives.* Develop and operate a domestic emissions trading system market and offset mechanism to help and promote the development of the green hydrogen value chain; apply financial rules that are favorable for green hydrogen, such as reducing the tax for device importing and prioritizing a land tax; and apply a price mechanism for electricity purchases supporting green hydrogen-based generators.
- *Technology standards.* Develop monitoring procedures and international standards for green hydrogen production, storage, and consumption; develop technical standards and guidelines for safety in the hydrogen value chain during the production, storage, and transportation of hydrogen/green hydrogen; prioritize comprehensive science and technology activities in the green hydrogen value chain, focusing on various fields to identify deployable technologies for Vietnam; build green hydrogen research and production facilities; and promote training and technology transfer activities to receive new technologies.

On-grid solar and wind power with improved storage systems over green hydrogen production and its derivatives like ammonia will be a priority for power generation.

- *Market/labor.* Focus on essential conditions for green hydrogen industry development, such as the level and cost of electrolysis technology, the price of RE, water source, land availability, environmental safety regulations, and qualified human resources; create green hydrogen demand in the economy; develop production infrastructure, such as an electricity grid for distributing green hydrogen; develop carbon-pricing mechanisms to increase competitiveness for green hydrogen; and develop human resources in green hydrogen.

For the power generation and energy industries, demand for green hydrogen is expected to increase. As this happens, Vietnam will need to improve the cost-effectiveness of hydrogen, especially when using green hydrogen as an alternative fuel for power plants. To do so, it should consider the following policy factors:

- Renovating gas-fired power plants with green hydrogen blended with liquefied natural gas (LNG) (over 10%–15%) is costly. Hence, the future use of hydrogen in thermal power generation must be thoughtfully evaluated and deemed feasible only if it matches or surpasses the cost of coal and LNG.
- On-grid solar and wind power with improved storage systems over green hydrogen production and its derivatives like ammonia will be a priority for power generation.
- The global value chain for green hydrogen is growing, and affordable supply is anticipated from countries with the lowest renewable energy costs. Given these trends, Vietnam could consider exporting green hydrogen sources.
- Conducting in-depth studies and pilot projects will be critical to realize the reality of green hydrogen.

Vietnam and many other countries around the world are optimistic about the prospects for developing the hydrogen industry to realize their goals for reducing emissions. The demand for hydrogen in the industrial sector will increase, and the Vietnamese government is keen to mostly satisfy this demand with green hydrogen. To achieve this goal, it has already implemented many policy initiatives, conducted scientific research, and begun construction of pilot projects in the hydrogen industry. As it continues along this path, Vietnam will benefit from the lessons for hydrogen development that it has learned from other countries, especially the United States, where investment capital in this field is large.

Nguyen Duc Tuyen is an Associate Professor at the Hanoi University of Science and Technology in Vietnam and an Adjunct Associate Professor at the Shibaura Institute of Technology in Japan. He was a 2022–23 Clean EDGE Asia Fellow at the National Bureau of Asian Research.

Endnotes

1 Thijs Van de Graaf et al., *Geopolitics of the Energy Transformation: The Hydrogen Factor* (Abu Dhabi: International Renewable Energy Agency, 2022).

2 International Energy Agency (IEA), *Net Zero by 2050: A Roadmap for the Global Energy Sector* (Paris: OECD Publishing, 2021).

3 Vietnam Petroleum Institute, "VPI dự báo thị trường hydrogen tiềm năng có thể đạt sản lượng 22 triệu tấn/năm vào năm" [2050 VPI Forecasts That the Potential Hydrogen Market Could Reach an Output of 22 million Tons/Year by 2050], January 21, 2022, https://vpi.pvn.vn/vpi-du-bao-thi-truong-hydrogen-tiem-nang-co-the-dat-san-luong-22-trieu-tan-nam-vao-nam-2050.

4 Ministry of Natural Resources and Environment (Vietnam), "Decision No. 739/QD-BTNMT on the Implementation Plan for the Tasks and Solutions to Achieve the Results of the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change issued by the Minister of Natural Resources and Environment," 2023, https://thuvienphapluat.vn/van-ban/Tai-nguyen-Moi-truong/Quyet-dinh-739-QD-BTNMT-2023-thuc-hien-De-an-nhiem-vu-giai-phap-ve-bien-doi-khi-hau-560886.aspx.

5 N.H. Luong, "Current Status of Hydrogen Production and Uses in PVN" (presentation at the 4th Asia Pacific Meeting on Near Surface Geoscience and Engineering, February 2022), http://vepg.vn/wp-content/uploads/2021/03/thuyet-minh-qhd8-22-2.pdf.

[6] Luong, "Current Status of Hydrogen Production and Uses in PVN"; and Ministry of Industry and Trade (Vietnam), "National Comprehensive Energy Plan for the Period 2021–2030, with a Vision towards 2050," August 2023, https://moit.gov.vn/tin-tuc/phat-trien-nang-luong/quy-hoach-tong-the-ve-nang-luong-quoc-gia-thoi-ky-2021-2030-tam-nhin-den-nam-2050.html.

[7] Ministry of Industry and Trade (Vietnam), "National Comprehensive Energy Plan for the Period 2021–2030, with a Vision towards 2050."

[8] T. Thanh, "Vietnam Will Operate Its First Green Hydrogen Plant in 2024," Comsumption and Production, 2022, http://scp.gov.vn/tin-tuc/t12994/viet-nam-se-van-hanh-nha-may-hydro-xanh-dau-tien-vao-2024.html.

[9] V. Huong, "Proposal to Build a 175 Trillion VND Green Hydrogen Center in Quang Tri," 2022, https://baodautu.vn/de-xuat-xay-dung-trung-tam-hydro-xanh-175000-ty-dong-tai-quang-tri-d173269.html.

[10] Fuel Cell and Hydrogen Energy Association et al., "Road Map to a U.S. Hydrogen Economy: Reducing Emissions and Driving Growth across the Nation," 2021, https://www.fchea.org/us-hydrogen-study.

[11] Chrishelle Lawrence and Chip Berry, "U.S. Households' Heating Equipment Choices Are Diverse and Vary by Climate Region," U.S. Energy Information Administration, April 6, 2017, https://www.eia.gov/todayinenergy/detail.php?id=30672.

[12] U.S. Department of Energy, *Department of Energy Hydrogen Program Plan* (Washington, D.C., 2020), https://www.hydrogen.energy.gov/pdfs/hydrogen-program-plan-2020.pdf.

[13] U.S Department of Energy, "Hydrogen Shot: Hydrogen and Fuel Cell Technologies Office," https://www.energy.gov/eere/fuelcells/hydrogen-shot.

NBR

THE NATIONAL BUREAU *of* ASIAN RESEARCH

600 UNIVERSITY STREET, SUITE 1012
SEATTLE, WA 98101 • 206-632-7370

1819 L STREET NW, NINTH FLOOR
WASHINGTON, D.C. 20036 • 202-347-9767

WWW.NBR.ORG @NBRNEWS