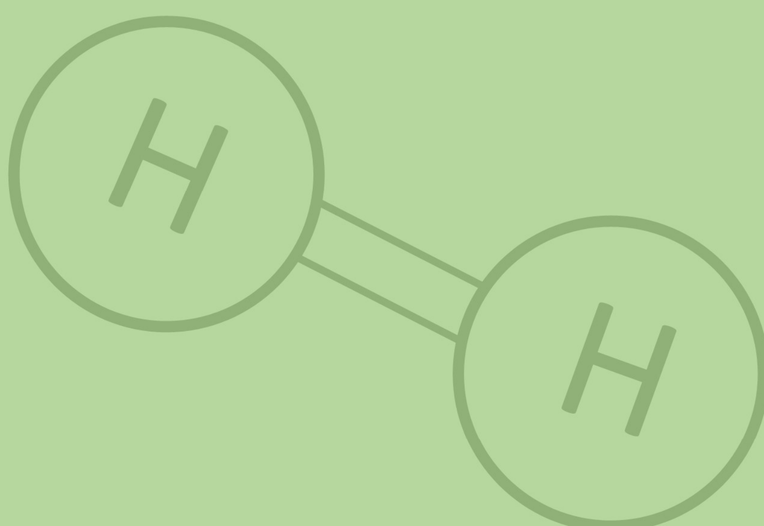
APERC

HYDROGEN REPORT 2024



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Forewords

As the APEC energy landscape evolves, clean and low-carbon hydrogen has emerged as an important pillar in the transition toward a more sustainable and resilient future. The APEC Policy Guidance to Develop and Implement Clean and Low-Carbon Hydrogen Policy Frameworks in the Asia-Pacific, which was adopted by the energy ministers in Lima in 2024, represents a collective commitment by APEC member economies to advance hydrogen as a key enabler of decarbonization, energy security, and economic growth.

This report highlights the progress of APEC member economies in developing hydrogen production capacity, end-use applications, and supporting policies. While notable advancements have been made, challenges remain in growing clean and low-carbon hydrogen production, securing demand, and harmonizing policies and standards. The insights presented here are intended to serve as a foundation for continued collaboration among policymakers, industry leaders, and research institutions, reinforcing APEC's leadership in the global hydrogen market.

By fostering innovation, investment, and regulatory alignment, APEC member economies can accelerate the development of a robust clean and low-carbon hydrogen market, contributing to a cleaner and more sustainable energy future.

Kazutomo IRIE

President
Asia Pacific Energy Research Centre

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Highlights

- The clean and low-carbon hydrogen industry remains in its early stages of development. While 2024 has seen significant advancements in project deployment, it has also highlighted persistent challenges that may delay its implementation.
- The APEC region continues to lead global efforts in low-carbon hydrogen development, accounting for most of the committed production capacity, which has reached 4.2 million tonnes per year in 2024. Additionally, APEC economies have expanded the number of end-use projects, with state-owned enterprises playing a major role in their execution.
- China hosts the largest share of renewable energy-based hydrogen projects within APEC, with a committed capacity of 1.8 million tonnes per year as of 2024. In contrast, the United States has demonstrated progress in clean hydrogen projects that are fuel by natural gas accounting for approximately 1.6 million tonnes per year of committed capacity.
- The establishment of hydrogen technology hubs—a strategy actively pursued by Australia, Canada, and the United States—has played a critical role in accelerating project development and securing investment.
- APEC member economies are shifting from policy formulation to implementation, with a strong emphasis on financial support mechanisms and the expansion of hydrogen hubs. Some economies have introduced hydrogen supply auctions to stimulate clean hydrogen production, while others have implemented targeted incentives, including the implementation of subsidies and tax credits, particularly for renewable-based hydrogen projects.
- Although international standards for zero- and low-carbon hydrogen are still under development, certain economies, including Canada and Korea, have established domestic standards to facilitate policy implementation and sectoral support measures.
- However, high production costs, technological challenges, and uncertainty regarding long-term support schemes pose significant challenges, leading some project developers to abandon planned initiatives. While clean and low-carbon hydrogen production capacity is expanding, demand uncertainty remains the primary barrier to market maturity, creating risks for long-term investments.
- Natural hydrogen exploration is gaining momentum, with projects underway in the United States, Canada, and the Republic of the Philippines to assess its commercial viability.

Definitions

To this report, the following concepts are defined as follows:

Zero Carbon Hydrogen: A definition based on hydrogen production's carbon intensity. This refers to hydrogen produced without greenhouse gas (GHG) emissions. It may include green hydrogen, depending on the specific methodology used to measure emissions.

Clean Hydrogen. A broader definition based on hydrogen production's carbon intensity. This refers to hydrogen produced with minimal GHG emissions, including green hydrogen and other low-carbon production methods. The exact emission threshold varies depending on regulations and certification standards.

Low Carbon Hydrogen: Hydrogen produced with significantly reduced GHG emissions compared to conventional methods. This includes hydrogen derived from fossil fuels with carbon capture and storage (CCS). The specific emission threshold varies based on regulatory frameworks and certification schemes.

Green Hydrogen: A definition based on production technology. This refers to hydrogen produced via electrolysis, where the electricity supply comes exclusively from renewable energy sources such as solar, wind, or hydropower.

Pink Hydrogen: A definition based on production technology. This refers to hydrogen produced via electrolysis, where the electricity supply comes exclusively from nuclear power.

Blue Hydrogen: A definition based on production technology. This refers to hydrogen produced from natural gas using Steam Methane Reforming (SMR) or Autothermal Reforming (ATR), combined with Carbon Capture and Storage (CCS) to reduce emissions.

Natural Hydrogen: Also known as native hydrogen or white hydrogen, this refers to naturally occurring hydrogen found in the Earth's crust. It can be extracted from geological formations and may represent a potential zero-emission hydrogen source if harnessed sustainably.

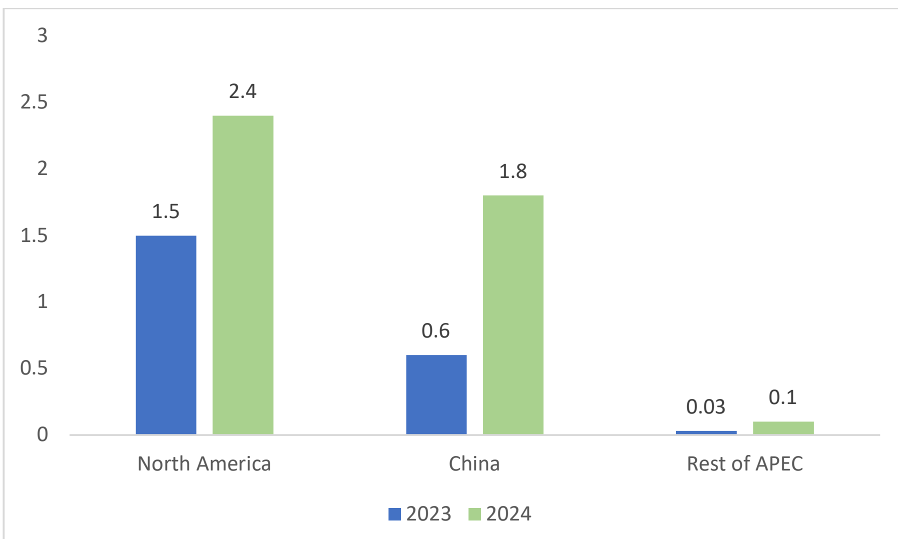
APEC economy members recent hydrogen developments

Despite growing interest and investment, the clean and low-carbon hydrogen industry faces economic and regulatory uncertainties that must be addressed to accelerate market adoption and achieve carbon neutrality goals. In 2024, the APEC region led the world in committed hydrogen production capacity. The hydrogen production capacity that reached final investment decision (FID) has increased to more than 4.2 million tonnes of hydrogen, reflecting a 68% growth—primarily driven by developments in China, mainly renewable energy-based hydrogen, and North America, mainly natural gas-fuelled hydrogen with carbon capture and storage. Despite these significant advances, 2024 also highlighted challenges in securing hydrogen and hydrogen product offtakes, causing delays in the progression of hydrogen projects to more mature stages.

Several APEC economies have transitioned from policy development to the implementation of financial support initiatives for hydrogen projects. Many of these initiatives have focused on establishing hydrogen hubs to serve as catalysts for broader industry development.

While interest in clean hydrogen remains strong, the creation of end-use demand continues to be the biggest hurdle. These challenges are characteristic of the maturation process that emerging technologies undergo as they move toward large-scale adoption.

Figure 1 Estimated committed annual H_2 generation capacity by 2030 (Million tonne of H_2)



Source: Estimation based on the Hydrogen Insights 2024, IEA Hydrogen Production Project Database 2024 and APERC

In August 2024, the energy ministers from the 21 APEC member economies issued a joint statement endorsing the "APEC Policy Guidance to Develop and Implement Clean and Low-Carbon Hydrogen Policy Frameworks in the Asia-Pacific." This policy guidance recognizes clean hydrogen as a crucial tool for decarbonizing multiple sectors, including chemicals, transportation, and power.

The document outlines key areas where member economies should focus their efforts highlighting the following topics: standards and certification, value chain development, research and innovation, finance and investment, and public and social awareness. Additionally, it establishes fundamental principles for implementation, emphasizing that hydrogen production should align with APEC's energy targets—doubling renewable energy from 2010 levels by 2030 and reducing energy intensity by 45% from 2005 levels by 2035. The guidance also underscores the importance of policy coherence, inclusiveness, and strategic planning, encouraging member economies to develop comprehensive plans for integrating hydrogen into their energy systems.

Australia

The update of the Australia's National Hydrogen Strategy was released in 2024. In contrast to the previous Hydrogen Strategy, Australia sets a goal of producing between 15 to 30 million tonnes of renewable hydrogen by 2050. It also sets the following milestones to monitor the progress of annual hydrogen production.

- 2030: 0.5-1.5 million tonnes
- 2035:3-5 million tonnes
- 2045:5-12 million tonnes
- 2050:9-20 million tonnes

Additionally, Australia also aims to export between 0.2 million to 1.2 million tonnes of renewable energy-based hydrogen (or equivalent in hydrogen embodied products) by 2030.

While recognizing that hydrogen produced from steam methane reforming with CCS may play a role in the early stages of developing the clean hydrogen industry, the updated Hydrogen Strategy predominantly emphasizes renewable energy-based hydrogen.

The strategy provides Australia's vision for clean hydrogen: Australia will be a clean hydrogen supplier at a competitive cost, Australia will also promote the use in the most prospective demand sectors for clean hydrogen, and Australia will establish partnership to consolidates potential trades routes.

Australia is supporting production with the Hydrogen Production Tax Incentive (HPTI) and the Hydrogen Headstart Program (HHP). The HPTI will provide AUD 2 (USD 1.27) per kg of hydrogen to eligible renewable energy-based hydrogen producers[1] for a maximum of 10 years between 2027-28 and 2039-40. In June 2024, the HHP Round 1 received the full application of the six shortlisted projects. The Australian Renewable Energy Agency, ARENA, through a competitive round, provides grant funding for 10 years from the commissioning date to large-scale renewable hydrogen and its derivates production projects to close the gap between the sale price and the actual cost of renewable energy based hydrogen[2]. In May 2024, Australia announced investment in AUD 2 billion (USD 1.27 billion) for the Round 2 of the HHP.

Additionally, there are advancements on the Guarantee of Origin scheme frameworks. The Future Made in Australia (Guarantee of Origin) Bill 2024 and its supportive Future Made in Australia (Guarantee of Origin Charges) Bill 2024 and the Future Made in Australia (Guarantee of Origin Consequential Amendments and Transitional Provisions) Bill 2024 were introduced by Government to the Australian Parliament. The Guarantee of Origin establishes a scheme to certify renewable electricity and products such as hydrogen. The last proposal expands the scope of productions to include analysis of the green steel industry. This Bill has passed both houses by November 2024.

Aligned with the Australia's National Hydrogen Strategy, the building of regional hubs continues. Australia is investing around AUD 500 million (USD 318 millions) for the implementation of these hubs

[1] Among the eligibility criteria are that FID must be reached by June 30th, 2030, carbon intensity of hydrogen must be less or equal to 0.6 kg CO2 / kg H2 from well to gate, minimum total electrolyser capacity of 10 MW and facilities must be in Australia.

[2] Eligibility criteria include projects with plate capacity of 50 MW located at a single site.

and the study of future ones. There are seven major hydrogen hubs that have been funded by the program:

- the Pilbara and Kwinana in Western Australia
- the Hunter Valley in NSW.
- Bell Bay in Tasmania
- Gladstone and Townsville in Queensland
- Port Bonython in South Australia

In February 2024, the Albanese and Cook Governments finalised an AUD 140-million agreement to build the Pilbara hydrogen hub.

On the other hand, in October 2024, Origin Energy, a major proponent of this project, announced its intention to make an exit from the Hunter Valley Hydrogen Hub to prioritize capital expenditure on other options focussed on renewable energy and storage and the difficulty to reach FID for its hydrogen projects as the market is developing at a slow pace. The initial phase of this project consists of a 50 MW electrolysis system.

Additionally, HHP will provide hydrogen production credit for 10 years for large-scale (> 50 MW electrolysis single-site capacity) renewable energy-based hydrogen projects through competitive hydrogen production contracts. The total budget for the program is AUD 2 billion (USD 1.27 billion). The shortlist of selected project to present full applications was announced in December 2023. Full applications were expected by mid-2024. The six projects shortlisted were the following:

- 105-MW H2Kwinana in Western Australia. The end-use of this project is ammonia, sustainable aviation fuel, and minerals processing. This project is expected to produce around 44 tonnes per day of hydrogen. This project could increase production capacity by increasing electrolyser capacity. Scenarios with production of 143 tonnes per day with electrolyser capacity ranging from 380 to 418 MW and 429 tonnes per day with electrolyser capacity ranging from 1 030 to 1 133 MW have been studied.

- 144-MW HIF Tasmania e-fuel Facility in Tasmania. The end-use of this project is e-fuel production. AT full capacity this project is expected to produce 100 million litres of e-fuels.

- 750-MW Port of Newcastle Green Hydrogen Project in New South Wales. The end-use of this project is ammonia production.

- 50-MW in Phase 1 and 200 MW in Phase 2 Hunter Valley Hydrogen in New South Wales. The end-use of this project is ammonia production and fuel for mobility. As mentioned earlier, Origin energy announced its intention to make an exit from the project in October 2024.

- 720-MW Central Queensland Hydrogen Project in Queensland. The end-use of this project is ammonia production. Initial hydrogen production is targeted at 200 tonnes per day. If the project increase electrolyser size to 2 GW, production can be targeted at 800 tonnes per day. This project is also studying the development of a hydrogen liquefaction facility at the Port of Gladstone that would produce 400 tonnes per day of liquified hydrogen.

- 1.625-GW Murchison Hydrogen Renewables Project in Western Australia. The end-use of this project is ammonia production. It is expected to produce 2 million tonnes of ammonia per year.

Final decision about these projects would be announced by the end of 2024. The budget for round 2 of the HHP, additional AUD 2 billion (USD 1.27 billion), was announced in May 2024 although the process is expected to start in 2025.

Additionally, some hydrogen production demonstration projects are operating in Australia. In February 2024, Denham hydrogen demonstration plant started operations. The estimated production is 13 tonnes per year, and it has a 348 KW proton exchange membrane (PEM) electrolyser and electricity is supplied by a dedicated solar farm of 0.704 MW that also provides electricity a remote microgrid in Denham, Western Australia. Hydrogen will be used to produce base load power in this microgrid.

In August 2024, Christmas Creek Renewable Hydrogen Mobility Project became operational. This project uses a 1.4 MW PEM electrolyser system (2 units of 700 kW) and is designed to produce 530 kg H2 pe day. Hydrogen fuels coaches that are replacing diesel coaches at the Christmas Creek Iron mine in Pilbara region. Fabrun, a New Zealand company has participated in the design, build and commissioning of this project.

The Hazer Commercial Demonstration Plant is located in Perth. Biomethane from a waste treatment plant is converted into hydrogen and synthetic graphite via pyrolysis in this demonstration plant. Hazer announced over 360 hours of continues operation in September 2024. The stated production capacity is 100 tonnes of hydrogen and 380 Tonnes of graphite per year. Part of the hydrogen produced will be used for in-site power generation.

According to HyResources, a platform for knowledge sharing supporting the development of Australia's hydrogen industry, there were 15 clean and low-carbon operating projects in Australia by October 2024. Overall potential hydrogen production capacity in operation stands at 580 tonnes of clean hydrogen per year. This capacity is 105 tonnes higher that the capacity reported last year, although it is important to note that not all the projects are constantly operating at full capacity. Most of these projects are electrolysis based and are connected to the grid for operation.

There is also a total hydrogen production capacity that is under construction and accounts for an addition 7400 tonnes of hydrogen per year. This capacity is expected to enter between the last quarter of 2024 and the end of 2025. The Gladstone PEM Project is among the biggest of these projects. It is expected to operate 30 MW electrolyser by 2025 in its first phase and increase its capacity to 50 MW in 2028. When it operates at full capacity the plant is expected to produce 8000 tonnes per year and will be powered by the renewable energy of the electricity market.

The Yuri Renewable Hydrogen to Ammonia Project is expected to finish construction in 2025 and will operate a 10 MW electrolyser to produce 640 tonnes of hydrogen per year to replace the SMR produced hydrogen at Yara Fertiliser's liquid ammonia plant in Western Australia.

The Kogar Creek Renewable Hydrogen Demonstration Plant is currently under construction in Chinchilla. The project will be powered by dedicated solar panels and battery installation and will have a capacity of 75 000 tonnes of hydrogen per year using 1 MW PEM electrolyser. This project is expected to enter operations by mid-2025.

Other projects in the pipeline have also shown advancements. Woodside Energy is proposing the H2Perth project. The project would use 65 terajoules of natural gas per day and between 150 to 250MW of electrolyser capacity to produce H2 in the first phase, with all future project phases scaling up green hydrogen production capacity and blue hydrogen production phased out by 2050. In October 2024, Woodside signed conditional offtake deal to ship liquid hydrogen to Singapore for Keppel's data centres. H2Perth would provide part of the required hydrogen.

In May 2024, Allied Green Ammonia in Northern Territory signed a memorandum of understanding with Trammo SASS of France for the cryogenic liquid ammonia off-take of its production. The announced capacity of the project is 958 500 tonnes of ammonia that is produced from 174 500 tonnes of hydrogen per year.

In December 2024, Kawasaki Heavy Industries announced its withdrawal from the Hydrogen Energy Supply Chain (HESC) project due to delays in hydrogen procurement from Australia. The HESC project aimed to establish a liquid hydrogen supply chain between Latrobe, Australia, and Kobe, Japan. The pilot phase of the project was completed in February 2022 with the arrival of the Suiso Frontier, a hydrogen carrier ship, at the Port of Kobe in Japan, carrying a load of liquefied hydrogen from the Port of Hastings in Victoria, Australia. Earlier in November 2024, Kawasaki Heavy Industries had already announced a 75% reduction in the size of the ship's tanks due to lower-than-expected international demand for the transportation of liquid hydrogen.

Other projects that have been announced are still under lower level of maturity. They account for several millions of tonnes of clean hydrogen which are expected to enter to hydrogen production after 2030 if they are realized. Among them we highlight the Australian Renewable Energy Hub, with 1.6 million tonnes of hydrogen per year and Western Green Energy Hub with 3.5 million tonnes of hydrogen per year if it runs at full scale.

Brunei Darussalam

After the conclusion of the AHEAD project where the feasibility of transporting hydrogen using methylcyclohexane from Brunei Darussalam to Japan was proven, Brunei Darussalam is evaluating the role that hydrogen may play in its economy.

Canada

Clean economy investment tax credits were enacted into law in Canada in June 2024. Carbon capture, utilization, and storage (CCUS), clean technology (CT), clean hydrogen (CH) and clean technology manufacturing (CTM) are available to a taxable Canadian corporation on qualifying expenditures.

Clean hydrogen investment tax credit offers clean hydrogen producers tax rebates between 15% and 40% on eligible equipment purchases that were acquired and available for use between March 2023 and before 2035. Clean ammonia projects are also eligible for a 15% of tax rebates if the carbon intensity of the clean hydrogen produced and used for ammonia production is less than 4 kg CO_2/Kg H_2.

Table 1. Clean hydrogen tax credit incentive structure for hydrogen production

Carbon intensity tiers	Tax credit rate
Less than 0.75 kg	40%
0.75 kg to less than 2.0 kg	20%
2.0 kg to less than 4.0 kg	15%
4.0 kg or higher	N.A.

Table 2 Clean hydrogen tax credit incentive structure for ammonia production

Carbon intensity tiers of hydrogen consumed	Tax credit rate
Less than 4.0 kg	15%
4.0 kg or higher	N.A.

Additionally, Natural Resources Canada has published guidance documents for potential applicants, covering three areas: technical and equipment, carbon intensity modelling, validation and verification. Clean Hydrogen Investment Tax Credit (ITC) workbook is also available.

In May 2024, Canada's Minister of Citizens' Services announced CAD 10 million (USD 7 million) in funding for projects supporting clean hydrogen. Of this, CAD 9.4 million (USD 6.61 million) will be used to establish a new Clean Hydrogen Hub at the Simon Fraiser University's Burnaby campus.

In August 2024, Canada's Minister of Energy and Natural Resources announced CAD 9.14 million (USD 6.42) to fund six projects to support innovation in Canada's clean hydrogen sector. This includes CAD 1.25 million (USD 880 000) to develop a pyrolysis -based hydrogen production pilot power plant.

The Hydrogen Strategy's Codes and Standard Working Group published the Canadian Hydrogen Codes and Standards Roadmap in February 2025 to identify gaps in codes and standards along the hydrogen value chain and introduce existing gaps, technical details, and policy actions needed for deployment.

Natural Resources Canada released the *Hydrogen Strategy for Canada: Progress Report* in May 2024. The report provides a detailed overview of the development of the hydrogen industry in Canada after the release of *Canada's Hydrogen Strategy* in 2020. It indicates that six electrolysis-based hydrogen projects and seven fossil fuels-based hydrogen with CCS are currently operational in Canada. The deployed low-carbon hydrogen production capacity reaches 3 450 tonnes of H_2 per year. Including projects at all levels of maturity as well as announced ones, the report estimates 80 low-carbon hydrogen projects with a total capacity of more than 5 million tonne of H_2 per year.

Of the 32 recommendations outlined in the *Canada's Hydrogen Strategy*, the progress report finds that Canada is on target to implement 13, progressing on 16, while 3 have seen limited progress. Most of on target recommendations pertain to establishing domestic partnership and collaboration among the stake holders and developing relevant policy and funding support. Recommendations in progress are focused on the development of pilot projects, hydrogen hubs, and hydrogen codes and standards. Finally, those recommendations with limited progress are related to engaging potential hydrogen end-users.

Among the most important advancements reported are the emerging of hydrogen hubs.

- The first and largest hub, Edmonton Region Hydrogen Hub, that was launched in 2021 comprises more than 25 projects, including an initiative of getting 5000 hydrogen and dual-fuel powered vehicles by 2028 known as the 5000 Hydrogen Vehicle Challenge. A significant milestone was achieved with the launch of Alberta's first commercial hydrogen fuelling station in March 2024. Air Products' Net-Zero Hydrogen Energy Complex will supply low-carbon hydrogen to this hub, approximately 140 000 tonnes of hydrogen per year from natural gas and carbon capture and storage using Autothermal reforming technology (ATR). ATR and steam methane reforming (SMR) are the two mature technologies to produce hydrogen from natural gas.
- Vancouver hosts a major hub for hydrogen technology innovation, fuel cell, and manufacturing companies. The Simon Fraser University and the University of British Columbia participate in this initiative.
- In July 2024, the city of Prince George received CAD 150 000 (USD 105 440) from the Pacific Economic Development Agency of Canada (PacifiCan) to develop a regional hydrogen hub. Prince George is considered as a strategic location due to its closeness to existing infrastructure and potential connectivity to Prince Rupert's port facilities. However, the

Coyote Hydrogen project was put on hold in October 2024 due to the inability to secure competitive renewable electricity supply; consequently, the project was no longer considered as commercially viable. This project, which would have produced 140 000 tonnes of hydrogen and 700 000 tonnes of ammonia annually, required 1 000 MW of hydropower capacity at affordable price.

- Ontario's Hydrogen hub is located in the Sarnia-Lambton area. This hub aims to replace existing grey hydrogen supply with low-carbon hydrogen, especially for petroleum refining and production of ammonia for fertilizers. This hub also benefits from nearby salt caverns for potential hydrogen storage. The hub is forecasted to increase supply up to 1 million tonnes of hydrogen per year by 2050.
- The cities of Bécancour, Shawinigan, and trois-Rivières participate in Québec's *Vallée de la transition énergétique.* The initiative aims to develop three sectors: energy storage, transport & electrification, and hydrogen, industrial & transportation decarbonization. Bécancour hosts Air Liquid's 20 MW PEM electrolyser and an air separation unit. This project is powered by hydropower sources and expected to be operational by 2025
- Additional early-stage hubs that are mentioned in the report are Calgary in Alberta, Selkirk in Manitoba, and Grey-Bruce in Ontario.

In April 2024, Nujio'qonik project, an electrolysis-based hydrogen project, received approval from the Canadien province of Newfoundland and Labrador. With a total capacity of 250,000 tonnes of green hydrogen per year, the 1.5GW of electrolyser will be powered by a 3GW of wind energy power plant.

Chile

In February 2024, Chile launched the Green Hydrogen Accelerator Version 3.0 program. This program was created by the Energy sustainability Agency (ESA) to support hydrogen production and consumption projects in Chile. The first version of this program, introduced in 2021, co-financed the Minería San Pedro project, which was inaugurated in August 2024.

In addition to providing co-financing for hydrogen production and consumption projects, the program aims to monitor the implementation of these initiatives to facilitate the transfer of knowledge and experience on the implementation of green hydrogen projects. Version 3.0 of this program has a budget of approximately USD 1.3 million and focuses on co-financing between 25% and 75% of project implementation costs. Eligible projects must have completed basic engineering studies and have an electrolyser capacity of up to 500 kW. They must also focus on hydrogen consumption, self-production, or production for use in industries such as logistics, transport, or electricity generation.

Two projects were awarded financial support under this version of the program in August 2024.

The first project, Enabling a Green Hydrogen Hub for Transport Logistics in the Antofagasta Region, is led by the Marion Molina Research Centre. This project involves implementing infrastructure for the production, storage, compression, and distribution of green hydrogen for use in heavy-duty vehicles in the city of Calama.

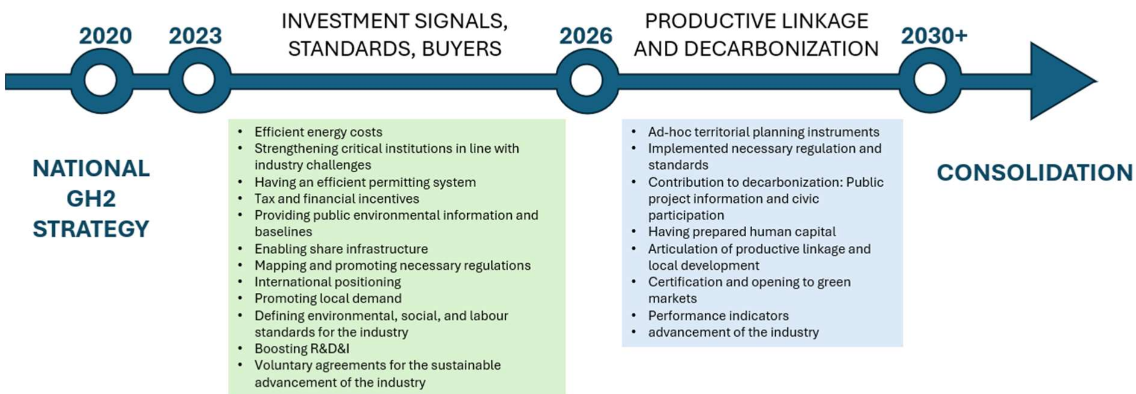
Following the withdrawal of the second awardee, KH DOS Spa was conditionally granted support for developing its project.

After the release of the National Green Hydrogen Strategy in November 2020, which set goals to achieve 5 GW of electrolysis capacity by 2025, increase to 25 GW by 2030, and a target price of 1.5 USD/kg, Chile unveiled the Green Hydrogen Action Plan 2023–2030 in April 2024. The Green Hydrogen

Action Plan outlines 18 lines of action, 81 specific actions, and 174 milestones, providing a clear pathway for implementing policies to support the production and adoption of green hydrogen in Chile. The implementation of this Action Plan has two time-windows.

One time window covers the period between 2023 to 2026 and is focused on providing investment signals and the design and implementation of relevant regulation and rules for the development of a hydrogen industry. The second time window covers the period between 2026 to 2030 and is focused on creating the condition for starting the productive phase of the hydrogen industry.

Figure 2 Time windows for Chile's Green Hydrogen Action Plan 2023-2030



Source: Chile's Green Hydrogen Action Plan 2023-2030

In June 2024, the Ministry of Energy launched the "Green Hydrogen Explorer", an online tool that allows to visualize ongoing hydrogen projects and explore different information such as levelized cost of hydrogen.

In addition to the current programs that support green hydrogen projects such as Facility H2V Chile, the Production Development Corporation (CORFO) is preparing the launch of new green hydrogen support programs by the end of 2024.

According to the Ministry of Energy's Green Hydrogen Explorer tool, there were 21 green hydrogen underway in Chile by 2023. However, other sources, such as H2Chile, mentions around 74 projects although most of them are at pilot stage.

The largest operating project is Haru Oni, phase 1. This project has an annual production of 750 000 litres of methanol for export and uses 1 MW of electrolyser.

Among the most important milestones in project development over the past year are the following:

- In April 2024, Chile's National Oil Company (ENAP, based on its Spanish acronym) awarded the construction of its first 1 MW green hydrogen plant to the German company Neuman & Esser. The plant is expected to begin production in 2025. There is a leading role of ENAP in the development of hydrogen infrastructure in Magallanes region. This is aligned with one of key milestones of Chile's Green Hydrogen Action Plan released in 2024.
- In August 2024, the Minera San Pedro Project was inaugurated. This project was partially funded by the Ministry of Energy through the Green Hydrogen Accelerator program. This

program is managed by the Sustainability Energy Agency. Led by San Pablo Mining Company in collaboration with the National Pilot Project Centre, this project has a current production capacity of 1 kg of hydrogen per day with plans to scale up to 3 kg of hydrogen per day of continuous operation.
- In November 2024, Ferrocarril Antofagasta Bolivia (FCAB) launched the first hydrogen-fuelled train in South America. Developed by the Chinese AHTECH CRRC Qishuyan Company, the design of the train was tailored to the operating conditions of this zone.

Additionally, two projects that received approval for the Environmental Impact Assessment during 2024 are as follows:

- Hydrogen Verde Bahia Quintero, with an estimated annual production of 430 tonnes of green hydrogen.
- HyEx that targets an annual production of 3200 tonnes of green hydrogen for ammonia production in its pilot stage. A proposed scale-up aims to increase production to 130 000 tonnes of green hydrogen or 700 000 tonnes of ammonia per year.

The combined capacity of operational and approved projects is estimated at 43.8 MW of electrolyser capacity and 7000 tonnes of hydrogen per year. Notably, most of this production is attributed to the HyEx and Bahía Quintero projects.

Two additional projects are currently undergoing Environmental Impact Assessments:

- Green Hydrogen and Ammonia Volta plant with annual production of 110 000 tonnes of hydrogen per year and 620 000 tonnes of ammonia
- HNH project that announced 3 GW capacity of electrolyser and 520 000 tonnes of Hydrogen per year of annual production

Of the six projects supported by Chile's Production Development Corporation (CORFO) in its 2021 financing round, four remain in the feasibility study phase:

- Antofagasta Mining Energy Renewable (AMER): Estimated annual production of 60,000 tonnes of e-methanol
- HyPro Aconcagua: Estimated capacity of 3,000 tonnes of green hydrogen, aimed at replacing fossil-fuel-derived hydrogen in refineries
- H2V CAP: Annual capacity of 1,550 tonnes of green hydrogen
- Faro del Sur: Plans to produce 25,000 tonnes of hydrogen per year, with the goal of manufacturing e-methanol and e-gasoline for export

The total pipeline of announced projects that have yet to complete feasibility studies is estimated at 808 MW of electrolyser capacity and an annual production potential of approximately 3.5 million tonnes of hydrogen.

On the other hand, as part of its action plan, Chile signed a Memorandum of Understanding (MoU) with the United Kingdom to unlock funding for green hydrogen projects. This agreement aims to support investments exceeding £5 billion, primarily for hydrogen exports to the UK.

People's Republic of China

After the adoption of the Hydrogen Industry Development Plan (2021-2035) in 2022, more ambitious local initiatives have been issued to complement and implement this plan. The Plan envisioned 50,000 hydrogen fuel-cell vehicles on the road and aimed at green hydrogen production using renewable feedstock resources to reach between 100,000 to 200,000 tonnes per year by 2025.

In February 2024, The National Development and Reform Commission (NDCR) issued the Catalogue for the Guidance of Green and Low-Carbon Transition Industries (2024 Edition). The Catalogue provides important information to financial institutions and investors by specifying industries that are considered crucial for achieving green and low-carbon energy transition. The 2024 issue includes activities throughout the whole value chain of the hydrogen from production, transportation, storage to the end-use as an energy source.

In March 2024, China's National Energy Administration (NEA) released the "Guiding Opinions on Energy Work in 2024". This document guides the energy sector in implementing the State Council energy policies. This document calls for the formulation of relevant policies to accelerate the hydrogen industry, promote technology innovation, develop of hydrogen pilot demonstrations products, focus renewable energy-based hydrogen production, and expand hydrogen energy application scenarios.

In July 2024, NDRC announced RMB 300 billions (approximately USD 42 billions) to step up subsidies replace of old polluting equipment, truck, ships, and buses with those that use cleaner fuels. Hydrogen is considered among these cleaner fuels. The subsidies will be funded by ultra-long special treasury bonds. In the following months, the Ministry of Transport, NDRC and Ministry of Finance issued specific plans to clarify subsidy standards for various vehicles and vessels.

In November 2024, China's Ministry of Finance announced allocation of the 2025 energy conservation and emission reduction subsidy budget. The budget allocated for fuel cell vehicles total RMB 1 625 billions and will be distributed on ten provincial-level administration: Beijing, Tianjin, Hebei, Inner Mongolia, Shanghai, Jiangsu, Zhejiang, Shandong, Henan, and Ningxia.

In November 2024, China released 33 hydrogen energy policies across 24 provinces and cities. Hydrogen has become officially classified as a source of energy accordant to the launch of China's first Energy Law. The main implications of this classifications are that hydrogen will be subject to development plants ant national and local levels and the price of hydrogen will be subject to government guidance.

In December 2024, China's Ministry of Industry and Information Technology, NDRC and NEA jointly released the Implementation Plan to Accelerate the Application of Clean and Low-Carbon Hydrogen in the Industrial Sector. This plan proposed detailed approaches in seven technical areas and related policy support to accelerate green hydrogen application.

According to the International Energy Agency (IEA)'s Global Hydrogen Review 2024, China is the largest global consumer of hydrogen, with an estimated consumption of 40 million of tonnes of hydrogen per year. Unabated coal gasification is the main method of hydrogen production in China, which underscores the importance of China's efforts to decarbonize its hydrogen supply.

The Hydrogen Insight September 2024 report by the Hydrogen Council and McKinsey & Company highlights that over 140 low-carbon and renewable energy-based hydrogen projects have been announced in China. In terms of committed investment, China has secured 1.8 million tonnes per year of hydrogen production capacity, including the capacity of several projects announced at the end of 2024, predominantly from renewable sources, representing 55% of the total global green hydrogen capacity. This commitment corresponds to an investment of over USD 31 billion.

Additionally, as of September 2024, China accounts for around 65% (1150 MW) of the estimated 1750 MW of operating electrolyser capacity worldwide. Most of these installations utilize alkaline electrolysers[3].

Of the 26 GW of global electrolyser manufacturing capacity that had reached a final investment decision by September 2024, the Hydrogen Insight September 2024 report indicates that 40% is in China, reaffirming the economy's leading role in the development of the electrolyser manufacturing industry.

By the end of 2023, China had more than 450 operational hydrogen refuelling stations, potentially making it the APEC economy with the largest number of stations, surpassing Japan and Korea. Despite this milestone, China may face challenges in achieving the goal of 1,200 stations by 2025, as outlined in the 2025 targets set by several provinces and municipalities[4].

During 2024 several projects have started their construction phase. Some important milestones are the followings:

In early 2024, China Petroleum & Chemical Corporation (Sinopec) announced that its Kuga green hydrogen project in Xinjiang would reach its planned annual production capacity of 20,000 tonnes by the end of 2025. The project began operations in 2023, producing 0.1 million tonnes of hydrogen in its first year.

In September 2024, China began the construction of a USD 1.5 billion green hydrogen project located in Mulei also in Xinjian. The project includes a 200 MW hydrogen-fired power station for grid backup and six hydrogen filling stations designed to fuel 600 trucks. It is expected to produce approximately 40,000 tonnes of green hydrogen annually, along with 320 tonnes of industrial oxygen and 51.6 million tonnes of high-temperature water. Additionally, the facility is anticipated to store hydrogen sufficient to generate 1,000 MWh of electricity.

State-owned China Energy Engineering Corporation (CEEC) has begun construction of the Songyuan Hydrogen Energy Industrial Park in September 2024. This project is set to become the largest renewable energy-based hydrogen production facility. The 640 MW plant, located in Songyuan, Jilin province, will use alkaline electrolyser technology to produce hydrogen, which will be utilized to produce 200,000 tonnes of green ammonia and 20,000 tonnes of methanol annually. This project is a part of the broader "Hydrogen Powers Jilin" initiative, which aims to triple the output of the Songyuan facility. Songyuan Hydrogen Energy Industrial Park involves a total investment of USD 4 billion and includes the construction of 750 MW of wind power and 50 MW of solar power capacity.

Another significant project, developed by China Coal Group, has received approval from the regional government of Inner Mongolia. With an estimated cost of USD 203 million, this facility will process approximately 2,000 tonnes of cow manure per day as feedstock to produce 200,000 tonnes of green methanol annually. Construction is expected to begin in September 2025.

[3] The alkaline electrolysers are a mature and commercially available technology, offering the lowest investment costs among electrolyser types and the capability to be assembled in high-capacity stacks (up to 10 MW). In contrast, the proton exchange membrane (PEM) electrolyser, which has higher investment costs and is typically assembled in stacks with lower capacities (up to 2 MW), is considered more suitable for integration with intermittent renewable energy sources due to its greater flexibility and responsiveness.

[4] In China, the central government formulates policies that are then implemented by local governments. These local governments are responsible for executing detailed plans to ensure that the central policies are effectively carried out at the regional and local levels

Separately, Geely launched its first green methanol plant in September 2024. This project is built at Bayin Aobao Industrial Park in Inner Mongolia. In its initial phase, the facility is set to produce 100,000 tonnes of methanol per year, with plans to scale up production to 500,000 tonnes annually in subsequent phases. This project will be the biggest green methanol plant.

In October 2024, a liquid hydrogen shipment was successfully transported from Rotterdam to Yantian Port in Shenzhen, China, covering 20,000 km. The shipment, conducted by China National Offshore Oil Corporation (CNOOC) in partnership with French company Air Liquide, marked a pioneering step in global hydrogen logistics akin to earlier projects such as the transportation of liquid hydrogen from Australia to Japan in 2022. Details about the shipment's volume and the hydrogen's origin were not disclosed.

Also, in October 2024, Shuangliang, a Chinese manufacturing group specialized in energy efficiency solutions and advanced technological equipment, announced the world's largest alkaline electrolyser, with a capacity of 5,000 Nm^3/h[5]. Based on real-time data presented during the launch conference, this capacity corresponds to a 20 MW electrolyser stack, with an efficiency ranging between 59% and 72%, depending on the current density during operation.

In November 2024, China Coal Ordos, a subsidiary of China Coal Group, began construction of a green hydrogen and green methanol plant at the Tuke Industrial Park in Uxin Banner, Inner Mongolia. The announced production capacity of this project is 100 000 tonnes of green methanol per year, the same capacity announced for Geely's methanol project.

In December 2024, the Beijing-based Hygreen Energy delivered five 5 MW alkaline electrolyser systems –a total capacity of 25 MW– to Huadian Weifang Power Generation in Shandong province. This marks the first large-scale renewable energy-based hydrogen project developed under the "Hydrogen Into Ten Thousand Homes" initiative, led by China's Ministry of Science and Technology in collaboration with the Shandong Provincial Government. The project is expected to produce 3.6 tonnes of hydrogen per day, supplying hydrogen to refuelling stations and blending it into natural gas systems for industrial and residential users.

CenerTech, as subsidiary of CNOOC, announced the successful run of 1 MW seawater electrolysis plant with an output of 200 Nm^3/h. This breakthrough allow the plant to use seawater directly and cut costs associated with water desalination. The efficiency of this electrolyser was estimated at around 55%, slightly lower than conventional alkaline electrolysers.

Hong Kong, China

In June 2024, Hong Kong, China announced its hydrogen development strategy. Although the strategy does not set specific targets or estimate hydrogen consumption, it envisions the adoption of hydrogen in transport, mobile machinery, and power generation.

The document outlines a series of actions required for integrating hydrogen into Hong Kong China's energy system. A legislative proposal to regulate the production, storage, transport, supply, and use of hydrogen is expected to be submitted by the first half of 2025. Additionally, the development and approval of hydrogen standard certifications must be completed by 2027, and public hydrogen filling stations must be installed by the same year. The strategy also reaffirms a commitment to maintain financial support for hydrogen adoption as part of the broader effort to achieve carbon neutrality.

[5] In contrast to announcements in other parts of the world, China's companies usually describe electrolyser capacity in hydrogen production units such as normal cubic meter per hour instead of power input to electrolyser.

In February 2024, Hong Kong China's first hydrogen-powered double-deck bus entered operation. The bus operates eight trips daily between Kai Tak and Cheung Sha Wan. Its hydrogen refuelling station is located in Kowloon; however, access is restricted due to regulatory limitations.

In November 2024, Hong Kong China inaugurated its first public hydrogen refuelling station in Yuen Long. This project was designated as a trial initiative under the economy's hydrogen development strategy

The Hong Kong China's Strategy of Hydrogen Development document released in 2024 presents a list of fourteen hydrogen trial projects that have been examined. Most of the projects aim to use hydrogen in transport.

Table 3 Hydrogen trial projects examined

Trial Projects	use
A hydrogen filling facility at its West Kowloon Depot	Transport
A public hydrogen filling station at Au Tau, Yuen Long	Transport
A hydrogen extraction facility at its Tai Po plant	Hydrogen production
A HFC double-deck bus	Transport
Use of a hydrogen tube trailer to deliver hydrogen to a hydrogen fuelled light rail vehicle	Transport
A hydrogen fuelled light rail vehicle in Tuen Mun as a non-revenue train	Transport
Five HFC double-deck buses and a hydrogen filling facility at its bus depot in Chai Wan	Transport
Using hydrogen fuel to supply electricity to a site office at a construction site in Lok Ma Chau	Power generation
Extracting hydrogen from existing towngas network at suitable site in Sai Kung to generate electricity at a public housing construction site in Tung Chung.	Power generation
Using hydrogen fuel to supply electricity to a site office at a construction site in Lok Ma Chau	Power generation
Two HFC refuse collection vehicles	Transport
Three HFC street Washing Vehicles	Mobile equipment
The use of hydrogen power generation equipment to supply electricity to electric machinery at a construction site in Sheung shui	Power generation
Production of hydrogen by using landfill gas and installation of related hydrogen filling facilities at the South East New Territories Landfill Extension	Hydrogen production

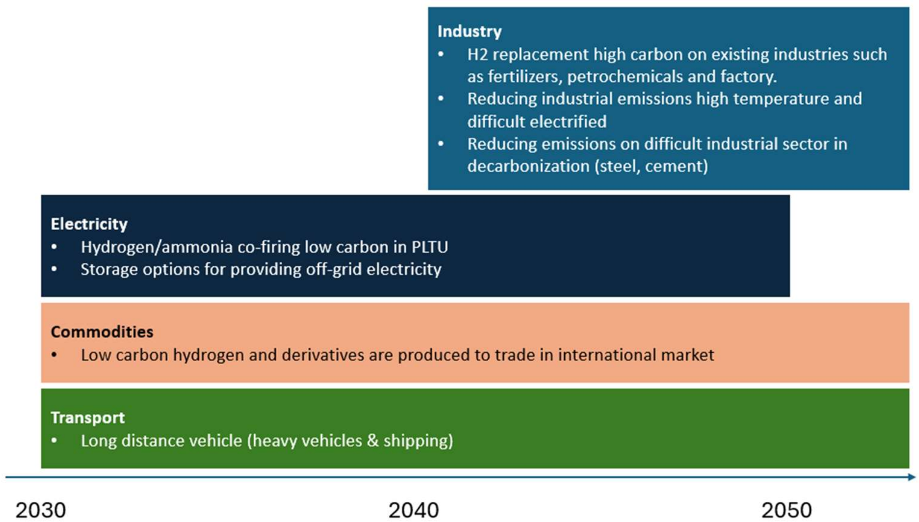
Source: Hong Kong China's Strategy of Hydrogen Development document

Indonesia

The National Hydrogen Strategy Report, published by the Directorate of New, Renewable Energy and Energy Conservation under the Ministry of Energy and Mineral Resources in December 2023, provided clear signals to energy companies such as Pertamina and PLN to advance green hydrogen pilot projects. Indonesia's National Hydrogen Strategy is built upon three fundamental pillars:

- Reducing dependency on fossil fuels to enhance energy sovereignty and security
- Meeting decarbonization targets by fostering a domestic hydrogen market
- Leveraging Indonesia's unique position as a maritime economy to export hydrogen and its derivatives to global markets

Figure 3. Potential applications of hydrogen in Indonesia's National Hydrogen Strategy



Source: Indonesia's National Hydrogen Strategy

Although the strategy does not establish specific hydrogen production targets, it assesses the potential applications of hydrogen. According to the NZE (Net Zero Emissions) scenario outlined in the report, the projected low-carbon hydrogen demand is as follows:

Transport Sector

- 2031: 0.04 TWh
- 2060: 89 TWh

Industrial Sector

- 2041: 2.8 TWh
- 2060: 79 TWh

In addition, three Indonesian National Standards (SNI) related to hydrogen were issued in 2024:

- SNI ISO 14687:2019: Hydrogen fuel quality – Product specifications
- SNI ISO 19880-1:2020: Hydrogen gas – Refuelling stations – Part 1: General requirements
- SNI ISO/TR 15916:2015: Basic considerations for hydrogen system safety

Indonesia is currently developing a National Roadmap for Hydrogen and Ammonia with a long-term vision to 2060. Efforts are underway to establish a regulatory framework to support hydrogen adoption, while tax reduction incentives are being studied for inclusion in the New and Renewable Energy (EBET) Bill.

Perusahaan Listrik Negara (PLN), an Indonesian state-owned electricity generation and distribution corporation, and PT Pertamina, an Indonesian state-owned oil and natural gas corporation, play significant roles in the development of green hydrogen demonstration projects.

Pertamina New & Renewable Energy (Pertamina NRE), a subsidiary of PT Pertamina, inaugurated the first Indonesia's hydrogen refuelling station (HRS) in Daan Mogot, Jakarta. During the launch ceremony, Pertamina NRE signed a Joint Development Agreement with Toyota Motor Manufacturing Indonesia to establish a hydrogen-based transportation ecosystem.

Pertamina is also committed to leveraging geothermal energy for green hydrogen production. Progress on the Ulubelu pilot project has been ongoing throughout the year. In October 2024, a memorandum of understanding (MoU) was signed between Pertamina Power Indonesia (a subsidiary of Pertamina NRE) and Genvia, a solid oxide electrolyser supplier. This collaboration aims to explore the integration of geothermal energy with solid oxide electrolyser (SOEL) technology.

In February 2024, Indonesia announced the completion of Southeast Asia's first geothermal-based green hydrogen production facility at the Komajang Geothermal Power Plant (PLTP). The facility has a production capacity of 4.3 tonnes of hydrogen with a purity level of up to 99.9%. PLN reported that this green hydrogen plant is the 22nd facility operated by the corporation. The accumulated annual production capacity is 203 tonnes of hydrogen per year. Of this, 75 tonnes will be allocated for cooling power plants, while the remaining 128 tonnes will fuel 438 vehicles. Additionally, PLN launched Indonesia's first hydrogen refuelling station in Senayan, Jakarta. It was announced that hydrogen fuel would cost Rp276 per kilometre (USD 0.017), significantly lower than the Rp1,300 per kilometre (USD 0.080) estimated for gasoline.

PT Pupuk Indonesia (Persero[6]), a state-owned enterprise and one of Asia's largest fertilizer producers, announced the commencement of the Front-End Engineering Design (FEED) for the Green Ammonia Initiative to Aceh (Project GAIA) in August 2024. This hybrid green ammonia project is a collaboration with Japanese firms ITOCHU Corporation and Toyo Engineering Corporation. Using TOYO's technology, Persero will produce green ammonia as feedstock for ITOCHU to manufacture marine fuel. A final investment decision is anticipated in 2025.

In February 2024, Japan's JERA and PT PLN Energi Primer Indonesia signed an MoU to collaborate on the development of a liquefied natural gas (LNG) value chain. The agreement also includes a study to assess the feasibility of transitioning to hydrogen and ammonia value chains.

Other hydrogen pilot projects currently developed by PT PLN (Persero)

- Utilization of hydrogen to produce green ammonia, which is used as Co-firing of coal-fired power plant Labuan 2x300 MW, in Labuan, Banten Province
- Production of hydrogen from Excess power of diesel – PV Hybrid Power Plant Medang (562 kW Diesel + 314 kWp PV + 576 kWh BESS) in Medang Island, West Nusa Tenggara Province

[6] PT Persero stands for Limited Liability Company Persero, a type of state-owned enterprise structured as a limited liability company, where at least 51% of its shares are owned by the government. PT Pupuk Indonesia (Persero) and PT PLN (Persero) are example of this type of enterprises.

- Utilization of fuel cell methanol to replace diesel in Kuil Diesel Power Plant, 100 kW, Kuil Island, Bangka Belitung Province
- Utilization of hydrogen fuel by fuel cell power generator to replace Rengit Diesel 2x100 kW in Rengit Island, Bangka Belitung Province
- Hydrogen co-firing in Batam Combined Cycle Power Plant 60 MW. Batam, Riau Islands Province
- Green hydrogen Co-firing at Pesanggaran Gas-Diesel Power Plant 16 MW, Pesanggaran, Bali Province

Japan

In February 2024, Japan announced the 7th Strategic Energy Plan, reaffirming its commitment to hydrogen and ammonia targets. The CIF price target for hydrogen is 30 yen/Nm³, with a maximum annual production of 3 million tonnes by 2030, increasing to 12 million tonnes by 2040 and 20 million tonnes by 2050 at a price target of 20 yen/Nm³. For the ammonia, the demand target is 3 million tonnes per year by 2030, with a price target of 15–20 yen/Nm³, and approximately 30 million tonnes per year by 2050.

To support these goals, the Hydrogen Society Promotion Act enacted in May 2024, introduced a business plan certification system for low-carbon hydrogen and derivates projects. Certified business plans can apply for support if they meet specific conditions:

- Joint Development: The business plan must be developed collaboratively by hydrogen suppliers and users. This requirement aims to mitigate the risk of insufficient low-carbon hydrogen offtakers.
- Supply Timeline: Hydrogen supply must begin by a specified fiscal year and continue for a defined period in the target sector.
- Investment by Hydrogen Users: Hydrogen users must make new capital investments and carry out other business activities for the use of low-carbon hydrogen.
- Infrastructure Development: Supportive infrastructure such as ports, roads and land use must be developed in accordance with the business plan.

Under this law, the Japan Organization of Metals and Energy Security (JOGMEC) is responsible for providing funding support. The developed support measures include the following:

- **Contracts for Difference (CfD) Program**: This program addresses the price gap between domestic or imported low-carbon hydrogen and conventional fuels it aims to replace. The CfD program was launched at the end of 2024.
- **Hub Development Support Scheme:** Support for the development of Low-carbon hydrogen hubs includes funding for part of the front-end engineering design, engineering, and construction costs of domestic transport and storage facilities.

The definition of low-carbon hydrogen and its derivatives is specified in a Ministry of Economy, Trade, and Industry (METI) ordinance. According to METI’s "About the Hydrogen Society Promotion Act" presentation, ammonia, synthetic fuel, and synthetic methane are planned to be classified as low-carbon hydrogen derivatives.

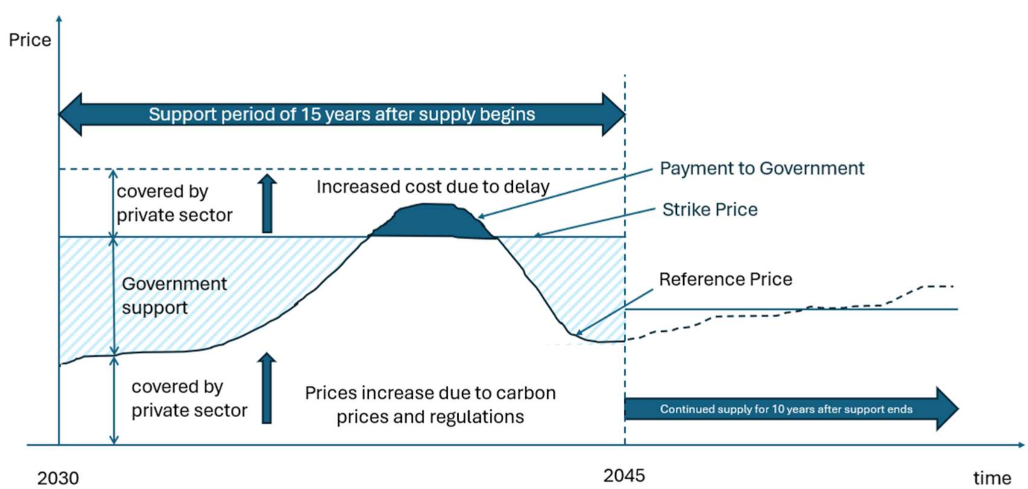
Table 4 Low-carbon hydrogen, ammonia, e-fuel and e-methane conditions

Hydrogen or derivate	Boundary	Concept of setting standard values	Reference Value
Hydrogen	Well to gate	Approx. 70% reduction of unabated fossil fuel-based hydrogen	3.4 $kgCO2_e/KgH_2$
Ammonia	Well to gate	Approx. 70% reduction of unabated fossil fuel-based ammonia	0.87 $kgCO2_e/KgNH_3$
Synthetic fuel	Whole Supply Chain	Approx. 70% reduction of unabated fossil fuel-based hydrogen. Add energy related emissions for synthesis and transportation, etc.	39.9 $gCO2_e$/MJ
Synthetic methane	Whole Supply Chain	Approx. 70% reduction of unabated fossil fuel-based hydrogen. Add energy related emissions for synthesis and transportation, etc.	49.3 $gCO2_e$/MJ

Source: Ministry of Economy, Trade and Industry (METI)

Japan has pledge USD 20 billion to support the implementation of the HPA. Japan officially launched its CfD subsidy program for clean hydrogen in December 2024. This support scheme will subsidize the difference between the strike price—the price required to establish a low-carbon hydrogen supply project—and the reference price, which represents the market price of the fuels that low-carbon hydrogen is intended to replace. These reference prices will reflect the effect of carbon pricing that will be implemented in Japan. The program prioritizes projects capable of delivering low-carbon hydrogen by fiscal year 2030. Support will be provided for 15 years after supply begins, one of the longest supports provided in APEC, with the condition that projects must continue operating for at least 10 years after the conclusion of the subsidy period.

Figure 4 Contract for difference scheme



Source: Ministry of Economy, Trade and Industry (METI). Translation by APERC

The hydrogen hub development support schemes are focused on promoting the use of low-carbon hydrogen in Japan. This initiative is currently implemented through the "Subsidy for Measures to Promote the Introduction of Non-Fossil Energy (Hydrogen Supply Infrastructure Development Project)." Accessing this subsidy involves three phases. In Phase 1, the Consortium for Resilient Omni-energy Supply System (CROS) initiates a public tender process to select feasibility studies for further development. Phase 2 focuses on the front-end engineering and design (FEED) phase, while the final phase involves construction. Once selected, JOGMEC provides funding to the selected projects ranging from USD 635,000 to 1,270,000. The first phase of the initial tender concluded in May 2024 with the selection of 10 projects. A second tender was announced and is expected to conclude by December 2024.

In September 2024, Japanese companies and TotalEnergies from France launched the Japan Hydrogen Fund. This private sector initiative aligns with the Japanese government's efforts to support the development of hydrogen economy. The initial fund amounts to $400 million, with investors including Toyota Motor Corporation, Iwatani Corporation, Sumitomo Mitsui Banking Corporation, MUFG Bank, Tokyo Century Corporation, Japan Green Investment Corporation for Carbon Neutrality, and the Bank of Fukuoka.

Japan has been actively working on formalizing cooperation agreements, including the signing of several MoU and cooperation, and investing in projects across several APEC economies. Some of these initiatives are mentioned in the other partner economy section.

In March 2024, Japan revealed a plan to partner with private sector to invest 33 billion to develop a new type of aircraft powered by cleaner technologies. These include electric power, hydrogen combustion, and hydrogen fuel cells, with the target deployment by 2035. Later, Japan announced support for a similar research project similar that will a develop a 4 MW fuel cell system for use in aviation.

In September 2024, Mitsubishi Corporation and Exxon Mobil signed a Project framework agreement for participation in Exxon's Baytown Project in the USA. If final investment is achieved by 2025, Mitsubishi will act as an offtaker of low -carbon ammonia and an equity participant of the project. The Bayton project is expected to produce 1 billion cubic feet of hydrogen and will require that part of Mitsubishi LPG terminal in Namikata, Ehime Prefecture, to be converted into an ammonia terminal.

Additionally, in May 2024, Japan announced 10 projects that had been selected in the Phase 1 of the selection process for the "Hydrogen Supply Infrastructure Development Project" a hydrogen hub development support scheme developed under the framework of the HPA.

Table 5 Selected feasibility studies for Phase 1 Subsidy for Measures to Promote the Introduction of Non-Fossil Energy (Hydrogen Supply Infrastructure Development Project)

Applicants	Selected project name
ERA Corporation, Japan Steel Corporation, AGC Corporation, Kashima Minami Joint Power Co., Ltd., TEPCO Energy Partner Co., Ltd., Ibaraki Prefecture	Survey project on the development of ammonia/hydrogen supply chains in the northern Kanto region starting from Hitachi Naka
Hokkaido Electric Power Co., Ltd., IHI Co., Ltd., Marubeni Corporation, Mitsui & Co., Ltd., Tomakomai Wharf Co., Ltd.	Large-scale ammonia supply base project in the Tomakomai area of Hokkaido

Mitsubishi Corporation, Takasago Thermal Engineering Co., Ltd., Air Water Hokkaido Co., Ltd.	Survey project on the supply of green hydrogen in Chitose City and infrastructure development with a view to cooperation with other points in Hokkaido
Kansai Electric Power Co., Ltd.	Survey on the potential demand, transportation infrastructure, and impact on the local economy for the introduction of clean hydrogen in the Harima and Kobe regions of Hyogo Prefecture
Idemitsu Kosan Co., Ltd., Tokuyama Co., Ltd., Tosoh Co., Ltd., Japan Zeon Co., Ltd.	Shunan Region Ammonia Wide-Area Supply Base, Regional Pipeline Development, Combustion Equipment Study Project
Mitsui & Co., Ltd., Mitsui Chemicals Co., Ltd., IHI Corporation	Business feasibility study project for the development of ammonia supply bases in the Sakai and Senhoku areas of Osaka
Kawasaki Heavy Industries, Ltd.	Feasibility Study for Hydrogen Utilization and Formation of Hydrogen Network in the Provincial Complex Area of Sakaide City, Kagawa Prefecture
Japan Petroleum Exploration Co., Ltd., Mitsubishi Gas Chemical Co., Ltd., IHI Corporation, Mitsui & Co., Ltd., Mitsui O.S.K. Lines Corporation	Survey for the construction of an ammonia supply base in the Soma area of Fukushima Prefecture
Kawasaki Heavy Industries, Ltd.	Feasibility Study for Promoting the Introduction of Hydrogen
Kawasaki Heavy Industries, Ltd., Japan Steel Corporation	Liquefied Hydrogen Feasibility Study

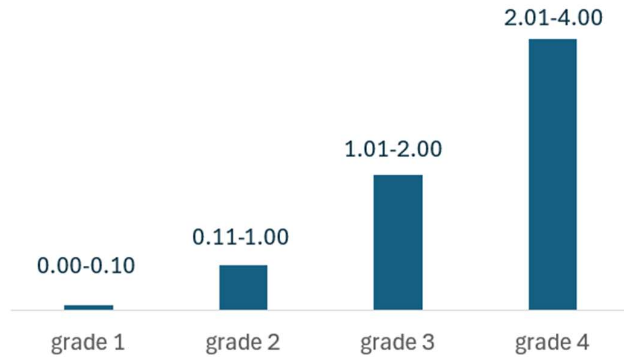
Source: Consortium for Resilient Omni-energy Supply System (Cros)

Toyota released its latest hydrogen capsule for trials, a new technology that could improve the refuelling of fuel cell vehicles and supply hydrogen for other applications, such as emergency fuel supply or cooking. The capsules are portable cartridges that can be replaced after their hydrogen content has been consumed. This technology is an upgrade of a previous version released in 2022.

Republic of Korea

In March 2024, the Ministry of Trade, Industry, and Energy (MOTIE) enacted and announced the notice on the operation of the Clean Hydrogen Certification System. This milestone in the implementation of the Clean Hydrogen Certification Scheme defines the procedures for obtaining clean hydrogen certification. The notice specifies the grades of clean hydrogen and the corresponding certification criteria.

Figure 5 Hydrogen grade and emission intensity ($kgCO_{2eq}/kgH_2$)



Source: Ministry of Trade, Industry and Energy (MOTIE)

The system boundary for measuring greenhouse gas emissions in clean hydrogen production is based on the "well-to-gate" system, meaning emissions are calculated from raw material extraction to hydrogen production. Emissions are further divided as follows:

- Direct emissions (Scope 1): Emissions directly produced by the process
- Indirect emissions (Scope 2): Emissions associated with electricity generation for hydrogen production
- Other indirect emissions (Scope 3): Emissions indirectly related to the process, such as transportation and supply chain impacts

A supplementary provision in the notice indicates that emissions from the following activities will not be accounted for until a future date determined by MOTIE:

- Shipping emissions for procuring raw materials for hydrogen production
- Transportation of captured carbon dioxide during hydrogen production
- Transportation of synthesized carriers after hydrogen production

The Korea Energy Economics Institute was designated as the certification operating institution. Additionally, in March 2024, the Korea Testing Certification Institute (KTC) was appointed as the first clean hydrogen certification testing and evaluation organization, and the Korea Testing & Research Institute (KTR) was designated as the testing agency.

Under the Clean Hydrogen Production Standard System (CHPS), the Korea Power Exchange launched the world's first clean hydrogen power auction in May 2024. The auction bid volume was 6500 GWh of electricity per year[7], produced by hydrogen power generation (fuel cells) or co-fired power generation with a minimum blending ratio of 20%, based on heat content, using clean hydrogen[8].

The contracts, which will start in 2028, have a 15-year duration. The evaluation criteria weigh 60% of the qualification on price and 40% on non-price factors. Within the non-price factors, 45% depends on

[7] The 10th electricity supply & demand basic plan estimates 13 TWh by 2030 and 47.5 TWh by 2036 of clean hydrogen electricity generation.

[8] Clean hydrogen is defined as hydrogen with a greenhouse gas emission intensity less than 4.00 $KgCO_2eq/kgH_2$.

the hydrogen grade, with 35 points awarded to Grade 1, 32 to Grade 2, 8 to Grade 3, and 1 to Grade 4. Bids must meet both the total LCOE ceiling price and the fuel cost index ceiling price.

Also, in November 2024, the 7th Hydrogen Economy Committee meeting was held, with participation from various hydrogen industry stakeholders. The main issues discussed included:

- Designation of Hydrogen-Specialized Hubs: Three cities—Donghae and Samcheok in Gangwon Province, and Pohang in Gyeongsang Province—were designated as Korea's first hydrogen-specialized hubs. These hubs aim to integrate hydrogen companies and serve as central points for fostering the hydrogen industry. Construction of these complexes is expected to be finalized by 2028.
- Government Support for Hydrogen Supply: The committee emphasized the need for government support to secure a stable hydrogen supply for transportation. This includes backing the development of technologies, particularly the early development of large-scale liquid hydrogen carriers, and liquid hydrogen storage systems.
- Hydrogen City 2.0 Strategy: The upgraded version of the Hydrogen City initiative aims to establish a diverse hydrogen ecosystem in the designated cities. Planned developments include the deployment of fuel cells across various building facilities as well as the introduction of hydrogen trams, trucks, and expanded hydrogen transportation infrastructure.

In December 2024, MOTIE announced its approval to establish the Korea Clean Hydrogen Promotion Institute. The institute will support the clean hydrogen industry's development by facilitating research, commercialization, evaluation, and verification processes.

Korea has seen advancements specially in the developing of hydrogen demand in its economy as part of its efforts to transition towards a hydrogen-based economy. In parallel, Korea is actively working to establish a domestic hydrogen supply infrastructure, including the inauguration of hydrogen production facility, distribution networks, and pipelines. In the process of developing regional hydrogen hubs, key industrial complexes in Korea, such as Ulsan, Changwon and Incheon, play a pivotal role in supporting these efforts.

Korea held the construction completion ceremony of its first commercial-scale liquid hydrogen production plant in Changwon, Gyeongnam Province in January 2024. This facility represents a KRW 95 billion (USD 66 million) investment by Doosan Enerbility, the Gyeongnam Provincial Government, and the city of Changwon. It has an annual production capacity of 1825 tonnes. Despite ceremony, the plant did not start operations and report any sales during last year.

The Incheon liquid hydrogen plant commenced operations in May 2024, becoming the world's largest facility of its kind. This plant, built with a KRW 700 billion investment by SK E&S, has an annual capacity of 30 000 metric tonnes of liquid hydrogen, sufficient to fuel 5,000 hydrogen-powered buses. SK E&S has also announced plans to construct 40 hydrogen refueling stations and related distribution networks by 2026.

Additionally, the Korean government conducts regular monitoring of hydrogen demand and supply in collaboration with businesses. In December 2024, MOTIE released its latest findings on hydrogen demand and supply prospects for mobility. According to MOTIE, hydrogen demand for mobility in Korea reached 9499 tonnes in 2024, marking a 64% increase from 2023 levels of 5741 tonnes. For the upcoming winter period (December 2024 to February 2025), hydrogen demand is projected at 4504 tonnes, while supply is expected to reach 7,865 tonnes.

In November 2024, the world's first clean hydrogen power generation auction was held in Korea. Korean Southern Power Co. (KOSPO) was the sole winner with its bid to blend ammonia into the coal supply for the 2.1 GW Samcheok Power Unit. KOSPO won the auction by offering a total clean hydrogen production of 750 GWh, which accounts for only 11% of the total 6,500 GWh offered in the auction. The price ceiling was set at KRW 500/kWh (approximately USD 0.35/kWh).

At the end of 2024, Korea launched a project to develop a liquefied hydrogen carrier vessel tentatively named Hydro Ocean K. The project participants include Pusan National University's Hydrogen Ship Technology Centre, Samsung Heavy Industries, HD Hyundai Heavy Industries, and Korea Gas. The vessel's construction and demonstration are expected to be completed by the end of 2028.

Malaysia

After the publication of the Hydrogen Economy & Technology Roadmap (HETR) in 2023, Malaysia has actively supported the energy transition and the decarbonization of its hydrogen sector in alignment with the roadmap. Malaysia has set a goal to produce 2 million tonnes of low-carbon hydrogen by 2030 and 16 million tonnes by 2050, following the Emission-Driven Scenarios outlined in the HETR.

Table 6 Business as Usual Scenario reported in the Hydrogen Economy & Technology Roadmap

	Business As Usual Scenario (BAU)		
	2030 (short-term)	2040 (Mid-term)	2050 (Long-term)
GHG Emission Intensity Reduction	1.57% reduction of GHG emission intensity by 2050		
Primary source	99.94% Low carbon H2 0.06% Green H2	78.07% Low carbon H2 23.13% Green H2	51.14% Low carbon H2 49.53% Green H2
Production Volume (Million Tonne)	1	4	7
% Final Energy Consumption	1.1%	3.6%	6.0%
Power (million tonne per year)			
Industry Heat (million tonne per year)	0.03	0.22	0.48
Industry non-energy (million tonne per year)	0.32	1.32	2.32
Mobility (Million tonne per year)	0.0006 (0.1% of TIV)	0.03 (1% of TIV)	0.46 (10% of TIV)
Marine (million tonne per year)			
Export (million tonne per year)	0.55	1.88	3.2
Cumulative Investment	RM 6.9 billion USD 1.5 billion	RM 58 billion USD 15.8 billion	RM 201 billion USD 44.2 billion
Revenue Generation	RM 7.4 billion (Domestic) USD 1.6 billion (Domestic) RM 20.3 billion (Export) USD 4.5 billion (Export)	RM 37.1 billion (Domestic) USD 8.2 billion (Domestic) RM 218.77 billion (Export) USD 48.1 billion (Export)	RM 151.7 billion (Domestic) USD 33.4 billion (Domestic) RM 408.93 billion (Export) USD 90.0 billion (Export)
GDP Contribution	RM 49 billion USD 10.8 billion	RM 292 billion USD 64.2 billion	RM 663 billion USD 145.9 billion

GNI Contribution	RM 61.6 billion USD 13.6 billion	RM 595 billion USD 130.9 billion	RM 1350 billion USD 297 billion
Job Creation	168000		

Source: MOSTAI, Hydrogen Economy & Technology Roadmap (2023)

Table 7 Emission Driven Scenario reported in the Hydrogen Economy & Technology Roadmap

	Emission Driven Scenario (EDS)		
	2030 (short-term)	2040 (Mid-term)	2050 (Long-term)
GHG Emission Intensity Reduction	6.94% reduction of GHG emission intensity by 2050		
Primary source	90.14% Low carbon H2 9.86% Green H2	61.66% Low carbon H2 38.34% Green H2 (13.17% imported)	53.37% Low carbon H2 46.63% Green H2 (6.3% Imported)
Production Volume (Million Tonne)	2	8	16
% Final Energy Consumption	3.3%	10.6%	18.8%
Power (million tonne per year)	0.05	0.99	2.05
Industry Heat (million tonne per year)	0.03	0.63	1.32
Industry non-energy (million tonne per year)	0.97	2.7	5.58
Mobility (Million tonne per year)	0.01 (1% of TIV)	0.12 (5% of TIV)	0.92 (20% of TIV)
Marine (million tonne per year)	0.03	0.21	0.41
Export (million tonne per year)	0.55	1.88	3.22
Cumulative Investment	RM 12 billion USD 2.6 billion	RM 148 billion USD 32.6 billion	RM 577 billion USD 126.9 billion
Revenue Generation	RM 12.1 billion (Domestic) *USD 2.7 billion (Domestic)* RM 20.3 billion (Export) *USD 4.5 billion (Export)*	RM 151.8 billion (Domestic) *USD 33.4 billion (Domestic)* RM 218.77 billion (Export) *USD 48.1 billion (Export)*	RM 497.2 billion (Domestic) *USD 109.4 billion (Domestic)* RM 408.93 billion (Export) *USD 90.0 billion (Export)*
GDP Contribution	RM 61 billion USD 13.4 billion	RM 637 billion USD 140.1 billion	RM 1573 billion USD 346.1 billion
GNI Contribution	RM 99 billion USD 21.8 billion	RM 829 billion USD 182.38 billion	RM 2200 billion USD 484 billion
Job Creation	211680		

Source: MOSTAI, Hydrogen Economy & Technology Roadmap (2023)

To promote investment in sustainable energy technologies, Malaysia revised its Green Technology Tax Incentive program in the 2024 National Budget. In April 2024, new GITA (Green Investment Tax Allowance) guidelines were introduced for assets and projects, expanding eligibility to include green hydrogen projects. Applications for these tax incentives must be submitted to the Malaysian Investment Development Authority.

Table 8 GITA Project for Business Purposes

Type of incentive	Details
GITA: Projects for Business Purposes	• Allowance of 100% of qualifying capital expenditure for green projects for 3 years from first expenditure • Offset against 70% of statutory income per year, with unused allowances carried forward • Applications accepted through the Invest Malaysia portal until Dec 2026

Additionally, other tax incentives are available:

- GITA: Assets – Applicable to companies that acquire qualifying green technology assets
- GITE: Services – Applicable to green technology service providers, such as solar power plants

Sarawak's hydropower potential is considered as an important advantage for promoting green hydrogen production. The two main projects in this Malaysian state are H2ornbill and H2biscus. Although these projects have not yet reached a Final Investment Decision stage, some advancements have been announced.

In April 2024, JGC Holdings Corporation, a Japanese company, announced the FEED contract for the H2ornbill project. This project, which is being developed by a partnership of ENEOS Corporation and Sumitomo Corporation from Japan, along with the Sarawak Economic Development Corporation (SEDC), is expected to have a production capacity of 90,000 tonnes of hydrogen annually. Of this, 2,000 tonnes will be supplied to domestic users, while the remainder will be converted to methylcyclohexane (MCH) for export to Japan.

Meanwhile, H2biscus is a collaboration between SEDC, LOTTE Chemical, Samsung Engineering, and the Korean National Oil Corporation. The project's output will include 7,000 tonnes of green hydrogen for domestic use, as well as 630,000 tonnes of green ammonia, 600,000 tonnes of blue ammonia, and 460,000 tonnes of green methanol. Most of these products are expected to be exported to Korea.

Additionally, SEDC has also signed an agreement with Gentari, a subsidiary by Petronas, a Malaysian multinational oil and gas company, to develop Sarawak H2 Hub in Bintulu. This project would be built in the Bintulu Petchem Industrial Park and has the potential to become one of the first hydrogen hubs in Southeast Asia. This potential is further supported by the proximity to infrastructure at Bintulu Port, a key LNG export gateway.

Early in 2024, Semarak Renewable Energy announced that it had secured USD 400 million in funding from private investors for the first phase of a green hydrogen project. This phase will have a production capacity of 6,000 tonnes of hydrogen per year and include the construction of a 130 MW floating solar plant and the installation of a 60 MW electrolysis system. A second phase is under study, proposing an additional 130 MW of photovoltaic capacity and increasing hydrogen production to 22 tonnes per day.

In November 2024, LBS Bina Group Berhad (LBS) announced the signing of a MoU with Invest Sabah Berhad, the Sabah Forestry Development Authority, and Midwest Green Sdn Bhd for the development of a 10 GW green hydrogen hub in Sabah, powered by solar and wind energy. The project is expected to have a production capacity of 250,000 tonnes of green hydrogen per year.

On the other hand, Sarawak's Autonomous Rapid Transit (ART) project continues to progress. The project, part of the Kuching Urban Transportation System (KUTS), aims to provide a reliable, efficient, and sustainable public transportation network to alleviate traffic congestion in the Kuching urban area. The ART concept includes dedicated lanes for hydrogen fuel cell electric vehicles. As part of the project, 55 hydrogen-powered buses will be supplied.

In January 2025, MAIRE, an Italian engineering and technology group, announced a contract for the licensing, engineering, construction, and commissioning of a hydrogen production unit that will be part of a new biorefinery located in the Pengerang Integrated Complex. This biorefinery is an initiative by PETRONAS Mobility Lestari Sdn. Bhd., in partnership with other companies. The project is expected to produce 38,000 normal cubic meters (Nm^3) of hydrogen per hour, which will be used to process raw materials to produce sustainable aviation fuel (SAF), hydrotreated vegetable oil (HVO), and bio-naphtha. The total contract value is estimated at approximately USD 125 million, and the plant is expected to begin operations in 2028.

Mexico

Mexico does not have specific norms dedicated to low carbon hydrogen although, in March 2024, the Secretariat of Energy (SENER) published its 11 guidelines regarding hydrogen development in Mexico. These guidelines outline the strategic role of the Mexican State in promoting the production and adoption of hydrogen and its derivatives, with a focus on favouring low-carbon options.

The guidelines represent Mexico's vision of hydrogen as a strategic energy source for its energy sector development. The guidelines can be summarized as follows:

- The Mexican State will establish priorities and long-term vision for integrating hydrogen into productive sector, including the development of a roadmap
- Foster a hydrogen culture
- Promote the production of all types of hydrogen, prioritizing low-carbon solutions
- Mexican State has main role in coordinating and driving the low carbon industry
- Promote education, research, and innovation in hydrogen technologies
- Develop a comprehensive regulatory framework for the hydrogen value chain
- Align strategies under SENER's coordination to accelerate sectoral growth
- Establish economic, financial, and technological conditions for cost-competitive hydrogen production
- Create conditions for Mexico's self-sufficiency in low-carbon hydrogen
- Identify infrastructure gaps critical to hydrogen development
- Build partnerships with financial institutions to support hydrogen initiatives

In addition to these guidelines, the Mexican Hydrogen Association (AMH2) has released the "Industrial Strategy for Clean Hydrogen in Mexico 2024", a study that analyses the potential of hydrogen within the country's energy sector. According to the study, the economic impact of six hydrogen projects currently under development could reach USD 1.8 billion in investment by 2030, generate 67,701 jobs, and contribute an additional USD 2.5 billion to the Mexican economy.

The Mexican Hydrogen Association (AMH2) also indicated that 18 clean hydrogen projects have been proposed, representing an investment of USD 21 billion and the creation of approximately 3 million jobs by 2050. This marks an increase of eight projects compared to announcements made in 2023. Currently, all the projects are under development, but none are yet operational.

In May 2024, Tango Solar announced the construction of a new Tango Solar Norte solar plant in El Fuerte, Sinaloa. The project involves an investment of USD 1.172 billion. The solar plant will have a capacity of 921 MW of direct current, with 787 MW dedicated to powering an electrolyser that will produce 41,485 tonnes of hydrogen annually. The construction is expected to take 5.5 years and the plant is projected to have a 40-year operational lifespan. The hydrogen produced will be used for trucks at the El Oro compression station, which is part of the natural gas network.

In March 2024, Mexican Petroleum (PEMEX) launched its Sustainability Plan. As the largest hydrogen consumer due to its refinery operations, PEMEX outlined opportunities for low-carbon business, including hydrogen. The plan mentions a pilot project for green or blue hydrogen at the Deer Park refinery in Texas, slated for short-term implementation between 2025 and 2029. Medium-term goals (2030–2035) include importing green hydrogen from North America, particularly Texas, to the Cadereyta refinery in Nuevo León. After 2035, domestic hydrogen production and exports are planned through a joint venture with the Federal Commission of Electricity (CFE). The plan estimates market opportunities of USD 1 billion by 2030, USD 3 billion by 2040, and USD 4 billion by 2050.The Marengo I project, located in Campeche, southern Mexico, is expected to produce 170,000 tonnes of green ammonia annually. It will utilize a 200 MW electrolyser powered exclusively by photovoltaic and wind energy. The hydrogen produced will be used for industrial and maritime purposes. A final investment decision is anticipated by the first half of 2025.

In July 2024, Aslan Energy Capital from Singapore signed a MoU with the Mexican state of Sonora to acquire 35,000 hectares for developing a green hydrogen power plant. The plant will produce ammonia for fertilizer, with production targets of 600,000 tonnes by 2028 and 1.2 million tonnes by 2030.

Also in July 2024, the Helx-Itsmo project in Puerto Santa Cruz was announced. The project involves a total investment of USD 10 billion and is an initiative of Copenhagen Infrastructure Partners. The hydrogen produced will be used for green ammonia exports and marine transportation.

However, two previously announced projects have encountered delays. The Delicias Solar project, with an annual capacity of 3,205 tonnes of hydrogen, has requested an extension for its commencement date. It was initially planned to start renewable electricity production in 2026. Additionally, the Neptuno Solar project, designed to produce 18,300 tonnes of hydrogen annually, has not yet received construction approval.

Another significant development is the expropriation of the U-3400 hydrogen plant within the Tula refinery. In December 2023, Mexico declared the hydrogen supply from Air Liquide, the plant's owner, to be of public purpose.

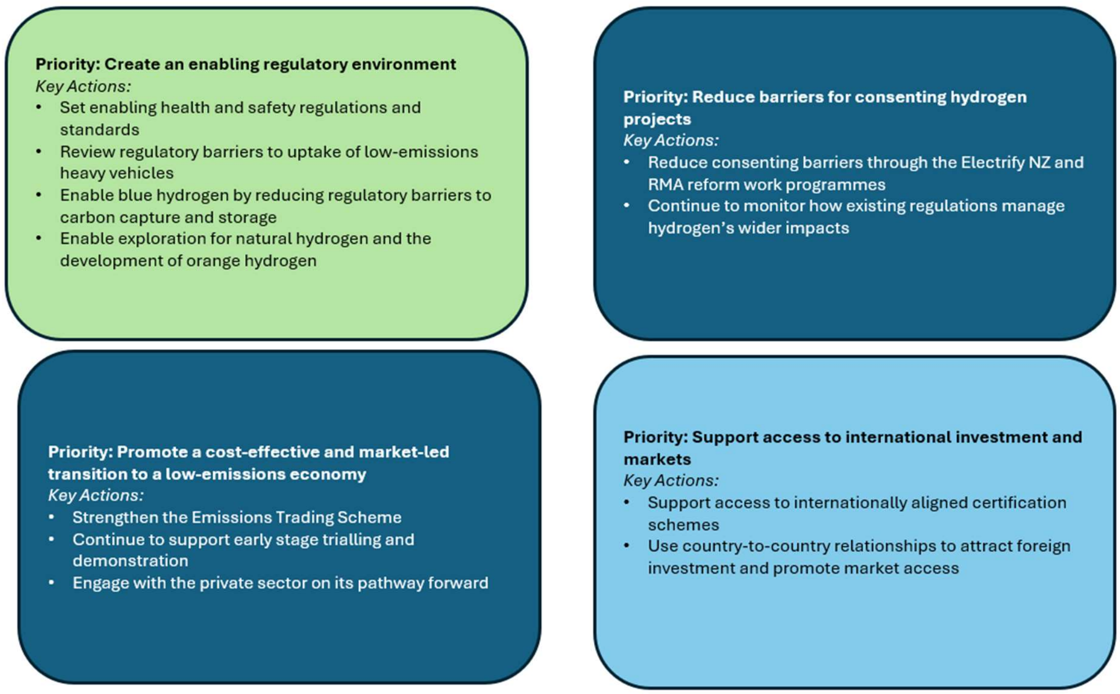
New Zealand

In April 2024, New Zealand released the Climate Change Strategy. This strategy aims to reduce greenhouse gas emissions by 50% from 2005 levels and biogenic methane by 10% from 2017 levels by 2030. By 2050, the strategy seeks to achieve net-zero emission and reduce biogenic methane by 24 to 47% from 2017 levels in accordance with the Climate Change Response Act 2002. One of the pillars of this strategy is the development of credible market to support climate transition, including the pricing of emissions.

In July 2024, 13 international hydrogen related safety standards were adopted by New Zealand. This adaptation is part of the hydrogen standards implementation strategy published in May 2023.

In November 2024, the Ministry of Business, Innovation & Employment, launched the Hydrogen Action Plan. This plan sets four key priorities and 11 actions, focusing on adapting the regulatory framework to eliminate inefficient barriers to hydrogen project development, especially projects involving blue hydrogen. New Zealand's vision emphasizes that hydrogen industry development should be market-led and delivery-oriented.

Figure 6 Key action in the New Zealand's Hydrogen Action Plan



Source: New Zealand Government's Hydrogen Action Plan

Four potential hydrogen applications are identified in Hydrogen Action Plan: transport (especially heavy vehicles, planes, and shipping), industry (as a chemical feedstock and for e-fuels, steel, and process heat), power (as a backup generator and for grid stability), and for export.

While no specific hydrogen production targets are set, the document estimates that between 640,000 and 1,200,000 tonnes of hydrogen could be produced annually by 2050.

A notable change from earlier documents, such as A Vision for Hydrogen in New Zealand, is a shift from favouring renewable electricity-based hydrogen to a more inclusive approach that acknowledges a significant role for natural gas-based hydrogen. The Hydrogen Action Plan also explores the potential of natural hydrogen and artificially stimulated geological hydrogen, also known as orange hydrogen. Additionally, the document states that several regulatory adaptations should be implemented by 2025.

In December 2024, New Zealand released its second Emission Reduction Plan (2026–2030), which incorporates key elements from the Hydrogen Action Plan.

In September 2024, New Zealand's Energy Efficiency & Conservation Authority (EECA) launched the Low Emissions Heavy Vehicle Fund. This fund, targeted at vehicles with a gross vehicle mass greater than 5.9 tonnes, provides financing for up to 25% of the cost of new zero-emission vehicles or 25% of the cost to convert eligible internal combustion engine (ICE) vehicles to zero-emission vehicles.

Hydrogen vehicles qualify as zero-emission vehicles under the fund, and dual-fuel vehicles that operate on both hydrogen and diesel are also eligible for this support.

In January 2024, the Green Hydrogen Production, Transportation, and Utilization in New Zealand and the Republic of Fiji proof of concept (PoC) project was launched. This project is a collaboration between organizations from three different economies: Halcyon Power Limited, the leading green hydrogen producer in New Zealand; Fiji Gas Pte Limited, from the Republic of Fiji; and Obayashi Corporation, from Japan.

Under the project, hydrogen is produced from a geothermal source in New Zealand and transported by land to an export port in Auckland. From there, hydrogen is shipped to the Republic of Fiji, where it will be used as fuel for a hydrogen-diesel dual-fuel generator. Obayashi Corporation oversees the overall management of the project. The initiative is supported by Japan's Joint Crediting Mechanism (JCM).

Some milestones of this project were achieved during 2024.In April 2024, Halcyon inaugurated New Zealand's first green hydrogen fuelling station in Wiri, South Auckland. Finally, in December 2024, the Republic of Fiji commissioned its hydrogen-diesel dual-fuel generator. Additionally, Hiringa Energy opened three hydrogen refuelling stations in Wiri, Te Rapa, and Palmerston North during 2024.

In contrast, some major projects did not commence operations in 2024 as originally expected. The Kapuni Green Hydrogen Project, which has the potential to produce green hydrogen-based urea to replace 7,000 tonnes of imported urea, and the Pouakai NZ project, with a capacity of 600 tonnes of green hydrogen per day, remain under feasibility studies.

Papua New Guinea

In 2024, Papua New Guinea continues to study the potential role of hydrogen in its energy system. Some feasibility studies are underway to assess the viability of projects that can utilize Papua New Guinea's renewable energy sources, such as hydro and geothermal energy.

Peru

In March 2024, the Green Hydrogen Promotion Law (Law No. 31992) was enacted. This law aims to promote the development of the green hydrogen value chain to supply both domestic and international markets through specific policies, actions, and funding. It defines green hydrogen as hydrogen produced using technologies with low greenhouse gas emissions. The Ministry of Energy and Mines is responsible for promoting green hydrogen derived from renewable energy, developing complementary regulations that establish the requirements for certification of origin, and defining the conditions for accessing potential tax and financial benefits.

In August 2024, Peru issued Legislative Decree No. 1629, which amended Article 2 of Law No. 31992, the Green Hydrogen Promotion Law. This decree redefined green hydrogen as hydrogen obtained from water through processes that use renewable energy resources as an energy source.

In January 2024, Fenix, a major electricity producer in Peru operating a combined-cycle natural gas-fired thermal plant, inaugurated its first green hydrogen project. The hydrogen production facility, located within its power plant in Chilca, near Lima, includes a photovoltaic system that powers an electrolyser. The project aims to produce 8,000 m^3 of green hydrogen annually, fully meeting the plant's internal hydrogen demand for the generator cooling system. In July 2024, Phelan Green Hydrogen announced the concession of 40,000 hectares of land in La Joya and additional 50 hectares in Matarani Port, both located in the southern Arequipa region. The project involves a total investment of USD 2.5 billion and includes the installation of a 1.8 GW solar power plant. The project is expected to produce 80 000 tonnes of green hydrogen annually, which will be converted into 440,000 tonnes of ammonia for export through Matarani Port. The official launch is expected in mid-2025.

Additionally, Horizonte de Verano, another green hydrogen project located in Arequipa, is undergoing early development studies. If completed, it is expected to produce 420,000 tonnes of green ammonia in its first phase.

Republic of the Philippines

Hydrogen has been acknowledged as a potential alternative for supplying clean energy since the Republic of the Philippines' Energy Plan 2022-2040. The increasing share of renewable energy described in the Republic of the Philippines' Energy Plan 2023-2050 has created opportunities for hydrogen to play a more specific role, particularly as renewable energy storage when coupled with offshore wind projects. The Energy Plan 2023-2050 also indicates that the Republic of the Philippines will explore the feasibility of sustainable aviation fuel (SAF) and hydrogen in transport vehicles.

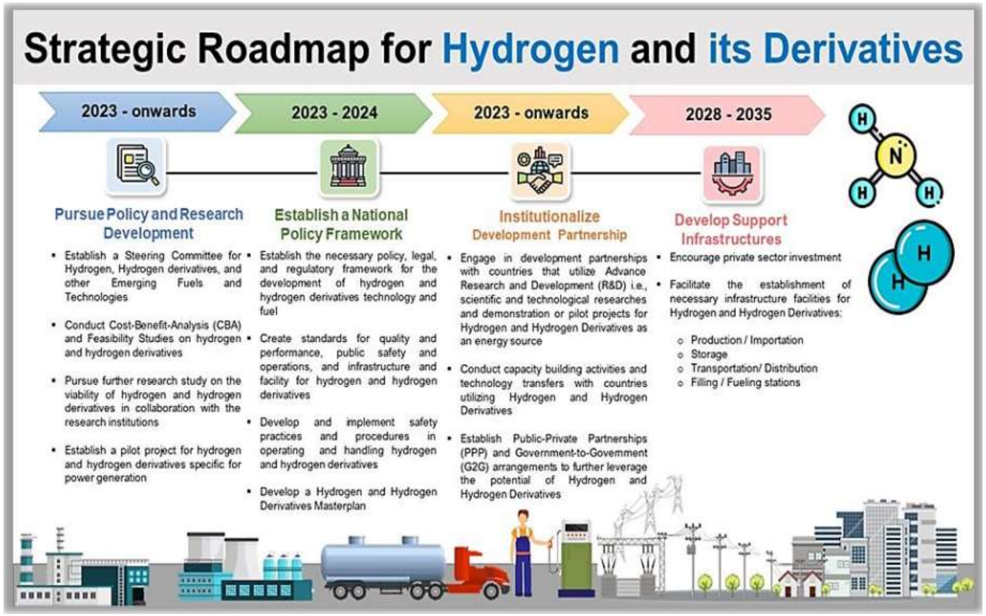
Following some milestones set in the Energy Plan 2023-2050, the Republic of the Philippines' Department of Energy released the Department Circular (DC) N° DC2024-01-0001 Providing a National Policy and General Framework, Roadmap, and Guidelines for Hydrogen in the Energy Sector, also referred as Hydrogen Energy Guidelines, in January 2024. This document establishes the regulatory framework for implementing hydrogen related projects and activities across the entire hydrogen value chain, except for the exploration of natural hydrogen —also known as native hydrogen in the Republic of the Philippines—, which is regulated by the Presidential Decree (PD) N° 87 Oil Exploration and Development Act of 1972 as indicated in the Department Circular (DC) N° DC2023-11-0031.

The Hydrogen Energy Guidelines provide definitions for terms such as green hydrogen, which includes not only hydrogen produced from electrolysis powered by renewable energy but also hydrogen derived from biogas reforming and biomass through biochemical conversion.

Additionally, the section on utilization specifies that hydrogen stored for power generation must be managed as part of hydrogen energy storage systems and governed by Department Circular No. DC2023-04-0008: Prescribing the Policy for Energy Storage Systems in the Electric Power Industry.

The Hydrogen Energy Guidelines also establish the Hydrogen Energy Industry Committee (HEIC) and Technical Working Groups (TWGs) to oversee the development of the hydrogen sector, identifies potential incentives for qualifying hydrogen projects, and mandates the development of the Republic of the Philippines' Hydrogen Roadmap to the HEIC.

Figure 7 Timeline of Roadmap for Hydrogen and its derivates



Source: Energy Plan 2023-2050

Two predetermined areas in Central Luzon, known as PDA-PH-1 of 134 000 hectares and PDA-PH-2 of 96 000 hectares, were offered by the Philippines' Department of Energy (DOE) to interested applicants. By November 2024, the DOE had received five applications that were reviewed and were eligible for further evaluation. The DOE was preparing to award the first hydrogen exploration contracts.

In July 2024, Hydrogène de France (HDF) Energy signed three Memorandum of Cooperation (MoCs) with the DOE and the Mindanao Development Authority (MinDA) to develop green hydrogen projects. The use of this hydrogen is energy storage for intermittent renewable energy sources to provide firm power. The first stages of this cooperation will include grid assessment and hydrogen projects feasibility studies.

Russia

Russia is the third-largest hydrogen consumer in APEC, following China and the U.S. The Green Hydrogen Innovation Centre (GHIC) reported that conventional hydrogen production in 2021 reached approximately 3.4 million tonnes for ammonia production and 2.7 million tonnes for refining. GHIC's analysis projects that by 2025, hydrogen production will increase to 3.8 million tonnes for ammonia and 3.1 million tonnes for refining.

Among the 41 projects listed in the Russian Atlas of Hydrogen and Ammonia Projects, the Sakhalin project announced key advancements in 2024. In March, the Hydrogen Engineering Centre—a hydrogen technology testing facility at the Special Design Bureau of Marine Research Automation Tools (SKB SAMI) under the Far Eastern Branch of the Russian Academy of Sciences—installed 30 kW of photovoltaic modules to power green hydrogen production. The Sakhalin hydrogen cluster is set to begin operations by the end of 2026, with an initial production capacity of 20,000 tonnes per year. The second phase, planned for 2030, aims to expand capacity to 100,000 tonnes annually.

In August 2024, a team of Russian scientists announced a new hydrogen synthesis method using natural gas reservoirs. Based on steam methane reforming principles, this approach could selectively extract hydrogen while leaving carbon behind, potentially reducing emissions.

In October, Gazprom revealed plans to explore the potential of natural hydrogen—also known as white or golden hydrogen—at the Kovykta field in the Irkutsk region. Initial exploration results suggest promising opportunities for natural hydrogen as an alternative to green hydrogen in the future.

Singapore

Following the vision outlined in Singapore's National Hydrogen Strategy, published in 2021, most hydrogen projects currently underway in Singapore involve the construction of hydrogen-ready turbines for electricity generation.

The primary mechanism driving hydrogen project development in Singapore, in alignment with the Singapore National Hydrogen Strategy launched in 2022, is the Centralized Process established by the Energy Market Authority (EMA) in July 2023. This process involves EMA projecting electricity demand for the next ten years. If a capacity insufficiency is identified, EMA calls Request for Proposals (RFP) to invite the private sector to develop and construct low-carbon and hydrogen-ready power generation units. Up to 2024, two RFPs have been announced for 1.8 GW of total capacity. The plants will initially operate on a blend of natural gas and 30% hydrogen, with plans to transition to 100% hydrogen fuel in the future.

In July 2024, the Create Thematic Programme in Decarbonization was launched with USD 90 million budget to foster research on hydrogen utilisation and the production of green chemicals including sustainable fuels.

In January 2024, YTL PowerSeraya won the first RFP for the construction and operation of a 600 MW hydrogen-ready combined cycle gas turbine at its Pulau Seraya Power Station. This initiative is part of the EMA's Centralized Process to facilitate the development of new power generation capacity. The investment is estimated at USD 800 million, with completion expected by 2027. In June 2024, EMA issued a second call for proposals for the construction of two additional hydrogen-ready power plants. Consequently, Pacific Light Power announced in January 2025 that it had secured one of the second RFPs, involving a USD 1 billion investment in a 600 MW hydrogen-ready natural gas power plant on Jurong Island, scheduled for completion by 2029.

Meanwhile, construction of Keppel's 600 MW hydrogen-ready gas-fired power plant is ongoing. This plant will initially operate on a blend of natural gas and 30% hydrogen, with plans to transition to 100% hydrogen fuel in the future. The facility is being built on a brownfield site previously used by a chemical plant. Additionally, Keppel is conducting a feasibility study on developing a power plant on Jurong Island that would utilize ammonia directly as a fuel.

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In October 2024, Woodside Energy, an Australian company, signed a conditional offtake contract to supply clean liquid hydrogen to Keppel starting in 2030. The hydrogen, produced at Woodside's hydrogen production facilities—including the H2Perth project in Australia—will be used to power Keppel's data centres in Singapore.

In November 2024, Sembcorp Industries, a Singaporean government-owned energy and urban development company, signed a Joint Development Framework Agreement (JDFA) with PT PLN Energi Primer Indonesia (EPI) and PT Transportasia Gas Indonesia (TGI) to develop a hydrogen transportation pipeline connecting Sumatra, the Riau Islands in Indonesia, and Singapore. This pipeline will have a capacity of 100,000 tonnes of hydrogen per year, supplying Sembcorp Industries' 600 MW hydrogen-ready gas turbine on Jurong Island.

These new hydrogen power plants will complement the 340 MW open-cycle gas turbine currently under construction by Meranti Power announced in 2023.

On the other hand, in May 2024, Fortescue announced the successful trials of the use of liquid ammonia blended with diesel and hydrogenated vegetable oil (HVO) in a marine vessel in the Port of Singapore in Jurong Island.

Chinese Taipei

The *2050 Net Zero Carbon Emissions Roadmap* and the following *Hydrogen Energy Development Roadmap* that were published in 2022, considered hydrogen as one of the 12 strategies that will be used to reach net zero by 2050; by then, Hydrogen is targeted to supply between 9 to 12% of total electricity generation. Previously a goal of 60 MW of fuel cells for power generation by 2050 was set in the *Energy Transition Paper*. Several institutions are working on the development of the *Hydrogen Development Strategy and Applications* that is expected in 2025.

Following its first low-carbon ammonia import in June 2023, TFC, a fertilizer and chemical company and one of the largest companies in Chinese Taipei, signed MoUs to assess the feasibility of developing green hydrogen and ammonia value chains. In July 2024, TFC signed a MoU with IHI Corporation to explore the establishment of a clean ammonia value chain in Japan and other economies. Similar MoUs were signed with Hoku Energy LTD, a subsidiary of Hoku Energy Limited UK, in September 2024. Later, in October 2024, TFC signed another MoU with Mitsubishi Heavy Industries to evaluate the ammonia value chain, covering receiving, storage, handling, delivery, and combustion for power generation.

Meanwhile, Japanese ITOCHU Corporation and Chinese Taipei-based U-Ming Marine Transport signed an MoU to explore the joint ownership and operation of ammonia-fuelled ships. This agreement also studies the use of other clean fuel alternatives, such as clean methanol, and devices for saving energy.

In February 2024, Taipower signed a MoU with IHI Corporation and Sumitomo Corporation to promote an ammonia co-firing demonstration project at the Dalin Power Plant. Taipower aims to achieve 5% ammonia co-firing for power generation by 2030. Dalin Power Plant has one 800 MW coal-fired unit that can reduce emissions by 9 000 tonnes of CO2 per year.

Among the demonstration projects that operated in 2024, the Hsinta H_2 co-firing project in Kaohsiung successfully tested one of its 119 MW turbines with a 5% hydrogen mix.

Additionally, the Steel and Chemical Co-production Pilot Plant, a collaborative project between the Industrial Technology Research Institute (ITRI) and China Steel Corporation (CSC), has run trial operations. In this project, CO2 captured from CSC's industrial processes and electrolysis-based hydrogen are used to produce methane and methanol. These products serve as feedstock for chemical plants to produce other materials.

During the pilot phase, the plant is expected to reduce CO2 emissions by 4,900 tonnes per year. The demonstration phase, targeted for 2025, aims to achieve a reduction of 240,000 tonnes of CO2 per year, while the commercial phase, projected for 2040, is expected to reduce CO2 emissions by 2,900,000 tonnes annually.

Thailand

Thailand released the draft of the 2024 National Energy Plan with the intention of reducing greenhouses emissions by between 30 to 40% by 2030. The National Energy Plan is composed of 5 key plans:

- Power Generation Development Plan (PDP 2024)
- Alternative and alternative Energy development Plan (AEDP)
- Energy conservation Plan (EEP)
- Natural gas management Plan (Gas Plan)
- Fuel Management Plan (Oil Plan)

The PDP 2024 has proposed the hydrogen blended with natural gas to generate 5% of electricity from 2030.

Thailand has been exploring the role of hydrogen in achieving its carbon neutrality goal by 2050 and net-zero emissions by 2065. A target has been proposed for 5% of the country's electricity to come from hydrogen blended with the natural gas supply. In this regard, Thailand has witnessed the signing of several MoUs between the Electricity Generating Authority of Thailand (EGAT) and various institutions to research the adoption of hydrogen co-firing technology.

In February 2024, EGCO, a subsidiary of EGAT, signed an MoU with Bangkok Industrial Gas and Thailand Post to study the use of hydrogen energy in the logistics sector. In June 2024, Mitsubishi Heavy Industries and EGAT signed an MoU to implement a hydrogen co-firing pilot project at one of EGAT's power plants.

Meanwhile, PTT, the state-owned oil and gas company, has initiated a pre-feasibility study on 100% hydrogen-fuelled gas turbine power generation.

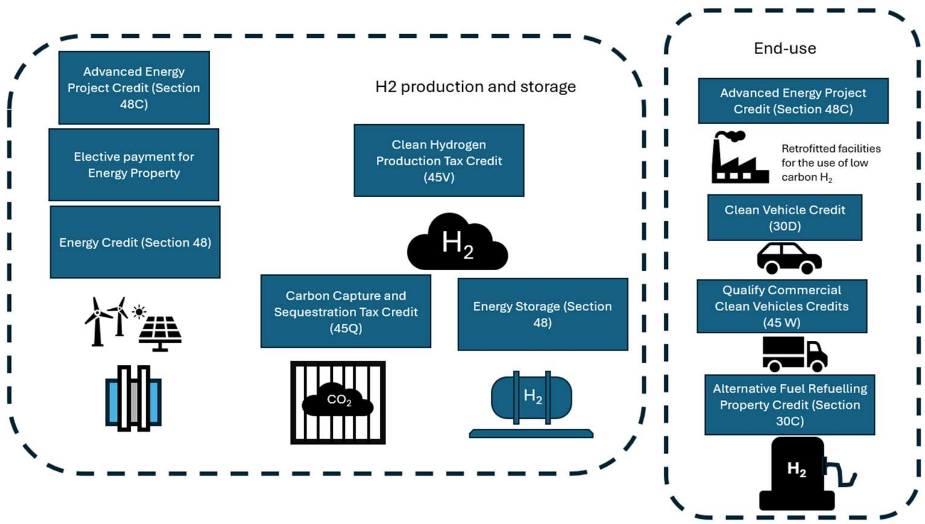
United States

The United States consolidates its position as the second-largest hydrogen consumer and producer. According to the IEA's Global Hydrogen Report 2024, total hydrogen demand reached 13 million tonnes in 2023. By 2024, demand is projected to grow to around 13.5 million tonnes, with an increasing share used for refining.

According to Hydrogen Insights, in September 2024, the United States hosts the largest number of committed hydrogen production capacities that have reached final investment decisions for 2030, amounting to approximately 1.6 million tonnes per year. Most of this capacity relies on natural gas with carbon capture and storage (CCS). Additionally, the installed electrolyser capacity for hydrogen production in the United States is estimated at 110 MW. If projects in early stages of development are included, the total capacity could reach between 5.6 and 9.1 million tonnes per year, as estimated by the IEA's Global Hydrogen Report 2024.

The United States has implemented subsidy mechanisms to support the development of the hydrogen value chain. These measures, many of which were established under the Inflation Reduction Act of 2022 (IRA), aim to promote innovation and investment across hydrogen production, storage, and end-use applications. The Department of Energy (DOE) has outlined key federal incentives applicable to hydrogen projects, summarized below:

Figure 8 Schematic of Federal Incentives for Hydrogen Projects



In May 2024, the U.S. Department of Treasury and the Internal Revenue Service (IRS) released final rules for Clean Vehicle Credits under Sections 25E and 30D. These credits provide up to USD 7500 for fuel cell vehicles purchased between 2023 and 2032. In October 2024, Clean Vehicle Credits for commercial vehicles were introduced under Section 45W. Heavy-duty vehicles weighing more than 14 000 pounds are eligible for a maximum credit of USD 40 000.

In December 2024, Treasury and the IRS released final rules for the Section 48 Energy Credit, also known as the Investment Tax Credit (ITC). This tax credit promotes clean energy investment by providing up to 30% credit on eligible investments in energy properties[9]. The amendments include clarifications on energy storage, specifying that a Section 48 credit can be claimed for energy storage technologies co-located with and sharing power conditioning equipment with a qualified facility under Section 45. Additionally, hydrogen energy storage properties do not need to store hydrogen solely for energy purposes to qualify.

- In early 2025, Treasury and the IRS released the final rules for Section 45V, also known as the Clean Hydrogen Production Tax Credit. While no major changes were made compared to earlier proposals, the final version included several updates:
- **Incrementality Criteria:**
    - The final rules specify that electricity produced by nuclear plants at risk of retirement can meet the incrementality criteria under certain conditions. These include co-dependence with the hydrogen project, with eligibility capped at 200 MW per plant

[9] Energy property is defined by the section 48(a)(3), which includes qualified equipment and construction, reconstruction, or erection of which is completed by the taxpayer.

  - States with significant greenhouse gas reduction policies (e.g., California and Washington) meet incrementality requirements. States that will adopt such policies can be included in the future.
  - Carbon capture investments for thermal power plants starting within 36 months before hydrogen project operations are considered incremental.
- **Lifecycle Emissions Standards:** Lifecycle greenhouse gas emissions will use the default values in the 45VH2-GREET model for methane sources, including wastewater and animal manure.
- **Time-Matching Requirements:** Hourly time-matching between clean power generation and hydrogen production will be required starting in **2030** (delayed by two years from earlier proposals).

On the other hand, the rules also indicate how to calculate lifecycle greenhouse gases emissions from a wide range methane sources such as wastewater, animal manure, coal mine methane. Upstream methane leakage rates will be based on the default values of 45VH2-GREET model.

In December 2024, the DOE published the Department of Energy Hydrogen Program Plan, a comprehensive strategy to accelerate hydrogen research and development across the United States. While the document was developed by the DOE, it also highlights the roles of other institutions in achieving national hydrogen goals.

Early in 2025, The U.S. halted fundings from Inflation Reduction Act (IRA) and the infrastructure Investment and Jobs Act (IIJA), putting clean hydrogen support schemes on hold. Given that initial support to the U.S. hydrogen hubs were already awarded, the main impact, if this decision is maintained, will be observed in hydrogen production support schemes and CO_2 sequestrations support schemes that could be awarded once clean hydrogen production starts.

Significant milestones have been achieved in the implementation of the economy's first hydrogen hubs. As part of the USD 7 billion Regional Clean Hydrogen Hubs (H2Hubs) initiative, seven clean hydrogen hub projects were selected in 2023. Each hub comprises several hydrogen production and demand projects, with a combined capacity exceeding 3 million tonnes by 2030. The hubs aim to use diverse energy sources for hydrogen production, including renewable and nuclear energy for electricity, as well as natural gas with CCS, leveraging the most competitive energy sources available in each region.

Of the selected hubs, five have signed contracts with DOE during 2024:

- **California Hydrogen Hub (Alliance for Renewable Clean Hydrogen Energy Systems, ARCHES):**
  The California Hydrogen Hub was the first regional clean hydrogen hub to sign an agreement, securing initial support of USD 30 million, with the potential for up to USD 1.2 billion in federal funding. Hydrogen production at this hub will be powered by renewable energy, including biomass, and aim avoid 2 million metric tons of CO2 emissions per year. The hub plans to provide hydrogen to power:
  - 3 large ports with 200+ pieces of cargo-handling equipment
  - 5,000+ fuel-cell-electric trucks
  - 1,000+ fuel-cell-electric buses
  - 1 marine vessel
  - Turbines and stationary fuel cells

- **Pacific Northwest Hydrogen Hub (PNWH2):**
  In July 2024, the Pacific Northwest Hydrogen Hub became the second U.S. regional clean hydrogen hub to officially sign an agreement, receiving initial federal support of USD 27.5 million, with the potential for up to USD 1 billion in total funding. This project, spanning Washington, Oregon, and Montana, aims to decarbonize heavy-duty transportation, agriculture, and industry. The hub will leverage abundant renewable energy, primarily hydropower, to produce 335 tonnes of hydrogen per day. However, in August 2024, USA Fortescue, a subsidiary of the Australian mining and energy multinational company, announced it would pause development of a green hydrogen plant, one of the hub's main projects, citing high electricity prices.
- **Appalachian Hydrogen Hub (ARCH2):**
  The Appalachian Hydrogen Hub became the third regional hydrogen hub to receive initial federal support of USD 30 million from a potential total of USD 925 million in July 2024. This hub involves projects across West Virginia, Ohio, and Pennsylvania, with the potential to produce up to 1,500 tonnes of hydrogen per year. However, by October 2024, approximately five from the initial 15 projects that were part of this initiative were cancelled.
- **Gulf Coast Hydrogen Hub (HyVelocity)** and **Midwest Hydrogen Hub (MachH2):**
  In November 2024, the Gulf Coast Hydrogen Hub (HyVelocity) in Texas and the Midwest Hydrogen Hub (MachH2), spanning Illinois, Indiana, Iowa, and Michigan, signed agreements with the Department of Energy (DOE). HyVelocity will receive initial funding of USD 22 million, with the potential for up to USD 1.2 billion, to produce hydrogen and derivatives, aiming to avoid 7 million tonnes of CO2 emissions. MachH2 will receive USD 22.2 million in initial funding, with the possibility of up to USD 1 billion in total federal support.

The two hubs that have not yet signed an agreement are:

- **Heartland Hydrogen Hub (HH2H):**
  Spanning Minnesota, North Dakota, and South Dakota, the HH2H has an estimated federal support of USD 925 million. However, in August 2024, Marathon Petroleum Corporation announced its withdrawal from the development of the Prairie Horizon Hydrogen Project, a key component of the HH2H initiative, citing unfavourable market conditions.
- **Mid-Atlantic Hydrogen Hub (MACH2):**
  This hub has an estimated federal support of USD 750 million.

On the other hand, in January 2024, Plug Power began production of liquid green hydrogen at its Woodbine plant in Georgia. The plant operates eight 5 MW proton exchange membrane electrolysers, capable of producing up to 15 tonnes of hydrogen per day—enough to power 15,000 forklifts daily. Plug Power reported its first commercial delivery in February 2024.

CF Industries' Louisiana green ammonia plant is set to begin production in 2025. The plant will be located within CF Industries' ammonia production complex in Donaldsonville, the largest ammonia-producing facility in the world. The project includes a 20 MW alkaline water electrolysis system provided by Thyssenkrupp Nucera. The production capacity is expected to reach 18,144 tonnes of hydrogen for green ammonia.

In November 2024, CF Industries announced plans to make a final investment decision on a blue ammonia facility, expected to produce 1.4 million tonnes of ammonia annually. This decision is anticipated in early 2025.

In September 2024, ECL, a data centre startup, announced the world's first 1 GW off-grid, hydrogen-powered AI factory data centre. This project will be located in Houston, Texas. The initial phase will consist of a 50 MW data centre, expected to be operational by mid-2025. Hydrogen will be supplied via a three-pipeline system. The initial stages of the project will use "blue" or "turquoise" hydrogen, with plans to transition to "green" hydrogen as it becomes more widely available.

Also in September 2024, Kit Carson Electric Cooperative (KCEC) announced that Questa Hydrogen Project in New Mexico received, and USD 95.6 USD million awards funded by the Empowering Rural America Program through the Department of Agriculture (USDA). This project will use reclaimed wastewater from a closed Chevron's molybdenum mine. The project is expected to be completed by 2028.

In early October 2024, the U.S. DOE announced USD 10 support for the City of Duluth, Minnesota, to support the deployment of a green iron plant. This support is part of the Clean Energy to Communities (C2C) program.

Later in October 2024, Ways2H Inc., a hydrogen production company, announced the successful completion of a proof-of-concept test, producing 110 kg of hydrogen from one tonne of municipal solid waste. According to Ways2H Inc., hydrogen produced through its innovative process could be sold to end-users at costs ranging from USD 3 to USD 4 per kg when sourced from large-scale facilities, while hydrogen from small-scale facilities could be sold at prices ranging from USD 6 to USD 14 per kg. The process is reported to have a carbon footprint of up to negative 30 kg of CO2 equivalent per kg of hydrogen.

In December 2024, Air Products made its exit from an announced hydrogen project in Texas. The project, which was initially described as the largest U.S. green hydrogen project and a joint venture with AES Corporation, never reached a final investment decision. Air Products sold its stake in the project to its partner.

Viet Nam

In February 2024, Viet Nam issued a decision to promulgate the Plan for implementing its Hydrogen Energy Development Strategy to 2030, with a vision toward 2050. This document assigns several implementation tasks to various units within the Ministry of Industry and Trade. In addition to the required regulatory adaptations at different levels to enable hydrogen adoption, this plan considers the acceleration of adoption of hydrogen in thermal power plants.

After the adoption of Viet Nam's National Hydrogen Development Strategy for 2030 with a vision toward 2050, in February 2024, several announcements were made in the economy.

In March 2024, plans to build a green hydrogen project in Quang Tri, Viet Nam, were announced. The hydrogen plant will be located in Gio Linh Industrial Park and will involve a USD 2400 million investment, including 1200 MW of wind power, 800 MW of solar power, and a 1 GW electrolyser to produce 60,000 tonnes of hydrogen per year. The first phase of the project will consist of 200 MW of solar power.

In November 2024, a proposal was made to build a green hydrogen project in Ninh Thuan with a production capacity of 400,000 tonnes of hydrogen per year. The total investment is estimated at USD 2,000 million and includes 1 GW of wind power and 500 MW of solar power.

If these projects reach final investment decision stage, they will join the Tra Vinh green hydrogen plan, for which construction began last year. This project is expected to start commercial operations in 2026 with a total production capacity of 24 000 tonnes per year.

Additionally, as part of a demonstration project for hydrogen-fuelled buses in Ho Chi Minh City, Pure Hydrogen, an Australian clean energy company, and the Viet Nam ASEAN Hydrogen Club (VAHC) signed a MoU. Under this agreement, Pure Hydrogen will provide three hydrogen fuel cell minibuses and two hydrogen fuel cell coaches.

Summary of hydrogen documents and initiatives implemented in 2024.

Economy	Main documents or policy
Australia	*2024 National Hydrogen Strategy* *The Future Made in Australia (Guarantee of Origin)*
Canada	*Clean economy investment tax credits*
Chile	*Green Hydrogen Action Plan*
People Republic of China	*China's Hydrogen Energy and Fuel Cell Industry Development Plan (2020-2030)* *Hydrogen Industry Development Plan (2021-2035).*
Hong Kong China	*Hydrogen Development Strategy*
Indonesia	*National Hydrogen Strategy Report*
Japan	*Hydrogen Society Promotion Act*
Republic of Korea	*Clean Hydrogen Certification System* *Clean Hydrogen Production Standard System (CHPS),*
Malaysia	*Green Investment Tax Allowance guidelines*
Mexico	*11 guidelines regarding hydrogen development in Mexico*
New Zealand	*Climate Change Strategy* *Hydrogen Action Plan*
Peru	*Green Hydrogen Promotion Law* *Legislative Decree No. 1629*
Republic of Philippines	*Hydrogen Energy Guidelines*
Singapore	*EMA's Centralised Process*
Chinese Taipei	*Hydrogen Energy Development Roadmap.*
Thailand	*Power Generation Development Plan (PDP 2024)-Draft* *Alternative and alternative Energy development Plan (AEDP)-Draft* *Energy conservation Plan (EEP)-Draft* *Natural gas management Plan (Gas Plan)-Draft* *Fuel Management Plan (Oil Plan)-Draft*
United States	*Clean Vehicle Credits* *Investment Tax Credit (ITC)* *Department of Energy Hydrogen Program Plan*
Viet Nam	Plan for implementing its Hydrogen Energy Development Strategy to 2030

Advances in other hydrogen sources

Producing hydrogen from clean energy sources remains costly. Although naturally occurring hydrogen, also known as white hydrogen, exists, it has been long believed to be too scarce to serve as a viable energy source. However, recent discoveries suggest that substantial reserves may be present, prompting renewed interest in its potential.

There are several theories on how natural hydrogen is formed, but it is considered that the primary mechanism is serpentinization. In this process, iron- and magnesium-rich rocks, such as olivine, react with water to form serpentine minerals, releasing hydrogen gas in the process.

Since 2012, Mali has been extracting approximately 50,000 cubic feet of natural hydrogen per day to power a turbine supplying electricity to a village of 1,500 people. While estimates suggest that significant reserves of natural hydrogen exist globally, the feasibility of large-scale extraction and transportation remains uncertain. Nevertheless, some studies have estimated production costs below USD 1/kg H_2, making it a potentially cost-effective alternative.

Interest in natural hydrogen gained momentum in 2024 with several key developments. In Canada, Max Power Mining announced the award of permits in Saskatchewan to explore for natural hydrogen. Out of 45 wells sampled, seven reported hydrogen concentrations above 10%, with some sites reaching as high as 96.4% purity. If successful, this project would become the largest natural hydrogen initiative in Canada. Meanwhile, the Philippines has also prioritized natural hydrogen exploration, as its geological formations are well-suited for its production.

In addition to white hydrogen, another emerging form of naturally sourced hydrogen is gold hydrogen, which is produced from residual hydrocarbons in depleted oil and gas fields through microbial activity or controlled chemical reactions. In July 2024, Gold H_2 signed a MoU to develop a pilot project in Texas to demonstrate commercial gold hydrogen production at a targeted cost of USD 0.80/kg. If successful, this method could repurpose existing fossil fuel infrastructure for clean hydrogen production at competitive prices.

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