

The image shows a row of large, white, spherical hydrogen storage tanks in an industrial facility. Each tank is supported by a blue vertical pillar and a network of blue and silver structural beams. The tanks are arranged in a line, receding into the distance. The background features a bright blue sky with scattered white clouds. The overall scene is clean and modern, representing a state-of-the-art hydrogen storage system.

Ashurst

Investing in hydrogen


A global guide

Outpacing change

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With the growing investor focus on the emerging hydrogen market, our [interactive tool](#) helps clients navigate the evolving hydrogen strategies and regulations, the available incentives and major projects taking place in countries that are focused on this market.

The purpose of the interactive map is to enable better decision-making with regards to investability in hydrogen around the world. The tool provides our clients with a complete picture when considering their investment opportunities by covering the same questions for each country on policy, regulation, market developments and opportunities to allow comparison.

Australia

Policy and regulation

1. Is there a government hydrogen strategy or policy?

1.1 National and State Hydrogen Strategy

Yes, [Australia's National Hydrogen Strategy](#) was published on 22 November 2019. The [State of Hydrogen 2021 Report](#) provides an update of the Australian Government's progress on the National Hydrogen Strategy so far.

Each Australian state and territory, except for ACT, have also released their own hydrogen strategies:

- [Queensland Hydrogen Industry Strategy 2019-2024](#), published on 30 May 2019;
- [Western Australian Renewable Hydrogen Strategy and Roadmap](#), published on 17 November 2020
- [South Australia's Hydrogen Action Plan](#), published in September 2019;
- [Northern Territory Renewable Hydrogen Strategy](#), published in July 2020;
- [Victorian Renewable Hydrogen Industry Development Plan](#), published on 25 February 2021;
- [Tasmanian Renewable Hydrogen Action Plan](#), published in March 2022; and
- [New South Wales Hydrogen Strategy](#), published in October 2022.

1.2 The National Energy Transformation Partnership (NETP)

On 12 August 2022 the Energy Ministers at Commonwealth, State and Territory levels agreed to establish a new [National Energy Transformation Partnership \(NETP\)](#). The NETP creates a framework in support of national alignment and cooperation to enable a smooth transformation, certainty and collaboration in Australia's energy industry. Through the partnership, each jurisdiction will work collaboratively whilst continuing to pursue its own policies on the energy transformation. Further amendments are to be considered in December 2022. The Australian government has made a \$157.9 million commitment to facilitating the priority works of the NETP.

1.3 Policy Amendments Affecting Hydrogen

The Australian Government has agreed to amendments on 28 October 2022 that extend the National Gas Law and National Energy Retail Law (NERL) to hydrogen. The consumer protection, retailer authorisations and exemptions and retailer of last resort elements of the NERL will be amended to apply to the hydrogen industry's operations. These reforms provide consistency and support in Australia's approach to developing a competitive hydrogen industry. This consistency is set to foster a competitive and cost-efficient market domestically, by:

- Encouraging competition in contestable parts of the industry;
- Allowing existing facilitated and regulated retail markets to function; and
- Ensuring consumers continue to benefit from the consumer protection measures under the NERL.

2. What are key goals and commitments included in the strategy/policy?

The key goals of Australia's National Hydrogen Strategy are that by 2030:

1 Export: Australia is one of the top three exporters of hydrogen to Asian markets;

How?: Australia has committed to co-funded projects with various nations that range from technological collaborations, supply chain testing and standards development.

2 **Safety: Australia has an excellent hydrogen-related safety track record;**

How?: The Australian Government is a member of the U.S centre for Hydrogen Safety. This gives all Australian governments access to some of the worlds foremost expertise in hydrogen safety

3 **Economy: Hydrogen is providing economic benefits and jobs in Australia; and**

How?: 'H2 under 2': The Australian Government has set a goal for hydrogen production of under \$2 per kilogram to make hydrogen competitive with conventional fuels. Some Australian states, including NSW, WA and NT, have set similar goals as part of their hydrogen strategies. NSW, for example, has set a goal of hydrogen priced at under \$2.8 per kilogram by 2030. Other states, including Victoria, QLD, SA, Tasmania and ACT, have not made any such goals but have rather set out key focus areas for developing the hydrogen industry in their respective states.

4 **Certification: Australia has a robust, internationally accepted, provenance certification scheme in place.**

How? The department of Climate Change, Energy, the Environment and Water have developed a [proposed approach to a Guarantee of Origin scheme for hydrogen](#) in Australia and are currently conducting industry trials with the Clean Energy Regulator.

Australia's hydrogen strategy assumes global demand for hydrogen will expand to between 20 - 230 million tonnes by 2050, with Australia's share of this market at between 2 - 20 million tonnes. At that projected market share, hydrogen exports could be worth up to \$10 billion each year to the Australian economy.

3. **Which industry sectors are most likely to be affected by hydrogen deployment?**

The industry sectors which are most likely to be affected by hydrogen development include:

- the energy sector (including electricity grid support, electricity generation and gas networks);
- chemical production (including ammonia production);
- mining and other off-grid large electricity consumers;
- heavy and light transport industries;
- steel making; and
- industrial heat.

4. **Who are the main regulators for the hydrogen market?**

The Energy National Cabinet Reform Committee established a governance structure including three bodies to oversee Australia's energy market which will also regulate the hydrogen industry: the Australian Energy Regulator, the Australian Energy Market Commission and the Australian Energy Market Operator. Relevant authorities in each state will regulate planning and environmental approvals, workplace health and safety, the supply of power and utilities and dangerous goods regulation and standards. While the scheme is still undertaking trials, the Clean Energy Regulator is expected to be the regulator of the proposed Guarantee of Origin scheme.

5. **Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?**

The National Hydrogen Strategy supports the development of both blue and green hydrogen and includes both types in its definition of renewable hydrogen. The National Hydrogen Strategy does not contemplate any move to a focus on green hydrogen in the future.

Some Australian states, including NSW, QLD, NT and Tasmania, have committed to pursuing green hydrogen only. WA, similar to the federal government, explicitly supports the development of both blue and green hydrogen, whereas other states have not explicitly expressed support for the development of blue or green hydrogen.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The Australian government has included carbon capture and storage (CCS) as a key part of its National Hydrogen Strategy. It has also announced in March 2022 it will invest over \$300 million to support development of CCS and carbon capture, use and storage (CCUS) projects, and it has also developed a method to credit abatement from new CCS projects under its Emissions Reduction Fund (a fund established to purchase abatement of carbon emissions, in the form of Australian carbon credit units). The Victorian and Australian Governments are developing a multi-user CCS hub network in Gippsland, Victoria through their joint 'CarbonNet project'. Notably, due to legislative constraints, the Australian Government-owned green bank, Clean Energy Finance Corporation (CEFC), expects to be prohibited from investing in blue hydrogen projects due to the fact that they include a CCS component. In 2022, the CEFC became the first Industry Supporter of the Australian Carbon Industry Code of Conduct, which is identified as an important risk management and due diligence tool in assisting the participation and procurement in the hydrogen market.

7. Are there targets for the production of hydrogen?

There are currently no targets for the production of hydrogen as part of the National Hydrogen Strategy. The Australian Government considered in its National Hydrogen Strategy that mandatory national targets would not be appropriate at this time but should be re-considered periodically as the market develops. The NSW State Government has set a target for the production of 110,000 tonnes of renewable hydrogen production per year by 2030 but other states have not set such targets.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The National Hydrogen Strategy and state and territory strategies include a number of financial incentive mechanisms to support the production of hydrogen (these are detailed below in the discussion of government funding available for hydrogen projects (13)). The National Hydrogen Strategy and many state and territory government strategies do not include any business models to support the production of hydrogen.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

The Australian Government along with state and territory governments are currently reviewing legal frameworks and standards relevant to the development and safety of the hydrogen industry to determine if existing regulatory frameworks are sufficient and if any amendments are required.

The National Hydrogen Strategy includes developing a Guarantee of Origin or certification scheme. In June 2021, the Australian Government's Department of Industry, Science, Energy and Resources released a [discussion paper](#) outlining the proposed design of the Guarantee of Origin scheme. The Australian Government has committed \$9.7 million to support trials of this scheme to be conducted with the Clean Energy Regulator, with a further \$2.2 million committed in the 2022-23 Budget.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

10.1 National Regulations

The Australian federal regulatory framework does not currently clearly define regulatory requirements relating to the production, storage, transportation and/or supply of hydrogen. However, any hydrogen production facility should consider broad regulatory issues such as environmental impact, storage of dangerous goods and water sourcing requirements. The Australian Government is working with state and territory governments to review and develop frameworks and standards relevant to the development of the hydrogen industry. The NETP aims to provide certainty in the storage and transmission of hydrogen nationally.

10.2 State Regulations

- NSW passed an Energy Legislation Amendment Bill in November 2021 which introduced significant exemptions from government fees for green hydrogen producers. The NSW Hydrogen Strategy also contemplates further reforms which are yet to be introduced.

SA has declared hydrogen to be a regulated substance, bringing hydrogen under the regulatory framework of its *Petroleum and Geothermal Energy Act 2000*. Following the change of government in March 2022, SA has proposed separate legislation in relation to licencing and regulating hydrogen energy.

- In May 2020, the Queensland Government released the [Queensland Hydrogen Investor Toolkit](#) which provides an overview of the information on regulatory approvals in Queensland.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

The energy and infrastructure sectors in Australia are subject to Australia's foreign investment regulatory regime, which involves assessment and approval by the Foreign Investment Review Board (FIRB). Amendments to the *Security of Critical Infrastructure Act 2018* (Cth), effective from 2 and 14 December 2021, expanded the scope of 'critical infrastructure assets' to the energy sector. Critical infrastructure assets are subject to greater scrutiny from FIRB. Critical infrastructure assets relating to the energy sector include critical electricity, gas, energy market operator and liquid fuel assets. Proposed foreign investment into 'critical infrastructure assets' will likely require mandatory FIRB approval. Significant criminal and civil penalties can apply for non-compliance with the *Foreign Acquisitions and Takeovers Act 1975* (Cth), such as taking an action notified to FIRB prior to receiving FIRB approval.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website states that Australia is a signatory to 15 bilateral investment treaties (BITs) in force and 21 other treaties in force which may contain protections for investors in Australia. These can be accessed from UNCTAD's Investment Policy Hub.

Australia was a party to The Energy Charter Treaty (ECT), a multilateral investment treaty which specifically addresses energy trade, transit and investment between its contracting parties, however, Australia recently withdrew from the treaty in December 2021.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

As part of its National Strategy, the Australian Government committed \$464 million over 5 years from 2021-22 to develop hydrogen hubs in regional Australia of which an estimated \$30 million is available for Hydrogen Hub Development and Design Grants. Applications for this grant program closed on 22 November 2021.

Federal government funding was also available through the Australian Renewable Energy Agency (ARENA) Renewable Hydrogen Development Funding program which closed on 20 January 2021. The CEFC Advancing Hydrogen Fund is aiming to invest up to \$300 million in eligible projects to support the development of the hydrogen industry. A further \$22.8 million has been committed to support the Australian Energy Regulator to assist in the integration of renewable energy into the National Energy Market.

Australian state and territory governments, including NSW, Victoria, WA, QLD, SA and Tasmania, have created similar funds including grant programs. Tasmania, for example, has created the Tasmanian Renewable Hydrogen Industry Development Funding Program which includes \$20 million worth of grants and Victoria has created the Hume Hydrogen Highway grant which will support the development of refuelling stations along the Hume Highway

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being deployed in Australia to examine and test the feasibility of clean hydrogen production and use in different sectors. The Australian and Victorian governments are jointly supporting the [Hydrogen Energy Supply Chain Pilot \(HECS\) Project](#) to produce hydrogen in Victoria and export it to Japan in order to test the liquefied hydrogen supply chain from Australia to Japan. The first shipment of liquefied hydrogen took place on 21 January 2022. The pilot phase of the project is one year and the decision to progress to a commercialisation phase will be made after the pilot phase is completed.

In WA:

- A green hydrogen pilot project was started in September 2022 to demonstrate and share knowledge on developing, constructing and operating a renewable hydrogen production plant in Australia. The project uses electrolysis to generate hydrogen for the production of renewable ammonia. Once commissioned, the project will be among the largest renewable powered electrolyzers globally.
- The [Asian Renewable Energy Hub](#) which was first proposed in 2014 by NW Interconnected Power Pty Ltd will be capable of producing approximately 1.8 million tonnes per annum of green hydrogen, and up to 10 million tonnes per annum of green ammonia.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Australia, however there are a number of projects in the pipeline. In May 2021, ARENA announced that it conditionally approved \$103.3 million towards three commercial-scale clean hydrogen projects as part of its Renewable Hydrogen Development Funding Round. These projects include:

- Engie Renewables Australia Pty Ltd (Engie): ARENA has conditionally approved up to \$42.5 million towards a 10 MW electrolyser project to produce renewable hydrogen in a consortium with Yara Pilbara Fertilisers at the existing ammonia facility in Karratha, Western Australia;
- ATCO Australia Pty Ltd (ATCO): ARENA has conditionally approved up to \$28.7 million towards a 10 MW electrolyser for gas blending at ATCO's Clean Energy Innovation Park in Warradarge, Western Australia; and
- Australian Gas Networks Limited (AGIG): ARENA has conditionally approved up to \$32.1 million in funding for a 10 MW electrolyser for gas blending at AGIG's Murray Valley Hydrogen Park in Wodonga, Victoria.

Key resources used:

[Australia's National Hydrogen Strategy 2019](#)

[Australian Government's State of Hydrogen 2021 Report](#)

[Advisian Australian hydrogen market study, Sector analysis summary dated 24 May 2021](#)

[ARENA's Renewable Hydrogen Development Funding Round](#)

[ARENA – Hydrogen Energy](#)

[ARENA – Yuri Renewable Hydrogen to Ammonia Project](#)

[AEMC's 'Hydrogen: the new Australian manufacturing export industry and the implications for the National Electricity Market \(NEM\)](#)

[DCCEEW – Extending the national gas regulatory framework to hydrogen blends and renewable gases](#)

[Joint media release: Delivering Australia's climate and energy transformation](#)

[National Energy Transformation Partnership](#)

[Australia | Green Hydrogen Organisation \(gh2.org\)](#)

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Belgium

Policy and regulation

1. Is there a government hydrogen strategy or policy?

On October 29, 2021, the Belgian federal government adopted its first hydrogen strategy. This document announced Belgium's ambitions for renewable molecules and the role it would like to play as an import and transit hub in Europe.

On October 12, 2022, the federal government validated an update of this strategy to reflect the state of progress of its implementation. Additional measures are announced therein taking into account recent developments in the sector.

The strategy of the federal government can be found [here](#).

2. What are key goals and commitments included in the strategy/policy?

The federal hydrogen strategy aims to prepare Belgium for the climate challenges, alongside the technological, political and economic challenges of the coming decades. This strategy is based on 4 pillars/objectives described below.

Pillars/objectives	Measures to achieve the pillars/objective
Positioning Belgium as an import and transit hub for renewable molecules in Europe	<ul style="list-style-type: none">• Since 2021: Engage with key partners in order to open 3 main import routes (North Sea route, Southern route and the shipping route) for renewable molecules• 2022: Support the development of hydrogen import infrastructure to have the first imports of H₂-molecules (or of H₂-derivatives to be cracked into H₂-molecules) by 2026• 2023: Organise hydrogen master classes together with the Belgian Hydrogen Council to establish close relationships with key exporting partners• 2023-2024: Investigate how the development of both electricity and hydrogen networks can complement each other in the North Sea
Expanding Belgian leadership in hydrogen technologies	<ul style="list-style-type: none">• 2021: Support research and pilot projects on hydrogen technologies with the two federal R&D funds (Energy Transition Fund and call Clean Hydrogen for Clean Industry)• By 2025: Develop a hydrogen test infrastructure• By 2026: Develop a limited electrolysis capacity of minimum 150 MW
Establishing a robust hydrogen market	<ul style="list-style-type: none">• 2023: Set up a framework ensuring an optimal planning of energy transport networks• 2022-2023: Adapt the legal and regulatory framework for the transport of hydrogen per pipeline• 2023-2024: Investigate with the Belgian Regions and/or Europe how the federal government can help to put in place a system to unlock the demand for renewable H₂-molecules and H₂-derivatives• By 2025: Develop a European voluntary certification scheme and a register for H₂-molecules and H₂-derivatives• By 2025: Develop a market hub for H₂-molecules and H₂-derivatives linked to physical supply hubs in Belgium

-
- By 2026: Develop 100 to 160 km of additional H2 pipelines (new and/or repurposed) to be operated under non-discriminatory third-party access conditions
 - By 2028: Interconnect the Belgian H2 transport network with Germany, France and the Netherlands
-

Investing in cooperation as a key success factor

- Implement a structural consultation on hydrogen within Belgium
- Adopt a proactive and dynamic attitude within the working groups dedicated to hydrogen (Benelux, Pentilateral Energy Forum and European Union)
- Represent Belgium in international organisations and forums on hydrogen
- Continuous interactions with the sector, research institutes and citizens to keep this hydrogen strategy up to date with the evolution of the barriers and needs

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The Belgian federal government strategy identifies four sectors that hydrogen will help to make climate neutral by 2050:

- the industry sector (chemical, steel, glass, etc.);
- the transport sector;
- the heating of buildings; and
- the energy distribution sector.

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

Yes, the federal government hydrogen strategy supports the development of both low-carbon hydrogen and renewable hydrogen.

The federal government hydrogen strategy aims to have only renewable hydrogen in the Belgian energy mix by 2050 or before if possible.

In order to achieve that objective, it is considered necessary to have a phased approach where fossil production with lowered GHG emissions can play a transitional role to kickstart the market.

According to the strategy, such a phased approach would be best suited to ensure both the lowest possible carbon emission and a level-playing field for hydrogen in the current economic context while giving priority only to the climate neutrality of the H2 production would slow down the pace of development of the sector, and thus the development speed of decarbonised solutions for the industry, the transport sector and the other H2 applications.

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The Belgian federal government hydrogen strategy only supports the development of hydrogen production via steam methane reforming and auto-thermal reforming provided that the production installations are coupled with carbon capture and storage as well as pyrolysis plants.

Large scale projects aiming to capture and store CO2 are currently in development in Belgium e.g. the Antwerp@C project.

6. Are there targets for the production of hydrogen?

The production of renewable hydrogen will remain limited in Belgium because of the limited local renewable energy potential. Nevertheless, Belgium has set itself the target of having at least 150 MW of electrolysis capacity into operation by 2026.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The incentive mechanisms in place in Belgium to support the production of hydrogen consist mainly in subsidies granted to selected projects (see question 12 below).

The Belgian federal government also tries to incentivise investors to finance hydrogen projects in Belgium by establishing a legal framework providing sufficient legal certainty to companies active in the sector (see question 9 below).

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

The Renewable Energy Directive 2018/2001 (RED II) introduced guarantees of origin for renewable hydrogen. The Belgian federated entities (i.e. the Regions of Belgium) have transposed that directive with the Flemish Decree of 26 April 2019 establishing a system of guarantees of origin for gas, heat and cooling, the Walloon Decree of 25 May 2022 amending various energy provisions in the context of the partial transposition of Directives 2019/944/EU of 5 June 2019 concerning common rules for the internal market in electricity and the Renewable Energy Directive 2018/2001/EU and the Brussels Ordinance of 6 May 2021 on the organisation of thermal energy networks and the accounting of thermal energy in the Brussels-Capital Region and their respective implementing governmental orders.

Except for guarantees of origin, there are no standards existing at Belgian level to distinguish between low-carbon and renewable hydrogen. In the future, the Belgium authorities intend to rely on the standards that are being developed at EU level.

The Belgian federal government is also supporting Hincio, a strategy consultancy firm specialized in energy transition and sustainable mobility, in the development of a European voluntary certification scheme and a register for H₂-molecules and H₂-derivatives via the Energy Transition Fund. A pilot phase in Belgium is foreseen within this project. In a second phase, this work could also be extended to low-carbon molecules.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The regulatory requirements relating to the production, storage, transportation or supply of hydrogen are currently mainly governed by the Law of 12 April 1965 on the transport of gaseous and other products through pipelines and the various Royal Decrees implementing this law. Some regional environmental laws may also be applicable in case a hydrogen project requires an environmental/building licence. These laws and implementing acts do not explicitly cover hydrogen.

The Belgian Parliament is currently working on a law that would specifically concern the regulatory requirements relating to the transportation of hydrogen. With this law, the intention is to designate a network operator for the transport of hydrogen modelled on the role of the electricity and gas network operators. This operator will be responsible for open and non-discriminatory access to the transport network and for ensuring the quality of the hydrogen. The law is intended to be enacted before the summer of 2023.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

- In June 2022, the Belgian federal government and the governments of the federated entities (i.e. the Communities and the Regions in Belgium) agreed on a draft cooperation agreement to introduce an ex ante federal foreign investment screening mechanism in Belgium, primarily inspired by Regulation (EU) no 2019/452 (not yet in force and will not be in force before July 2023).
- The envisaged federal screening regime will apply to direct and indirect acquisitions by non-EU investors of:
 - more than 25% of the voting rights in undertakings or entities established in Belgium whose activities touch upon, among others, critical infrastructure for energy, technologies and raw materials that are of essential interest for technologies of strategic importance and the supply of critical inputs like energy; or
 - more than 10% of the voting rights in undertakings or entities established in Belgium whose activities touch upon, among others, energy provided that the target's turnover exceeded EUR 100 Mio in the preceding book year.
- It implies a mandatory and suspensory notification of the acquisition. The responsible entity will assess whether

the acquisition may negatively impact on national security, public order or the strategic interests of the Belgian federated entities and may possibly impose remedies.

- In January 2019, the Region of Flanders introduced an a posteriori regional screening mechanism regarding foreign (EU or non-EU) controlling investments in a Flemish or local governmental entity or any other entity controlled by the Flemish government, representing public strategic interests in Flanders.
- No distinct foreign investment screening mechanisms are currently in force or foreseen in the Walloon or Brussels Regions.

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

According to the United Nations Conference on Trade and Development (UNCTAD) Belgium is a signatory to 59 bilateral investment treaties (BITs) that are in force ([here](#)). Moreover, certain other treaties may contain other investment protection provisions.

Belgium is also a signatory to the Energy Charter Treaty (ECT), a multilateral investment treaty which specifically addresses energy trade, transit and investment between its contracting parties.

Belgium currently has no bilateral investment treaties in force with Member States of the European Union as the European Union has competence in this area on behalf of the Member States.

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

Yes, the Belgian federal government has set up a number of programmes and funds to support research and development in the field of hydrogen. For instance:

- The Energy Transition Fund supports, among other things, research and development on the production, transport and storage of hydrogen and its derivatives. It has been active since 2017, remain in place until 2025 and subsidises various projects following an annual call for projects for a total amount of 20 to 30 million euros per year.
- The call for projects Clean Hydrogen for Clean Industry is organized within the framework of Belgium's national recovery and resilience plan. It focusses on the development of promising technologies for the production and use of hydrogen and its derivatives with a relatively high maturity level. In this way, the federal government aims to stimulate investments that will enable a faster scaling of commercial applications. A first call was launched in April 2022 for a total support of maximum 50 million euros. A second one will be launched in 2023 for a total support of 10 million euros.
- The H2 Import Call focuses on the development and demonstration of technologies that enable the import of hydrogen (in any form whatsoever, H₂-derivatives included) and its injection on a hydrogen transport network. This call will be launched in early 2023, with an envelope of 10 million euros.

The Walloon government via, among others, its Walloon Kyoto Fund and its Walloon Recovery Plan and the Flemish government via, among others, its Ecology Premium have also made funding available to hydrogen projects.

Belgian companies active in the hydrogen sector can also ask for public funding at EU level to several public bodies like the EU Innovation Fund.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

Yes, there are several pilot projects in Belgium to produce and collect clean hydrogen.

For instance:

- The University of Liège, via one of its spin-off BeBlue, has launched a pilot project to produce green hydrogen from solar energy for ESA's spacecrafts.

- Scientists from the University of Leuven have launched a pilot project to produce green hydrogen from solar energy and moisture.
- A pilot project is underway at the University of Gent to produce green hydrogen from wind energy.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Belgium, but there are plenty of projects ongoing, at different stages of development, including:

- The HyoffWind project, being developed by a consortium of different companies like Virya Energy, Fluxys, John Cockerill and BESIX, which aims to build a green hydrogen production facility in Zeebrugge;
- Plug Power's project to build a 35-tonnes-per-day green hydrogen generation plant at the Port of Antwerp-Bruges;
- Antwerp@C project in Antwerp which aims to store and reuse CO₂ to produce blue hydrogen; and
- The HaYrport project in Liège, being developed by Liege Airport and CMI, which aims to equip the airport with installations for production, distribution and the use of green hydrogen.

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Canada

Ashurst collaborated with Blake, Cassels & Graydon LLP in the preparation of this chapter, we are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, a federal Hydrogen Strategy was published in December 2020. Specific provinces across the country have also published their own hydrogen strategies that include individualized targets and ambitions. For example, Alberta, Canada's current largest producer of hydrogen, has published the Alberta Hydrogen Roadmap, which sets forth its plans to position itself as a global supplier-of-choice in clean hydrogen exports by 2030.

2. What are key goals and commitments included in the strategy/policy?

The Hydrogen Strategy's (the "Strategy") aim overall is to reduce emissions while promoting domestic and international opportunities in the hydrogen economy.

The Strategy's primary short-term goal is to establish a foundation for Canada's hydrogen economy by 2025 through the development of necessary infrastructure and technologies to support both the growth of existing hydrogen applications and the development of emerging applications. The Strategy advises further diversifying the hydrogen sector to apply existing industrial technologies to new applications, such as residential heating, between 2025 and 2030. The Strategy's eventual long-term goal is to expand Canada's supply and distribution of hydrogen, with the goal of hydrogen making up a significant portion of domestic end-use energy by 2050.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industry sectors that are most likely to be affected by the replacement of fossil fuels by clean hydrogen in Canada include:

- the power sector;
- transportation;
- heating; and
- refining and manufacturing.

The Strategy highlights opportunities to reduce emissions through actions such as retrofitting existing technology with carbon capture and storage, installing new clean hydrogen technology that does not produce carbon, and switching to hydrogen blends in heavy industry. The Strategy mentions that hydrogen has the potential to decarbonize sectors of the Canadian economy, including resource extraction, freight, and the production of other inputs, such as steel and cement.

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

Yes, the Strategy highlights Canada's opportunities to take advantage of blue hydrogen development, particularly given the abundance of fossil fuels found in several of its provinces. The Strategy also emphasizes that Canada is in a strong position to produce green hydrogen, with projects to develop this type of hydrogen already in motion in certain provinces

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The development of low-carbon hydrogen is a strategic priority for Canada. Canada has a target of net-zero emissions by 2050, and to achieve this goal, all hydrogen production must either be carbon neutral or offset. Currently the most cost-competitive of these strategies is to use fossil fuel-derived hydrogen coupled with carbon capture utilization and

storage (CCUS) to produce carbon neutral hydrogen due in large part to Canada's ample low-cost natural gas.

The Strategy recognizes that there is significant growth potential in CCUS and clean hydrogen production in Canada. Moving forward, Canada is considering various strategies that will use the country's natural advantages to achieve its hydrogen goals. These include reducing industrial emissions and facilitating the production of low-carbon hydrogen. The Strategy also recognizes that emissions resulting from hydrogen production can be decreased using bioenergy with CCUS and identifies that there is a significant opportunity to reduce emissions associated with hydrogen in midstream oil and gas by retrofitting existing conversion technology with CCUS.

Other provincial strategies are also moving CCUS forward. Alberta, as a world leader in hydrogen production and CCUS technology, has mature natural gas-based hydrogen production processes currently in place throughout the province. These processes can realize near-term clean hydrogen by retrofitting existing infrastructure and building new facilities outfitted with CCUS. Over time, emissions can be further reduced using competitive, cost-effective technologies such as renewable energy-based hydrogen production and emerging natural gas decomposition. As further detailed in Section 14 below, a number of CCUS projects are currently underway or in development in Alberta.

6. Are there targets for the production of hydrogen?

Canada's Hydrogen Strategy has suggested a vision for hydrogen to make up 6% of delivered energy by 2030 and 30% of delivered energy by 2050.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are several incentives in place to support hydrogen production in Canada. Canada's Strengthened Climate Plan, which includes carbon pricing, the Clean Fuel Standard, and a \$1.5 billion Low-carbon and Zero-emissions Fuel Fund, implements foundational federal initiatives the federal Government believes are required to achieve the Strategy's goals. Carbon pricing adds costs to the production of greenhouse gas emissions; the Clean Fuel Standard incentivizes the use of low-carbon hydrogen through tax credit eligibility; and the Low-carbon and Zero-emissions Fuel Fund supports projects that reduce greenhouse gas emissions. Each incentive aims to encourage hydrogen uptake and production over time.

Canada has also implemented a Clean Technology Investment Tax Credit to encourage investments made in clean electricity generation systems, such as those which involve hydrogen. This refundable tax credit is equivalent to 30 percent of the capital cost of eligible equipment.

In its 2022 Fall Economic Statement, the federal Government also indicated that it is implementing a tax credit for investments in clean hydrogen production. The federal Government has proposed that a company which reaches the lowest carbon intensity tier and complies with all other eligibility requirements will receive an investment tax credit of at least 40 percent. The refundable credit will be made available across a variety of clean hydrogen pathways starting in 2023 and phased out after 2030.

Additionally, Canada's Net Zero Accelerator initiative provides up to \$8 billion over seven years to support projects to decarbonize large greenhouse gas emitters, fast-track the growth of clean technology, and expedite industrial transformation to achieve Canada's net-zero goals.

Individual provinces, including Alberta, British Columbia, and Quebec, have also implemented their own incentives to encourage hydrogen adoption.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are currently no existing standards in place for the classification of hydrogen in Canada.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

Canada does not currently have a clear, harmonized regulatory framework setting out regulatory requirements related to hydrogen. Certain federal legislation such as the *Canadian Environmental Protection Act, 1999* and the *Canada Water Act* will apply to the hydrogen industry across the country.

Much of the regulation of hydrogen is done at a provincial level. For example, in October 2022, the British Columbia

Government introduced amendments to the *Oil and Gas Activities Act* and the *Petroleum and Natural Gas Act* to enable further hydrogen development in the province. Alberta has clear regulatory requirements related to the production, storage, transportation and supply of hydrogen through the Responsible Energy Development Act, applicable portions of the *Pipeline Act* and the *Oil and Gas Conservation Act*. It is also the first jurisdiction in Canada with regulation for large scale CCUS projects, with the Carbon Sequestration Tenure Regulation.

While early hydrogen projects can be expected to operate within existing regulatory regimes, it can be expected that there will be development of a comprehensive and long-term policy and regulatory framework that includes hydrogen in the near future.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Foreign investment in Canada is generally regulated by the federal Government under the *Investment Canada Act* (the “ICA”). The ICA applies when a non-Canadian establishes a new business in Canada or proposes to acquire control (directly or indirectly) of an existing Canadian business. For relevant transactions, a notification or an application for review must be filed with the Department of Industry and/or the Department of Canadian Heritage, as per the ICA.

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Canada is a signatory to 37 bilateral investment treaties (BITs) that are in force, and in addition certain other treaties may contain protections for investors in Canada. These can be accessed from the Government of Canada Treaty Series online [database](#) maintained by the Treaty Law Division of the Department of Foreign Affairs and International Trade, and the United Nations Conference on Trade and Development’s [Investment Policy Hub](#).

In 2021, the Government of Canada signed a Memorandum of Understanding with the Government of the Netherlands on cooperation in the field of hydrogen energy. The intention is that this will lead the way for increased cooperation between the two countries, cementing the role that hydrogen plays in building a cleaner net-zero future. Priority areas of cooperation set out in the Memorandum of Understanding are: 1) cooperation on setting up export-import corridors for clean hydrogen between Canada and the Netherlands; and 2) creating an aligned agenda for promoting investments in hydrogen infrastructure, the hydrogen supply chain, and facilitating collaboration between private parties in both countries.

In August 2022, the Government of Canada signed a joint declaration of intent with the Government of the Federal Republic of Germany to establish a Canada-Germany Hydrogen Alliance (the “Alliance”). The Alliance will commit the two countries to: enable investment in hydrogen projects through policy harmonization; support the development of secure hydrogen supply chains; establish a transatlantic Canada-Germany supply corridor; and export clean Canadian hydrogen by 2025.

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

There have been a number of different funding initiatives regarding various different areas of hydrogen development in Canada.

In June 2021, the Canadian government launched the Clean Fuels Fund which aims to invest \$1.5 billion to grow the production of clean fuels in Canada, such as hydrogen. Funding is provided through conditionally repayable contribution agreements of up to 30 percent of the total eligible project costs, to a maximum of \$150 million, per production project and up to \$5 million for feasibility studies.

Also, see Section 7 for discussion of Canada’s Net Zero Accelerator initiative.

Additionally, there are various provincial-level funding incentives for hydrogen projects.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being developed in Canada regarding the production or offtake of clean hydrogen, including those that are outlined below.

[FortisBC Energy](#) has partnered with Suncor Energy and Australia-based Hazer Group to test the production of “turquoise hydrogen,” an almost zero-emission method for capturing and converting methane from burning gas. This would be the first project of its kind in Canada, following similar projects in Germany and France. If developed commercially, the plant could eventually produce up to 2,500 tonnes of zero-emission hydrogen fuel a year.

The [Edmonton Region Hydrogen HUB](#) was launched in 2021 by an alliance of government, Indigenous, academic and economic development leaders to kickstart the Edmonton Region’s low-carbon hydrogen economy. The Hydrogen HUB will serve as a blueprint of how to accelerate a strong hydrogen economy that can be replicated in other regions across the country with low-cost, low-carbon hydrogen. With help from the Transition Accelerator, a Canadian organization working towards a net-zero future, over 25 potential projects are planned relating to the supply, delivery and use of low-carbon hydrogen. These projects include the use of hydrogen for municipal and commercial vehicle fleets and home and industrial heat and power.

The [Alberta Zero Emissions Truck Electrification Collaboration](#) is a pilot project to test the ability of hydrogen to fuel the province’s heavy freight transportation sector. The project is led by the Alberta Motor Transport Association and features the development of two long-range fuel cell trucks for operation between Edmonton and Calgary. The project intends to test and demonstrate a 700-kilometre plus range fuel cell truck performance in Alberta conditions. If successful this project will pave the way towards broader decarbonization in the transportation sector across Canada.

In 2022, ATCO began delivering a blend of natural gas containing five percent hydrogen to approximately 2,100 customers in Fort Saskatchewan in a first-of-its-kind project for Alberta. The [Fort Saskatchewan Blending Project](#) is intended to be used as a stepping-stone into the Canadian hydrogen market, and if successful, will validate the pursuit of larger-scale hydrogen-blending activities across the country.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Canada, however, there are a number of projects in varying stages of development. These include:

- Varennes Carbon Recycling, the 88MW water electrolysis plant being developed in Quebec, which is expected to produce 11,000 metric tons of green hydrogen annually. This will be one of the world’s first and biggest production facilities for green hydrogen and is expected to begin commissioning in late 2023;
- the Air Products Hydrogen Production and Liquefaction Facility in Alberta, which will capture three million tonnes of CO₂ yearly and product 1,500 tonnes of hydrogen daily;
- Suncor and ATCO’s collaboration on a clean hydrogen production facility in Alberta;
- Japanese ITOCHU Corporation’s partnership with Petronas for the creation of a natural gas based ammonia facility with CCUS in Alberta to export ammonia as a hydrogen carrier to Asian markets;
- the development of Ekona Power’s novel system for low-cost, clean hydrogen production for industrial processes. The project will demonstrate a direct carbon fuel cell, which converts solid carbon by-product from the hydrogen production process to electrical power, enhancing the economics of hydrogen production in Alberta;
- Aeolis Wind Power and Evolgen’s Thunder Mountain Wind Project, which is set to produce renewable hydrogen in British Columbia;
- Artura Power’s low carbon energy project, Niagara Hydrogen Centre, being developed in Ontario; and
- Spirit of Scotia by Green Hydrogen International in Nova Scotia, which is expected to be an integrated green hydrogen production, storage and transport project up to a potential 500GW in size to supply a secure source of green hydrogen to Europe and North American markets.

Denmark

Ashurst collaborated with Bech-Bruun (Johan Weihe and Per Hemmer) in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

With the [Danish Climate Agreement for Energy and Industry of 22 June 2020](#), a Danish parliamentary majority decided that Power-to-X (PtX) and carbon capture and storage are key elements in Denmark achieving its climate policy objectives. Therefore, steps were taken to prepare Danish strategies for PtX and for utilisation of carbonaceous products (Carbon Capture and Utilisation - CCU).

On 15 December 2021, the Danish government published its proposal for promoting hydrogen and green fuels (PtX). Following negotiations, the government and all parties of the Danish Parliament but one reached a political agreement regarding promotion and development of hydrogen and green fuels in Denmark (the "[PtX Strategy](#)") on 15 March 2022.

2. What are key goals and commitments included in the strategy/policy?

The PtX Strategy from 15 March 2022 sets out an aim to build upwards of 4 - 6 GW of electrolysis capacity by 2030.

Key initiatives in the PtX Strategy include the following:

- Funding (DKK 1.25 billion) through a tender for operational support of the production of hydrogen and other PtX products. Subsidies will be granted as a fixed-price supplement for a 10-year period.
- Dialogue between the government and the European Commission on allocating DKK 344 million of REACT-EU funds and the Just Transition Fund to establish an investment subsidy scheme for innovative green key technologies focusing on PtX and hydrogen, including green production and demonstration projects.
- An application-based scheme for construction of direct links between major electricity consumers (e.g., PtX plants) and electricity producers (wind farms/solar parks) if such direct links are socio-economically beneficial.
- Option for Energinet and the grid companies to use geographically differentiated consumption tariffs and local tariffs with respect to energy communities and industry communities producing and consuming electricity concurrently.
- An analysis of possibilities and consequences of introducing a derogation for projects involving PtX plants with direct connection to offshore wind farms with respect to a distance limitation of 15 km under the open-door scheme for offshore RE installations.
- Framework for construction of hydrogen infrastructure that can eventually be linked to a common European hydrogen infrastructure. This includes giving Energinet and Evida the possibility of owning and operating hydrogen infrastructure.
- A PtX task force will be assigned to identify and handle regulatory barriers blocking the establishment of a new Danish utility sector using PtX solutions. The task force will also be assigned to strengthen the framework conditions for hydrogen and PtX products. Further, a secretariat within the Danish Energy Agency is set up as a point of contact for project developers and authorities requesting guidance with authorisation procedures etc.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

According to the government's proposal for promoting hydrogen and green fuels (PtX), PtX fuels may play an important role in sectors where direct electrification is not possible or prohibitively expensive. It is assessed that the following sectors have significant potential for PtX fuels:

- Aviation
- Shipping
- The industrial sector's internal heavy road transport and high-temperature processes
- Parts of heavy road transport

4. Who are the main regulators for the hydrogen market?

The Ministry of Climate, Energy and Utilities is responsible for the overall strategy and policy for the development and regulation of the energy sector.

The Danish Energy Agency administers energy and supply in Denmark, including new hydrogen technologies. A secretariat within the Danish Energy Agency is set up as a point of contact for project developers and authorities requesting guidance with authorisation procedures etc. regarding PtX.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The Danish PtX strategy focuses exclusively on producing green hydrogen.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

Separate strategies have been adopted for PtX and carbon capture and storage (CCS). The PtX Strategy focuses exclusively on the production of green hydrogen.

The CCS strategy consists of two parts of which the first part - A road map for capture, transportation and storage of CO₂ - was presented in June 2021. With the first part of the CCS strategy, it was decided to establish a basis for safe and sustainable storage of CO₂ in Denmark and import/export of CO₂ to/from Denmark.

In December 2021, a political agreement secured the second part of the CCS strategy which included initiatives intended to ensure that the first Danish CCS facilities will be operational in 2025. These initiatives concern framework conditions for CO₂ storage in Denmark and the principles of the first implementation of a CCUS subsidy pool.

An amount of DKK 16 billion has been allocated to a CCUS subsidy pool scheduled for deployment between 2024 and 2048. The funds in the subsidy pool are to be deployed in two phases. In the first phase, funds are deployed based on a tender for contract on subsidy for carbon capture and storage. documentsThe winner of the tender for CCUS funds is expected announced primo 2023.

The first tender round for licenses for investigation of CO₂ storage and CO₂ storage on the Danish continental shelf was held in Q3 2022 with a deadline for applications on 1 October 2022. Licenses for investigation of suitable CO₂ storage locations can be granted for up to 6 years. Where a suitable location for CO₂ storage is defined, the license can be extended for up to 30 years.

7. Are there targets for the production of hydrogen?

The PtX Strategy from 15 March 2022 sets out that Denmark is aiming to build upwards 4-6GW of electrolysis capacity by 2030.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The PtX Strategy aims to create framework conditions that are appropriate for ensuring that the production and use of hydrogen and PtX products may eventually perform on market terms.

Innovative energy and supply projects may apply to the Danish Energy Agency for a so-called regulatory test zone status if regulatory barriers prevent the implementation of the respective projects. If the Danish Energy Agency grants a project a regulatory test zone status, the project may be exempted from specific regulation for a defined period of time. Two PtX projects were the first projects to obtain regulatory test zone status in 2021.

Together with a broad majority of the Danish Parliament, the Danish government has allocated substantial funds for the purpose of promoting PtX technologies and enabling the production of green hydrogen to reach an industrial scale. See question 13.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

No existing standards are in place for the classification of low-carbon or renewable hydrogen in Denmark.

The Danish PtX Strategy supports the development of common EU rules and the certification of green hydrogen, and

the government has committed itself to work for the development of a harmonised EU system that can document the origin of carbon. The European Commission's process of drafting a legislative proposal on a certification system for CO₂ emissions is followed closely from the Danish side. The European Commission's proposal on a certification system for CO₂ emissions is expected to be presented by the end of 2022. Further, the European Commission is currently preparing a delegated regulation that is expected to lay down detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin and the resulting fuel as fully renewable.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

In 2021, the Danish Energy Agency and Energinet (Danish TSO for electricity and gas) conducted a market dialogue with relevant actors within the hydrogen industry. In the market dialogue, the actors highlighted the need for a clear regulatory framework to realise the potential of hydrogen projects.

The government has initiated a 360-degree review of existing regulation relevant to hydrogen projects with the objective of identifying regulatory barriers to the development of a hydrogen market and infrastructure, e.g., regulatory barriers related to environment, security, planning and levies. A key initiative in the Danish Government's PtX strategy is the establishment of a PtX secretariat within the Danish Energy Agency. One of the secretariat's tasks are to identify and address barriers and opportunities for the development of PtX in Denmark. The PtX secretariat will be the contact point for inquiries about PtX. Among other things, the secretariat will be able to provide guidance on permitting processes and act as a link between stakeholders and authorities.

According to the government, new regulation will be drafted for the establishment, operation and use of hydrogen infrastructure, as will regulation allowing existing gas infrastructure to be repurposed for hydrogen transport. Further, proposals for the necessary legal basis for the state-owned companies Energinet and Evida to own and operate hydrogen infrastructure are also in the pipeline.

Hydrogen production from renewable energy sources, which are not injected into and transported through the gas system, is covered by the scheme for guarantees of origin for gas from renewable energy sources under the Danish Gas Supply Act. Energinet (the Danish TSO for electricity and gas) is developing a guarantees of origin scheme for hydrogen injected into the collective grid that is expected to be ready in 2023.

A bill defining the framework for the establishment of hydrogen infrastructure is expected to be put forward in autumn 2022.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

On 1 July 2021, the *Danish Investment Screening Act* (FDI Act) entered into force. The *FDI Act* introduces a mandatory sector-specific foreign investment control and a voluntary cross-sector foreign investment control.

Under the mandatory sector-specific foreign investment control, foreign investors must apply for authorisation from the Danish Business Authority if their investment or special financial agreement falls within particularly sensitive sectors and activities and meets other detailed conditions.

One of the particularly sensitive sectors is "critical infrastructure". The specific assessment of what constitutes critical infrastructure is based on socially important sectors and underlying socially important functions. According to the Danish Executive order no. 1491 of 25 June 2021, socially important functions in the energy sector comprise:

- Production, storage capacity, transport and delivery of electricity.
- Production, transport and storage of heating and cooling.
- Production, storage capacity, transport and delivery of gas.
- Production, storage and transport of crude oil as well as oil products for transport and the petrochemical industry.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Denmark is a signatory to a number of bilateral trade agreements. On a multilateral level, Denmark has signed the [Energy Charter Treaty](#) (ECT) that grants foreign investors fundamental rights with regard to their investments and offers investor-state dispute settlement. The ECT is undergoing a process of modernisation. The European Commission negotiates on behalf of the Member States based on a common EU negotiating mandate that focuses on

bringing the ECT in line with global climate ambitions. The Danish government supports the modernisation of the ECT.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

The Danish government has, together with a broad majority of the Danish Parliament, allocated substantial funds for the purpose of promoting PtX technologies and enabling the production of green hydrogen to reach an industrial scale:

A subsidy pool of DKK 1.25 billion is allocated for a tender for operational aid for the production of hydrogen and other PtX products within a 10-year period. The tender is expected to be launched in 2023.

DKK 850 million is allocated for the Danish participation in the Important Project of Common European Interest (IPCEI) on hydrogen.

The Energy Technology Development and Demonstration Programme (EUDP) supports new technologies in the energy sector and specific funds have been set aside for PtX technologies.

Further, the government has announced that it will earmark DKK 344 million for innovative green technologies, particularly PtX technologies, via funds from the REACT-EU initiative and the Just Transition Fund.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

Several different pilot projects are being deployed in Denmark to examine and test the feasibility of clean hydrogen production and use in different sectors, eg.:

- [Brande Hydrogen](#): The project partners are Siemens, Gamesa Renewables, Everfuel and Green Hydrogen Systems. The world's first project that aims to produce green hydrogen directly from the power of wind turbines.
- [The Green HyScale and GreenLab Skive](#): The partners are Greenlab, Everfuel, Eurowind Energy, Green Hydrogen Systems, Norlys Holding, Energinet, Danish Gas Technology Center, E.on Denmark, DTU Energy and EA Energy Analyses. A crucial steppingstone for hydrogen projects in the offshore gigawatt-scale and hydrogen production. The project is expected to provide 40 GW in 2030.
- [Estech](#): The engineering and development company, Estech, has developed a pilot project consisting of a combined carbon capture and PtX plant. The project has recently received DKK 20.6 million from EUDP.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There is currently no existing commercial-scale green hydrogen production in Denmark. Several projects are in the pipeline, including:

- [Aalborg Forsyning](#): Aalborg Forsyning, Reno-Nord and Copenhagen Infrastructure Partners (CIP) have partnered up to build a PtX plant ready for production in 2028. The fuel is planned to be used for the heavy-transport sector.
- [Green fuels for Denmark](#): Ørsted, Copenhagen Airports, A.P. Møller Maersk, DSV, DFDS, SAS, Everfuel, NEL, Molslinjen, Haldor Topsøe, COWI, Copenhagen Municipality and the Capital Region of Denmark are planning to build a plant that will deliver green fuels equivalent to the total consumption of all domestic flights in Denmark. The project is expected to be completed in 2027.
- [Green Hydrogen Hub](#): The project partners include Gas Storage Denmark, Eurowind Denmark and Corre Energy. The project aims to be the first fully commercially viable, 100 % green, large-scale hydrogen production, storage and CAES solution. The electrolysis capacity targets for the project are 350 MW in year 2025 and 1000 MW in

According to the government's proposal for promoting hydrogen and green fuels (PtX) from December 2021, the production of hydrogen from projects in Denmark announced by December 2021 will amount to approximately 7 GW of electrolysis by 2030.

Egypt

Ashurst collaborated with Shalakany Law Office in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

In 2015, Egypt launched the "[Sustainable Development Strategy 2030](#)", developed in alignment with the United Nations Sustainable Development Goals (SDGs), in which the Egyptian government seeks to maximize the use of local energy sources, whether traditional or renewable, and the development of the productive capacity of the energy sector to be more effective in boosting the economy and adapt to the ever-growing changes in the energy field.

As part of the Sustainable Development Strategy 2030, Egypt intends to prepare a national strategy for the production of hydrogen, particularly green hydrogen, in order to enter the global competition for clean energy sources. The details of the strategy shall be published before June 2022.

The National Committee in charge of preparing the hydrogen strategy is coordinating with the EBRD in order to select a consultant to determine the technical, legal and financial requirements for developing hydrogen projects in Egypt, and in assisting the Egyptian government with studies for developing green hydrogen.

2. What are key goals and commitments included in the strategy/policy?

The general strategy is to keep up with the pace of the global development in the field of renewable energy, and to add green hydrogen to the integrated national energy system, in light of the growing international interest in green hydrogen projects as a promising clean source of energy in the near future.

The key goals of the strategy are:

- Guaranteeing energy security;
- Increasing the contribution of the energy sector to the GDP;
- Maximizing the use of domestic energy resources;
- Promoting rational and sustainable management of the sector;
- Reducing energy intensity; and
- Reducing the environmental impact of harmful emissions in the sector (e.g. carbon).

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The electricity production sector, as members of the Egyptian government expressed on numerous occasions that the government's target is that 42% of the electricity of the country is to be produced via renewable energy (including green hydrogen) by the year 2035.

4. Who are the main regulators for the hydrogen market?

The Ministry of Climate, Energy and Utilities is responsible for the overall strategy and policy for the development and regulation of the energy sector.

The Danish Energy Agency administers energy and supply in Denmark, including new hydrogen technologies. A secretariat within the Danish Energy Agency is set up as a point of contact for project developers and authorities requesting guidance with authorisation procedures etc. regarding PtX.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The government hydrogen policy supports the development of green hydrogen while low-carbon (blue) hydrogen has not been addressed by the strategy so far.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The Sustainable Development Strategy 2030 does not directly address carbon capture and storage.

7. Are there targets for the production of hydrogen?

The Egyptian government's target is to have 42% of electricity produced via renewable energy (including green hydrogen) by the year 2035.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are multiple incentives in place to support the production of green and clean energy generally and hydrogen specifically, as follows:

- Tax incentives: The General Authority for Investment and Free Zones ("GAFI") will start implementing the tax incentives outlined in the [Investment Law No. 72](#) for the year 2017 (the "Investment Law") for projects in the green energy sector, which entails a 30% deduction from the net taxable profit of the project. The legislation also hands companies a flat 2% customs rate on machinery imported for the project, in addition to a five-year exemption from stamp duty and notary fees on certain expenses.
- Non-tax incentives (fast approvals and less bureaucracy): The Council of Ministers approved a draft Ministerial Decree regarding certain strategic projects, requiring them to obtain a single approval for the establishment, operation and management of the project. Such strategic projects include, inter alia, the production, storage and export of green hydrogen, green ammonia.
- The Investment Law already introduced the "Single Approval" concept for the investment proposals of projects related to renewable energy (e.g. green hydrogen) since 2017. In this regard, the competent authorities will issue the decision and will inform applicants of approval or rejection within 20 working days from receiving an application. GAFI will follow up on applications with any authorities who do not meet the new deadline.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

No.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

There have not been any laws or decrees regulating the production, storage, transportation or supply of hydrogen yet as it is a new industry making its first steps in Egypt. The framework is determined according to the memoranda of understanding ("MoUs") and agreements concluded by the Egyptian government with the energy companies and investors undertaking the establishment of hydrogen projects in Egypt.

However, according to Cabinet of Ministers Decree No. 56 for the year 2022, projects, amongst others, relating to the production, storage, transmission and/or exportation of green hydrogen and green ammonia are considered national/strategic projects and are subject to a single approval, provided that the project fulfills at least 2 criteria of the below list:

- The project shall contribute to increasing exports by exporting at least 50% of its products abroad annually, within maximum period of 3 years from the date of starting the activity.
- The project shall obtain its financing as foreign funds transferred from abroad through an Egyptian bank, in accordance with the conditions determined by the Board of Directors of the Central Bank of Egypt.
- The project shall aim at reducing imports, localize the industry and deepen the local component in its products. The percentage of the local component of raw materials and production requirements in its products should be a minimum of 50%, provided that said percentage is calculated by deducting the value of the imported components from the cost of the product.
- The project is established in one of the areas in need of development.

- The project must contribute to the transfer and localization of modern and advanced technology in Egypt, and to support innovation, development and scientific research.
- The project shall aim at securing strategic goods for the country and limit its import.
- The project should use national labor intensively.
- The project shall contribute to reducing the environmental impact, reducing heat and gas emissions, and improving the climate.

Companies establishing green hydrogen projects and fulfilling at least two of the above criteria, shall submit an application in order to obtain a single approval from GAFI, which will either accept or reject the application after verifying whether at least two of said criteria are fulfilled.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

There are no foreign investment restrictions related to energy and infrastructure sectors. The Investment Law grants foreign investors protection such as financing the project from abroad without restrictions in foreign currency. The foreign investor shall also have the right to freely own, manage and use the project, gain profits and transfer such profits abroad. In addition, the foreign investor shall have the right to liquidate the project at any time. All cash transfer operations related to foreign investment are allowed to be undertaken without any delay. The State further allows the transfer of the local currency into foreign currency.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Egypt has entered into numerous Bilateral Investment Treaties (“BITs”). The BITs to which Egypt is a signatory party are with, inter alia, Albania, Algeria, Argentina, Armenia, Australia, Austria, Belarus, Belgium and Luxembourg, Bosnia and Herzegovina, Bulgaria, Canada, China, Comoros, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Indonesia, Italy, Japan, Jordan, Kazakhstan, Latvia, Lebanon, Malaysia, Morocco, the Netherlands, Occupied Palestinian Territory, Oman, Poland, Portugal, Qatar, Republic of Korea, Romania, the Russian Federation, Singapore, Slovakia, Spain, Sri Lanka, Sweden, Switzerland, Syria, Thailand, Turkey, Turkmenistan, Ukraine, the United Arab Emirates, the United Kingdom, the United States and Vietnam.

Egypt has also entered into a number of Multilateral Investment Treaties and free trade agreements. These include the Unified Agreement for the Investment of Arab Capital in the Arab States and the COMESA Investment Treaty, which provide substantive investment protections and easy recourse to international arbitration. Egypt is also a signatory to the 1958 New York Convention on the Recognition and Enforcement of Arbitral Awards.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

There are no grants or other governmental funding available to hydrogen products to date. That said, the government provides incentives to hydrogen projects in the form of the tax exemptions provided under the Investment Law. Please refer to our responses to question (7) above.

There are talks that Egypt’s hydrogen development strategy study could be financed through a treasury grant by the French Agency for Development (AFD). Discussions are ongoing with the Electricity Ministry, but there is nothing final yet in this regard.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

The Egyptian government has signed multiple MoUs and agreements with international investors to produce hydrogen, such as the following:

- The government, represented by the Egyptian Electricity Holding Company (EEHC) and the Egyptian Natural Gas

Holding Company (EGAS), signed an initial agreement with Italian energy company Eni to assess the technical and commercial feasibility of projects for the production of green hydrogen through the storage of CO₂ in depleted natural gas fields.

- The first MoU was signed in August 2021 with Siemens Energy to build a plant with a capacity of 100 to 200 MW. Under the MoU, Siemens and the Egyptian government will jointly promote investment, technology transfer, and implementation of projects related to hydrogen production.
- The Sovereign Fund of Egypt (SFE) concluded an agreement in March 2022 with the consortium of Norway's Scatec, Egyptian businessman Nassef Sawiris, ammonia producer Fertigllobe and Orascom Construction, in order to establish and operate a 100 MW green hydrogen plant in Ain El Sokhna. The project is set to start by 2024, making it Egypt's first operational green hydrogen plant.
- Egypt and the EU should sign an MoU in the upcoming days during the Conference of the Parties to the UNFCCC 27 summit in November 2022, in order to develop a "Mediterranean Green Hydrogen Partnership". The Egyptian Minister of Foreign Affairs met with the EU Executive Vice President and they have expressed their intent to form a partnership to work on "hydrogen trade between Africa, Europe, and the Gulf" according to a joint statement.
- There has been interest from different investors, such as South Korea's Hyundai Rotem and Italian energy company Snam, who have discussed the subject of hydrogen production with government officials.
- The Egyptian government, represented by the New and Renewable Energy Authority, the Ministry of Electricity, the Egyptian Electricity Transmission Company, the Suez Canal Special Economic Zone and the Sovereign Fund signed 7 new MoUs for the production of green hydrogen, since August 2022.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

- There are no projects that have materialized on the ground yet; only MoUs and agreements that have been concluded between the government and investors.

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Finland

Ashurst collaborated with Dittmar and Indrenius in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

In June 2022, the Finnish Government announced a new national energy and climate strategy aiming at carbon neutrality by 2035. The new energy and climate strategy includes a section on hydrogen and this forms Finland's hydrogen strategy. Further details have been expected, but have not yet been issued by the Finnish Government.

2. What are key goals and commitments included in the strategy/policy?

As a part of the goal to achieve carbon neutrality by 2035, Finland is preparing comprehensively for the deployment of hydrogen solutions throughout the value chain for when hydrogen solutions reach commercial viability. It is expected that the use of zero-emission hydrogen and electric fuels will be prioritised in Finland for the needs of industry, transport and the energy system, and also for export.

The Finnish gas transmission system operator Gasgrid Finland Oy announced in June 2022 that it will develop a national hydrogen transmission infrastructure to enable a regional hydrogen market in the future. In May 2022, Gasgrid Finland Oy together with two industrial partners also announced the potential construction of Finland's first hydrogen transmission infrastructure demonstration project extending beyond an industrial site.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industrial sectors likely to be affected by the hydrogen deployment are:

- the power sector;
- road freight; and
- shipping and aviation;

Currently, the biggest users of hydrogen in Finland are oil refineries, biofuel production companies and the chemical industry. In these sectors, where hydrogen is already being used, a shift to low-carbon hydrogen is expected.

4. Who are the main regulators for the hydrogen market?

There is currently no sector-specific legislation in place and therefore no sector-specific regulators either.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The hydrogen strategy supports both low-carbon hydrogen and renewable hydrogen.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The Government has allocated € 150 million in its [Sustainable Growth Programme](#) towards investment, among other things, in hydrogen projects and carbon capture and recovery projects. In addition, some €66 million were granted by the Ministry of Economic Affairs and Employment in October 2022 through the EU's Recovery and Resilience Facility (RRF) for investments into industrial-size production facilities for renewable methane and methanol, respectively. Further decisions are expected during 2022. The Government-controlled innovation investor Business Finland also has various programs related to supporting innovation in the hydrogen economy and carbon capture, usage and storage (CCUS), for example, Bio and Circular Finland, Power to X, Smart Energy, and Smart Manufacturing.

The hydrogen strategy also includes plans to accelerate the development and introduction of CCUS.

7. Are there targets for the production of hydrogen?

According to the hydrogen strategy, Finland's target is to have at least 200 MW of electrolyser hydrogen production capacity by 2025 (in 2021, the capacity was 9 MW) and at least 1000 MW by 2030.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The Government has allocated € 150 million in its Sustainable Growth Programme towards investment, among other things, in hydrogen projects and carbon capture and recovery projects.

The primary target group for these investments is large companies in the energy technology and energy-intensive industries and their supplier networks, as well as SMEs that commercialise innovations. There are no restrictions on the size of company that can benefit from these investments and no specific regions or industries are targeted however, investments will not be allocated to projects for the production of hydrogen from natural gas. The funding from the Sustainable Growth Programme is therefore intended to foster innovation in the field of electrolyser hydrogen however, the Government acknowledges the difficulties relating to commercialisation of such technologies in the hydrogen strategy.

In its hydrogen strategy, the Government announced that it will investigate the feasibility of introducing carbon contracts-for-differences (CCfDs) as an incentive mechanism to accelerate transformation into low-carbon industry.

Hydrogen distribution stations for traffic use can already obtain investment aid and hydrogen fuel is now included in the renewable fuel distribution obligation system.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are no national standards in place for the classification of low-carbon or renewable hydrogen. However, the Government released a publication in early 2022 on hydrogen economy where it recognised the need for clear, EU-wide criteria and standards for low-carbon and clean hydrogen.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

To date there are no national regulatory requirements relating to the production, storage, transportation or supply of hydrogen in Finland. The hydrogen strategy states that if necessary, national regulation regarding hydrogen will be developed.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

There is no sector-specific legislation in place in Finland relating to foreign investments in energy and infrastructure sectors. However, there is legislation in place that provides that a foreign corporate acquisition will be subject to monitoring if, as a result of the proposed corporate acquisition, a foreign owner will control a certain proportion of votes or will have actual influence in a company active in the defence and security sector or a business undertaking considered critical for vital functions of society.

In this instance, a notification must be made to the Ministry of Economic Affairs and Employment which confirms the proposed acquisition in the first instance, but may refer to the Council of State of Finland which in turn may refuse to confirm the acquisition if it is deemed necessary due to a critical national interest.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website states that Finland is a signatory to 62 bilateral investment treaties (BITs) that are in force, and in addition certain other treaties may contain protections for investors in Finland. These can be accessed from the Ministry of Foreign Affairs' [website](#), and UNCTAD's Investment Policy Hub.

The Energy Charter Treaty (ECT) is a multilateral investment treaty which entered into force in April 1998 and specifically addresses energy trade, transit and investment between its contracting parties, which include Finland and all other EU states (except Italy). Discussions as to the modernisation of the ECT have been ongoing for several years focusing, in particular, on investment protection and “greening” the ECT.

These discussions have focused on reducing the protections accorded to fossil fuels and explicitly protecting emissions reduction technologies (including hydrogen and CCUS). This should be kept under review. There are differing views as to whether hydrogen production and CCUS would be afforded protection under the current terms of the ECT.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

The Government has allocated € 150 million in its Sustainable Growth towards investment, among other things, in hydrogen projects and carbon capture and recovery projects. In addition, some € 66 million were granted by the Ministry of Economic Affairs and Employment in October 2022 through the RRF for investments into industrial-size production facilities for renewable methane and methanol, respectively. Further decisions are expected during 2022. In 2021, the Ministry of Economic Affairs and Employment also granted funding to two hydrogen demonstration projects worth approximately €40 million in total.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being deployed in Finland to examine and test the feasibility of clean hydrogen production and use in different sectors, such as:

- [SSAB's](#) industrial-scale research project, which aims to produce fossil-free steel using hydrogen reduction and clean electricity;
- [Q Power and Wärtsilä](#) aim to produce synthetic natural gas from hydrogen and carbon dioxide; and
- [Flexens](#) which aims to produce and utilise clean hydrogen for ferry transport.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

Finnish gas industry company [Voikoski's](#) plant in Kokkola, which started operating in 2014, appears to be the only commercial-scale clean hydrogen plant in Finland. There are also a number of projects in the pipeline at different stages of development, including the following projects:

- [Neste Corporation's](#) clean hydrogen project 'SHARC' which aims to produce clean and low-carbon hydrogen for refining oil and bio fuels. The EU Innovation Fund has granted €88 million to the project. The project is currently in the feasibility stage.
- [P2X Solutions](#) plans to construct a 20 MW electrolyser plant, which will start producing green hydrogen using electricity produced by wind, solar, biomass or hydropower for industrial and transport use. The plant is due to be operational by the end of 2024.
- [Ren-Gas](#) has signed five co-operation agreements since the start of the year with different parties regarding feasibility studies of Power-to-Gas plants/facilities which would have electrolysis capacities ranging between 20-60 MW.

Last updated December 2022

France

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Initially, the French Minister in charge of energy transition issued a hydrogen deployment plan for the energy transition in June 2018. This plan was based on three main axes: the creation of a decarbonised industry, the development of renewable energies storage capacities and the development of zero-emission solutions for road, rail and waterway transport.

This initiative was followed by the issuance of the National Strategy for the development of the low-carbon Hydrogen in France by the Government on 8 September 2020 (the "[Hydrogen National Strategy](#)") as part of the stimulus plan aiming to accelerate ecologic, industrial and social transition in France.

In addition, hydrogen is at the heart of the massive investment plan France 2030 announced by the French President on 12 October 2021, with one of the objectives is for France to become the leader of green hydrogen. France 2030 increases the financial support for hydrogen up to €9 bn.

2. What are key goals and commitments included in the strategy/policy?

There are three priorities in the Hydrogen National Strategy, namely industry decarbonisation to meet carbon-neutrality in 2050, development of hydrogen-powered heavy mobility and support to high-level research and development of training offers.

In this context, three major objectives have been set by the French Government:

- Raising the number of electrolysers to significantly contribute to economy decarbonisation (development of 6.5 GW low-carbon hydrogen production capacities based on electrolyse).
Corresponding priority: decarbonising industry by creating a French electrolysis industry.
- Development of clean mobilities specifically for heavy vehicles, i.e. utility vehicles, trucks, trains, river shuttles, ships, planes (the objective is to save 6 million tonnes of CO₂).
Corresponding priority: developing heavy-duty mobility with low-carbon hydrogen.
- Creation of an industrial sector generating jobs and guaranteeing our technological expertise.
Corresponding priority: support research, innovation and skills development to foster the uses of tomorrow.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industry sectors where clean hydrogen may displace fossil fuels in France include:

- Steel and chemical industry
- Transport
- Power sector (in particular renewable energy)
- Refining industry
- Heating

Sectors where hydrogen is already being used in smaller quantities, such as electronics or food industry, are also expected to switch to low-carbon hydrogen.

4. Who are the main regulators for the hydrogen market?

As the market is nascent in France, a specific regulator for the hydrogen market has not been appointed as yet. However, the Energy Regulatory Commission (known as the "CRE") will play a role in the development of the market. Based on the provisions of the Hydrogen Ordinance dated 17 February 2021, the opinion of the CRE will be sought on the general terms and conditions of the operating aid which will be granted to low-carbon and renewable hydrogen

production facilities by electrolysis of water, having been selected through a tendering process. Additionally, the implementation decree of the Hydrogen Ordinance will be enacted in light of the opinion of the CRE.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The Hydrogen National Strategy and the investment plan France 2030 aim to focus on the development of low-carbon hydrogen by electrolysis of water and renewable (green) hydrogen. The French Government's strategy is first to promote hydrogen decarbonisation mechanisms through the development of electrolyzers, in line with the European strategy for the development of hydrogen.

However, the French Energy Regulatory Commission (the "CRE") recently insisted on the fact that the priority should be the decarbonisation objective regardless of the primary energy source that is used (i.e., low-carbon hydrogen or hydrogen produced from renewable energy). According to the CRE, the public support in favour of hydrogen should not be based on the category of hydrogen but only on the emission threshold of CO₂ equivalents emitted per kilogram of hydrogen produced.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

N/A

7. Are there targets for the production of hydrogen?

France's target is to have 6.5GW low-carbon hydrogen production capacities based on electrolyzers and to save more than 6 Mt of CO₂ (which equals the carbon annual emissions of a city like Paris) by 2030. France is aiming to be carbon neutral by 2050.

In its latest study, the France Hydrogène association estimates that the objective of the Hydrogen National Strategy (i.e., 6.5GW low-carbon hydrogen production capacities production in France by 2030) could be reached or even exceeded, with between 15 and 25 hydrogen production projects identified over French regions.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

In the Hydrogen National Strategy, the French Government announced that €7 bn will be provided until 2030 in support of the three priorities mentioned in response to question 2 above. The France 2030 plan increased this amount up to €9 bn. According to the Hydrogen National Strategy, the support for hydrogen deployment would take the form of incentive mechanisms.

To date, incentive mechanisms are mainly based on subsidies granted to hydrogen-related projects selected through competitive procedures, e.g. calls for proposals (appels à projets) and calls for expression of interest (appels à manifestation d'intérêt). The French prime minister recently announced that 10 French projects would be granted €2.1 bn as part of the Hydrogen National Strategy.

In addition, the ordinance No. 2021-167 of 17 February 2021 with respect to hydrogen (the "[Hydrogen Ordinance](#)") establishes a specific legal framework including public support mechanisms which may only benefit low-carbon and renewable hydrogen production facilities by electrolysis of water. This public support is opened to any person located on the territory of a Member State of the EU or the European Economic Area who intends to build or operate a production facility on the national territory. It may take the form of either an operating aid or a combination of financial support to investment and operating aid under terms and conditions to be set by the relevant administrative authorities. In both cases, the facilities or projects benefitting from such support will be selected through two-stage tendering procedures based on transparency and equal treatment principles. The operating aid cannot lead to a remuneration of the producer exceeding a reasonable return on invested capital, taking into account the risks in relation to the activities benefitting from the aid. The implementation of such provisions is subject to a decree which has not been enacted so far meanwhile, the contemplated incentive mechanism is still under discussion before the European Commission as part of the state aid regime.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

The Hydrogen Ordinance provides standards for the classification of the various categories of hydrogen. These definitions have been incorporated in the [French Energy Code](#):

- “hydrogen” is defined as the gas composed of dihydrogen molecules (in a proportion set in a ministerial order) which results from the implementation of an industrial process.
- “renewable hydrogen” is defined as hydrogen produced either by electrolysis using electricity from renewable energy sources, or by any other technology using exclusively one or several renewable energy sources and which does not conflict with other uses allowing their direct valuation.
- “low-carbon hydrogen” is the hydrogen whose production process generates emissions which are less than or equal to the threshold triggering the qualification of renewable hydrogen without however falling within this qualification since other criteria are not met.
- “carbonaceous hydrogen” is defined as hydrogen which is not renewable hydrogen nor low-carbon hydrogen.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The regulatory framework applicable to hydrogen is mainly based on (i) the Hydrogen Ordinance whose provisions have been incorporated into the French Energy Code, and (ii) the French Mining Code.

The Hydrogen Ordinance contains various regulatory requirements relating to the production, storage, transportation and supply of hydrogen (focusing however on renewable hydrogen) whereas the French Mining Code sets out provisions which apply only to storage of hydrogen.

The Bill relating to the acceleration of the production of renewable energies, currently under discussion in the French Parliament, authorizes renewable hydrogen production facilities on brownfields or industrial basins of unsaturated brine in coasted areas but not located in an urbanised area as an exception to the prohibition under the French Coastal Law (loi Littoral).

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Foreign investment restrictions apply to activities likely to prejudice the interests of national defence, public order or public safety and which concern infrastructure, goods and services that are essential to guarantee integrity, security and continuity of energy supply. The same applies to R&D activities on critical technologies which include energy storage and technologies in relation to renewable energy production. As a result, provided that the transaction meets other criteria referred to in the French Monetary and Financial Code (see articles L. 151-1 et seq. and R. 151-1 et seq.), it may fall within the scope of French FDI regulations and be subject to the authorisation of the Minister in charge of Economy.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The Energy Charter Treaty (ECT) is a multilateral investment treaty which specifically addresses energy trade, transit and investment between the contracting parties, which includes France. Discussions as to the modernisation of the ECT led by the European Union have been ongoing for several years, and focus in particular on investment protection and “greening” the ECT. These discussions have focussed on reducing the protections accorded to fossil fuels and explicitly protecting emissions reduction technologies (including hydrogen).

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

As indicated in response to question 7 above, there are various government grants and subsidies available to hydrogen projects which are awarded on the basis of calls for tender and calls for expression of interest issued by

public authorities (e.g., ADEME, Agence nationale de la recherche, Secrétariat général pour l'investissement, etc.).

In addition, an Important Project of Common European Interest ("IPCEI") on hydrogen has been launched jointly by EU Member States and Norway in December 2020. This initiative should enable the development of numerous large-scale low-carbon and renewable hydrogen production projects in Europe. France will reserve an exceptional financial allocation of €1.5 billion for this action, out of a total of €7 billion of public and private investments deployed by the European Commission services. As of 8 March 2022, 15 French projects have been selected and 10 of them have been approved by the European Commission. 2 other French projects have been approved in September as part of a second round of the IPCEI scheme dedicated to the production and transport of hydrogen.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are different pilot projects being deployed in France to examine and test the feasibility of clean hydrogen production and use in various sectors.

For example, [GRHYD project](#) has been launched in 2014, and inaugurated on 11 June 2018. GRHYD is a local-scale project led by Engie in partnership with GRDF, the French Atomic Energy and Alternative Energies Commission (Commissariat à l'énergie atomique et aux énergies alternatives), Areva H2Gen, and ADEME. The demonstrator uses wind-generated electricity and supplies 100 homes in the Dunkirk Urban Community with carbon-free hydrogen for heating, hot water and cooking. The hydrogen is mixed with natural gas to a maximum volume of 20% of the total volume of gas supplied. The experimentation of this demonstrator should make it possible to evaluate the economic and technical prospects of power-to-gas for housing.

The [Jupiter 1000 project](#), piloted by the gas transport operator GRTgaz, has enabled it to carry out the first hydrogen injections into its network. The demonstrator, located in Fos-sur-Mer (South of France), has a capacity of 1 MW and a power production capacity of 5 million kWh over three years. By allowing hydrogen to be injected into existing networks, power-to-gas makes it possible to store the surplus renewable electricity in existing gas infrastructures, which leads to greater flexibility in the electricity network.

On 6 March 2020, Engie Solutions, Michelin and Morbihan Energies signed agreements to supply a Michelin industrial site in Vannes and to build a charging station for light and heavy vehicles, which will be located nearby ([Hygo](#)). The project is operational since October 2021 and carried out by Hygo (founded by Engie and Morbihan Energies). The project allows the development of the use of hydrogen at a local level in Morbihan.

In addition, several projects to experiment the use of hydrogen-powered buses have been launched. For example, the Tethys project led by the syndicat mixte des transports pour le Rhône et l'agglomération lyonnaise (Sytral) is experimenting with the use of two hydrogen-powered buses on a bus line in the Lyon public transport network.

On 28 September 2022, the Sealhyfe project was inaugurated in Saint Nazaire. It is the world's first offshore production site that will produce up to 400kg of green energy per day. The hydrogen will be produced on a floating platform from a 1MW electrolyser designed by Plug Power and directly powered by offshore wind turbines.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

Within the framework of the French government's low-carbon and renewable hydrogen development policy, several calls for tenders have been launched.

In March 2021, [Air Liquide and ArcelorMittal](#) announced their intention to develop an innovative low carbon steel production unit using low carbon hydrogen. Air Liquide will supply ArcelorMittal with low carbon hydrogen, contributing to the production of steel with reduced CO2 emissions. This project was considered as an Important Project of Common European Interest ("IPCEI") on 8 March 2022 by the French Minister of Economy and was approved by the European Commission on 21 September 2022 as part of the second round of the IPCEI scheme ("Hy2Use").

In March 2022, Air Liquide also received support from the French government for its 200 MW electrolyser project in Normandy ([Air Liquide Normand'Hy](#)). This project is part of the IPCEI and is expected to be operational in 2025.

In May 2021, McPhy announced their intention to develop an electrolyser gigafactory in Belfort. This project is part of the first round of the IPCEI ("Hy2Tech") and was approved by the European Commission on 15 July 2022. On 28 September 2022, the French government announced that this project will receive support up to €114 m.

Germany

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, the [German National Hydrogen Strategy](#) was published by the German Federal Ministry for Economic Affairs and Climate Action on 10 June 2020.

In June 2022, the Federal Ministry for Economic Affairs and Climate Action (Bundesministerium für Wirtschaft und Klimaschutz) has published a Progress Report on the implementation of the German National Hydrogen Strategy. The Progress Report outlines the key milestones that the German government has achieved since the German National Hydrogen Strategy was adopted emphasising, inter alia, that with the 62 German IPCEI hydrogen projects, over 2 GW of electrolysis capacity and 1,700 km of hydrogen pipeline network for hydrogen have been initiated or that with the amendment of the *German Energy Industry Act* (Energiewirtschaftsgesetz -EnWG) and the associated Hydrogen Network Charges Ordinance (Wasserstoffnetzergeldverordnung) the first measures for implementing the necessary regulatory framework for hydrogen have been adopted. However, the Progress Report also shows that the German government has still a number of remaining task set itself for the successful ramp-up of a hydrogen economy.

The current German Government has already announced to amend, the German National Hydrogen Strategy its current period of government. A respective amendment has, however, not yet published.

2. What are key goals and commitments included in the strategy/policy?

Clean hydrogen is a key element of the German Government's decarbonisation strategy. With the National Hydrogen Strategy, the Federal Government intends to provide a coherent framework for the generation, transport and use of hydrogen, encouraging the relevant innovations and investment. It focuses in particular on the following goals:

- Making hydrogen a competitive option;
- Developing a domestic market for hydrogen technology in Germany, paving the way for imports;
- Establishing hydrogen as an alternative for other energy sources;
- Making hydrogen a sustainable base material for the industrial sector;
- Enhancing transport and distribution infrastructure;
- Fostering science, mobilising skilled labour;
- Establishing international markets and cooperation for hydrogen;

Building up and securing the quality assurance infrastructure for hydrogen production, transport, storage and use, Improving the policy environment and addressing current developments on an ongoing basis.

- Based on these general aims, the German National Hydrogen Strategy also contains an action plan with the steps necessary for the National Hydrogen Strategy to succeed. For that purpose, the National Hydrogen Strategy contains **38 detailed measures** for a first ramp-up phase until 2023; for the following phase (beginning in 2024), which should stabilise the newly emerging domestic market and mould the European and international dimension of hydrogen. Further measures shall be continuously developed.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The German National Hydrogen Strategy targets the following sectors and strategic markets:

- **Hydrogen and power production market:** To enable the market penetration and export of hydrogen technologies, the German Government wants to establish a domestic market that provides a strong and sustainable base for the production and use of hydrogen, while furthering the energy transition. As hydrogen is to have long-term prospects of being used in a sustainable and economic way, capacities for generating electricity from renewables (particularly wind power and photovoltaics) shall be systematically improved.

- **Transport:** As mobility applications offer a great potential for hydrogen uses, the German Government intends to strengthen the hydrogen-based or PtX-based mobility in Germany (e.g. by more ambitious GHG reductions or minimum quotas for hydrogen-uses / renewable fuels of non-biological origin – RFNBOs). The introduction of fuel cell vehicles shall complement battery-powered electric mobility and help significantly reduce air pollutants and carbon emissions in mobility areas such as local public passenger transport (buses, trains), parts of heavy-duty road transport (trucks), commercial vehicles (e.g. for use in construction work or agriculture and forestry) or logistics (delivery traffic; other commercial vehicles such as forklift trucks). For that purpose, the German Government also wants, inter alia, to support the German automotive and truck suppliers in their structural transformation process, to strengthen Germany's machinery and plant manufacturing sector or to promote investments in hydrogen infrastructure (e.g. refuelling stations).
- **Industry:** In the industry sector, the German Government intends that gaseous and liquid sources of energy shall be gradually replaced by alternative technologies, paving the way for the use of alternative resources or processes with either zero or very low carbon emissions (e.g. by implementing quotas for climate-friendly base substances). The National Hydrogen Strategy explicitly addresses the refinery, chemical and steel industries having processes that enable the use of hydrogen. The Government's aim is, wherever possible, to channel upcoming investments in production facilities on an industrial scale into climate-friendly technologies, e.g. by supporting carbon contracts for differences for the industry. Therefore, hydrogen is set to play an important long-term role in safeguarding the attractiveness of Germany's industrial sector.
- **Heating:** Even after the efficiency and electrification potentials for process heat generation and the building sector have been harnessed, the National Hydrogen Strategy states that there will continue to be long-term demand for gaseous fuels. In the long run, the German Government intends that hydrogen and its downstream products shall help in various ways to decarbonise parts of the heating market (e.g. by funding fuel-cell heating systems or H₂-ready heating installations).

4. Who are the main regulators for the hydrogen market?

The Federal Network Agency (Bundesnetzagentur) is the main regulator for the German hydrogen market. With regard to the different funding and support programs, the Federal Ministry for Economic Affairs and Climate Action (Bundesministerium für Wirtschaft und Klimaschutz) is another key player in the hydrogen market.

For ensuring a successful implementation, constant monitoring and a further development of the National Hydrogen Strategy, also a specific hydrogen governance structure has been established in Germany, including a State Secretaries' Committee (composed of the different relevant German ministries), a National Hydrogen Council (consisting of 26 experts from business, science and civil society) as well as a cooperation mechanism between the Federal Government and the different German states.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The German National Hydrogen Strategy emphasises that hydrogen needs to be established as a decarbonisation option in order for Germany to become GHG-neutral and to meet its international obligations under the Paris Convention. However, the German Government considers only hydrogen that has been produced using renewable energy, i.e. **only green hydrogen**, to be sustainable in the long term. The Government therefore seeks to use green hydrogen, promote its rapid market rollout and establish the necessary value chains. The Government believes that both a global and European hydrogen market will emerge in the coming ten years and that also carbon-free (e.g. blue or turquoise) hydrogen will be traded on this market. Given Germany's close integration in the European energy supply infrastructure, carbon-free hydrogen will be relevant for Germany, but shall, if available, only be used temporarily. The German National Hydrogen Strategy does not contain any specific aims for the development of low-carbon (blue) hydrogen, but only focusses on green hydrogen.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The German National Hydrogen Strategy **does not contain** aims for low-carbon (blue) hydrogen and the German Government does not support the carbon capture and storage.

7. Are there targets for the production of hydrogen?

In the current National Hydrogen Strategy, the German Government set out its aim to establish up to **5 GW of hydrogen generation capacity** by 2030 including the offshore and onshore energy generation facilities needed for this. This corresponds to 14 TWh of green hydrogen production. An additional hydrogen capacity of 5 GW shall to be established, if possible by 2035 and no later than 2040.

The current German Government has already announced to amend the German National Hydrogen Strategy in the current period of government. This amendment shall, inter alia, also contain an increased target of **10 GW of hydrogen generation capacity** in Germany by 2030 including the offshore and onshore energy generation facilities needed for this.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The German National Hydrogen Strategy focuses on supporting private investments in the sustainable production, transport, and use of hydrogen.

For that purpose, private sector investments in hydrogen production facilities in Germany are supported by a variety of public investment subsidies.

As well as providing investment grants and as part of the efforts to promote climate-friendly industrial procedures, the National Hydrogen Strategy contains the ambition to support the use of electrolyzers. For this purpose, the German federal Government will launch a new pilot programme entitled "Carbon Contracts for Difference". Carbon contracts for difference shall be concluded between the state and companies in the energy-intensive industry in order to offset the additional costs of climate-friendly production processes compared to conventional processes. The aim is to provide the industry with investment security and with incentives to bring forward climate protection projects. Under the carbon contracts for difference, the Federal Government will guarantee that it will provide funding amounting to the difference between the actual cost of avoiding emissions (e.g. by agreeing on a project-based contractually agreed carbon price) and the ETS prices for the construction and operation of decarbonisation. Should the future ETS price rise above the contractually agreed carbon price (i.e. the cost of avoiding emissions for the respective technology), companies would be obliged to pay back the difference to the state. These carbon contracts for difference shall deliver a reliable investment environment and create incentives for the early implementation of climate projects which in turn will create indirect incentives for the production of hydrogen and the ramp-up of hydrogen technologies.

The German Government is currently developing a respective carbon contracts for difference programme which shall enable the development of a respective contracting platform ("H2Global"), initially focusing on the steel and chemical industries. This funding instrument is to be extended to other sectors at a later date.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are currently no legally binding standards in place in Germany for the classification of hydrogen. However, according to the coalition agreement of the parties of the new German Government, the German Government intends to support the development of a uniform certification mechanism for hydrogen at the European Level.

On a legally non-binding level, the German TÜV SÜD provides a green hydrogen certification that is already used in practise in Germany as the possibility of furnishing third-party evidence for climate-friendly hydrogen production.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The regulatory framework for hydrogen is currently still developing in Germany. The existing regulatory framework defines the requirements applying to different aspects of the hydrogen value chain, but there are areas where greater regulatory certainty is still required.

- **Production:** With regard to the production of hydrogen, the initial statutory regulations have been introduced in Germany in 2021 for the possible offshore wind-based production of hydrogen. The *German Offshore Wind Energy Act* (Windenergie-auf-See-Gesetz) contains special provisions for so-called "other energy production areas" (sonstige Energiegewinnungsbereiche) in which hydrogen can be produced offshore. Other statutory regulations relate, for example, to certain privileges of hydrogen production, such as the exemption from certain statutory levies (e.g. the

EEG levy). Further statutory measures are still to be expected with regard to hydrogen production in Germany.

- **Transportation:** The regulation of hydrogen networks has so far been the focus of the regulatory framework in Germany. The *German Energy Industry Act* (Energiewirtschaftsgesetz) designates hydrogen as a separate energy source; hydrogen is “energy” insofar as it is pipeline-bound. It also stipulates that hydrogen is to be qualified as “gas” insofar as hydrogen is fed into a gas supply network. The *Energy Industry Act* also contains new regulations for pure hydrogen networks. So far, hydrogen networks in Germany have not been subject to strict regulation like gas supply networks. Rather, as a basic principle, only a few selected regulatory provisions that apply to gas supply networks also apply to hydrogen networks (e.g. rules regarding permitting, responsibility of authorities, legal protection). More extensive regulatory requirements only apply if the hydrogen network operator decides on a voluntary basis to opt-in the regulation. If there is an effective opt-in declaration, inter alia, the following additional regulatory requirements apply: grid connection obligation, grid access obligation, grid fee obligation or unbundling regulations.
- **Storage:** The *Energy Industry Act* also contains new regulations for hydrogen storage facilities. Hydrogen storage operators are also subject to the (voluntary opt-in) regulation rules that apply to hydrogen network operators.
- **Supply:** No special regulatory requirements apply to the supply of hydrogen. The unbundling regulations must be observed for operators of hydrogen networks or hydrogen storage facilities, according to which these activities must be completely independent of the hydrogen supply.

In general, it is noteworthy with regard to the current German legal framework for hydrogen that the legislator intends this to be a transitional regime aimed at enabling a quick market ramp-up. A final legal framework is to be established in Germany only once the relevant EU regulations have also been developed and need to be implemented.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Yes. The *German Foreign Trade and Payments Act* (Außenwirtschaftsgesetz) and the Foreign Trade and Payments Ordinance (Außenwirtschaftsverordnung) establish a strict investment control regime for direct and indirect investments in energy and infrastructure assets by non-EU investors. If energy and infrastructure assets in the single case qualify as “critical infrastructure” (e.g. generation and storage assets beyond a certain capacity), every acquisition of 10% or more of the voting rights in the respective companies is subject to a mandatory notification obligation and must not be concluded before it has been cleared by the German Ministry of Economic Affairs and Climate Action, with strict gun-jumping provisions. In all other cases, acquisitions of 25% or more of voting rights may be subject to an ex-officio review procedure and can be reviewed and sanctioned up to five years after signing of a sale and purchase agreement.

The *German Foreign Trade and Payment Act* requires, however, that the respective company to be invested in is an operator of an existing critical infrastructure. Therefore, a Greenfield investment is not subject of a review, as future critical infrastructure is not included in the scope of the foreign investment control.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website states that Germany is a signatory to 155 bilateral investment treaties (BITs) that are in force, and in addition certain other treaties may contain protections for investors in Germany. These can be accessed from the UNCTAD’s Investment Policy Hub on the website of the UNCTAD.

In addition, the Energy Charter Treaty (ECT) is a multilateral investment treaty which specifically addresses energy trade, transit and investment between its contracting parties, which includes Germany. Subject to the ECT are also rules on investment protection.

With the Treaty of Lisbon, responsibility for foreign direct investment was transferred to the EU so that the EU Commission has the possibility to negotiate agreements on investment protection for the EU and the 27 EU member states. These are to replace the bilateral agreements of the individual member states.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

- Between 2006 and 2016, funding of around €700 million has been approved under the National Innovation Programme I on Hydrogen and Fuel Cell Technology (NIP I), and between 2016 and 2026, a total of €1.4 billion in funding will be provided in phase II of this program (NIP II).
- Under the Energy Research Programme, funding is provided to build an excellent research landscape. Between 2020 and 2023, €310 million will be provided for practice-oriented basic research on green hydrogen and another €200 million will be provided over this period to strengthen practice-oriented energy research on hydrogen technology.
- In addition, €600 million will be provided between 2020 and 2023 to foster the “Regulatory Sandboxes for the Energy Transition”, which shall help to speed up the transfer of technology and innovations from the lab to the market, not least for hydrogen solutions.
- As part of Germany's decarbonisation programme, funding is also provided for investment in technologies and largescale industrial facilities which use hydrogen to decarbonise their manufacturing processes. More than €1 billion will be provided for this between 2020 and 2023. There are also programmes that promote the use of hydrogen in manufacturing and for the purpose of eliminating and utilising carbon emissions in the base materials industry.
- Under the “package for the future” program, a funding of another €7 billion for speeding up the market rollout of hydrogen technology in Germany and another €2 billion for fostering international partnerships will be provided.
- 62 German hydrogen projects are involved in the European IPCEI initiative, partly receiving also additional national support. In July 2022, the European Commission has already approved four initial projects in Germany (i.e. “BoschPowerUnits” of Robert Bosch GmbH, “Sunfire1500” of Sunfire GmbH, “Pegasus” of Daimler Truck AG and “NextGen HD Stack” of EXPO Fuel Cell Technologies GmbH) under the EU state aid law on the basis of which these projects can now receive a national funding. Further German hydrogen projects are still in approval process under the IPCEI initiative.

In addition, there are numerous further funding programs initiated by the German States for regional hydrogen purposes. The precise amounts available for each of these programmes depend, inter alia, on the budget estimates made by the responsible ministries.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being deployed in Germany to develop electrolyser production, and to examine and test the feasibility of clean hydrogen production and use hydrogen in different sectors. In particular, there are three hydrogen flagship projects in Germany representing an important contribution by the Federal Ministry of Education and Research to establishing the National Hydrogen Strategy.

- **H2Giga:** The H2Giga flagship project aims at mass production of electrolysers for the scale-up of hydrogen. The project focuses on establishing the series production of electrolysers in a manner that is not limited to specific technologies. Together, established manufacturers of electrolysers, suppliers from various technology sectors (including many small and medium-sized enterprises) as well as research institutions and universities are working on the advancement of existing electrolysis technologies. The following technologies shall then be ready for series production: PEM electrolysis, Alkaline electrolysis (AEL) and High-temperature electrolysis (HTEL).
- **H2Mare:** The H2Mare flagship project explores the offshore production of green hydrogen and other power-to-X products. The project partners strive to integrate the water electrolyzer directly into an offshore wind turbine and thus provide innovative technologies to produce green hydrogen offshore. The direct coupling of wind turbines and electrolysers shall minimize the costs of hydrogen production, since infrastructure costs can be significantly reduced when a connection to the power grid is not needed. H2Mare also works on solutions to directly produce secondary products such as green methanol or green ammonia in addition to green hydrogen (i.e. offshore power-to-X).

- **TransHyDE:** The TransHyDE flagship project aims at developing a hydrogen transport infrastructure, whilst also evaluating and demonstrating several technologies for hydrogen transport. For that purpose, TransHyDE will separately test and scale up four transport technologies each in four respective demonstration projects: (i) hydrogen transport in high-pressure containers, (ii) hydrogen transport in existing and new gas pipelines, (iii) transport of hydrogen bound in ammonia and (iv) hydrogen transport by means of LOHC.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Germany, but there are a number of projects in the pipeline at different stages of development. One key element for the market ramp-up of the hydrogen market in Germany is the Important Project of Common European Interest (IPCEI) program on hydrogen. In June 2021, the German Federal Ministry for Economic Affairs and Climate Action selected a total of 62 projects (from a total of more than 230 submitted project outlines) that cover the entire hydrogen value chain and gives an overview of one of the most important commercial scale clean hydrogen projects that are currently under development in Germany, including inter alia:

- **GetH2:** The project aims to establish the core for a nationwide hydrogen infrastructure in Germany. The initiative consists of companies (e.g. bp, RWE, OGE, Evonik, BASF or ThyssenKrupp), municipalities and institutions (e.g. Technical University Clausthal) that are actively committed to creating a competitive hydrogen market. In several projects, the partners of the initiative are driving forward the development of technologies for the production, transport, storage and purchase of green hydrogen. They are planning the realisation of pipeline networks, electrolysis plants in the megawatt range and hydrogen applications in refineries, in the steel industry or in heavy-duty transport. The 5,100-kilometre GetH2 network shall be built step by step by 2030.
- **doing hydrogen:** The project “doing hydrogen” is the establishment of an eastern German hydrogen hub which connects H2 projects in Mecklenburg-Western Pomerania, Brandenburg, Berlin, Saxony and Saxony-Anhalt to form a hydrogen hub including production, transport, storage and consumption. The project is supported by, inter alia, Gascade, Ontrans, Enertrag and Vattenfall and shall be ready to launch in 2026.
- **LGH2:** bp and Orsted aim to jointly produce green hydrogen on an industrial scale. For this purpose, an electrolysis plant with a capacity of 60 MW is to be built in Lingen to replace the grey hydrogen currently used in fuel production at the bp refinery. Orsted will supply the necessary green electricity from its offshore wind farms in the North Sea. The project shall be realised by 2025.
- **LHyVE:** The project “Leipzig Hydrogen Value chain for Europe (LHyVE)” shall establish a regional hydrogen network in the area of Leipzig consisting of hydrogen production and hydrogen storage facilities, a regional hydrogen network for the distribution of hydrogen and different hydrogen customers. The project is supported by, inter alia, Leipziger Gruppe, Ontras and BMW and shall be ready to launch in 2026.
- **SENECA – H2 MOBILITY:** Deutschland GmbH & Co. KG (held by Air Liquide, Daimler, Linde, OMV, Shell and TOTAL. BMW, Honda, Hyundai, Toyota and Volkswagen) intends to extend the expansion of the hydrogen infrastructure in Germany. The initial goal is to operate 100 hydrogen stations in seven German metropolitan areas (Hamburg, Berlin, Rhine-Ruhr, Frankfurt, Nuremberg, Stuttgart and Munich) and along connecting trunk roads and highways. Starting in 2021, additional stations will be built where there is demand for commercial vehicles and where a public refuelling station makes sense for a growing network for passenger cars.

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India

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Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, the 'National Hydrogen Mission' was announced by the Prime Minister of India on 15 August 2021 and subsequently the Ministry of Power, Government of India (GoI) notified the Green Hydrogen/ Green Ammonia Policy (Green Hydrogen Policy) on 17 February 2022.

Subsequent to the Green Hydrogen Policy, on 4 January 2023, the Union Cabinet of GoI approved the 'National Green Hydrogen Mission' ("Green Hydrogen Mission") to further boost the growth of green hydrogen in India.

2. What are key goals and commitments included in the strategy/policy?

The Green Hydrogen Mission provides the vision, intent and direction for harnessing hydrogen energy and some key goals are as follows:

- to develop India as a global hub for manufacturing hydrogen and fuel cells technology across the value chain;
- put forward a specific strategy for the short term (4 years), and broad strokes principles for long term (10 years and beyond) would be devised;
- provide necessary flexibility to capture benefits from advances in the technological landscape;
- the GoI will facilitate demand creation in identified segments, including seeking use of green hydrogen in industry such as in fertilizer, steel, petrochemicals and so on;
- engaging in activities to create volumes and infrastructure, demonstrate usage in niche applications including transport and industry;
- have focused research and development, implement a facilitative policy to support usage, and putting in place a robust framework for standards and regulations for hydrogen technologies; and
- to aid the government in meeting its climate targets and making India a green hydrogen hub, which will help in meeting the target of production of five million tonnes of green hydrogen by 2030 and the related development of renewable energy capacity.

The Green Hydrogen Policy itself did not set any goals/milestones for or by stakeholders, however, a supplementary report published by the National Institute for Transforming India (NITI Aayog) in June 2022 provides that India can achieve the following targets if the right steps are taken, with a USD 1 billion investment into hydrogen research and development to enable breakthrough technologies for the world at scale and the speed that is required to be the world's largest:

- electrolysis (green hydrogen generation) capacity of over 60 GW/5 million tonnes by 2030 for domestic consumption, which will help India meet the 500 GW renewable energy target;
- producer of green steel at 15-20 million tonnes by 2030 — a pioneering effort to make green steel mainstream for the world;
- electrolyser with an annual manufacturing capacity of 25 GW by 2028 delivering affordable ones for India and the world; and
- producer of green ammonia for exports by 2030 helping India's allies to decarbonise, this may require up to 100 GW of green hydrogen.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The Green Hydrogen Mission primarily aims to decarbonise industrial, mobility and energy sectors; and supports

pilot projects in emerging end-use sectors and production pathways. The industry sectors where clean hydrogen may displace fossil fuels in India, subject to pilot trials, include:

- Refinery
- Iron ore and steel
- Nitrogenous fertilizers
- Petrochemicals production
- Fuel Cell Electric Vehicles (FCEVs) and Battery Electric Vehicles (BEVs)
- Power generation

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

For now, the Green Hydrogen Policy and the Green Hydrogen Mission only support the development of Green Hydrogen.

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

For now, there is no specific policy which supports the development of low-carbon hydrogen. While the GoI has announced the National Hydrogen Mission, it has not, so far, communicated a clear ambition for low-carbon hydrogen deployment. Further, the Green Hydrogen Policy focuses on Green Hydrogen and Green Ammonia.

6. Are there targets for the production of hydrogen?

India's target is to develop green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country by 2030.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The Green Hydrogen Mission provides various incentives including the ones stated below, in order to support the establishment of Green Hydrogen ecosystems:

- Under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Programme, two distinct financial incentive mechanisms will be provided targeting domestic manufacturing of electrolyzers and production of Green Hydrogen. INR 174.9 Billion (approx. USD 2.14 Billion) has been set aside for the SIGHT Programme.
- Support to pilot projects in emerging end-use sectors and production pathways. INR 14.66 Billion (approx. USD 180 Million) has been set aside for such pilot projects.

Further, it is expected that the GoI will bring in a production-linked incentive (PLI) scheme in the coming months to give impetus to [manufacturing](#) green hydrogen and its key component electrolyser.

The Green Hydrogen Policy issued by the Ministry of Power, GoI provides amongst others, the following benefits:

- Manufacturers of Green Hydrogen or Green Ammonia are allowed to purchase renewable power from the power exchange or set up renewable energy capacity themselves or through any other developer. The open access for sourcing renewable energy will be granted within 15 days of receipt of application. The unconsumed renewable power can be banked up to 30 days with the distribution company and can be taken back when required.
- Distribution licensees can also procure and supply renewable energy to the manufacturers of Green Hydrogen or Green Ammonia in their States at concessional prices which will only include the cost of procurement, wheeling charges and a small margin as determined by the State Commission.
- Waiver of inter-state transmission charges for a period of 25 years will be allowed to the manufacturers of Green Hydrogen and Green Ammonia for the projects commissioned before 30th June 2025.
- The renewable energy plant which manufactures Green Hydrogen or Ammonia will be given connectivity to the grid

on priority basis to avoid any procedural delays.

- Manufacturers of Green Hydrogen or Green Ammonia will be allowed to set up bunkers near Ports for storage for exports/use by shipping, at applicable charges by the Port Authorities.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

While the National Hydrogen Mission document contains a comparative paragraph on three categories of hydrogen i.e. grey hydrogen, blue hydrogen and green hydrogen, renewable hydrogen has been defined as 'Green Hydrogen/ Green Ammonia' in the Green Hydrogen Policy and the GoI through the Green Hydrogen Mission plans to develop a robust standards and regulations framework. Currently there is no specific set of definitive standards for classification and/or certification of blue hydrogen.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The Green Hydrogen Policy provides certain details with respect to production, storage, transportation and supply of hydrogen, such as:

Production:

- Green Hydrogen / Green Ammonia (Hydrogen /Ammonia) should be produced from biomass and by electrolysis of water using renewable energy, including renewable energy which has been banked, and from a co-located renewable energy plant, or sourced from a remotely located renewable energy plants.
- Land in renewable energy parks can be allotted for the manufacture of Green Hydrogen/ Green Ammonia.
- The GoI proposes to set up manufacturing zones, and Green Hydrogen / Green Ammonia production plants can be set up in such manufacturing zones.

Storage:

- Manufacturers of Green Hydrogen / Green Ammonia would be allowed to set up bunkers near Ports for storage of Green Ammonia for export / use by shipping at applicable charges.

Transportation:

- Connectivity to the ISTS for Renewable Energy capacity set up for the purpose of manufacturing Green Hydrogen / Green Ammonia would be granted on priority under the Electricity (Transmission system planning, development and recovery of Inter State Transmission charges) Rules 2021.
- The waiver of inter-state transmission charges would be granted for a period of 25 years to the producer of Green Hydrogen and Green Ammonia from the projects commissioned before 30th June 2025.

Banking:

- Banking would be permitted for a period of 30 days for Renewable Energy used for making Green Hydrogen/ Green Ammonia.
- The charges for banking would be as fixed by the State Commission which should not be more than the cost differential between the average tariff of renewable energy bought by the distribution licensee during the previous year and the average market clearing price (MCP) in the Day Ahead Market (DAM) during the month in which the Renewable Energy has been banked.
- In order to achieve competitive prices, Ministry of New and Renewable Energy (MNRE) may aggregate demand from different sectors and have consolidated bids conducted for procurement of Green Hydrogen/Green Ammonia through any of the designated implementing agencies.

Compliance:

- Renewable Energy consumed for the production of Green Hydrogen / Green Ammonia shall count towards Recruitment Process Outsourcing (RPO) compliance of the consuming entity. The renewable energy consumed

beyond obligation of the producer would count towards RPO compliance of the Distribution Company (DISCOM) in whose area the project is located.

- Distribution licensees may also procure and supply Renewable Energy to the manufacturers of Green Hydrogen / Green Ammonia in their States. In such cases, the distribution licensee should only charge the cost of procurement as well as the wheeling charges and a small margin as determined by the State Commission.
- MNRE will establish a single portal for all statutory clearances and permissions required for manufacture, transportation, storage and distribution of Green Hydrogen /Green Ammonia. The concerned agencies/authorities will be requested to provide the clearances and permissions in a time-bound manner, preferably within a period of 30 days from the date of application.

Further, per the Hydrogen Mission, a robust standards and regulations framework is to be developed soon to support the establishment of Green Hydrogen ecosystems. Further, an enabling policy framework will also be developed.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

The Foreign Direct Investment Policy of India allows 100% investment under automatic route in following activities:

- exploration activities of oil and natural gas fields;
- infrastructure related to marketing of petroleum products and natural gas;
- marketing of natural gas and petroleum products, petroleum product pipelines, natural gas/pipelines;
- LNG regasification infrastructure; and
- market study and formulation and petroleum refining in the private sector, subject to the existing sectoral policy and regulatory framework in the oil marketing sector and the policy of the Government on private participation in exploration of oil and the discovered fields of national oil companies.

Further, upto 49% equity investment under automatic route is allowed for activities such as Petroleum refining by the Public Sector Undertakings (PSU), without any disinvestment or dilution of domestic equity in the existing PSUs.

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

India is a signatory to 7 bilateral investment treaties (BITs) that are in force as on 10 January 2023, and in addition certain other treaties may contain protections for investors in India. These can be accessed from [UNCTAD's Investment Policy Hub](#).

India is neither a member nor an observer of the Energy Charter Treaty, therefore, protection to international investors follow international recommendations and consensus such as by the OECD, UNCTAD, and WTO.

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

The Green Hydrogen Mission provides INR 197.4 Billion (approx. USD 2.4 Billion), including an INR 174.9 Billion (approx. USD 2.14 Billion) for the SIGHT programme, INR 14.66 Billion (approx. USD 180 Million) for pilot projects, INR 4 Billion (approx. USD 48.7 Million) for R&D, and INR 3.88 Billion (approx. USD 47.3 Million) towards other mission components.

Further, the Ministry of Petroleum & Natural Gas has a Hydrogen Corpus Fund (HCF) and this fund participates in funding R&D projects which are led by the oil industry. Among the projects currently being funded are for finding multiple pathways for production of hydrogen, H-CNG, and hydrogen production through decomposition of natural gas.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

On 20 April 2022, the Ministry of Petroleum and Natural Gas, GoI notified that Oil India Limited (OIL) has commissioned India's first 99.999% pure Green Hydrogen pilot plant, with an installed capacity of 10 kg per day at its Jorhat Pump Station in Assam.

Further, on 30 July 2022, Prime Minister of India participated in the Ujjwal Bharat Ujjwal Bhavishya- Power @2047 Programme and launched a pilot project named "the Green Hydrogen Mobility Project" at Leh, Ladakh, for five fuel cell buses to run in and around Leh. This pilot project would be the first deployment of FCEVs for public use in India. Further, the "Green Hydrogen Blending Pilot Project" was also launched at NTPC Kawas Township as India's first green hydrogen blending project helping in reducing the usage of natural gas.

The Ministry of Petroleum and Natural Gas on its website has further listed pilots based on green hydrogen which are being planned. The below listed pilots are in preliminary stages and the modalities are being worked on to achieve its purpose.

- Two pilot for setting up of solar hydrogen refuelling stations at two locations- for demonstration of fuel cell vehicles at tourist sites like Delhi-Agra, Gujarat (Statue of Unity) etc.
- One pilot for setting up a green hydrogen plant to explore an opportunity of replacing conventional hydrogen in refinery to green hydrogen.
- One pilot for production of green hydrogen and its blending with CNG at an appropriate site in Rajasthan for dispensing at retail outlets.
- One pilot for setting up of green hydrogen infrastructure and pipeline injection of green hydrogen in City Gas Distribution (CGD) network.

Further, under the Ministry of Road Transport & Highways, Toyota Kirloskar Motor Pvt. Ltd. along with International Centre for Automotive Technology (ICAT) conducted a pilot project to study and evaluate the world's most advanced FCEV Toyota Mirai which runs on hydrogen, on Indian roads and climatic conditions. This was a first of its kind project in the country aimed at spreading awareness about Hydrogen, FCEV technology and disseminating its benefits to support hydrogen-based society for India. Union Minister of Road Transport & Highways, GoI inaugurated this pilot project on 16 March 2022.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are a few existing commercial-scale clean hydrogen production projects in India, and there are a number of projects in the pipeline, at different stages of development, including the following:

- Larsen & Toubro's (L&T) Green Hydrogen Plant in Hazira, Gujarat produces 45 Kg of Green Hydrogen daily and L&T in January 2023 announced it has signed an agreement with the Norway-based H2Carrier to develop floating green ammonia projects for industrial-scale applications.
- Adani New Industries Ltd (ANIL) announced that it has partnered with France's Total Energies SE to invest USD 50 billion over the next 10 years in India to produce green hydrogen and develop an ecosystem around it.
- Reliance Industries Limited (RIL) has signed a preliminary agreement with Government of Gujarat to invest INR 5.95 Trillion (USD 72.6 Billion) over the span of 10 to 15 years to set up 100 GW renewable energy power plant and green hydrogen eco-system development.
- Indian Oil Corporation Ltd. (IOCL) is going to set up subsidiary to house its green energy businesses and is setting up green hydrogen plants at its Panipat and Mathura refineries.
- Chennai Petroleum Corporation, a subsidiary of IOCL, has recently issued an EOI for the design, manufacturing and commissioning of the electrolyser and related items for the production of green hydrogen at its refinery at Manali in Chennai.
- Greenko Group announced that India will for the first-time export green energy from 2025, with the first shipments going to a Singapore power plant as it signed an MoU with Singapore's Keppel Infrastructure.
- GAIL announced that it has awarded a contract to set up one of the largest Proton Exchange Membrane (PEM)

electrolyser in India which would be installed at GAIL's Vijaipur Complex, in Guna district of Madhya Pradesh.

- Bharat Petroleum Corporation Ltd. (BPCL) has invited bids and is in the process of installing a 5 MW electrolyser system to set up a green hydrogen production facility in a phased manner in one of its city gas distribution projects.
- Fusion Fuel Green, which has offices in Portugal and Ireland, has signed an agreement with BGR Energy Systems, an engineering, procurement, and construction (EPC) company based in Chennai, India, to install green hydrogen production facilities in Tamil Nadu.

Last updated January 2023.

Indonesia

Policy and regulation

1. Is there a government hydrogen strategy or policy?

There is currently no specific government hydrogen strategy or policy in Indonesia. Instead, hydrogen is classified as “new energy” under [Law No. 30 of 2007 on Energy \(Energy Law\)](#) and [Government Regulation No. 79 of 2014 on National Energy Policy \(Energy Policy\)](#). Hence while there is no specific policy for hydrogen, there is a general policy for new energy sources within Indonesia’s regulatory framework.

In [Presidential Regulation No. 22 of 2017 on National Energy Plan \(Energy Plan\)](#), there is also a general action plan on the utilization of liquified new energy (including hydrogen) for the transportation sector. This sets out the Indonesian government’s plans to:

- develop technology to produce hydrogen and utilize hydrogen for transport;
- develop a hydrogen-fuelled vehicle industry; and
- draft regulations on hydrogen-fuelled vehicles for public and private transportation.

While the government’s strategic direction on hydrogen is not yet concrete, in a press conference in June 2022, the Indonesian Minister of Energy and Mineral Resources, Arifin Tasrif, [stated that hydrogen](#) is expected to be one of the contributors to the energy transition and has an important role in decarbonising the global energy system. This is further illustrated by the government announcing plans to utilize hydrogen for transportation system and industrial sectors in the New Capital City of Nusantara. The Parliament is also drafting a New and Renewable Energy Bill which, [according to announcements](#), is anticipated to provide a clearer framework for new energy, which may include hydrogen.

2. What are key goals and commitments included in the strategy/policy?

As set out in Point 1, the Indonesian government does not yet have a specific hydrogen policy or strategy. However, there are plans for the use of hydrogen in relation to hydrogen-fuelled vehicles and using hydrogen to contribute to the energy transition.

Hydrogen-fuelled vehicles

As stated above, the Indonesian government has plans to utilize hydrogen in the transportation sector. Based on the Energy Plan, these plans are to be carried out by the Ministry of Transportation, the Ministry of Energy and Mineral Resources (MEMR), Ministry of Industry and the Ministry of Research and Technology. The government aims for the outcomes of the Energy Plan to be achieved by 2050.

Energy Transition

In general, the Energy Law provides for the prioritization of new and renewable energy. This is consistent with the goals expressed in other laws such as [Law No. 30 of 2009 on Electricity, as amended by Law No. 11 of 2020 \(Electricity Law\)](#), which states that utilization of primary energy sources must be performed by prioritizing new energy and renewable energy sources.

Pursuant to the Energy Policy, Indonesia aims for at least 23% of its energy mix to consist of new and renewable energy by 2025, provided that this is economically feasible. As of June 2022, the share of new and renewable energy in [Indonesia’s energy mix was 12.8%](#).

3. Which industry sectors are most likely to be affected by hydrogen deployment?

Numerous sectors in Indonesia including transportation, industrial manufacturing, heat, and power generation may use hydrogen.

Hydrogen deployment is expected to be most prevalent in Indonesia’s energy sector as a substitution feedstock to coal for power generation. Coal-fired power plants currently represent [approximately 61%](#) of Indonesia’s installed

capacity. The Indonesian government is now focusing on reducing coal's dominance in the generation mix by retiring coal-fired power plants. In light of this, hydrogen fuel may become an alternative to fossil fuel, especially for companies/industries that are looking to reduce their carbon emissions.

Furthermore, the Directorate General of New and Renewable Energy within MEMR [has stated that the utilization of hydrogen](#) will primarily be used for internal combustion technology commonly used by motorized vehicles in Indonesia and will support Indonesia's electrical vehicle national programme.

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

Currently, Indonesia's legislation and policies do not distinguish between the types of hydrogen (including blue or green hydrogen). The Energy Policy provides that sources of new energy can come from both renewable and non-renewable energy sources.

Nonetheless, the Indonesian government's policy has recently put more focus on renewable energy sources as a result of Indonesia's commitments under the Paris Climate Agreement (**Paris Agreement**). In an effort to decrease its carbon emissions, Indonesia has a nationally determined contributions (**NDC**) reduction target of 29% (unconditionally) or 41% (conditionally, with international assistance) against the business-as-usual scenario by 2030 in order to meet its Paris Agreement commitments.

In addition, [MEMR has declared](#) that Indonesia will rely on the development of green hydrogen in the future, especially to pursue the decarbonisation of industrial sectors (such as the cement, ceramics and glass industries).

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

There is currently no specific regulation on carbon capture and storage (CCS) in Indonesia. However, there is an increased focus of the Indonesian government on CCS (especially MEMR and certain State-owned Enterprises such as Pertamina, the national oil company) and MEMR is currently preparing a regulation regarding CCS. It has been reported that the regulation will include coverage of the rights of contractors to implement CCS in their work areas, mechanisms for approval and implementation of projects, economic incentives, monitoring, measurement and reporting.

At the 2022 Indonesian Petroleum Convention, [the Director General of Oil and Gas at MEMR, announced](#) that this MEMR regulation is at the harmonization stage with the Ministry of Law and Human Rights and would be issued at the end of 2022. However, this appears to be delayed as the regulation has not yet been issued to date.

CCS is considered by the Government to be one of the main pillars of its strategy to decarbonize especially for sectors where carbon abatement is otherwise limited.

6. Are there targets for the production of hydrogen?

There are currently no specific targets for the production of hydrogen in Indonesia.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are no incentive mechanisms in place specifically for the production of hydrogen. However, [Presidential Regulation No. 112 of 2022 on the Acceleration of Renewable Energy Development for the Supply of Power](#) stipulates certain government incentives which are available for the development of renewable energy. These incentives are applicable in the context of green hydrogen, which is produced using electrical energy from renewable electrical energy.

These incentives include:

Economic Incentives:

- Income tax facilities;
- Import tax facilities (in the form of import duty exemption);
- Land and building tax facilities;

- Financial support/facilities for geothermal development; and
- Financial and/guarantee facilities through state-owned-enterprises appointed by the government.

Non-Economic Incentives:

- Ministry support (which includes the prioritization of renewable energy projects);
- Ease of licensing; and
- Guarantee of land availability from the local government.

Additionally, there are a number of government incentives available for National Strategic Projects which are determined by the Indonesian government (i.e. these are significant projects with a strategic nature part of a scheme by the Government to accelerate growth and improve public welfare and regional development in Indonesia). These incentives include, amongst others, central government guarantee against political risks, waivers of certain regulatory requirements (e.g. local content requirements), easing of licensing processes, support on land acquisition & rights of way, and tax holidays.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are no standards in Indonesia for the classification or certification of low-carbon or renewable hydrogen. However, the Indonesian Government has recently enacted a framework for carbon pricing, a carbon tax and carbon trading which will regulate carbon emissions across a wide range of industries.

One of these regulations is [Ministry of Environment and Forestry Regulation No. 21 of 2022 on the Guidelines for the Implementation of Carbon Pricing](#) which establishes “Carbon Credits” as an instrument for proof of performance of greenhouse gas emissions reduction. Each Carbon Credit represents a greenhouse gas emissions reduction or increase in greenhouse gas absorption which is equal to 1 tonne of CO₂. As such, if an entity reduces its greenhouse gas emissions through the utilization of green hydrogen, it will be eligible to receive Carbon Credits.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

There are currently no specific regulatory requirements or restrictions for the production, storage, transportation or supply of hydrogen in Indonesia.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

As set out in Points 1 and 2, the Indonesian government has plans to utilise hydrogen in the transportation and industrial sectors (such as steel industry, cement, glass and other manufacturing sub-sectors). Pursuant to [Presidential Regulation No. 10 of 2021 on Investment Business Fields, as amended by Law No. 49 of 2021](#), transport and industrial manufacturing are 100% open to foreign investment, with the exception of sea transportation and domestic commercial air transportation (both of which are restricted to a maximum of 49% foreign ownership).

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Indonesia has not ratified any specific international treaty pertaining to hydrogen. Indonesia’s commitments to energy transition are embodied through its ratification of the Paris Agreement under the United Nations Framework Convention on Climate Change through [Law No. 16 of 2016](#).

Additionally, [Indonesia has entered into several Bilateral Investment Treaties](#) (BIT) to promote greater investment flows between Indonesia and other countries, and to set out standards of protection for investments made in Indonesia by foreign investors. As of January 2023, Indonesia had BITs in place with Singapore, UAE, Russia, Denmark, Finland, Iran, Saudi Arabia, Venezuela, Qatar, Mozambique, Czech Republic, Thailand, Bangladesh, Cuba, Syrian Arab Republic, Morocco, Mauritius, Mongolia, Jordan, Uzbekistan, Sri Lanka, Ukraine, Poland, Sweden, Tunisia, and the Republic of Korea.

These BITs may contain protections for international investors which include; the guarantee of fair and equitable treatment, physical security within the territory of Indonesia, protection from unwarranted expropriation or dispossession, and compensation for losses owing to war or other armed conflict.

In addition to BITs, [Indonesia is party to a number of investment-related intergovernmental agreements](#) such as the Agreement on Trade-Related Investment Measures (TRIMs), the General Agreement on Trade in Services (GATS) and the Multilateral Investment Guarantee Agency (MIGA) Convention. These agreements provide for, amongst others, fair treatment of investment, transparency in the trade system and protection against political risks.

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

Please refer to Point 7 above.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

The following projects are currently under development in Indonesia:

- [East Sumba hybrid project](#): A green hydrogen hybrid project with solar and wind power generation is currently being developed in East Sumba (NTT province) by Hydrogène de France and US International Development Finance Corporation.
- [Ulubelu pilot project](#): A green hydrogen fuel project being developed by Pertamina. The project aims to produce green hydrogen fuel from the Ulubelu geothermal working area with Pertamina's own Refinery Unit III Plaju as the offtaker.

As set out in Point 1, the government of Indonesia has also expressed its intention to utilize hydrogen energy in the New Capital City of Nusantara. However, no formal plans have been published to date.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Indonesia.

Last updated January 2023

Ireland

Ashurst collaborated with Arthur Cox LLP in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

There is no specific hydrogen strategy or policy currently in place in Ireland, however the Government committed to publish a policy/regulatory roadmap for green hydrogen use in the natural gas grid during the course of 2023 in its [Climate Action Plan 2021](#).

There is also a Private Members' Bill before Parliament (the Green Hydrogen Strategy Bill 2022), which would require the government to draft and publish a hydrogen strategy within six months of the Bill being enacted. The Bill is transitioning through the legislative process but has not yet been enacted.

2. What are key goals and commitments included in the strategy/policy?

A policy / regulatory roadmap is anticipated in the near term. However, goals and targets developed to date which are specific to hydrogen are set out in:

- [Ireland's Climate Action Plan 2021](#);
- [Gas Network Ireland's \(GNI\) Ten Year Development Plan 2021 \(TYNDP\)](#); and
- [Ireland's National Energy and Climate Action Plan 2021-2030 \(NECP\)](#).

In Ireland, the key objectives and commitments indicated in the Climate Action Plan and the TYNDP align with EU policy and it is anticipated that hydrogen will play a significant role in achieving Ireland's decarbonisation goals. Beyond 2030, it is anticipated that the gas network in Ireland can be fully decarbonised by utilising hydrogen and in the interim, hydrogen could be in the network in low blended volumes. Ireland intends to align with the EU Hydrogen Strategy and EU Energy System Integration Strategy.

Ireland signed the EU Hydrogen Initiative by which signatories commit to continue research and investment in the production and use of hydrogen as a future-oriented technology.

In relation to power generation, Ireland has set a high renewable energy target (80% of electricity demand to be met by renewables by 2030) and the Government has committed to identifying a path to deliver 1-3 TWh of zero emissions gas, including green hydrogen. Accommodating this volume of renewable capacity on a small island system will require investment in transmission infrastructure and significant investment in interconnection and storage. In this context, green hydrogen is seen as part of an integrated energy system in terms of providing back-up for intermittent renewables, seasonal storage of renewable energy, and ensuring security and resilience in energy suppliers.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The Climate Action Plan 2021 envisages that hydrogen will have a role in decarbonising:

- power generation;
- heating;
- industry; and
- transport (particularly public transport, road freight, shipping and aviation).

4. Who are the main regulators for the hydrogen market?

The Commission for Regulation of Utilities ("CRU") is the regulatory authority in the energy sector in Ireland. The *Gas Act 1976* transposes EU Directive 2009/73/EC on the internal market in natural gas including the requirements in relation to third party access to the gas system and powers and functions of the CRU. Powers and functions of the

CRU in relation to gas markets and gas safety are also provided for in the *Electricity Regulation Act 1999* and the *Gas (Interim) (Regulation) Act 2002*. Functions include advising the Minister on the development of the gas industry and regulating the development of natural gas undertakings with respect to safety. In carrying out certain duties (under section 9(3) of the *Electricity Regulation Act 1999* and Directive 2009/73/EC), the Minister and Regulator shall have regard to the need to “integrate large and small scale production of ... gas from renewable resources ... in networks ... in the most cost effective way”.

The national regulator responsible for health and safety of workers and those affected by work activity is the Health and Safety Authority (“HSA”). Under the Dangerous Substances (Flammable Liquids and Fuels Distribution and Commercial Supply Stores) Regulations 2019, which apply to the keeping, conveying, loading and unloading of dangerous substances (including hydrogen), the HSA is the appeals authority in relation to licence applications for retail stores.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

There is no express distinction under Irish law between green hydrogen and blue hydrogen, however the focus to date appears to be on green hydrogen.

Ireland’s NECP states that, to decarbonise fully, it is vital to prioritise the development of green hydrogen. The use of blue and grey hydrogen are also contemplated however, the focus in subsequent policy documents is increasingly on the role that zero-emissions gases, in particular green hydrogen and biomethane, can play in net zero emissions by 2050.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

There is currently no specific regime or policy in place in Ireland in relation to carbon capture and storage (CCS).

However, Ervia, the gas network operator in Ireland, is currently undertaking a CCS feasibility study and certain policies have referred to CCS, namely:

- Ireland’s NECP states that blue hydrogen can only be acceptable where there is full capture and storage of the resulting carbon, while grey hydrogen without carbon capture could not be considered to be acceptable in the transition to a fully decarbonised energy system; and
- one of the actions listed in Ireland’s Climate Action Plan includes to “examine and oversee the feasibility of the utilisation of Carbon Capture and Storage in Ireland”, with a number of steps identified that are to be taken between 2021 and 2024.

7. Are there targets for the production of hydrogen?

The Government commits in the Climate Action Plan 2021 to identifying a path to deliver by 2030 1-3 TWh of zero emissions gas, including green hydrogen.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are currently no express incentives in place however, several instruments provide support which may indirectly promote the production of hydrogen:

- the Accelerated Capital Allowance is a tax incentive scheme which promotes investment in energy efficient products and equipment and in 2022 there was an expansion of the relief for investment in hydrogen powered vehicles and refuelling equipment;
- the Alternatively Fuelled Heavy-Duty Vehicle Purchase Grant was introduced in 2021 which aims to promote the decarbonisation of the heavy duty sector and to assist market participants in the transport industry to transition from fossil fuels;
- the CNG Vehicle Grant Scheme is administered by Gas Networks Ireland and assists Irish fleet operators in the purchase of new CNG vehicles; and
- the Department of the Environment, Climate and Communications consulted on the introduction of a Renewable

Heat Obligation in 2021 under which it was proposed that electricity supplied for heat from renewable sources would not be subject to the obligation and it was proposed that use of green hydrogen would be given a double credit.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are no existing standards in place for the classification of hydrogen. However, Gas Networks Ireland is actively working with standards authorities to develop Irish and European gas infrastructure standards for hydrogen and hydrogen blends in existing gas networks.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

There is no specific regulatory framework in Ireland for hydrogen, although hydrogen is likely caught by certain existing regulatory regimes.

The definition of “natural gas” in the *Gas Act 1976* would, subject to certain technical criteria being met, include hydrogen. This means that the existing regulatory regime that applies to gas in Ireland would also apply to hydrogen i.e. the transmission, distribution and supply of hydrogen by pipeline would require a licence.

The storage of hydrogen in Ireland is subject to all applicable health & safety legislation.

In relation to the transportation of hydrogen, existing European Union legislation includes hydrogen within the definition of alternative fuels and such legislation regulates the operation of public hydrogen refuelling points to ensure compliance with EU standards.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Ireland does not currently have any restrictions on foreign direct investment. However, the Government has signalled its intention to prepare legislation to give effect to EU legislation which establishes a framework for the screening of foreign direct investments into the European Union on grounds of security or public order. Economic activity in Ireland must also comply with EU sanctions law.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Ireland is a party to a number of international treaties with investment provisions (including Co-Operation Agreements with various countries internationally). The United Nations Conference on Trade and Development lists a number of treaties with investment provisions that Ireland is a signatory to and which are in force.

Ireland is also a signatory to the Energy Charter Treaty, a multilateral investment treaty which entered into force in April 1998 and specifically addresses energy trade, transit and investment between its contracting parties.

Ireland currently has no bilateral investment treaties in force as the EU has competence in this area on behalf of Member States.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

Gas Networks Ireland has a Gas Innovation Fund of €4.17 million that is available to applicants. This consists of an innovation allowance of €1 million for research and €3.17 million for strategic projects. The key priorities that drive the Gas Innovation Fund are: (i) increasing throughput through the gas system; (ii) assisting in the transition to a low carbon economy; (iii) delivering significant carbon savings; and (iv) providing measurable value to all gas customers.

The Government in Ireland consulted in 2022 on application of Ireland's share of the EU Just Transition Fund, which may be used, among other things, to develop systems and infrastructure for clean energy. The European Investment

Bank has also made €3.4 billion available to help accelerate the shift towards renewable energy and sustainable transport and €2 billion of this will be invested in a number of projects across Europe, including wind power in Ireland and building pioneering PV plant using batteries and hydrogen.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

Gas Networks Ireland indicates that it is active in a number of European gas organisations assessing the readiness of existing gas networks to carry hydrogen and blends of natural gas and hydrogen, and that there is increasing confidence in the ability of the existing distribution networks to carry up to 100% hydrogen.

Gas Network Ireland indicates in the TYNDP that it has started to receive connection enquiries from prospective renewable hydrogen producers and is actively engaging with these producers. It states that has begun work packages to prepare the network to transport hydrogen, and the development of a hydrogen technical strategy, intended as a road map for the business to transition to hydrogen.

Gas Networks Ireland also collaborates with academic institutions researching the potential role of hydrogen in Ireland, including the GenComm project led by Belfast Metropolitan College, the aim of which is to produce renewable hydrogen for supply to buses in Belfast. Gas Networks Ireland also participates in project HyLight, which aims to provide tools to guide the cost-effective and sustainable large-scale implementation of hydrogen technologies.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

Projects under development include the following:

- The Green Connect Project aims to provide additional infrastructure to the national compressed natural gas refuelling network along the Core TEN-T road network, to include four renewable gas injection facilities;
- The H-Wind project is intended to advance the production of green hydrogen from offshore wind farms. It is led by the UCC MaREI Research Centre and co-funded by Science Foundation Ireland, Gas Networks Ireland, DP Energy, ESB, and Equinor ASA;
- EI-H2 announced plans to develop €120 million green hydrogen facility comprising a 50MW electrolysis plant at Aghada, Co. Cork;
- ESB and dCarbonX signed a Memorandum of Understanding for the joint assessment and development of Irish offshore green hydrogen subsurface storage; and
- SSE Renewables and Siemens Games Renewable Energy signed a Memorandum of Understanding in 2021 to explore the opportunity to produce and deliver green hydrogen through electrolysis using energy from two onshore windfarms in Scotland and Ireland.

Last updated December 2022

Italy

Policy and regulation

1. Is there a government hydrogen strategy or policy?

To date, Italy has not adopted a hydrogen strategy. However, the "[National Hydrogen Strategy Guidelines](#)" have been published, setting out the Italian Government's vision of the role of hydrogen in the context of the national decarbonisation pathway in accordance with the European Union's Hydrogen Strategy and the EU's broader environmental agenda.

Moreover, hydrogen is the subject of attention of both the national integrated energy and climate plan ([Piano Nazionale Integrato Energia e Clima](#) – hereinafter the "PNIEC") and the national recovery and resilience plan ([Piano Nazionale Ripresa e Resilienza](#) – hereinafter the "PNRR").

In order to meet the 2050 coal phase-out targets set by the European Green Deal, in December 2019 Italy adopted the PNIEC, which includes the goal of reducing emissions by 55% by 2040 and further increasing the use of energy production sources from renewable sources. To achieve the energy transition objectives, the PNIEC expressly promotes the production and use of hydrogen produced from renewable electricity, starting with research, development and demonstration activities.

In addition, the PNRR has allocated €3.19 billion for the development of hydrogen with the presence of two reforms and six investment lines.

2. What are key goals and commitments included in the strategy/policy?

According to the Guidelines for the National Hydrogen Strategy, in line with the European Hydrogen Strategy released by the EU in July 2020, hydrogen is uniquely positioned to contribute to national environmental goals and safer, more reliable energy production, especially when produced from renewable energy sources through electrolysis.

In particular, hydrogen can play a dual role in Italy:

- in the long term, up to 2050, it can support the decarbonization effort along with other low-carbon technologies, especially in hard-to-abate sectors; and
- in the short term, up to 2030, hydrogen will become progressively competitive in selected applications, enabling the development of a national hydrogen ecosystem, which is necessary to fully exploit hydrogen's potential over the long term.

For the next decade, the Government envisions the application of hydrogen in the transportation sector, particularly heavy-duty, in railways, and in industry, with specific reference to those segments where hydrogen is already used as a feedstock. The blending of hydrogen into the gas grid can be used to anticipate and stimulate the growth of the hydrogen market.

Since clean hydrogen is a key part of the government's decarbonisation strategy, to kick-start the development of the hydrogen market, the government plans to install about 5 GW of electrolysis capacity by 2030.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

According to the Guidelines for the National Hydrogen Strategy, the Government anticipates that the sectors most affected by hydrogen development will be:

- hard-to-abate sectors, such as energy-intensive manufacturing processes, steelmaking, or aviation;
- transport sector, in particular heavy duty (e.g. long-haul trucks) and railways;
- industrial sector, with specific reference to those segments where hydrogen is already used as a raw material, for example in the chemical sector and in oil refining.

4. Who are the main regulators for the hydrogen market?

The main Italian regulators for hydrogen market are:

- The Ministry for the ecologic transition;
- The Ministry for the economic development
- The Italian Energy Authority (ARERA)
- The GSE (the Authority in charge in case of public incentives)

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

To kick-start the development of the hydrogen market, the Government plans to install about 5 GW of electrolysis capacity by 2030 to meet part of the demand.

Therefore, the focus seems to be substantially on green hydrogen. However, the Guidelines for the National Hydrogen Strategy also clarifies that domestic production of green hydrogen could be supplemented with imports - where the country's location could be exploited as a hub for hydrogen trade - or with other forms of low carbon hydrogen, such as blue hydrogen.

The PNRR only mentions green hydrogen. This is something that is being debated and will reasonably be better understood in the near future based on the adoption of the National Hydrogen Strategy.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

Given that the actual regulatory framework (mainly the Guidelines for the National Hydrogen Strategy and PNRR) focus on green hydrogen, currently there is no specific strategy or policy supporting the development of low-carbon hydrogen (i.e. blue hydrogen).

7. Are there targets for the production of hydrogen?

The minimum target for the development of traditional gas transmission networks also for the transport of hydrogen is indicated by the MISE, which stipulate that by 2030 an average of up to 2% of distributed natural gas can be replaced by hydrogen.

To kick-start the development of the hydrogen market, the government plans to install around 5 GW of electrolysis capacity by 2030.

Please also note that the art. 23 of Law Decree no. 36 of 30 April 2021, as converted with amendments by Law no. 79 of 29 June 2022 establishes:

“the consumption of electricity from renewable sources in plants of electrolysis for the production of green hydrogen, even if the production plant and the electrolysis plant are connected through a grid with compulsory connection of a third party, is not subject to the payment of general system charges system referred to in Article 3(11) of Legislative Decree no. 79 of 16 March 1999.

Within 60 days of the date of entry into force of the present decree, a decree of the Minister for the ecological transition (“MITE”) shall identify the cases and the technical conditions details to the occurrence of which paragraph 1 (above) shall apply. With the same decree shall also establish the modalities by which the Regulatory Authority for ((energy, networks)) and the environment shall provide for to implement the provisions referred to in paragraph 1, without new or greater burdens on the public finance.

Hydrogen produced pursuant to paragraph 1 is not included among the energy products referred to in Article 21 of the Consolidated Text ((...)) of referred to in Legislative Decree no. 504 of 26 October 1995, and is not subject to excise duty pursuant to the same Consolidated Text if not directly used in heat engines as fuel”

In implementation of the provisions of Article 23, paragraph 2 (quoted above) of Decree Law no. 36 of 30 April 2022, the MITE Decree of 21 September 2022 identifies the cases and technical conditions under which the consumption of electricity from renewable sources in electrolysis plants for the production of green hydrogen can access the benefits under art.4 (i.e. the derogation from payment of the variable portion of the general charges relating to the electricity system referred). In particular, those entities, whether public or private, in relation to their annual consumption of

electricity from renewable sources used for the production of green hydrogen, in accordance with the provisions of articles 3 and 4 of the MITE Decree, are eligible for the benefits of this Decree.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Currently there are no incentive mechanisms in place. The Guidelines for the National Hydrogen Strategy provides that in order to kick-start the low-carbon hydrogen economy in Italy and meet the hydrogen penetration demand target, up to €10 billion of investment will be required between 2020 and 2030 (to which investments for renewable deployment should be added). This figure includes: (i) Investment needed for hydrogen production, €5-7 billion; (ii) Investment in hydrogen distribution and consumption facilities (hydrogen trains and trucks, refuelling stations, etc.), €2-3 billion; (iv) Investment in R&D, €1 billion; and (v) Some investment in infrastructure (such as gas networks) to properly integrate hydrogen production with end uses.

The PNRR approved by the Italian government has allocated €3,19 billion for the following hydrogen aspects: (i) production of hydrogen in industrial areas no longer in use; (ii) use of hydrogen in hard-to abate sectors; (iii) experimentation of hydrogen in local transport; (iv) experimentation of hydrogen in rail transport; (v) R&D on hydrogen sector; (vi) simplification of the regulatory framework; (vii) promotion of the competitiveness of hydrogen.

We are therefore awaiting the issuing of the National Hydrogen Strategy and the concrete application of the lines of investment envisaged in the PNRR.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

Also in relation to hydrogen, Legislative Decree no. 199 of 8 November 2021 provides for the issuance of Guarantees of Origin (GO) in application of, and in accordance with, CEN - EN 16325 standards. The sole purpose of the GO is to demonstrate to final customers the amount of energy from renewable sources in an energy supplier's energy mix as well as that supplied to consumers under renewable energy agreements.

Further regulatory developments are expected at European level, aimed at better regulating the technical aspects pertaining to hydrogen.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

Legislative Decree no. 199 of 8 November 2021, among the other things, provides for the regulation and simplification for the construction and operation of electrolyzers. In particular, in terms of procedural simplifications, it is provided that the construction of electrolyzers with power less than or equal to the threshold of 10 MW does not require the issuance of a specific permit (free-building activities). For other types of electrolyzers, a more structured authorization regime is envisaged, but in any case unified (single authorisation), again with a view to simplification.

Furthermore, Art. 23 of Decree-Law no. 36 of 30 April 2022 provides that the consumption of electricity from renewable sources in electrolysis plants is not subject to the payment of system charges (i.e. those charges established by the Italian Electricity and Gas Authority – ARERA - to cover the costs relating to activities of general interest for the electricity or gas system paid by end customers).

Finally, it should be noted that Article 21 of Legislative Decree No. 505 of 26 October 1995 exempts green hydrogen from the application of excise duty since it is not included among energy products (provided that it is not used directly as fuel in heat engines).

The regulatory framework can still be defined as immature and it is reasonable to expect in the short term further regulations aimed at defining in a more detailed manner, also from a technical point of view, the production, storage, transportation and supply of hydrogen.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Yes, such restrictions are provided under the Golden Power regulation, which refers to the special power of the Italian government to limit or stop (i) foreign direct investments and (ii) corporate transactions involving Italian strategic assets.

The Golden Powers provisions specify that the Italian Government shall review transactions concerning Italian public and private companies which, inter alia, hold “assets having strategic relevance” in the energy, transport and communication sector.

This would require notifying the Italian Government of the details of the transaction. The Government may, within 45 business days of such notification (unless this term is extended should further information be required), determine if it considers the assets as being strategic and accordingly exercise certain special powers which may result in imposition of sector specific conditions or, in extreme cases, in the veto to the transaction, if it determines that such steps are necessary for the protection of the essential interests of the State, or the protection of security and public order.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website reports a total of 102 Bilateral Investment Treaties (hereinafter the “BITs”) that Italy has entered into, many of which are in force and those in force are with non-EU countries. In addition certain other treaties may contain protections for investors in Italy (a full list can be [accessed at the site](#)).

European investors can instead rely on future investment protection on domestic law and domestic courts of the EU member states, as well as EU law and potentially the European Court of Justice in order to enforce their rights. Italy has terminated all of its BITs with other EU member states several years ago. Moreover, the European Commission has stated that intra-EU BITs are incompatible with European law since all Member States are subject to the same rules on cross-border investments, such as freedom of establishment and of capital, thus implying that any rights conferred by intra-EU BITs on a bilateral basis to investors of some Member States constitute nationality-based discrimination.

A mention needs to be made to the Energy Charter Treaty (hereinafter the “ECT”), entered into force in April 1998 and specifically addressing energy trade, transit and investment between its contracting parties, which included Italy. Italy withdrew from the ECT with effect as of 1st January 2016. A sunset clause provided in the same ECT extends the validity of the ECT for 20 years after the effective withdrawal date (i.e. until 1st January 2036) but only for investments made prior to the withdrawal date. The ECT cannot be invoked to seek protection of investments made in Italy in the energy sector after the withdrawal date.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

The PNRR foresees funds dedicated to hydrogen of over €3 billion, with investment lines linked to the use of hydrogen in the hard-to-abate, road and rail sectors, as well as for the creation of hydrogen valleys (i.e. industrial areas with an economy based fundamentally on hydrogen).

The Minister of Ecological Transition (Ministero della Transizione Ecologica - MITE), on 23 December 2021, issued a Ministerial Decree in order to implement the investment in research and development on hydrogen, provided within the PNRR, with the allocation of €110 million. The investment aims to support research and development activities focused on hydrogen in the following areas:

- production of clean and green hydrogen;
- innovative technologies for storage and transport of hydrogen and its transformation into derivatives and e-fuels;
- fuel cells for stationary and mobility applications; and
- integrated intelligent management systems to increase the resilience and reliability of intelligent hydrogen infrastructures.

Further actions related to the use of resources provided by the PNRR in the hydrogen sector are expected in the coming months.

Further resources can be granted by the Innovation Fund and the National Operational Plan (Programma Operativo Nazionale - PON) 2021-2027, and then allocated at local level by involving the relevant regional bodies. Finally, resources from the Important Projects of Common European Interest (Importanti progetti di Comune Interesse

Europeo - IPCEI) could also be used to support the large-scale industrial development of green hydrogen projects.

The Italian government has also identified a number of funds for the period of 2020 - 2021. The funds available are the Sustainable Development Fund (Fondo Crescita Sostenibile - FCS), the Law-Decree of 14 August 2020, no. 104, and Mission Innovation, composed of funds for research and funds for enterprises.

Between 2022 and 2033, additional funds will be available: National Electricity System Research (Ricerca di Sistema Elettronico Nazionale), CleanTech Fund, and Development and Cohesion Fund (Fondo per lo Sviluppo e la Coesione - FCS). Like the European funds, part of the national resources could be invested in green hydrogen projects.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

For the next few years, the goal in Italy is to develop the application of hydrogen in transport, railways and industry sectors.

A number of small-scale pilot projects are also planned in other sectors, e.g. biological methanation or secondary steelmaking sites and in the electrolyser sector.

It appears that Enel and Eni are working together on two pilot projects to supply green hydrogen to refineries identified by the oil group, a joint note announced.

In general, tender notices have recently been issued for PNRR projects. Some of these are related to the promotion of green hydrogen.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

In Italy, according to ENTSOG association (European Network of Transmission System Operators for Gas), five projects concern integrated systems for the production, transport and use of hydrogen, while four concern the final use of the vector. Such projects include:

- the [European Blue Dolphin project](#) involving the company Fincantieri, which envisages the construction of up to 50 hydrogen-powered vessels;
- the [DIVINA project](#) with which the companies Snam, RINA and Bormioli aim to introduce hydrogen into the glass industry cycle;
- the [H2iseO project](#) for a railway hydrogen valley in Valcamonica, the hydrogen road refuelling plant in Bolzano, realised by IIT and Autostrada del Brennero;
- the [Silver Frog project](#), promoted by the companies Hydrogenics, Meyer Burger, EcoSolifer, SolarPower Europe, European Energy and aimed at installing 10 GW of electrolysis capacity to produce green hydrogen from solar energy in northern Italy and distribute it through special pipelines to the chemical industry;
- a project (already completed) by Snam, which used a [10% mixture of methane and hydrogen to power a pasta factory in Contursi](#);
- Snam, RINA and GIVA Group's project to use hydrogen in the steel forging process;
- SGI's (Società Gasdotti Italia) [Pegasus project](#) for the production of 100% renewable natural gas from green hydrogen generated by electrolysis; and
- The [Prometeo project](#), an initiative coordinated by ENEA (National Agency for New Technologies and Sustainable Economic Development) involving several Italian companies (Snam, Fondazione Bruno Kessler, Maire Techimont, NextChem), which aims to bring the cost of green hydrogen down to less than €2 per kg by combining different production technologies; and
- EP Produzione S.p.A. is going to realize an hydrogen valley in Sassari(SS) – locality Porto Torres. In this regard, EP Produzione S.p.A. started the authorisation procedure. The goal is to install a new plant for H2 production by means of electrolysis of 5 MW.

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Malaysia

Ashurst collaborated with ZICO Law in the preparation of this chapter, we are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Malaysia is a federation and has Federal laws and policies which apply throughout the country, and State laws and policies which only apply to individual states.

At the Federal government level, Malaysia currently does not have a specific hydrogen strategy or policy in place. However, in September 2022, the Government of Malaysia ("**the Government**") launched the [Malaysian National Energy Policy \(2022-2040\)](#) ("**NEP**") which includes an outline of action plans for the development of a national hydrogen economy.

Under the NEP, the Government aims to develop a long-term hydrogen roadmap which optimises hydrogen production pathways across green, blue, and grey hydrogen ("**Hydrogen Roadmap**"). The Hydrogen Roadmap is currently being developed by the Ministry of Science, Technology, and Innovation ("**MOSTI**") in collaboration with NanoMalaysia Bhd, the Malaysian Green Technology and Climate Change Corporation, the National Nanotechnology Centre and the Academy of Sciences Malaysia. As of the date of writing, there are no precise details of what the Hydrogen Roadmap will entail.

The following government policy frameworks published in 2021 are also relevant to, but do not exclusively concern, hydrogen deployment:

- [Malaysia Renewable Energy Roadmap](#) ("**MyRER**")
- [Low Carbon Mobility Blueprint \(2021-2030\)](#) ("**LCM Blueprint**")

At the State government level, in May 2021 the Sarawak Government through its Economic Planning Unit presented [Sarawak's Hydrogen Economy Framework](#) ("**Sarawak Hydrogen Framework**"), which charts the development of the Sarawak hydrogen economy from around 2020 to 2030 and beyond.

2. What are key goals and commitments included in the strategy/policy?

Clear strategy and policy commitments will likely be determined under the Hydrogen Roadmap. For the present, the Government under the NEP commits to:

- creating a national strategy to optimise hydrogen production locations (e.g., by positioning Sarawak as a green hydrogen production hub);
- building a domestic hydrogen ecosystem supported by R&D, technology deployment and commercialisation capabilities across targeted areas along the hydrogen value chain of production, distribution, and end-use application; and
- developing regulations to ensure safe, secure, and equitable roll-out of hydrogen production, transport, and end-use applications.

Meanwhile, under the Sarawak Hydrogen Framework, Sarawak's main goal is to enable the widespread usage and commercialization of hydrogen and fuel cell technologies through the adoption of the following five Strategic Pillars:

- Producing hydrogen via renewable energy sources at a competitive cost;
- Optimising the transportation cost for hydrogen for domestic use and the export market;
- Commercialising green hydrogen in potential markets both in the region and beyond;
- Upscaling the usage of green hydrogen and hydrogen fuel cells in the transportation sector and other industries; and
- Increasing research & development efforts relating to the green hydrogen economy.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

Presently, most of Malaysia's hydrogen supply is used in the production process of heavy industries such as oil refining and the manufacturing of methanol, ammonia, iron, and steel. Grey hydrogen is the main type of hydrogen currently used in such processes. The deployment of blue / green hydrogen for the purpose of being used as a resource has the potential to decarbonise these production processes.

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

Yes.

The existing mix of policies and frameworks discussed above prioritise the development of **green hydrogen**.

- The NEP explicitly states that the adoption of **green hydrogen** will be a key technology focus area for Malaysia. It also states that Malaysia has the potential to be an export hub for **green hydrogen** in the long-term and sets out the Government's intention to position Sarawak as a **green hydrogen** production hub.
- MyRER exclusively refers to plans for developing new storage technologies for **green hydrogen** in the longer-term.
- The Sarawak Hydrogen Framework exclusively concerns the development of **green hydrogen** as Sarawak aims to be the front-runner for the **green hydrogen** economy in Southeast Asia by 2030.

Meanwhile, the Hydrogen Roadmap (currently under development) is anticipated to promote the production of **blue hydrogen** during the earliest phase of the development of Malaysia's hydrogen economy.

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The policies and frameworks above do not set out any action plans relating to carbon capture and storage ("**CCS**"). Furthermore, at the Federal level, no specific policies or regulations on CCS are in place as of the time of writing.

However, it is anticipated that under the Hydrogen Roadmap, the Government will commit to incentivising key players in the oil and gas industry through policy, investment, and tax intervention to utilise CCS in the production process of grey hydrogen during the earliest phase of the development of Malaysia's hydrogen economy.

At the state level, Sarawak has taken preliminary legislative steps to support the growth of CCS in the state. On 18 May 2022 the Sarawak State Legislative Assembly unanimously passed the Land Code (Amendment) Bill 2022 which, once officially in force, will empower the Sarawak Government to regulate and control the use of land for the storage, retention, capture and sequestration of carbon dioxide and other greenhouse gases. Such regulation and control would entail requiring industries operating in the state to comply with international requirements on reducing carbon emissions.

6. Are there targets for the production of hydrogen?

There are currently no official targeted figures for the production of hydrogen.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are currently no specific incentive mechanisms or business models in place to support the production of hydrogen. Nevertheless, under the NEP's Low Carbon Nation Aspiration 2040 plan, the Government commits to create incentives to attract investments for the development of low carbon technologies, including hydrogen production technologies, in the near future.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are currently no specific standards in place for the classification and/or certification of blue and green hydrogen.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

Malaysia does not have a regulatory framework which specifically concerns hydrogen. However, under the NEP, the Government commits to developing regulation to ensure safe, secure and equitable roll-out of hydrogen production, transport and end-use applications.

In any case, the following regulations currently in place may have an impact on the production, storage, transportation, or supply of hydrogen before any hydrogen-specific regulations are rolled-out in the future:

- The Environmental Quality Act 1974, in particular, Section 22 (which sets out restrictions on pollution of the atmosphere), the Environmental Quality (Clean Air) Regulations 2014 and the Environmental Quality (Control of Solid Waste Transfer Stations and Landfill) Regulations 2009 set out environmental regulations that businesses and industries must comply with.
- The National Land Code, Industrial Co-ordination Act 1957 and Occupational Safety and Health Act 1994 may be applicable in governing the storage and production of hydrogen in facilities situated in industrial zones or in approved standalone areas.
- The Technical Code for Hydrogen Storage and Safety with Fuel Cell as Power Generator for ICT Infrastructure developed pursuant to the Communications and Multimedia Act 1998 specifies requirements for the handling, labelling and storage of hydrogen by ICT industries utilising hydrogen-powered fuel cells as a power supply.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

In relation to the energy sector, the Government only allows foreign investors to hold up to 49% equity ownership in Malaysian incorporated companies that own power generating facilities utilising either renewable energy or non-renewable energy. For the oil and gas industry, all upstream activities require a licence from PETRONAS, and depending on the specific type of activity, the foreign equity limit falls between 30% and 100%.

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Malaysia is a signatory to 54 bilateral investment treaties (BITs) and 24 treaties with investment provisions (TIPs) in force that may offer protection to international investors in Malaysia.

Furthermore, Malaysia is currently a party to Investment Guarantee Agreements (“IGAs”) with 64 countries which are in force. A table of the countries that are parties to these IGAs can be [found here](#). IGAs will protect against nationalization and expropriation, ensure prompt and adequate compensation in the event of nationalization or expropriation, provide free transfer of profits, capital and other fees and ensure settlement of investment disputes under the Convention on the Settlement of Investment Disputes of which Malaysia has been a member since 1966.

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

There are no government grants or funding programmes specific to hydrogen projects. However, based on past hydrogen projects in Malaysia, the Government is willing to provide such financial support. The Malaysian hydrogen energy R&D community, which mainly constitutes local universities such as UKM, UTM, UM, UITM and UNITEN, have to date garnered research funding of over RM 40 million from the Ministry of Science, Technology and Innovation and Ministry of Higher Education.

Previously, the Government had in place a [Green Technology Financing Scheme](#) to support the growth of green technology in Malaysia. Under this scheme, green technology projects which were ready for commercialization could obtain a loan of up to RM500 million. However, this scheme had ended on 31 December 2022, and no announcements to renew it have been made as of now.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

Yes. They are as follows:

- **Southeast Asia's first integrated pilot hydrogen production plant and refuelling station in Kuching, Sarawak.** This pilot project was officially launched by the Sarawak Government on 27 May 2019. Construction and operation of the pilot project was undertaken by Sarawak Energy in collaboration with Linde EOX Sdn. Bhd., a subsidiary of Linde Malaysia. The production plant produces green hydrogen through electrolysis and is able to produce 130kg of hydrogen per day at a purity of 99.999%. The station is capable of fully refuelling up to 5 fuel cell buses and 10 fuel cell cars per day.
- **Pilot project to use vehicles powered by hydrogen in Sarawak's public transport system.** Sarawak introduced Southeast Asia's first hydrogen-powered buses in Kuching in 2019 under a pilot project closely tied to the pilot project above. Currently, the Sarawak Economic Development Corp ("**SEDC**") is importing more hydrogen fuel cell buses for the provision of free transport in the city.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

Yes. Details are as follows:

- On 26 January 2022, Samsung Engineering Co., Lotte Chemical Corp. and POSCO signed a MoU with SEDC to develop green hydrogen and ammonia at a plant to be built in Bintulu, Sarawak. Under this Sarawak H2biscus Project, a plant with the annual capacity to produce 7,000mt of green hydrogen will be built.
- On 11 March 2022, PETRONAS Hydrogen Sdn Bhd and ENEOS signed a Joint Feasibility Study Agreement ("**JFSA**") to advance the studies for a commercial hydrogen production and conversion project in Kerteh, Terengganu. Under the JFSA, both parties will pursue detailed technical and commercial feasibility studies for the production of low carbon hydrogen from PETRONAS's existing facilities and production of green hydrogen from a new hydro-powered electrolyser facility, amongst other things.
- On 24 May 2022, Hydrogène de France signed a MoU with PESTECH International Berhad to collaborate on green hydrogen production from hydropower plants in Cambodia and Malaysia.
- On 21 July 2022, PETRONAS Technology Ventures Sdn Bhd entered into a Supply Arrangement on Hydrogen Production Technology with SEDC Energy Sdn Bhd. The Supply Arrangement focuses on expanding the application of green hydrogen technologies in Sarawak. The parties will also explore opportunities for the design and development of a "Hydrogen City" in Sarawak.

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Morocco

Ashurst collaborated with Mokhtari Avocats in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

The Ministry of Energy, Mines and Environment published a Green Hydrogen Roadmap in January 2021 and, on 21 August 2021, the current Ministry of Energy Transition and Sustainable Development published the [National Green Hydrogen Strategy](#).

2. What are key goals and commitments included in the strategy/policy?

Through the hydrogen roadmap and strategy, Morocco aims to initiate a regional dynamic market by creating an economic and industrial sector focused on green molecules, particularly hydrogen, ammonia and methanol. This will consolidate Morocco's energy transition by reducing greenhouse gas emissions and supporting the decarbonisation of partner countries.

Green hydrogen will be implemented gradually in order to optimise the full potential for both the national economy and for export.

2020 – 2030: In the short term, Morocco will focus on two areas to develop the industry:

- The first is local use as a raw material in industry, particularly for the production of green ammonia in the fertiliser industry.
- The second is the export of green hydrogen products to countries committed to ambitious decarbonisation targets.

During this period, the costs of green hydrogen products would remain higher than those of conventional products. The development of the hydrogen industry would be based on various pilot and development projects supported by public authorities and subsidised funding from national and international financial institutions.

2030 – 2040: In the medium term, other specific favourable conditions, such as the reduction of the costs of green hydrogen products and the implementation of environmental regulations, will allow the development of the first economically viable projects, particularly for green ammonia and hydrogen, at national and international level.

Similar applies to exports of synthetic liquid fuels, namely paraffin, diesel and gasoline. As regions that import green hydrogen derivatives, such as Europe, adopt encouraging environmental regulations, Morocco will be presented with the opportunity to progressively develop this sector.

The local use of green hydrogen products in the electricity sector as a carrier for energy storage and in transport as a fuel could support the expansion of the hydrogen industry in Morocco. Pilot projects for these sectors could be launched in the short to medium term to test the technological applications and readapt them to the Moroccan context, with a view to optimising their long-term deployment.

In the energy sector, green hydrogen can be used as a vector for energy storage to reduce grid congestion and improve the flexibility of the national electricity system.

2040 – 2050: For this period and beyond, as the business cases for ammonia, hydrogen and green synthetic fuels for export improve, the development of green hydrogen technologies and industry will accelerate both globally and in Morocco.

This expansion will further evolve through the local use of green hydrogen in industry, for heat production, in the residential sector, for urban mobility, and for air transport. Nevertheless, the demand in these sectors, particularly in the residential sector, for green hydrogen or synthetic methane is likely to be small due to high investment requirements for the development of major distribution infrastructure.

In the transport field, the long-term development opportunities are mainly in heavy land transport and aviation. Some demand may emerge in the transport sector, likely associated with green hydrogen used for freight, mining and public transport in pilot projects.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industry sectors that will be affected through the hydrogen deployment include:

- electricity sector;
- shipping and aviation sector;
- fertiliser industry; and
- heating in the residential sector.

4. Who are the main regulators for the hydrogen market?

The main regulator /authority for the hydrogen market in Morocco is the Ministry of Energy Transition and Sustainable Development.

There are other institutions/actors, such as (i) the Moroccan Agency for Energy Efficiency (Agence Marocaine pour l'Efficacité Energétique), whose mission is to contribute to the implementation of government policy on renewable energy and energy efficiency, (ii) the National Authority for the Electricity Regulation (Autorité Nationale de Régulation de l'Electricité), which is responsible for regulating the electricity sector, including, among others, proposing draft laws to the government in the electricity sector and (iii) the Moroccan Agency for Sustainable Energy (Agence Marocaine pour l'Energie Durable – MASEN), which is the leading renewable energy group in Morocco and a central actor dedicated to the valorisation of renewable sources.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

No, the National Green Hydrogen Strategy and the Green Hydrogen Roadmap does not support low-carbon (blue) hydrogen.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

N/A – We know however that CCS solutions are being studied by certain energy developers and might be proposed to the government.

7. Are there targets for the production of hydrogen?

There are no official figures for the production of hydrogen. However, the Green Hydrogen Roadmap envisages that Morocco will have:

- a local market of 4 TWh and an export market of 10 TWh in 2030;
- a local market of 22 TWh and an export market of 45.9 TWh in 2040; and
- a local market of 39.2 TWh and an export market of 114.7 TWh in 2050.

In addition, two studies presented in 2020 by three German Fraunhofer research institutes (IMWS, IGB and ISI) revealed that, thanks to its privileged geographical location and its exceptional potential in wind and solar energy, Morocco could capture a significant share of the demand for green hydrogen, estimated at between 2 and 4% of world demand in 2030.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Nothing specific, except the government willingness to develop this field and green energy.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

N/A

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

There are no regulatory framework relating to the production, storage, transportation or supply of hydrogen so far.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

To the best of our knowledge, there are no exceptions to the foreign exchange office rules for investors in the energy and infrastructure sector.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

N/A

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

N/A

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

N/A

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

As far as we know, the development of two projects has been announced (mainly through medias):

- [HEVO Ammoniac Maroc Project](#): a project being developed by the Portuguese technology company Fusion Fuel Green, Consolidated Contractors (CCC) and Vitol. The total estimated investment is \$865 million with the objective of achieving a production of 31,850 tonnes per year of green hydrogen, 151,800 T/year of nitrogen and 183,650 T/year of green ammonia.
- The project aims to produce 3,650 tonnes of green ammonia in 2022, 20,000 tonnes in 2023, 40,000 tonnes in 2024 and 60,000 tonnes in 2025 and 2026. As for hydrogen production, 616 tonnes will be manufactured in 2022, 3,472 in 2023, 6,940 in 2024, 10,411 in 2025 and 2026.
- [Total Eren Project](#): The French group Total Eren has announced its decision to engage an investment of 100 billion Dirhams (approximately \$10,1 billion) in the realisation of a mega-project of hydrogen and green ammonia production in the region of Guelmim-Oued Noun in Morocco. This is a hybrid project, which will generate more than 10 GW by combining solar and wind energy.

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Namibia

Ashurst collaborated with Koep & Partners in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a Government hydrogen strategy or policy?

There is currently no Government hydrogen strategy or policy that outlines key goals, establishes a regulatory framework or provides policy support and incentives. However, the Government of Namibia has issued a [Request For Proposals](#) inviting experts to develop a strategy and roadmap for the production and use of hydrogen (with particular application to synthetic fuels) in Namibia. This strategy and roadmap will be the foundation for an “energy plan” for the country.

2. What are key goals and commitments included in the strategy/policy?

Not applicable.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The [SYSTEMIQ Impact Presentation](#), developed in collaboration with the Government of Namibia, highlights the following sectors as the first to be impacted by the deployment of hydrogen:

- long-haul trucking;
- mining trucking;
- fertiliser; and
- rail.

Hydrogen does not yet form part of any existing energy infrastructure in Namibia.

4. Who are the main regulators for the hydrogen market?

Not applicable.

5. Does the Government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (clean) hydrogen?

Not applicable.

6. If the Government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

Not applicable.

7. Are there targets for the production of hydrogen?

Not applicable.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Not applicable.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

Not applicable.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

Not applicable.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

There are currently no foreign investment restrictions specifically related to investment in the energy and infrastructure sectors. However, there are standard regulations regarding foreign investments i.e. exchange control restrictions.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Namibia is not signatory to any international treaties that offer specific protection for international investors in the energy sector. Only the standard investor protections provided to all foreign investors are applicable. For instance, the Government of Namibia has entered into double taxation agreements with the Governments of the following countries:

- Republic of Botswana;
- French Republic;
- Federal Republic of Germany;
- Republic of India;
- Malaysia;
- Republic of Mauritius;
- Romania;
- Russian Federation;
- Republic of South Africa;
- Kingdom of Sweden; and
- United Kingdom of Great Britain and Northern Ireland.

Market developments and opportunities

13. Are there any Government grants or other Government funding available to hydrogen projects (including for research and development)?

Yes, the [PTX Pilot Project Programme](#) provides grants for pilot projects. The grants provided by the Government are aimed at promoting international collaboration in the field of clean hydrogen and its derivatives with a specific focus on storage, transport, and the use of integrated application technologies. The funding arrangement will comprise of two modules:

- Module 1: Projects - Module 1 will fund companies/institutions that are systematically developing and promoting the sustainable production of clean hydrogen and its derivatives. This includes projects dealing with the production, storage, transport and the integrated use of clean hydrogen and its derivatives. Funding will be provided for technologies that make a contribution to an early market ramp-up as well as preparatory or accompanying development, where applicable.
- Module 2: Research Projects - Module 2 will fund research projects that are designed to accompany projects funded in Module 1. This includes preparatory or accompanying research like material development, simulations, modelling, scientific analyses, and studies.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are currently no notable pilot projects in place or planned. Any future pilot projects are likely to be commissioned through the [PTX Pilot Project Programme](#).

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial scale clean hydrogen production projects in Namibia but the [Hyphen Southern Corridor Development Initiative Project](#) is in development.

The Hyphen Southern Corridor Development Initiative Project has passed the pre-feasibility stage. The key figures on this project include an installed capacity of 5GW of renewable energy, 3GW of electrolysis, 300,000 tonnes of clean hydrogen per annum and a total investment of USD 9.4 billion. The project timeline is set up as follows:

- Development of this project commenced in 2021 and is expected to proceed until 2024.
- Phase one - construction on phase one is set to commence in 2025 and operations are set to commence in 2027.
- Phase two - construction of phase two is set to commence in 2027 and operations are set to commence in 2029.

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Netherlands

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Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, a [Government Strategy on Hydrogen](#) (Kabinetsvisie waterstof) was published on 30 March 2020. In addition, a National Hydrogen Programme Work Plan 2022-2025 ([Werkplan Nationaal Waterstof Programma 2022-2025](#)) was published on 7 July 2021.

In general, it is worth noting that the Netherlands is, after Germany, the largest hydrogen producer from fossil fuel sources in Europe. In 2018, the Netherlands had an annual production of 0.8 Mt, approximately 80% of which is produced from natural gas by application of steam methane reforming (SMR), while about 20% is generated as a by-product in the chemical industry. At present, the largest producers of hydrogen in the Netherlands are Air Liquide, Linde (Praxair), Air Products, Yingde Gases and Messer Group. Roughly 60% of the Dutch hydrogen production is used for ammonia production, while the remaining 40% is used in the (petro)chemical industry.

2. What are key goals and commitments included in the strategy/policy?

The Government Strategy on Hydrogen acknowledges the Netherlands' advantageous starting position for the further development and integration of hydrogen in its energy system. It has a large potential for increasing renewable power generation, required for the production of CO₂-free hydrogen, by means of offshore wind farms on the North Sea. This supply is located relatively close to potentially significant demand from industrial clusters aiming to become more sustainable. The Netherlands' ports, including the major port of Rotterdam, represent opportunities for importing hydrogen, and its well-developed gas infrastructure can be re-deployed for the transport of renewable hydrogen. Finally, it has the knowledge institutions necessary to conduct the fundamental and applied research required to further develop the hydrogen economy through innovation.

The Government Strategy on Hydrogen identifies a first phase in which the main goal is to decrease the cost of, and scale up, the production of renewable hydrogen. It notes that preparations must also be made for a later phase in which transport and storage infrastructure is developed. In this context, the Government Strategy on Hydrogen sets a policy agenda with four main elements:

- The development of legislation to create the preconditions necessary for the further development and integration of hydrogen in the energy system. The main areas of attention are: (i) identifying the conditions in which existing gas infrastructure can be re-deployed for the transport and distribution of hydrogen, (ii) market regulation in general and the assignment of temporary tasks to grid operators to kick-start the hydrogen market, (iii) the development of guarantees of origin and certification schemes taking into account EU legislation, (iv) ensuring safety and (v) ensuring the coordinated development of energy infrastructure, in particular the electricity and hydrogen grids.
- The cost reduction and scaling up of green hydrogen. The ambition is to scale up electrolysis capacity for the production of green hydrogen to approximately 500 MW of installed capacity by 2025 and 3-4 GW of installed capacity by 2030, with the aim of achieving a cost reduction of >50% in the next decade. The government aims to achieve this through (i) financial instruments supporting research, scaling up and implementation, (ii) possibly linking the development of wind energy at sea to hydrogen production via integrated tenders and (iii) possibly imposing a blending obligation for green hydrogen in the gas grid, thus increasing green hydrogen demand.
- Making end-use more sustainable, thus increasing the demand for CO₂-free hydrogen in (i) ports and industry clusters, (ii) the transport sector (e.g. 50 hydrogen filling stations by 2025), (iii) the built environment, (iv) the electricity sector, and (v) agriculture.
- Supporting policies, including (i) the continuation of the government's international strategy aimed at global and particularly European cooperation, (ii) regional policy aimed at stimulating regional development and improving regional cooperation, and (iii) supporting both fundamental and applied research by companies and knowledge institutions.

The National Hydrogen Programme Work Plan 2022-2025, with an outlook towards 2030, drawn up by a cross-sectoral hydrogen working group consisting of 19 organisations (among which government ministries, branch organisations, the TSOs and the port of Rotterdam) identifies two key goals: (i) upscaling offshore production of renewable electricity linked to the scale up of electrolysis capacity for the benefit of increasing the sustainable end-use of feedstock and fuels in the five main industrial clusters (Rotterdam-Moerdijk, Chemelot, Noordzeekanaalgebied, Schelde-Delta and Noord-Nederland), heavy transport and logistics and the Dutch port areas and (ii) the demonstration and development of decentralised hydrogen production.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The Dutch government has identified opportunities for the production and consumption of hydrogen in the following sectors: (i) ports and industry clusters, (ii) hydrogen and zero emissions policies for transport, (iii) built environment, (iv) electricity sector, and (v) agriculture.

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The Government Strategy on Hydrogen supports both low-carbon (blue) hydrogen and renewable (green) hydrogen.

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The government considers the capture, transport and storage of CO₂ (CCS) to be an important (transition) technology to make Dutch industry more sustainable and essential to achieve Dutch CO₂-reduction targets before 2030.

In general CCS is supported by various instruments, including mechanisms aimed at pricing CO₂ emissions and schemes aimed at reducing the (financial) risks involved in CCS projects. In addition, the government recognises that the involvement of state participations can support the development of CCC projects, e.g. the involvement of EBN, Gasunie and Port of Rotterdam in the Porthos project. This government support is elaborated below.

Supplementing EU ETS, the government has, through the *Environmental Taxes Act (Wet belastingen op milieugrondslag)*, introduced two additional pricing mechanisms, each aimed at stimulating the relevant companies to invest in measures that reduce their CO₂ emissions:

- a tax aimed at setting a minimum (i.e. floor) price for CO₂ emissions by EU ETS companies that generate electricity (Minimum CO₂-prijs elektriciteitsopwekking), which increases by 10% a year from EUR 21,30 in 2020 to EUR 31,90 in 2030. The tax equals the difference, if any, between the floor price and a lower EU ETS price. Thus, if the EU ETS price is higher than the floor price the tax rate equals zero; and
- a carbon tax (CO₂ heffing industrie) which applies to EU ETS installations in general as well as number of non-EU ETS installations. In 2022, the carbon tax equals a base amount of EUR 41,75 per ton CO₂-equivalent (the base amount is indexed annually) which increases by EUR 10,87 a year up to and including 2030. EU ETS installations pay the base amount decreased by the EU ETS price per ton of CO₂ emission (which price is set annually; for 2022 at EUR 60,78). If the EU ETS price is higher than the base amount, the carbon tax equals zero (as is the case in 2022). Non-EU ETS installations pay the full amount of the carbon tax. The carbon tax is paid for the annual volume of CO₂ emitted decreased by the number of so-called 'dispensation rights' for emissions that are exempted from the carbon tax (the total amount of which is annually reduced). The carbon tax has been set at a level that is expected to be sufficiently high to achieve the Netherlands' CO₂ emissions reduction targets for 2030 with a 75% certainty.

CCS is (financially) supported through a number of support schemes, including the [Stimulation of sustainable energy production and climate transition \("SDE++"\)](#). In the so-called [Climate Agreement \(Klimaatakkoord\) of 28 June 2019](#) it was agreed, in order to alleviate concerns that CCS would -at the expense of other technologies- use up most of the available SDE-subsidy, that a maximum of 10.2 Mtons of CCS will be subsidised, i.e. 7.2 Mtons for industry and 3 Mtons for electricity generation. The SDE++ subsidy is available to both CCS and CCU projects and is granted for a period of 15 years. After 2035, SDE++ subsidy will no longer be granted to CCS projects, reflecting its role as a transition technology.

Although the government has the intention to allow market participants to develop CCS projects, it envisages specific roles for certain state participations:

- EBN can monitor-and where necessary stimulate- research into the suitability of CO2 storage locations, optimise the re-use of existing infrastructure for CCS and EBN will be given a mandatory involvement in CO2 storage activities and may also be appointed as the party that will manage CO2 storage locations once the relevant CO2 storage permits have been revoked.
- Gasunie will be given the necessary room, within the limits set by the Gas Act, to participate in the realisation of CO2 transport infrastructure and the transport of CO2. The appointment of a public or regulated transport grid operator is however not envisaged.

The two most prominent CCS projects in the Netherlands, at present, are Porthos and Aramis:

- **Porthos** is a cooperation between EBN, Gasunie and Port of Rotterdam for the transport and permanent storage of CO2 for the benefit of their industrial launching customers Air Liquide, Air Products, ExxonMobil and Shell, each of which captures CO2 in order to produce blue hydrogen. Porthos will store the CO2 in depleted gas fields in the North Sea, with an annual storage capacity of 2.5 Mton. Porthos envisages becoming operational in 2024-2025.
- **Aramis**: Shell and TotalEnergies, together with EBN and Gasunie, have formed a partnership to develop a CCS project, also aimed at storing CO2 from industrial customers in depleted gas fields in the North Sea. The project is in its initial stages.

6. Are there targets for the production of hydrogen?

The Government Strategy on Hydrogen refers to the ambition set out in the Climate Agreement to scale up electrolysis capacity for the production of green hydrogen to approximately 500 MW of installed capacity by 2025 and 3-4GW of installed capacity by 2030.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The production of hydrogen is primarily (financially) supported through the Stimulation of sustainable energy production and climate transition ("SDE++"). Pursuant to the SDE++ the Minister of Economic Affairs and Climate Policy ("Minister") shall, upon application, on a first-come-first-served basis, grant a subsidy to a producer of hydrogen produced by a production installation that produces hydrogen by means of electrolysis with a nominal capacity of at least 500 kW and that is either connected to the grid or that has a direct connection to a production installation for wind or solar power (which is not itself subsidized and which produces the electricity used for the electrolysis). A hydrogen production installation is assumed to be used only when there is a surplus of renewable electricity. At other times electricity consumption must be minimal to avoid greenhouse gas emissions. Therefore, the installation must be capable, while ready for use, of using less than 1% electricity of its maximum capacity. The subsidy is granted for a period of 15 years. The actual production of the installation may not exceed 5,000 production hours. The receiver of the subsidy shall ensure that the production installation becomes operational within 4 years after the date of the subsidy decision.

In addition, the Dutch Government has made available a total of EUR 250 million for a proposed subsidy scheme (Subsidieregeling opschaling hernieuwbare waterstofproductie via electrolyse) which supports the construction and exploitation of small-scale electrolysers, and which is scheduled to enter into force as from 1 January 2023. Pursuant to this scheme, the Minister may, upon application, grant a single subsidy to a company for the realization of an electrolyser (the investment part) and the production of renewable hydrogen with that electrolyser (the exploitation part). The investment part of the subsidy runs until the electrolyser becomes operational, while the exploitation part runs for a period of 15 years as from the date the electrolyser has become operational. The subsidies are granted on a tender basis, i.e. the lower the subsidy amount applied for the higher the ranking. To be eligible for subsidy, the electrolyser must convert water to oxygen and hydrogen, it must be located in the Netherlands or its exclusive economic zone, have a nominal electric input capacity of at least 0,5 MW and no more than 50 MW, and it must be connected to the electricity grid and/or by means of a direct line, to a wind or solar production installation. The electrolyser must produce renewable hydrogen and if any non-renewable hydrogen is also produced (e.g. by electricity generated from natural gas) the greenhouse gas emissions reduction of all hydrogen produced must be at least 70%. The subsidy recipient shall ensure that the electrolyser becomes operational within 3 years after the date of the subsidy decision.

Other (potentially) available government grants or government funding are addressed in item 12 below.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

The development of a Guarantees of Origin (“GoO”) system for renewable hydrogen is required under the [Renewable Energy Directive 2018/2001](#) (RED II). In the Netherlands, this system has been implemented by means of the Act for the Implementation of the EU Renewable Energy Directive for Guarantees of Origin (Wet implementatie EU-richtlijn hernieuwbare energie voor garanties van oorsprong), which entered into force on 1 October 2022.

The Act only relates to GoOs for hydrogen from renewable sources, i.e. only green and not -at least not yet- to blue hydrogen. The GoOs designate the relevant form of energy (e.g. hydrogen) and distinguish between the renewable sources from which it has been produced (e.g. hydrogen on the basis of electricity, biomass, etc.).

The Act is elaborated in the existing Regulations governing Guarantees of Origin and Certificates of Origin (Regeling garanties van oorsprong en certificaten van oorsprong). The tasks in relation to GoOs for “other gas from renewable sources” are mandated to Vertogas, a Gasunie subsidiary. Vertogas is also a member of the CertifHy project, financed by the European Commission, and as such is involved in the development of (renewable) hydrogen certification.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

At present, there is no comprehensive regulatory framework in place regarding the production, storage, transportation or supply of hydrogen. The Minister does not consider the definition of “gas” in the *Dutch Gas Act* to apply to hydrogen, meaning that the majority of the provisions in the Gas Act do not apply to hydrogen.

The Gas Act and the Electricity Act prohibit grid operators (netbeheerders) from carrying out any activities other than those that are necessary for the proper performance of the tasks assigned to them by or pursuant to the Act. As these tasks do not include hydrogen related tasks (e.g. transportation and/or distribution), grid operators -at present- have no role in relation to hydrogen.

The Gas Act and the Electricity Act give network companies (netwerkbedrijven) a limited role in relation to hydrogen. Network companies are required, due to their ties with a grid operator, to limit themselves to activities attributed to them by law. These activities are limited to the construction and management of pipelines or installations for hydrogen. Pipelines include related equipment, such as compressors. Installations are located behind the connection to a grid and may include production installations (such as electrolyzers), storage installations and metering equipment. The construction of the infrastructure means the physical construction and maintenance of the infrastructure. The network company's responsibility in this regard is limited to ensuring that the infrastructure functions technically and physically. The management of the infrastructure means determining how the infrastructure is used or deployed and includes using the infrastructure for the transport of hydrogen but does not include any production, trading or supply activities which are, in principle, reserved for third parties.

The Authority for Consumers and Markets (Autoriteit Consument en Markt) (“ACM”), the national energy regulator, has emphasized that the above may change with the introduction of the Energy Act, which aims to integrate the Electricity Act and the Gas Act. The draft legislative proposal for the Energy Act has not (yet) been sent to Parliament. For now, therefore, the room for expanding the role of grid operators and/or network companies in relation to hydrogen appears limited. According to the ACM the Minister can, in specific cases, consider introducing governmental decrees which would allow him to, temporarily and subject to certain conditions, deviate from the provisions of the Gas Act and/or to, again temporarily, assign other tasks than the regulated tasks to a grid operator.

In the meantime, the ACM, in July 2022, published its Temporary Framework Hydrogen Pilot Projects (Tijdelijk kader waterstofpilots). In this document, the ACM notes the importance of grid operators being able to gain experience with hydrogen distribution. The ACM will therefore, pending the amendment of relevant legislation, refrain from enforcing the law against grid operators that participate in hydrogen pilot projects, provided that the relevant grid operator has applied for and received a temporary exemption order (gedoogbeschikking) from the ACM, which will be granted if the projects meet certain generic conditions as well as consumer protection and safety conditions. The generic conditions are as follows:

- The pilot concerns the application of hydrogen as heat supply in the built environment.
- The grid operator's role is limited to the realization (including the re-use of gas grids), operation and maintenance of a hydrogen grid. The grid operator may not be involved in the production, trading or supply of hydrogen.

- The pilot contributes to (and is not larger than necessary to achieve) a clear learning objective for the grid operator, pre-established with the consent of all parties involved, and the results of the pilot project will be shared transparently with the market.
- The ACM will refrain from enforcement only temporarily, i.e. until the role of the grid operator has been provided for by law, or the learning objective of an experiment has either been achieved or has proven unachievable, and in any event for no longer than 5 years from the date of publication of the Temporary Framework.

The above-mentioned consumer protection conditions are set out in some detail in an annex to the Temporary Framework. These conditions aim to secure that the supply of hydrogen is subject to at least the same guarantees as the supply of gas under the Gas Act. The aforementioned safety conditions will be set out in a temporary framework that is yet to be published. The State Supervision of Mines (Staatstoezicht op de Mijnen) (“SodM”) is the intended authority to supervise the safety of hydrogen pilot projects.

The Minister, in a letter to Parliament dated 10 December 2021, has provided the government’s views on the way in which the hydrogen market may be regulated and developed. In summary these are as follows:

- Hydrogen production, including electrolysis, is viewed as a commercial activity that is reserved for private (i.e. not publicly owned) market participants. The Government can consider giving network companies the possibility to develop electrolyser capacity, but only if the aforementioned market participants do not display sufficient appetite to invest.
- The development of one national hydrogen transport grid which functions as a whole technically and operationally is considered important because (i) this will, in time, facilitate a substantial, competitive physical market where supply and demand can meet, which contributes towards affordability, security of supply and uniform conditions and quality standards (ii) this is more cost-efficient than parts of a network being developed separately or in parallel (iii) this allows for the development of system functions, e.g. national access to storage locations, connections to other countries and import by means of ports and (iv) this can be a (cost) efficient alternative to long term investments in the national onshore and offshore electricity grid. The national hydrogen grid is envisaged to be developed, owned, operated and exploited by HyNetwork Services, an affiliate of Gasunie (the TSO for gas), to be appointed as regulated operator of the national hydrogen transport grid around 2025. Its exclusive task of operating the grid will be subject to legislation that ensures a.o. reasonable, objective and non-discriminatory (negotiated) third party access to the grid against reasonable tariffs. The development of such legislation in relation to existing private commercial grids is not envisaged. New large-scale private grids and/or geographically delineated private grids, insofar as these become subject to EU regulation, may be eligible for (partial) exemptions from said regulation.
- Large-scale hydrogen storage, which is considered important and necessary for maintaining the supply-demand balance in the future energy system, as well as hydrogen import terminals are also viewed as a commercial activity subject to third party access rules and tariffs depending on the outcome of EU negotiations (with the Dutch government aiming for nTPA or rTPA for storage facilities and nTPA for import terminals). As with hydrogen production, the government can consider giving network companies the possibility to develop storage facilities and/or import terminals, but only if market participants fail to do so. The potential for the development of storage capacity is expected to be greatest in the North and East of the Netherlands. The storage capacity required is estimated at 1-4 salt caverns (0.042-0.475 TWh equivalent) in 2030.

The main regulators for the evolving hydrogen market are the ACM and, for subjects relating to gas safety, the SodM

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Yes, there are any foreign investment restrictions related to energy and infrastructure sectors, although they are not (yet) directly applicable to hydrogen projects.

The *Dutch Electricity Act* and the *Dutch Gas Act* provide that the Minister may, for reasons of public safety or security of supply, prohibit or attach conditions to a change of control in (i) an electricity generating facility with a nominal electrical capacity exceeding 250MW or a company managing such a generation facility or (ii) a liquefied natural gas (LNG) facility or an LNG company irrespective of capacity or size, respectively. Furthermore, electricity and gas grids and their operators are publicly owned by law.

The Dutch government has put a legislative proposal for the so-called 'Investment, Mergers and Acquisitions Screening Act' (Wet veiligheidstoets investeringen, fusies en overnames) to Parliament. The proposed Act provides a general framework for the screening of investments on the basis of national security. If adopted, the Act will apply to pre-defined categories of critical infrastructure, including district heating operators, nuclear power companies, the Rotterdam Port Authority, banks, certain financial market infrastructure companies and companies active in the area of the exploration, transport and storage of natural gas. The government may designate additional categories of critical companies by means of government decree, which may include companies active in the hydrogen sector. The Act is intended to have retroactive effect as of 8 September 2020.

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The Netherlands, like the United Kingdom, is a signatory to almost 90 bilateral investment treaties (BITs) that are in force, according to the website of the United Nations Conference on Trade and Development (UNCTAD). The Netherlands is also a party to the Energy Charter Treaty (ECT), a multilateral investment treaty which entered into force on 16 April 1998 and specifically addresses energy trade, transit and investment between its contracting parties.

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

As discussed at item 5, hydrogen projects are supported by the SDE++ subsidy scheme since 2020. In addition, depending on the project and subject to applicable legislation limiting the possibility to cumulate different subsidies, the following support schemes are available:

- for fundamental research, the NWO (Nederlandse Organisatie voor Wetenschappelijk Onderzoek; Dutch Research Council) instruments;
- for industrial and experimental research, the [MOOI scheme](#) (Missiegedreven Onderzoek, Ontwikkeling en Innovatie; Mission-Driven Research, Development and Innovation) supports integrated solutions that contribute to climate objectives and focuses on projects for 'Wind at Sea', 'Renewable Energy on Land', 'Built Environment' and 'Industry';
- for projects focusing on mobility and transport, the [DKTI scheme](#) (Demonstratie klimaattechnologieën en -innovaties in transport; Demonstration of Climate Technologies and Innovations in Transport);
- for practical experiments, pilots and demos, the [DEI+ scheme](#) (Demonstratie Energie- en klimaatinnovatie; Demonstration of Energy and Climate Innovation) aimed at long term reduction of CO₂ (by 2030). Subsidies are available from 25% (up to 45% for certain projects) of the project's eligible costs of technologies for scaling up green hydrogen. The budget for 2022 is €58.6 million. The maximum subsidy per project is €15 million;
- for projects that focus on the feasibility of an innovative pilot or demonstration project, the [Top Sector Energy Industry Studies Regulation](#) (regeling Topsector Energie (TSE) Industrie studies);
- for R&D projects that can cost-effectively reduce CO₂ emissions in industry in 2030, the [TSE Industry R&D scheme](#) (TSE Industrie Onderzoek & Ontwikkeling);
- the [HER+ scheme](#) (Hernieuwbare Energietransitie; Renewable Energy Transition) for projects that lead to CO₂ reduction by 2030 and save on future expenditure on SDE++;
- specifically for small and medium enterprises, the [MIT scheme](#) (Innovatiestimulering Regio en Topsectoren; Innovation Stimulation Region and Top Sectors) and the Innovation Brokers Regulation (Innovatiemakelaarsregeling);
- the [SDS scheme](#) (Subsidie duurzame scheepsbouw; Subsidy for Sustainable Shipbuilding) which supports building or converting a ship to apply sustainability-enhancing innovations;
- [GroenvermogenNL](#), which is in the start-up phase and focuses on innovation and upscaling of hydrogen projects for the energy transition and green chemicals by investing in R&D, pilots, demonstration projects and human capital.

In addition, hydrogen projects may be able to make use of more general instruments supporting innovation, including:

- Fiscal: the Innovation scheme under the *Promotion of Research and Development Work Act (Wet Bevordering Speuren en Ontwikkelingswerk (WBSO))*, the Energy investment deduction for entrepreneurs (Energie-investeringsaftrek voor ondernemers (EIA)), the Environmental Investment deduction (Milieu-investeringsaftrek (MIA)) and the Arbitrary depreciation of environmental investments (Willekeurige afschrijving milieu-investeringen (Vamil));
- Credits: Innovation credit (Innovatiekrediet), Growth facility (Groeifaciliteit) and Early Stage Financing (Vroegfasefinanciering (VFF));
- Guarantees for bank loans: Guarantee Financing Entrepreneurs (Garantie Ondernemingsfinanciering (GO)) for medium-sized and large companies and the Guarantee for SME Credit (Borgstelling MKB-kredieten (BMKB));
- Investments: Seed capital funds for techno starters and Regional development companies (Regionale ontwikkelingsmaatschappijen (ROM)).

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

The TKI New Gas “Overview of Hydrogen Projects in the Netherlands” dated May 2021, contains a number pilot and demonstration projects, including:

- [PosHYdon](#), a Neptune Energy first of its kind hydrogen project on the operational Q13 offshore gas production platform which employs a 1 MW electrolyser that uses electricity generated by offshore wind turbines to convert seawater into demineralised water and, in turn, into hydrogen. The aim of the pilot is to gain experience of integrating energy systems at sea and the production of hydrogen in an offshore environment.
- Groene Hart H2, a Vermeulen Groep and NettEnergy project aimed at producing 500 kg / day of hydrogen by gasifying 10 ton / day of biomass (verge grass and wood waste). The hydrogen will be used in part by Vermeulen Groep, a civil engineering company, to make its business more sustainable.
- [Ijzendoorn](#), a hydrogen refueling floating solar island developed by SolarDuck, Voyex and Dekker Groep where 65 kW of solar power is connected to a 10 kW electrolyser that produces hydrogen. The hydrogen is bonded to a ‘liquid organic hydrogen carrier’ (LOHC), an oil-like liquid, so that it can be transported at room temperature, under the same atmospheric conditions as fuels such as diesel. Onboard of a vessel, the hydrogen is released from the hydrogen oil which can be recharged for its next usage.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in the Netherlands. There are however at least 40 clean hydrogen production projects, many of which are in the feasibility study or FEED-study process phases. These projects are briefly described in the TKI New Gas “Overview of Hydrogen Projects in the Netherlands” dated May 2021, which includes:

- Holland Hydrogen I, Shell has taken the final investment decision to build this green hydrogen plant, which will be Europe’s largest renewable hydrogen plant once operational in 2025. The 200MW electrolyser will be constructed on the Tweede Maasvlakte in the port of Rotterdam and will produce up to 60,000 kilograms of renewable hydrogen per day. The renewable power for the electrolyser will come from the offshore wind farm Hollandse Kust (noord), which is partly owned by Shell and Eneco (through the CrossWind Consortium). The renewable hydrogen produced will be supplied to the Shell Energy and Chemicals Park in Rotterdam, through the HyTransPort pipeline.
- [NortH2](#), an international consortium consisting of Equinor, Eneco, Gasunie, Groningen Seaports, RWE en Shell Nederland, is studying the feasibility of realising 3-4 GW of offshore wind power to produce around 800,000 tons of green by 2030, with an outlook towards 10 GW offshore wind power in 2040. The final concept is announced to be adopted mid-2022 and then further developed towards FID in 2024.
- H2 Conversion Park, a cooperation between BP, Deltalinqs, Nouryon, Port of Rotterdam and Shell, aims to build a 2 GW conversion park for large scale hydrogen production on the Maasvlakte in Rotterdam. From this central hydrogen production location, the hydrogen can be transported via an open access hydrogen backbone towards companies in the port of Rotterdam area. The first electrolysers that have been announced are Shell’s 150-250

MW electrolyser to become operational in 2023, and BP and Nouryon's H2-Fifty 250 MW electrolyser scheduled to become operational in 2025.

- [ELYgator](#), an Air Liquide project that will consist of a 200MW water electrolyser sourced from renewable power sources that will produce over 18,000 tons of renewable hydrogen per year, avoiding 4 million tons of CO₂ over the first 10 years of the plant's operation. The unit is planned to become operational in 2024.
- Energiepark Eemshaven-West, a Vattenfall project which aims to produce 100% renewable hydrogen in the Eemshaven-West area, by connecting wind and solar electricity production directly to an electrolyser and a battery, in order to decarbonise the mobility and industry sector. The green hydrogen is scheduled to be produced with a 10 MW electrolyser as from 2024, after which a ramp-up will take place towards 100 MW by 2027.
- [H2ermes](#), a project under development by Nouryon, Tata Steel and Port of Amsterdam aimed at establishing a 100 MW electrolysis plant on the Tata Steel site capable of producing 15,000 tons of green hydrogen per year with which Tata Steel can reduce the carbon footprint of its steel production.

Last updated December 2022

Norway

Ashurst collaborated with Schjødt in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, the Norwegian Government have launched both a [hydrogen strategy](#) and a [roadmap](#).

The former Norwegian Government published a Hydrogen Strategy on 3 June 2020 and an energy specific Road Map on 11 June 2020. The Road Map mentioned hydrogen 252 times, whilst also proposing the establishment of five maritime hydrogen junction points along the coast of Norway connected to onshore industry. Moreover, a target was set to develop five to ten hydrogen pilot projects by 2030. The so-called 'Heilo – Cooperation' was established by the Norwegian Research Council, Gassnova, Innovation Norway and Enova. Heilo provides an overview of all public support to decarbonise Norway, and a substantial section is dedicated to hydrogen projects.

Additionally, the newly formed Norwegian Government proposed to establish a hydrogen chain in their Hurdal Platform (the mission statement). This will set thresholds to produce blue and green hydrogen by 2030, particularly supporting hydrogen projects being constructed for the maritime and industrial sectors. This was followed up by the State Budget 2022, which allocated 8 MNOK 'to further research on hydrogen, 220 MNOK for the hydrogen maritime conjunction points, and 550 MNOK for the green transition to be distributed through Enova.

2. What are key goals and commitments included in the strategy/policy?

Clean hydrogen is a key part of the Norwegian Government's decarbonisation strategy.

Norway is the third largest exporter of natural gas in the world behind Russia and Qatar. Norway also supplies between 20 and 25 % of the EU gas demand, making it the second largest supplier to the EU. Approximately half of EU/EEAs capacity of hydropower magazines are also placed in Norway.

Due to its significant resources of gas and hydropower, Norway is a country which can provide the primary energy required for production of hydrogen from existing accessible energy resources in a cost-effective way and with competitive prices.

Since Norway's electricity production is nearly 100 % renewable, the Strategy and the Road Map provide that hydrogen is to be used for the hard to abate sectors such as the maritime sector, heavy transport, and general industry.

Hydrogen will be produced by electrolysis and from natural gas combined with CCS. Ammonia will also be a key product in this regard.

There are, however, no established targets for green or blue hydrogen even though the Hurdal Platform has envisaged that such targets will be established by 2030.

Nevertheless, climate targets regarding the cutting of emissions have been set to 50 - 55% by 2030 and climate sub-targets for certain sectors such as maritime have also been set. For example, all ferries and charter boats in coastal waters in Norway will be required to be zero emission vessels by 2026.

It is also worth noting that the current Norwegian Government issued a new export strategy on 10 March 2022 stating that offshore wind and green shipping are some of the key initiatives where hydrogen is expected to be an important contributor.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The power sector in Norway is nearly 100% fuelled by renewable energy due to the hydropower resources. As such, Norway does not have a downstream gas market but is a net exporter of gas. Heating is either covered by district heating or through direct electrification. Power and heating sectors are therefore already decarbonised in Norway.

Consequently, the industry sectors likely to be affected by hydrogen deployment are the hard to abate sectors, including:

- road transport;
- shipping and aviation; and
- general industry.

4. Who are the main regulators for the hydrogen market?

N/A

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The Hydrogen Strategy supports both low-carbon hydrogen and renewable hydrogen. This can be explained by Norway's significant resources i.e. hydropower and natural gas.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

In Norway, the Government has been providing substantial support for carbon capture and storage for more than a decade. Gassnova SF, a state-owned entity, was established in 2005 to promote technological development, and build competence for cost-effective and future-oriented solutions for CCS. Gassnova shall facilitate the Norwegian State's participation in CCS projects to provide maximum benefit for the State or State-owned entities.

As of today, the Norwegian CCS initiative consists of three main elements:

- the [CLIMIT programme](#), which provides financial support for development of CCS technology;
- the [Technology Centre Mongstad \(TCM\)](#), which is the world's largest and most flexible test centre for developing CO2 capture technologies and a leading competence centre for carbon capture. The State (being the majority owner) owns TCM together with Equinor, Shell and Total; and

the [Longship project](#).

Longship is one of the first industrial CCS projects to develop an open access infrastructure with the intent and the capacity to store significant volumes of CO2 from across the European continent. It consists of two capture projects, Norcem (cement production) and Fortum Oslo Varme (waste to energy plant) and a transportation and storage project, Northern Lights. The Government provides substantial financial support to the Longship project, both for capital and operational expenditures.

On the regulatory side, Norway has implemented the CO2 Storage Directive through separate CO2 Storage Regulations.

7. Are there targets for the production of hydrogen?

No targets have yet been set beyond the high level target of 50-55 % emissions cut by 2030. However, in the Government's Hurdal Platform it is suggested that hydrogen production targets will be set.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are several incentive mechanisms in place already.

Significant state funding is granted through Enova, the Norwegian Research Council, and Innovation Norway.

Moreover, two Research Centres for hydrogen have been established. The Norwegian Government announced the establishment of two new Research Councils in Trondheim and Bergen in early March 2022. These are connected to several other academic and industrial Clusters in Norway: [HYDROGENi](#) and [HyValue](#).

Norway has also joined Europe's IPCEI (Important Project for Common Interest) initiative for hydrogen.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are no existing standards in place for the classification of hydrogen, however in the Hydrogen Strategy, the Government states that green hydrogen will be produced from electricity from the grid, which is already fully renewable energy. The Strategy also refers to production from natural gas with carbon capture and storage.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation, or supply of hydrogen?

The existing regulatory framework defines safety standards for hydrogen referring to the regulation for dangerous substances.

Norway is also linked to the European internal market by the EEA-Agreement. The European Commission presented its Hydrogen and Decarbonisation Package on 15 December 2021. Given the third liberalisation package incorporates both the power and gas market into the EEA Agreement, this Hydrogen and Decarbonisation Package is expected to be EEA-relevant.

However, it is worth noting that RED II in the Clean Energy Package is still not incorporated into the EEA Agreement - it is currently under negotiations between the EU and the EEA EFTA States.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

There are no limitations to foreign investment in hydrogen production or infrastructure. However, the hydropower installations are publicly owned, whilst the exploitation of oil and gas resources are open to qualified private investments.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Norway is part of the European Internal Market and is recognised for its stability, democratic rule and its openness and transparent protection of foreign investments, particularly at the Norwegian Continental Shelf.

The Energy Charter Treaty (ECT) is a multilateral investment treaty which entered into force in April 1998. It specifically addresses energy trade, transit, and investment between its contracting parties, which include the UK and all EU states (except Italy). Discussions as to the modernisation of the ECT have been ongoing for several years, focussing on investment protection and "greening" the ECT. Norway has however, not ratified this Treaty.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

There has been a number of different funding initiatives targeted at different parts of the hydrogen value chain. Funds are channelled through Enova, Innovation Norway, and the Norwegian Research Council.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being deployed in Norway to examine and test the feasibility of clean hydrogen production and use in different sectors. Projects that have already been granted funds are as follows:

- [Yara International](#): received state aid estimated to 283 MNOK – Yara has been granted 283.25 MNOK from Enova to produce ammonia. Yara officially takes the first step towards full decarbonisation of the ammonia plant at Herøya in Porsgrunn. Yara's fertilizer factory at Herøya is one of Norway's largest sources of CO2 emissions after the oil and gas industry, releasing 800.000 tonnes of CO2 annually. A crucial element in fertilizer production is hydrogen which is converted into ammonia. By producing hydrogen based on renewable energy, Yara will be able to create

emission-free ammonia. Read more [here](#).

- Tizir Titanium and Iron AS: received state aid estimated to 261 MNOK. Tizir will carry out a development and demonstration project that will lead to the use of hydrogen instead of coal to reduce ilmenite at the smelter in Tyssedal. Through this project, new technology will be developed which will enable Tizir to build a full-scale plant in the future, replacing 85 % of coal consumption with hydrogen. Read more [here](#).
- [Horisont Energi](#): received state aid estimated to MNOK 482. Through the Barents Blue Project, Horisont Energi will establish ammonia production from natural gas with carbon capture and storage near Hammerfest in Finnmark. The project will use new and efficient technology and will be implemented by a joint venture to be established together with Equinor and Vår Energi. Read more [here](#).

The project of Tizir and Horisont Energi are also nominated as Norwegian contributions to IPCEI Hydrogen.

For all three projects, it is a prerequisite that the grants will be approved by the EFTA Surveillance Authority.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Norway. However, there are a number of projects in the pipeline at different stages of development. There is an increasing activity in the M&A sector where investors are already funding hydrogen production and development of the hydrogen value chain.

Last updated July 2022

Oman

Policy and regulation

1. Is there a government hydrogen strategy or policy?

No. There is currently no published national strategy relating specifically to hydrogen. However, Oman is actively pursuing a transition from relying on energy derived from hydrocarbons to renewable energy and is establishing a green economy as part of its national objectives (which are set out in Oman Vision 2040) and its recent commitment to reach net zero emission by 2050 (in line with the Paris Agreement). As part of this transition, the Oman government has recently increased its efforts to establish a vibrant hydrogen sector in Oman by pursuing various hydrogen projects. In March 2022, the Oman government also issued Royal directives which set out the steps Oman is taking to establish a framework for growth and investment in the sector.

Oman Vision 2040

In its national strategy document, Oman Vision 2040, Oman has identified “environment and natural resources” as a key focus area and has set out its key objectives. These include developing “a green and circular economy that addresses national needs and moves consistently with global trends”. Oman Vision 2040 further provides that “new infrastructure projects will be geared towards a green economy, green strategies and renewable energy production”. Oman has also set ambitious targets to meet 20% of its national energy demand by 2030 and, by 2040, to meet between 35% and 39% of its national energy demand.

Royal directives

In March 2022, Royal directives relating to the hydrogen sector were issued. The directives mandate the development of a legal framework and policies necessary for:

- the growth of the hydrogen industry;
- the allocation of sites for production of green hydrogen (focusing on attracting foreign investment);
- the conduct of studies;
- the establishment of new government structures within the Ministry of Energy and Minerals; and
- the establishment of a new state entity.

The Oman government recently announced the establishment of a new state-owned entity called Hydrogen Oman in line with the directives.

2. What are key goals and commitments included in the strategy/policy?

Please see our responses to question 1.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

Given that the hydrogen sector in Oman is still an emerging industry, it is difficult to predict which industry sectors are likely to be affected. The Oman government has stated that projects are being developed to meet local demands, including from the electricity and heavy industry (such as iron and aluminium) sectors, as well as global demands.

4. Who are the main regulators for the hydrogen market?

There is currently no specific regulatory body governing the hydrogen sector in Oman. However, the Royal directives of March 2022 relating to the hydrogen sector mandate the development of a legal framework and policies necessary for the establishment of new government structures within the Ministry of Energy and Minerals.

5. Does the government hydrogen strategy or policy support the development of both low-

carbon (blue) hydrogen and renewable (green) hydrogen?

There is currently no published national strategy on hydrogen. However, the Minister of Energy and Minerals of Oman announced that Oman will target an annual green hydrogen production of one million tons by 2030.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

N/A. There is currently no published national strategy on hydrogen.

7. Are there targets for the production of hydrogen?

There is currently no published national strategy on hydrogen. However, the Minister of Energy and Minerals of Oman announced that Oman will target green hydrogen production of one million tons by 2030.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are currently no financial or regulatory incentives to promote or support the production of hydrogen.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

We are not aware of any standards relating to the classification and/or certification of low-carbon or renewable hydrogen.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

There is currently no legal or regulatory framework which regulates hydrogen. Oman is currently in the process of developing such a framework.

The [Law for the Regulation and Privatisation of the Electricity and Related Water Sector promulgated by Royal Decree 78/2004](#) (the Sector Law) regulates the generation, transmission and distribution of all electricity.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

At present there are no restrictions relating to foreign investments in the energy and infrastructure sectors in Oman. The Sector Law allows 100% foreign ownership of companies that generate electricity through renewable energy. However, publicly tendered IPPs (including for renewable energy projects) in Oman typically include an obligation to list a minority shareholding in the project company on the local securities exchange for a specified period following commencement of commercial operations.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Oman is a party to international treaties relating to enforcement of foreign arbitral awards and judgments in Oman. While the Civil Procedure Law of Oman promulgated by Royal Decree 29/2002 does provide a framework for enforcement of foreign arbitral awards and judgments in Oman, the international treaties significantly enhance an international investor's ability to enforce (without the need to re-examine or re-litigate) where the arbitral awards or judgments are issued from other member states.

Enforcement of arbitration awards

Oman is a party to the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards of 1958 (the [New York Convention](#)) which it acceded to in 1998 and the Riyadh Arab Convention for Judicial Co-operation of 1983 (the [Riyadh Convention](#)) which it ratified in 1999. Where an arbitration award is issued from a member state of either the New York Convention or the Riyadh Convention, the courts of Oman should enforce such awards unless a party can raise valid grounds for refusing enforcement under the conventions or that the subject matter of the award

is against Oman public policy.

International investors can therefore agree to dispute by arbitration outside of Oman. Member states of the New York Convention, in particular, include arbitration seats widely used in cross-border transactions such as the United Kingdom, Singapore, United States of America, Switzerland and the United Arab Emirates.

Enforcement of judgments

Oman is party to both the Riyadh Convention and the he Gulf Cooperation Council Treaty for the Enforcement of Judgments, Judicial Delegation and Court Summons signed in 1996 (the [AGCC Protocol](#)) which, similar to the arbitration conventions, provide enhances the ability of investors to enforce foreign judgments issued from the courts of member states. .

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

We are not aware of any funding programmes or government grants set up for hydrogen projects.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

[Sohar Industrial Port](#) has announced its plans to turn the port into a hub for lower-cost hydrogen in place of traditional hydrocarbons, as well as plans to develop 3.5GW of solar power capacity.

State-owned OQ Alternative Energy has collaborated with Belgium's DEME Concessions to develop a [green hydrogen project in Duqm](#).

ACME Group have announced a [second, green hydrogen project](#) in partnership with the state-owned Tatweer. The project is expected to include a \$3.5 billion green ammonia plant.

The new state-owned entity, Hydrogen Oman is also expected to launch a public bid round in early November 2022 with the aim of awarding six blocks of land by 2023 for the development of green hydrogen projects.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

Oman has announced a number of sizeable plans and has entered into several MOUs and agreements for feasibility studies in relation to clean hydrogen projects. However, these are currently in their early stages.

Last updated December 2022

Portugal

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Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, the National Hydrogen Strategy (Estratégia Nacional para o Hidrogénio or “**EN-H2**”) was approved by Resolution of the Council of Ministers no. 63/2020, of 14 August 2020.

2. What are key goals and commitments included in the strategy/policy?

The EN-H2 is aligned with the 2050 Carbon Neutral Roadmap, approved by Resolution of the Council of Ministers no. 107/2019, of 1 July, which establishes the goal to achieve a carbon neutral economy by 2050, as well as with the National Climate and Energy Plan 2030, approved by Resolution of the Council of Ministers no. 53/2020, of 10 July, which constitutes the main instrument of the national energy and climate policy for the next decade towards a carbon neutral future.

In this context, Portugal envisages a key role for hydrogen in reducing emissions in difficult-to-decarbonize sectors and in end-uses, assuming as main goals for 2030:

- 2% to 5% of green hydrogen in energy consumption of the industry sector;
- 1% to 5% of green hydrogen in energy consumption of the road transport sector;
- 3% to 5% of green hydrogen in energy consumption of the domestic shipping sector;
- 1,5% to 2% of green hydrogen in final energy consumption;
- 10% to 15% of green hydrogen injection into natural gas grids;
- 50 to 100 hydrogen refuelling stations;
- 2GW to 2.5 GW of installed capacity in electrolyzers; and
- 50 to 100 hydrogen supply stations.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

Portugal's strategy focuses on deploying green hydrogen to promote decarbonisation of the following sectors: industry, transports and electricity.

On the industry front, the most likely to benefit from hydrogen as an option to decarbonise are the metal, cement, refining, chemical, extractive, food, glass and ceramics industries.

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

EN-H2 only supports the development of renewable (green) hydrogen.

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

N/A.

6. Are there targets for the production of hydrogen?

Portugal's target is to have an installed capacity up to 2,5GW by 2030 to produce green hydrogen through electrolyzers.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

At a national level, the Portuguese Government intends to implement a support scheme for green hydrogen production in 2020-2030 – a transparent and competitive mechanism that provides support by covering the difference between the production price of green hydrogen and the price of natural gas in the national market. The funds expected to be allocated to this mechanism are around 500 to 550 million euros.

Additionally, PO SEUR - Operational Programme for Sustainability and Efficient Use of Resources, established through an Execution Decision from the European Commission on 16 December 2014, issued an invitation in December 2020 calling for applications of renewable gas generation projects (including green hydrogen) with a view to grant a total of 40 million Euros to such projects.

The Portuguese Government has also launched, under Order nr. 6403-A/2020, of 17 June, a call for interested parties to manifest interest in participating in the Hydrogen Important Projects of Common European Interest (IPCEI) and, out of 74 interested parties, 37 have been considered eligible to constitute an IPCEI.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

The EU's current energy regulatory framework does not provide exact standards to define renewable ("green") and low-carbon ("blue") hydrogen. This legal uncertainty has hampered the role-out of green and blue hydrogen markets and infrastructure in the EU. To correct this, the European Commission legislative Package on Hydrogen and Decarbonized Markets introduced new legal definitions of renewable and low-carbon hydrogen that the Commission will be empowered to detail by adopting specific calculation methodologies and threshold determinations in delegated acts. The package includes a proposal for an EU Directive on Common Rules for the Internal Markets in Renewable and Natural Gases and in Hydrogen ("Proposed Gas and Hydrogen Directive").

The Proposed Gas and Hydrogen Directive includes definitions of renewable and low-carbon hydrogen that are in line with those of the proposal to amend the Renewable Energies Directive II ("Proposed Directive to Amend RED II"):

- Renewable hydrogen is defined by reference to the definition of the Proposed Directive to Amend RED II, as hydrogen that (i) derives its energy content from renewable sources other than biomass; and (ii) achieves a 70% GHG emission reduction compared to fossil fuels; and
- Low-carbon hydrogen is defined as hydrogen with an energy content that is derived from non-renewable sources, and that meets a GHG emission reduction threshold of 70% compared to fossil-based hydrogen.

Thus, the proposed main difference between renewable and low-carbon hydrogen would be the production process of the hydrogen and, in particular, the source of the energy that is used to produce hydrogen. This approach would allow low-carbon hydrogen to play a role in decarbonization and facilitate the energy transition until 2030. The expectation is that by 2030 the EU will introduce a stricter GHG reduction threshold for the definition of low-carbon hydrogen.

In Portugal, the legal framework for the organization and operation of the National Gas System (regime jurídico da organização e funcionamento do Sistema Nacional de Gás), approved by Decree-Law No. 62/2020, of 28 August, establishes the following definitions:

- Low-carbon gases are gaseous fuels produced from a process using energy from non-renewable sources whose carbon emissions correspond to less than 36.4 gCO₂(index 2)-eq/MJ; and
- Gases of renewable origin are gaseous fuels produced from processes using energy from renewable sources within the meaning of Directive (EU) 2018/2001 (which establishes that "energy from renewable sources" or "renewable energy" means energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas»).

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

Although the national regulatory framework is not yet highly detailed, the Directorate General for Energy and Geology (Direção-Geral de Energia e Geologia or DGEG) and the Portuguese Environment Agency (Agência Portuguesa do

Ambiente or APA) have published a Promoter's Guide on "Legislation and Regulation for the Hydrogen Economy", establishing that the production of green hydrogen, as a gaseous fuel of renewable origin, falls within the framework of the Responsible Industry Regime (Sistema de Indústria Responsável or SIR), annexed to Decree-Law no. 169/2012, of 1 August, which regime governs the prior administrative control of facilities intended for the production of gases of renewable origin in general.

Moreover, the legal framework for the organization and operation of the National Gas System, which provides for the regulation of the activities of production of low carbon gases and gases of renewable origin, determines that, in order to carry out these activities, interested parties must register in advance as producers of such gases, pursuant to Articles 69 et seq. of that legal framework.

Regarding the need for Environmental Impact Assessment (Avaliação de Impacte Ambiental), established by Decree-Law no. 151-B/2013, of 31 October, the law does not determine specifically that hydrogen projects are subject to such procedure. However, according to the abovementioned Promoter's Guide, the need to subject hydrogen production, transportation and storage projects to an environmental impact assessment procedure must be assessed in light of the activities that, pursuant to the abovementioned legal framework, may be obliged to carry out such procedure, in particular the following:

- Production: "integrated chemical process" and "treatment of intermediates and manufacture of chemicals";
- Storage: "surface and underground storage of fuels";
- Transportation: "Pipelines with a diameter of more than 800 mm and a length exceeding 40 km, for the transportation of gas" and "industrial installations for the transportation of gas";
- Associated projects: "water collection and transportation", "wind and solar photovoltaic power plants" and "infrastructures associated with electricity transmission".

Hydrogen is also one of the substances that falls within the scope of the Prevention of Severe Accidents Regime (regime jurídico da prevenção de acidentes graves), approved by Decree-Law no. 150/2015, of 5 August. Facilities where this substance is present in quantities equal to or greater than 5 tons (lower level) and 50 tons (upper level) are subject to a number of obligations, including communication obligations (Articles 14 and 15) and location compatibility assessment (Article 8), as well as the definition of a severe accident prevention policy (Article 16).

In addition, the operation of facilities where hydrogen production activities are carried out is conditional on obtaining an environmental licensing decision.

Decree-Law no. 12/2020, of 6 April, establishes the legal framework applicable to the Greenhouse Gas Emissions Trading Regime (regime jurídico aplicável ao comércio de licenças de emissão de gases com efeito de estufa), transposing Directive (EU) 2018/410 into national law. Under this regime and according to the provisions of Annex II, the production of hydrogen – specifically the production of hydrogen and synthesis gas by reforming or partial oxidation with a production capacity exceeding 25 tons per day, from which results in greenhouse gas emissions – is included in the scope of such legal regime. Therefore, depending on the type of project in question (depending on the type of technology, raw material and primary energy source used for the production of hydrogen or synthesis gas) it may or may be subject to the legal obligations set out in the abovementioned decree-law. Typically, green hydrogen projects based on the electrolysis of water using renewable energy sources (such as solar energy) are not covered by this regime.

It should be noted that the aforementioned diploma is also not applicable to facilities or parts of facilities used for research, development and testing of new products and processes, as well as to facilities using exclusively biomass, including equipment using fossil fuels only during start-up and shut-down situations.

Depending on the production process, the hydrogen production activity may also be covered by Decree-Law no. 39/2018, of 11 June, the Air Emissions Legal Regime (regime de emissões para o ar or REAR), which establishes the regime for the prevention and control of emissions of pollutants into the air, as it may be considered an activity of chemical products manufacture.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

There are no foreign investment restrictions related to energy and infrastructure sectors.

Please note, however, that the Council of Ministers may oppose to transactions resulting, directly or indirectly, in the

acquisition of direct or indirect control, by an entity from outside the European Union and the European Economic Area, over strategic assets (such as the ones that are necessary to provide essential energy services) if such transactions will likely and seriously threaten national security or the country's security of supply.

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Portugal is a signatory to the Energy Charter Treaty (ECT), an international agreement that entered into force in April 1998, which specifically addresses energy trade, transit and investment between its contracting parties, providing additional legal protection for international investments in the energy sector in signatory countries.

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

The Portuguese Recovery and Resilience Plan (Plano de Recuperação e Resiliência or PRR) establishes a set of reforms and public and private investments to be implemented in Portugal until 2026 with the European Union financial support, granted under the Recovery and Resilience Facility (as outlined in [Regulation \(EU\) 2021/241](#)) – particularly in what concerns the Climate Transition dimension, as 38% of the PRR's total allocation for reforms and investments is intended to support climate objectives, by means of measures such as supporting private projects for the production of hydrogen and use of other renewable energy sources, amid other energy transition measures.

The Portuguese government also instated the Environmental Fund (Fundo Ambiental), aimed at supporting sustainable development and climate change projects, and which revenues come from the carbon emission licenses auctions, the carbon tax on aviation, and maritime and fluvial travels, environmental administrative penalties, taxes such as the ISP (Tax on Petroleum and Energy Products), among others. The funding of the “Green Pipeline Project”, a pilot project for the injection of green hydrogen into the natural gas grid and decarbonisation of the energy sector, is one example of the support being provided by this fund.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being developed in Portugal regarding clean hydrogen production, among which:

- “Green Pipeline Project”: pilot project for the injection of green hydrogen into the natural gas grid and decarbonisation of the energy sector, under which the Portuguese government has authorised a fund of 867,692 euros until 2024;
- Creation of a Collaborative Laboratory (COLAB) for the development of R&D activities around the main relevant components of the hydrogen value chain.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Portugal, but there are some projects under development (in different stages of development), mainly in the area of Sines and only a few in other industrial or port areas. One of the projects located in Sines is set to start production in 2026.

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Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes. The National Development and Reform Commission (“**NDRC**”) published a comprehensive Medium-to-Long Term Plan for the Development of Hydrogen Industry (“**Hydrogen Plan**”) in March 2022, laying out the government’s overall policy and strategy on the hydrogen industry.

The key themes in the Hydrogen Plan are:

- Making it clear that hydrogen is a critical component of China’s national energy system in the future.
- Recognizing hydrogen as an important medium in transitioning the energy consumption to a green and low-carbon manner.
- Emphasizing the hydrogen industry as a strategic new industry.

2. What are key goals and commitments included in the strategy/policy?

The Hydrogen Plan lays out a three-stage development program with the relevant key goals as follows:

Phase	Key Goals
1 – by 2025	<ul style="list-style-type: none"> • Develop a relatively mature policy and institutional framework for the hydrogen industry • Maintain a basic level of control over the key technologies and manufacturing processes • Achieve substantive milestones in pilot projects • Establish a rudimentary supply of hydrogen based mainly on industrial by-product hydrogen and green hydrogen primarily targeted for near-site consumption • 50,000 fuel-cell vehicles in use
2 – by 2030	<ul style="list-style-type: none"> • Develop a complete system of hydrogen technological innovation and green hydrogen production and supply • Establish an orderly industrial supply chain • Achieve widespread application of green hydrogen
3 – by 2035	<ul style="list-style-type: none"> • Establish a mature hydrogen industry • Establish a hydrogen ecosystem with diversified application in sectors including transportation, energy storage and industrial process • Green hydrogen’s contribution to the energy consumption has increased significantly as an important pillar in supporting the green transition of the energy industry

As of now, China has not set out specific goals beyond 2025 for the production of hydrogen or green hydrogen or its contribution to the energy consumption. However,

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industries that conventionally use fossil fuel as their primary energy source and manufacturing inputs are anticipated to be affected the most by hydrogen deployment. Some examples are as follows:

- Power (as one of the energy storage methods in addition to pumped hydro and battery storage; distributed fuel-cell power generation facilities in specific locations)

- Infrastructure (for hydrogen distribution, e.g., piping and hydrogen stations)
- Automobile and other mobility sectors (hydrogen-powered mobility, transportation and logistics, with a particular emphasis on fuel-cell medium and heavy duty trucks)
- Steel, petrochemistry, metallurgy (shifting from conventional fuel (e.g., coal and gas) to hydrogen for generation of power in industrial process, use of hydrogen as deoxidiser, expanding the replacement of conventional fossil fuel inputs with hydrogen in petrochemical process)

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The Hydrogen Plan does not lay out a specific national plan for the production of blue and green hydrogen, envisaging both grey and green hydrogen to be produced in light of the local resources and industries. A diversified hydrogen production system that is clean, low-carbon and low-cost will be gradually built.

In places with clustered coking, chlorine alkali and PDH industries, utilisation of industrial by-product hydrogen should be preferred. However, there is also a general policy push for carbon capture, utilisation and storage (CCUS) under China's zero-carbon policy, which presumably applies to the current grey hydrogen industry as well.

Green hydrogen, on the other hand, has been singled out for emphasis in the Hydrogen Plan, with areas of plenty renewable resources encouraged to develop green hydrogen projects on a pilot basis.

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

In a national policy paper issued in September 2021 following China's announcement of its goals for carbon-peak and zero-carbon, CCUS has been listed as an area for technological improvement, pilot project development and commercialisation. While China has promoted the experimentation and pilot projects in CCUS area since early 2010s, so far China's progress in most sub-fields of CCUS sector remains limited to the pre-commercialization stage. As of the end of 2021, it is estimated that about 21 CCUS pilot or commercial projects are still running, mostly in relation to coal-fired power plants and enhanced oil/gas recovery projects.

In terms of policy incentives, CCUS has been listed as an encouraged sector for foreign direct investment and included in the PRC central bank's financing support for carbon-reducing projects. It remains to be seen if the government will issue further, more specific incentives in this regard.

6. Are there targets for the production of hydrogen?

As of 2021, China's annual hydrogen production is about 33 million tonnes, of which 12 million tonnes are of industrial quality.

The government has not set out any specific target for hydrogen production save that the Hydrogen Plan targets the green hydrogen production to reach a modest 100,000 to 200,000 tonnes by 2025.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

On the national level, the following hydrogen related projects have been listed as encouraged category and thus are capable of enjoying the general policy benefits applicable to encouraged industries:

- Technological development and application of the complementary system of hydrogen and solar and wind power generation.
- Technological development and application and equipment manufacturing in high-efficiency hydrogen production, hydrogen transportation and high-density hydrogen storage.

Some of the more developed regions in China, on the other hand, have promulgated more specific measures to incentivize the development of hydrogen industries, including setting out specific targets for hydrogen production, hydrogen filling stations and fuel cell vehicles. These measures are constantly evolving and investors are expected to approach the authorities for more details for any particular project.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There is no classification and/or certification of low-carbon or renewable hydrogen in China. Some local government (such as Beijing) has indicated their plan to establish certification standards for certifying renewable hydrogen in the coming years and industry bodies have been pushing for issuance of national standards in this regard in recent years, including convergence of national standards with international ones.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The regulatory requirements relating to the production, storage, transportation or supply of hydrogen are scattered and lack consistency. There have been a few industry standards issued in relation to the specific components of the hydrogen supply chain but most of them are rudimentary.

Recognising the problem, the National Energy Agency under NDRC issued a standardisation-related work plan for the energy sector, which includes the following key workstreams for the hydrogen industry:

- Fast pace the top-level design and system set-up for hydrogen related standards.
- Carry out the research and preparation of the standards for the production, storage, transportation, filling and diversified application of hydrogen to support the full development of the hydrogen industry chain.
- Pay particular attention to developing standards in relation to renewables hydrogen, complementary use of power and hydrogen, fuel cell and related system.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

China is generally supportive of foreign investment in the energy sector. In terms of power sector, the only restriction is that nuclear power plants must be majority owned by Chinese investors.

In addition, foreign investment in both large-scale conventional power plants and renewables/clean energy power plants is encouraged, including:

- Production, storage, transportation and liquefaction of green hydrogen
- Manufacturing of equipment for production, storage, transportation and safety-check of hydrogen
- Renewables power plants including solar, wind, geothermal etc
- Waste to energy projects
- Hydrogen filling stations
- New power storage equipment including hydrogen-related

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website states that China is a signatory to about 120 bilateral investment treaties (BITs) that are in force as at December 2022, and in addition certain other treaties may contain protections for investors in South Korea. These can be accessed from [UNCTAD's Investment Policy Hub](#).

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

China's government grants, subsidies and funding for the hydrogen sector are scattered among the many policy documents issued by both the national and local governments, with the local governments providing more specific funding in most cases. So far, there is no specific grant or funding for hydrogen production projects per se but the following measures are illustrations of how the grants, subsidies or funding may be obtained in practice for hydrogen investors:

- Currently, there are various national and local subsidies for purchasing fuel cell vehicles and for breakthroughs in fuel cell vehicle related technologies, in particular of those that can be demonstrated as being capable of commercialization. Reduced tariffs also apply to the import of key upstream equipment used in the manufacturing of fuel cell vehicles.
- Some local governments has issued policies granting subsidies for building hydrogen filling stations on a per station basis in amount reaching RMB 1.5 to 2.5 million.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

It appears that most of the demonstration projects in China so far have been undertaken by the SOE power majors – the following being some recent examples:

- Sinopec is nearing the completion of its first large-scale green hydrogen project in Kuche, Xinjiang. The project is expected to be operational by mid-2023 and capable of producing 20,000 tons of hydrogen per year using PV-generated electricity.
- SPIC started in late 2022 a solar and wind power supported green hydrogen to ammonia demonstration project in Baicheng, Jilin. The project is expected to generate green hydrogen of 32,000 tons per year (which can then be converted into green ammonia of 180,000 tons per year) by utilizing a power installation capacity of 800MW.
- Three Gorges Group started a PV-based hydrogen project with 750MW capacity, expected to generate 10,000 tons of green hydrogen per year, in Erdos, Neimenggu, in mid-2022.

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

Due to cost and technological constraints, so far there is no reported commercial scale green hydrogen project in China.

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Saudi Arabia

Policy and regulation

1. Is there a government hydrogen strategy or policy?

As of now and to the best of our knowledge, no national hydrogen strategy/policy has been launched as yet, the Kingdom has launched National Industry Strategy, which aims to reach an industrial economy that attracts investment and contributes to achieving economic diversification, developing domestic product and non-oil exports, in line with the objectives of the Saudi Vision 2030.

2. What are key goals and commitments included in the strategy/policy?

During Saudi-South African Investment Forum, 11 agreements and memoranda of understanding were signed in the public and private sectors in energy, water, green hydrogen, waste diversion, logistics, and aerial survey services, aimed at promoting the developing investment sectors between the two countries and between the Middle East and South Africa region. www.spa.gov.sa/2392578.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The Ministry of Investment has signed a memorandum of understanding with Alstom Company. The MoU aims to explore the future of sustainable transport in the Kingdom of Saudi Arabia and identify investment opportunities in the public transport sector related to railway infrastructure, sustainable transport technologies and reducing carbon emissions, in line with the objectives of the Kingdom's Vision 2030. www.spa.gov.sa/2374677.

4. Who are the main regulators for the hydrogen market?

Given all above mentioned MoU's were signed by the Minister of Energy, it can be assumed that The Ministry of Energy, Industry and Mineral Resources will be regarded as the main agency having oversight of the hydrogen market in Saudi Arabia, despite not being appointed a regulator per se. It is expected the National Hydrogen Strategy might address the question of a hydrogen market regulator once published.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

As stated above, there is no strategy or policy available in the public domain. However, through Saudi's public announcements, it can be inferred that Saudi Arabia has the required resources to pursue a green or blue hydrogen strategy. The Eastern region is more likely to produce and export blue hydrogen while the Western region would be suitable for producing green hydrogen with the development of renewable energy resources.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

As previously stated, there has been no information released in the public domain of a strategy or policy that can determine to what extent carbon capture and storage would be taken further.

7. Are there targets for the production of hydrogen?

Kindly refer to Question 13.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

For the plans that have been confirmed and released to public domain, refer to Question 13.

Theoretically, Saudi's endorsement to '[The Circular Carbon Economy framework](#)' could be deemed significant and provide an idea of where future business models and incentive mechanisms would be put in place to support the

production of hydrogen.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There is currently no defined statement in the public domain regarding the classification or certification of low carbon and/or hydrogen from renewable resources.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation, or supply of hydrogen?

There is no dedicated legislation for hydrogen.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

If it falls under the activity (oil exploration, drilling and production) it would be excluded from foreign investment.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

- We are not aware of any international treaty; however Saudi Aramco is a member of the Hydrogen Council.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

Research and development grants regarding hydrogen projects are being executed at King Abdullah Petroleum Studies and Research Center (KAPSARC) and the King Abdullah University of Science and Technology (KAUST).

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

- Saudi Arabia has catalysed the expansion of hydrogen in September 2020. [Aramco and the Institute of Energy Economics, Japan, in partnership with SABIC, successfully demonstrated the production and shipment of blue ammonia from Saudi Arabia to Japan](#) with support from the Japanese Ministry of Economy, Trade and Industry. Forty tons of high-grade blue ammonia were dispatched to Japan for use in zero-carbon power generation. This was the world's first blue ammonia supply-chain demonstration – a significant milestone.
- Saudi plans to build the world's [largest export-oriented green ammonia plant in the city of Neom](#). Saudi's zero-carbon fuel plan is to build a four gigawatt plant completely powered by wind and solar energy. This electricity will produce 650 tonnes of hydrogen daily via water electrolysis in a process known as 'green' hydrogen. This hydrogen will be used to produce 1.2million tonnes of ammonia per year, which will be shipped from Saudi Arabia's western coast to markets in Europe and Asia. (Scheduled in 2025).
- On the 18th of June in 2019 [Saudi Aramco inaugurated the first hydrogen fuelling station in Saudi Arabia](#). This pilot station will fuel an initial fleet of six Toyota Mirai fuel cell electric vehicles with high purity compressed hydrogen.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

At present, projects plans in Saudi through public announcements as mentioned in Question 13.

Last updated December 2022

Singapore

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, Singapore published its National Hydrogen Strategy in October 2022, which can be found [here](#).

2. What are key goals and commitments included in the strategy/policy?

- Singapore believes that low-carbon hydrogen has the potential to be a major decarbonisation pathway to support Singapore's transition towards its committed target of net zero emissions by 2050. While not an explicit goal or commitment, the expectation is that hydrogen will complement and diversify Singapore's power mix alongside solar, imported electricity, and other potential low-carbon energy sources; and that (depending on technological developments and the development of other energy sources), hydrogen could supply up to half of Singapore's power needs by 2050 and play an important role in decarbonising Singapore's industry.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

Hydrogen deployment in Singapore is expected to be most likely relevant to the following industrial sectors:

- power generation
- manufacturing (both as a fuel and as a feedstock)
- maritime and aviation
- land transport

4. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

Singapore's National Hydrogen Strategy refers to "low-carbon hydrogen" and does not explicitly distinguish between blue hydrogen and green hydrogen.

5. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

Singapore expects to be a net hydrogen importer and the focus of the National Hydrogen Strategy is in developing the low-carbon hydrogen supply chain and value chain.

6. Are there targets for the production of hydrogen?

Singapore's National Hydrogen Strategy does not contain any explicit target for the domestic production of hydrogen.

7. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Singapore's National Hydrogen Strategy does not include any explicit incentive for the domestic production of hydrogen.

8. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

No. However, part of Singapore's National Hydrogen Strategy is to work collectively with international partners (governments and international organisations) on a number of relevant areas including the development of "Guarantee of Origin" certification methodologies to certify low-carbon hydrogen with verified emissions intensities.

9. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

Not specifically. However, certain existing laws will likely apply to various activities relating to hydrogen; for example:

- the *Fire Safety Act 1993* and the *Fire Safety (Petroleum and Flammable Materials) Regulations* regulate hydrogen as a “flammable material” and therefore regulates, among other things, certain acts in respect of hydrogen such as: (i) import; (ii) storage; (iii) dispensation; (iv) conveyance over pipelines; and (v) transportation;
- the *Maritime and Port Authority of Singapore Act 1995* and the *Maritime and Port Authority of Singapore (Dangerous Goods, Petroleum, and Explosives) Regulations 2005* designate compressed hydrogen as a “First Schedule dangerous good”, such that any vessel carrying compressed hydrogen is subject to certain restrictions on movement in certain prescribed areas of the Singapore ports as well as in relation to the handling, discharging and loading of compressed hydrogen;
- the *Gas Act 2001* defines “gas” as including “town gas” which is defined as “any substance in a gaseous state which is conveyed in gas pipes and is manufactured from petrochemical feedstock or natural gas, and has hydrogen as one of its main constituents” and this may capture some forms of hydrogen (though likely not low-carbon hydrogen); and
- the *Workplace Safety and Health Act 2006* and the *Workplace Safety and Health (Major Hazard Installations) Regulations 2017* set out hydrogen as a “dangerous substance”, so that any premises where processing, manufacturing or bulk storage by way of trade or for the purpose of gain is carried on in respect of hydrogen where a prescribed quantity of hydrogen is present or likely to be present, is deemed to be a “major hazard installation” and subject to more stringent workplace health and safety requirements.

10. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Singapore operates a generally open policy towards foreign investment and there are no restrictions expressly targeted against foreign investment relating to the energy and infrastructure sectors. It should also be noted that Singapore offers a number of incentives such as tax breaks and grants to encourage international companies to base their regional headquarters or other key facilities in Singapore.

11. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website states that Singapore is a signatory to 38 bilateral investment treaties (BITs) and 33 treaties with investment protections (TIPs) that are in force, as well as a number of Investment Related Instruments (IRIs) – these can be accessed from the online database maintained by UNCTAD’s Investment Policy Hub [here](#). Singapore’s “Enterprise Singapore” agency also maintains an online database of bilateral and regional free trade agreements (FTAs) that Singapore is party to, which may contain protections for investors in Singapore; these can be accessed [here](#).

Market developments and opportunities

12. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

Certain grants for research and development are available specifically for low-carbon technology-related research, including in connection with hydrogen (in addition to the tax breaks and grants available for qualifying foreign investments).

Singapore introduced the Low-Carbon Energy Research (LCER) Funding Initiative in 2020 and the first phase of the programme awarded S\$55 million to projects aiming to improve the techno-economic viability of low-carbon technologies such as carbon capture, utilisation, and storage (CCUS) and hydrogen. For hydrogen, the LCER funded projects in areas such as the development of catalysts for ammonia cracking, and methane pyrolysis.

- The National Hydrogen Strategy provides and an additional S\$129 million of research funding under LCER will be set aside to support the development of low-carbon technologies including hydrogen; and that the need for further funding will be further assessed, depending on Singapore's national needs.

13. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are currently no particularly notable pilot projects in place or planned for the production of clean hydrogen in Singapore. On the offtake front:

- Keppel Infrastructure, through its wholly-owned subsidiary Keppel Energy, has announced that it has reached FID to develop the Keppel Sakra Cogen Plant, a 600-megawatt advanced combined cycle gas turbine (CCGT) power plant which can be run entirely on clean-burning hydrogen, and that the EPC contract for the construction of the plant has been awarded to a consortium comprising Mitsubishi Power Asia Pacific and Jurong Engineering. The plant is expected to be ready by the first half of 2026; and
- Keppel New Energy Pte Ltd, a wholly owned subsidiary of Keppel Infrastructure; Mitsubishi Heavy Industries, Ltd. and DNV, have announced that they have signed a Memorandum of Understanding (MoU) for a strategic collaboration to explore the feasibility and implementation of an ammonia-fired gas turbine on Jurong Island, Singapore

14. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects being developed, or in operation, in Singapore.

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South Africa

Ashurst collaborated with Bowmans in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, the Department of Science and Innovation published the [South African Hydrogen Society Roadmap \(HSRM\)](#) on 17 February 2022. The HSRM intends to serve as a national framework for policy and actions relating to hydrogen in South Africa.

Other government policies also recognise hydrogen's role and potential uses in the South African economy. These include:

- the Renewable Energy Policy of South Africa;
- the Integrated Energy Plan; and
- the Integrated Resource Plan.

2. What are key goals and commitments included in the strategy/policy?

The identified goals and commitments in the HSRM include:

- the decarbonisation of the transport and energy-intensive sectors by 2050;
- the creation of a green hydrogen export market so that South Africa can capitalise on the projected increase in demand in response to international climate commitments;
- the creation of a Centre of Excellence in Manufacturing for hydrogen products and fuel cell components which will contribute to their respective value chains;
- transforming and stabilising the power sector by employing green technologies; and
- increasing the role of hydrogen in the South African energy system.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The following sectors are most likely to be impacted by the deployment of hydrogen:

- the transport sector;
- energy-intensive sectors;
- the electricity sector;
- the aviation sector; and
- the mining sector.

4. Who are the main regulators for the hydrogen market?

There are no specific regulators of hydrogen production and exportation in South Africa. The production, storage, transportation or supply of hydrogen would largely be regulated as an industrial process, and it may be subject to environmental and health and safety regulations. The regulators would include local, provincial and/or national environmental authorities, as well as health and safety regulators from the local or national authorities. In addition, renewable energy production ties to the production of green hydrogen and would be regulated by the National Energy Regulator of South Africa (NERSA).

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

Yes, one of the aims of the HSRM is to develop the role of blue and green hydrogen in the energy system and the HSRM makes provision for the eventual transition from blue to green hydrogen by 2050. In the short term, South

Africa will focus on catalytic projects to stimulate local demand for all types of hydrogen to illustrate its commercial viability and scalability.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

As part of the building blocks for creating a South African hydrogen society, the HSRM includes two carbon capture, usage and storage (CCUS) pilot projects. One project focuses on creating a [CCUS site in an identified priority area in Mpumalanga](#) that has a high concentration of coal mining and power generation. This project forms part of HSRM's Action Plan for Hydrogen generation, storage and distribution and will be implemented between 2021 and 2024. It has been reported by the Council for Geoscience that geological mapping at the site has commenced and the project is set to become active in 2023. The second pilot project aims to create CCUS projects on a national scale.

7. Are there targets for the production of hydrogen?

Yes, the HSRM provides targets for hydrogen production. The targets, and their respective timeframes, are as follows:

- 2021-2024: small scale electrolysis production and at least 1MW of green hydrogen to be used, for example, in the transport sector and in power generation;
- 2025-2030: the construction of 5GW electrolysis capacity; the deployment of a total of 11.7GW electrolyser capacity; and, at least, 500kt of Hydrogen produced annually by 2030. The main areas of utilisation include power generation and the transport sector; and
- 2030-2040: increase electrolysis capacity to at least 15GW for full use in the transport industry and power generation.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are currently no direct incentive mechanisms or business models that support hydrogen production. However, the HSRM recognises existing incentive opportunities, such as tax incentives, that could support hydrogen production. These include:

- section 11D of the Income Tax Act No 58 of 1962 (ITA) may be used to advance research and development relating to hydrogen production as it does not circumscribe the categories of R&D;
- companies operating in Special Economic Zones (i.e. designated areas for targeted economic activities) may have a reduced corporate tax rate of 15% and an accelerated 10% tax allowance on buildings; and
- the Support Programme for Industrial Innovation (SPII), which is particularly focused on the development phase of innovative products or processes may be used to promote the development of hydrogen technologies.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are no existing standards in place for the classification and/or certification of low-carbon or renewable hydrogen in South Africa.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

South Africa does not have a regulatory framework that specifically concerns hydrogen. However, there are other, non-specific, regulatory regimes that may impact upon its production, storage, transportation or supply. This includes, for example, the Occupational Health and Safety Act 85 of 1993 regulations.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

There are no restrictions on foreign investments in the energy and infrastructure sectors. Neither the primary legal framework governing foreign investment in South Africa, the Protection of Investment Act 22 of 2015 (Investment Act),

nor sectoral regulations provide for such restrictions. However, the ownership requirements in the Broad-Based Black Economic Empowerment Act 53 of 2003 must be considered, these do not create compulsory investment thresholds but such thresholds may be a requirement for participation in any government investment support scheme.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

According to the United Nations Conference on Trade and Development (UNCTAD), South Africa has signed 50 bilateral investment treaties (BITs). Of the 50, however, 27 were signed but are not in force, 12 have been terminated and only 11 are currently in force. A summary of these treaties can be found on the UNCTAD's Investment Policy Hub [database](#).

It must be noted, however, that South Africa is not currently engaged in any new BIT negotiations and future negotiations are unlikely. The Investment Act is national legislation that is aimed at providing protection to investors and their investments. Significantly, the Act states that existing investments that were made under such treaties will continue to be protected for the period and terms stipulated in the treaties. Any investments made after the termination of a treaty, but before promulgation of this Act, will be governed by the general South African law. Therefore, it is envisaged that international investors will likely be protected in terms of national and not international law.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

There are no government grants or funding directly relating and available to Hydrogen Projects. However, the Critical Infrastructure Programme (CIP), run by the Department of Trade, Industry and Competition (DTIC) aims to, amongst other objectives, provide financial support to projects that alleviate dependency on the national grid. In the revised guideline to the CIP, published in November 2021, support for clean/green energy infrastructure was included. Although the CIP guideline does not define 'clean/green energy', the Deputy Minister of the DTIC has stated that the CIP would involve financial assistance in alleviating the infrastructure costs associated with hydrogen production, fuelling and transport facilities. The CIP guideline does not provide an estimate of the available funding.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

Yes, there are a number of pilot projects planned to determine the feasibility of green hydrogen in different sectors and to kick-start the development of a hydrogen society in South Africa. These include the following projects:

- the [Hydrogen Valley or Platinum Valley Project](#) is a project of the DSI, with various partners, to study the feasibility of developing catalytic green hydrogen hubs. These hubs will form part of the Hydrogen Valley and will be connected to form a 'Hydrogen Corridor'. The identified hubs are in Johannesburg, Durban/Richards Bay and Mogalakwena/Limpopo. The hubs will host pilot projects in the industrial, mobility and building sectors. The projects involve, for example, developing ethylene and ammonia from green hydrogen and running paper mills with hydrogen instead of natural gas fuels;
- the [COALCO₂ - X Project](#) aims to use green hydrogen and other pollutants found in flue gas from coal-fired boilers to make value-added products. The objective is to support the transition to a decarbonised energy system and assist in reducing gas emissions. This project will also be used to scale up domestic demand for hydrogen and create capabilities for the export market; and
- Boegoebaai, an area in the Northern Cape, has been identified by the government as a Strategic Integrated Project in the South African National Development Plan. The project, led by Sasol, is focused on determining whether an export hub for green hydrogen and ammonia is feasible and proposed construction projects include green hydrogen and ammonia production sites, a desalination plant to support the production of green hydrogen and a storage facility. The study commenced in June 2021 and will take 24 months to complete. In addition, Sasol has finalised a memorandum of agreement with both national and local government to develop the Boegoebaai site. The development aims to produce 400,000 tonnes of green hydrogen annually.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no commercial-scale clean hydrogen production projects in development or already operating in South Africa.

Last updated July 2022

South Korea

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, on 17 January 2019, the Ministry of Trade, Industry and Energy (MOTIE) announced the [Hydrogen Economy Vitalization Roadmap](#) (Roadmap) which focuses on hydrogen utilisation, such as hydrogen fuel cell vehicles and fuel cells. Further, South Korea enacted the Hydrogen Economy Promotion and Hydrogen Safety Management Act (the **Hydrogen Act**) on 4 February 2020 which came into effect on 5 February 2021. The latest amendment bill for the Hydrogen Act was passed in June 2022 and will come into effect on December 2022 (the **Amendment**).

On 26 November 2021, the MOTIE established the [First Master Plan for Hydrogen Economy Implementation \(Master Plan\)](#) which covers the entire hydrogen value chain of production, storage, transportation and utilisation.

2. What are key goals and commitments included in the strategy/policy?

The policy goal is to pioneer in the clean hydrogen economy through establishing a full-cycle ecosystem of hydrogen economy. The Master Plan includes four pillars of strategy and 15 objectives as set out below:

Phase	Key Goals
(1) Pioneer in domestic and global production of clean hydrogen	(i) Green hydrogen production (ii) Blue hydrogen production (iii) Overseas production of clean hydrogen
(2) Establish compact infrastructure	(iv) Establishment of hydrogen distribution infrastructure (v) Construction of hydrogen piping network (vi) Increase the number of hydrogen stations
(3) Utilise hydrogen in all aspects of day-to-day lives	(vii) Enlargement of hydrogen power generation (viii) Pioneer in global market of hydrogen mobility (ix) Establish foothold for hydrogen utilization in industrial fields
(4) Strengthen the foundation of the ecosystem	(x) Technology development/manpower cultivation/standardization (xi) Procurement of world-class hydrogen-safety (xii) Lead global collaboration (xiii) Nurture hydrogen-specialised enterprises and vitalize hydrogen finance (xiv) Diffuse hydrogen cluster city special regulatory zones (xv) Establish policy foundation and enhance public acceptance

The Master Plan puts a particular emphasis on clean hydrogen generation (i.e. green hydrogen and blue hydrogen), and aims to meet 100% of the anticipated annual demand of 27.9 million tons of hydrogen in 2050 with clean hydrogen, 60% of which is produced domestically or based on domestic technology and/or capital. The milestone targets under the Master Plan are:

- to reach a clean hydrogen ratio of 75% by 2030 and 100% by 2050; and

- to reach a self-sufficiency rate of 34% by 2030 and 60% by 2050.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industries that conventionally use fossil fuels as their primary energy sources are anticipated to be affected the most by hydrogen deployment. Some examples are as follows:

- the energy sector (due to the introduction of hydrogen power generation);
- infrastructure (for hydrogen distribution, e.g. piping and hydrogen stations);
- the automobile and other mobility sectors (e.g. hydrogen-powered mobility; transportation and logistics); and
- the steel, petrochemistry and cement sectors (due to the shift from conventional fuel (e.g. coal) to hydrogen for the generation of power).

The automobile industry has experienced the biggest impact so far, and it is expected that it will continue to be affected. Korea's current production capacity for hydrogen fuel cell cars is 10,000 cars per year. The Master Plan aims to increase the number of hydrogen fuel cell cars up to 850,000 cars per year by 2030, and up to 5,150,000 cars per year by 2050.

4. Who are the main regulators for the hydrogen market?

The main government entity responsible for hydrogen economy is the Ministry of Trade, Industry and Energy (MOTIE). The Hydrogen Act regulates the authorities of the MOTIE in relation to the promotion and management of the country's hydrogen economy.

Article 6 of the Hydrogen Act provides for the establishment of the Hydrogen Economy Committee, which is chaired by the Prime Minister and includes the Minister of Economy and Finance, the Minister of Science and ICT, the Minister of the Interior and Safety, the Minister of Trade, Industry and Energy, the Minister of Environment, the Minister of Land, Infrastructure and Transport, the Minister of Oceans and Fisheries, the Minister of SMEs and Startups, and other persons working at industrial, academic, research institutes, etc. with sufficient expertise and experience in fostering the hydrogen economy who are commissioned by the Prime Minister. The Hydrogen Economy Committee is responsible for the following:

- Matters concerning formulating and executing master plans in accordance with the Hydrogen Act, and reviewing and evaluating the implementation results thereof;
- Matters concerning recommendations for improving statutes and regulations pertaining to implementing the hydrogen economy;
- Matters concerning policy coordination, cooperation, and support related to the hydrogen economy by relevant central administrative agencies and local governments;
- Matters concerning cooperation between countries, establishment of a hydrogen industry ecosystem, and handling of grievances of enterprises, etc. in relation to the hydrogen economy;
- Matters required to undergo deliberation of the Committee under other statutes; and
- Other matters deemed necessary by the Chairperson of the Committee in relation to the hydrogen economy.

In accordance with the Hydrogen Act, the following institutions have been designated as the corresponding designated organizations:

- Hydrogen Convergence Alliance (H2KOREA) as the designated organization for hydrogen industry promotion;
- Korea Gas Corporation as the designated organization for hydrogen distribution; and
- Korea Gas Safety Corporation as the designated organization for hydrogen safety.

The designated organizations are responsible for facilitating the government's hydrogen economy policies by laying the requisite foundations such as training professionals and standardization, achieving price stabilization and establishing a fair distribution ecosystem, and establishing safety standards.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The MOTIE introduced a policy paradigm shift in the Roadmap from the conventional grey hydrogen to renewable green hydrogen in 2019. It supports a safe and economic hydrogen production and supply system through water electrolysis and importing the same from overseas. In addition, the Master Plan, puts emphasis on clean energy, both green and blue hydrogen.

With regard to green hydrogen, the Korean government plans to scale up:

- the electrolysis technology capacity from the current 500 KW to 1 MW by 2025, and 10 MW by 2030; and
- the electrolysis efficiency from the current 55% to 69% by 2030 and 77% by 2050.

In addition to setting out the expansion plan of water electrolysis for green hydrogen production, the Master Plan introduced a roadmap for the production of blue hydrogen, such as the establishment of new blue hydrogen clusters by 2025, technology development for early commercialization of CCUS (carbon capture, utilisation and storage), and procurement of storage facilities, inside and outside of Korea.

The Amendment will introduce the concept of clean hydrogen as “carbon-free hydrogen”, “low-carbon hydrogen”, and “low-carbon hydrogen compound”. Further, it will add an obligation to develop, produce and supply clean hydrogen unto the national and municipal governments, as well as mandate the inclusion of matters regarding the promotion of development, production, supply of clean hydrogen and matters regarding the transition to hydrogen economy for carbon neutralization to the Master Plan.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The Master Plan explicitly aims to achieve early commercialisation of CCUS technology in relation to blue hydrogen.

With regard to CCS (carbon capture and storage), it is proposed that exhausted gas fields in the East Sea (with a total storage capacity of 12 million tons) will be utilised for early commercialisation. The plan is for environmental reviews and safety evaluations to be completed by mid-2023, with facilities constructed by 2024, and for facilities to be operated for 30 years from 2025 to 2054.

- With regard to CCU (carbon capture and utilisation), it is proposed that CCU products will be commercialised to reduce green-house gas emissions through large scale substantiation focusing centrally on business sites with high green-house gas emissions. The plan is for the government to lead substantiation of small- and mid-size technology by 2026; procure commercial technology by 2028; and diffuse commercial technology through private technology transfer by 2030.

The Master Plan also proposes participation in international joint research in order to procure advanced CCU/CCS technology.

7. Are there targets for the production of hydrogen?

When the Roadmap was published in January 2019, the MOTIE anticipated that the annual demand for hydrogen would rise to 5.26 million tons by 2040. The Roadmap anticipated this demand would be met by extracted hydrogen (30%) and water electrolysis, byproduct hydrogen and overseas production (70%).

However, in November 2021, the MOTIE renewed its forecast and proposed an updated plan which anticipated annual demand for hydrogen would rise to 27.9 million tons by 2050, all of which is targeted to be supplied with clean hydrogen, with a self-sufficiency rate of 60% (accounting for hydrogens produced domestically as well as those produced overseas with domestic technology or capital). More specifically, the Master Plan includes the following production targets:

- Green hydrogen: 250,000 tons per annum by 2030 and 3 million tons per annum by 2050; and
- Blue hydrogen: 750,000 tons per annum by 2030 and 2 million tons per annum by 2050.

The Master Plan further intends to establish 40 overseas hydrogen supply chains by 2050 to diversity the supply chain for energy security enhancement, whereby the country would, together with the green hydrogen and blue hydrogen produced domestically, achieve a 60% self-sufficiency rate for clean hydrogen.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Currently, there are no incentive mechanisms/business models in place which specifically support the production of hydrogen. However, the following incentives may indirectly stimulate the production of hydrogen:

- national and local governments are authorised, pursuant to Article 17 of the Hydrogen Act, to grant certain tax benefits to businesses engaging in hydrogen activities and the Master Plan states that the government will push to enlarge tax incentives for hydrogen R&D activities and infrastructure investment to support the establishment of the foundation of supply and demand of hydrogen economy;
- the government may, pursuant to Article 9 of the Hydrogen Act, provide administrative and financial support to 'hydrogen-specialised enterprises' which meet certain thresholds in relation to its hydrogen business-related turnover or hydrogen business-related R&D investment amount compared to its total turnover. As part of the initiative to strengthen the foundation of the hydrogen ecosystem under the Master Plan, the government plans to designate 1,000 enterprises as hydrogen-specialised enterprises by 2040, and provide a distinguished support system, such as with regard to R&D and securement of market; and
- the Master Plan also provides a plan in relation to hydrogen finance which includes: utilising the existing climate fund to create an early market for hydrogen, establishing a hydrogen infrastructure fund to support the infrastructure for hydrogen production and distribution, and encouraging private hydrogen industry funds to nurture promising hydrogen businesses (including hydrogen-specialized enterprises). The Hydrogen Act also introduces 'hydrogen-specialised investment companies', which are required by law to invest more than half of its funds to hydrogen-specialised companies.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There is currently no classification and/or certification of low-carbon or renewable hydrogen under the Hydrogen Act. However, according to the Master Plan, the government plans to implement a clean hydrogen certification program, which will certify green hydrogen and blue hydrogen based on the amount of CO₂ emitted in the process of production. The Roadmap provided under the Master Plan is as follows:

- 2022 - conduct examination on CO₂ emissions by means of production of hydrogen.
- 2023 - select and appoint an institution to substantiate and certify CO₂ emission quantity.
- 2024 - official announcement of the operation of certification program.

There are multiple amendment bills for the Hydrogen Act that are currently pending before the Congress that address the classification of clean hydrogen, such as by allowing manufacturers to obtain clean hydrogen certification with respect to the hydrogen itself or by mandating manufacturers/importers/sellers to obtain clean hydrogen certification with respect to the production facility. The Amendment will introduce the legal grounds for certification of clean hydrogen by empowering the government to designate organisations for the certification.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The regulatory requirements relating to the production, storage, transportation and supply of hydrogen are unclear and lack consistency. The regulations in relation to the hydrogen safety management are governed under different statutes depending on whether the hydrogen is high pressure or low pressure.

The Korean government intends to streamline the hydrogen safety management regulations under the Hydrogen Act, and impose legal obligations on the suppliers and users of hydrogen, such as an obligation to conduct regular safety inspections. The Korean government is aiming to establish the "Comprehensive Plan for Safety Management of Full Cycle of Hydrogen" by November 2022 to prepare for the development and introduction of new hydrogen technology.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

The Foreign Investment Promotion Act and the Rules on Foreign Investments prohibits/restricts foreign investment in the following categories of business:

Business	Foreign Investment Restriction
Nuclear power generation	Fully restricted
Water power generation	
Thermo power generation	The aggregate domestic power generation facilities acquired by foreigners from KEPCO must be less than 30% of the aggregate domestic power generation facilities (only applicable with respect to purchase of facilities from KEPCO)
Solar power generation	
Other power generation	
Electricity transmission and supply	Foreign investment ratio must be less than 50% and foreign investors shall not hold more voting rights than the largest domestic shareholder
Sale of electricity	

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website states that South Korea is a signatory to 87 bilateral investment treaties (BITs) that are in force as at 1 April 2022, and certain other treaties also contain protections for investors in South Korea. These can be accessed from [UNCTAD's Investment Policy Hub](#).

Korea is currently only an observer and not an official member of the Energy Charter Treaty. Therefore, the protection of international investors follow international recommendations and consensuses including from the OECD, UNCTAD, and WTO.

The Master Plan states various international treaties sought by the Korean government including:

- overseas blue hydrogen storage treaties;
- Korea to take the initiative in establishing a global hydrogen association, with members of which Korea shall seek to enter into or amend existing FTA to introduce a new chapter on hydrogen; and
- mutual recognition agreement with regard to clean hydrogen certification by preparing joint evaluation standards with respect to the quantity of greenhouse emissions from production to release.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

Article 10 of the Hydrogen Act provides that the government may support hydrogen-specialised enterprises by providing subsidies or loans for:

- expenses incurred in technology development and training of experts necessary to innovate safe, economically friendly, and eco-friendly hydrogen businesses;
- expenses for international cooperation and technology exchanges with foreign countries; and
- expenses for the commercialisation of developed technology, the securement of market, or the filing of applications for intellectual property rights.

In 2022, the MOTIE will grant a KRW 1.9 billion fund to hydrogen-specialised enterprises for prototype manufacturing, technology introduction and certification and a separate KRW 1 billion will be used to support their R&D activities. Each hydrogen-specialised enterprise will be eligible for support of up to KRW 150 million from the MOTIE.

In addition, the Ministry of Science and ICT is planning to support up to KRW 2.75 billion by 2026 for R&D of core

technology for biochemical fermentation hydrogen production and source technology for liquid ammonia electrolysis-based hydrogen storage/extraction through the “Future Hydrogen Source Technology Development Project”.

Further, in September 2021, 17 key players participating in the hydrogen value chain voluntarily established the Korea H2 Business Summit, and announced in July 2022 the establishment of their first KRW 500 billion hydrogen fund, which will start investing in early 2023 to solidify the foundations for CCUS and the development of core hydrogen technology. The Korean government has committed to grant certain financial support (e.g. lower interest rates and expansion of loans) to the invested companies and support the fund's activities, such as deal sourcing, commercialisation of technology, and supporting SME's R&D.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

The Master Plan includes various clean hydrogen production projects such as:

- Green hydrogen production: [A project is ongoing in Jeju island](#) to utilise excess energy from wind power generation to produce 706 kg of green hydrogen.
- H2 STAR Project: Development of renewable energy, including clean hydrogen, overseas, based on domestic capital and technology. The proposal for this project in the Master Plan states the potential counterparty country (e.g., Australia, Saudi Arabia, UAE, etc.), the subject substance (e.g., green/blue ammonia), and usage (e.g., vehicles, coal power generation). The name of the project STAR stands for supply, transportation, application and relationship.
- Establishment of an international hydrogen exchange: According to the Master Plan, the hydrogen exchange, targeted to be established in 2023, will aim to set the standard price for hydrogen by procuring sufficient quantity by publishing the transaction price between domestic producers and domestic purchasers in 2023, and the price of overseas hydrogen upon domestic arrival by 2027.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

The Master Plan contains various commercialisation plans in relation to clean hydrogen production. Some examples are:

- Mass substantiation: Commercialisation of gigawatt-level water electrolysis facilities through mass substantiation for green hydrogen production in order to create an early market for hydrogen utilising renewable energy complexes in Jeju, Jeonbuk, and Jeonnam provinces. Most recently, the MOTIE announced the country's largest green hydrogen production substantiation project of 12.5MW scale in Jeju, which will be able to produce 1,176 tons per year at a 60% rate of operation to supply hydrogen to 200 garbage trucks and 300 intra-/inter-city buses in Jeju island.
- Maritime green hydrogen: Commercialisation of stationary and floating hydrogen production plants utilizing maritime-based renewable energy (wave power and wind power) by 2036 and maritime-bio linked plants by 2028.

The [Chungju Bio Green Hydrogen Station](#), the first commercial green hydrogen station in Korea established in March 2022, is expected to produce 500 kg of green hydrogen every day by producing and refining biogas produced from food waste.

Other ongoing commercialisation projects in relation to hydrogen production include:

- [Lotte Chemical installed CCU equipment](#) which applies gas separation membrane in its facility, which is currently under operation and is being plans for commercialisation of this technology.
- Doosan Heavy Industries & Construction is planning to construct the [Changwon Hydrogen Liquefaction Plant](#), an equipment which produces blue hydrogen by liquefying captured carbon dioxide using CCUS technology, by 2023.
- Biox is producing 20 litres of hydrogen per day by HAAMA system which utilises food waste, and is also testing an integrated process that simultaneously manages green hydrogen production and waste fluid.

Spain

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, the Council of Ministers approved the [Spanish Hydrogen Roadmap](#) (Hoja de Ruta del Hidrógeno) on 6 October 2020.

On 14 December 2021, the Council of Ministers approved the Strategic Project for the Recovery and Economic Transformation on Renewable Energies, Renewable Hydrogen and Storage (Proyecto Estratégico para la Recuperación y Transformación Económica (PERTE) de Energías Renovables, Hidrógeno Renovable y Almacenamiento) which foresees a public budget of €1,555 million for the development of renewable hydrogen.

2. What are key goals and commitments included in the strategy/policy?

The Hydrogen Roadmap aims to develop 4GW of electrolyzing capacity by 2030 and intends to qualify Spain as a technological benchmark in the production and use of renewable hydrogen, as well as the creation of innovative hydrogen value chains to contribute to the following objectives:

- Reducing local pollutant emissions and greenhouse gases generated during the production cycle.
- Take advantage of the surplus of renewable energy generated during off-peak electricity consumption hours, by allowing manageability and continuity of the production cycle from renewable energy sources through energy storage.
- Extending decarbonisation and renewable energy consumption to such sectors where electrification is not feasible or cost-effective.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

- Refining, chemical and metallurgical industries;
- Gas and electric sectors including energy storage;
- Mobility (road, maritime, railway and/or aviation transportation); and
- Residential sector.

4. Who are the main regulators for the hydrogen market?

There is a regulatory gap on specific provisions applicable to green hydrogen production facilities. Indeed, the existing legal framework considers hydrogen production as an industrial activity (chemical industry for the production of inorganic gas).

Despite the foregoing, rulemaking and oversight competences in Spain belong to State, regional and local administrations:

- Mainly, the Ministry for the Ecological Transition and Demographic Challenge (Ministry of Energy) (in particular, Subdirectorato General for Hydrocarbons and New Fuels).
- The Ministry of Industry, Tourism and Commerce.
- The National Markets and Competition Commission (CNMC).
- The Department of Energy/Industry in each relevant autonomous region.
- The Department of the Environment in each relevant autonomous region.
- Local authorities.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

No, both the Hydrogen Roadmap and the [Strategic Project for the Recovery and Economic Transformation on Renewable Energies, Renewable Hydrogen and Storage](#) are only intended for the development of green hydrogen.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

N/A.

7. Are there targets for the production of hydrogen?

The target set out in the Hydrogen Roadmap is to achieve 4GW of electrolyzing capacity by 2030.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Currently there are no incentive mechanisms in place to support the production of green hydrogen. However, measure No. 5 of the Hydrogen Roadmap states that taxation should provide incentives for renewable hydrogen as opposed to hydrogen whose origin is not traceable. No further actions have been carried out yet in this regard.

[The Value Chain of the Automotive Industry Boosting Plan](#) (Plan de Impulso de la Cadena de Valor de la Industria de la Automoción) promotes an integral review of vehicle taxation schemes in order to introduce a greater environmental approach.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

Yes, Royal Decree 376/2022, of 17 May, on the sustainability and reduction of greenhouse gases emissions' criteria for biofuels, bioliquids and biomass fuels as well as on the system of guarantees of origin of renewable gases (Real Decreto 376/2022, de 17 de mayo, por el que se regulan los criterios de sostenibilidad y de reducción de las emisiones de gases de efecto invernadero de los biocarburantes, biolíquidos y combustibles de biomasa, así como el sistema de garantías de origen de los gases renovables), which partially transposes Directive 2018/2001 on the promotion of the use of energy from renewable energy sources and provides for the implementation of a Guarantees of Origin scheme for gases obtained from renewable sources (e.g., biogas, biomethane or renewable hydrogen, etc.). Additionally, Royal Decree 376/2022, of 17 May has been implemented by Order TED/1026/2022, of 28 October on the supervision and auditing scheme for the abovementioned guarantees of origin

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

There is currently a regulatory gap on regulation applicable to green hydrogen production facilities (e.g. administrative authorisations, requirements for the accreditation of the renewable origin of the energy consumed for the production of green hydrogen) and, in particular, to green hydrogen injection into the natural gas grid.

There is a bill for a Hydrogen Law at parliamentary process of enactment, which was published as a proposal on 26 July 2021. As of today, we are not aware of any further development in this regard.

The existing regulatory framework considers the hydrogen production as a chemical industry consisting on the production of inorganic gas and is subject to strict environmental requirements. The Hydrogen Roadmap provides for the simplification and removal of regulatory burdens that currently affect the production of green hydrogen and proposes several measures intended to this purpose.

In light of the foregoing, a new specific regulatory framework for the injection of renewable gases has been recently approved and foresees two different forms of supply: (i) by direct injection into the natural gas transmission and distribution grids; and (ii) by direct piping to a gas consumption facility. Nevertheless, please bear in mind that, this new regulatory framework will require further regulatory and technical development.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Yes, a new foreign direct investment (FDI) control has been implemented in the context of the COVID crisis, in accordance to which acquisition transactions (above one million euros) in which the Investor (as defined below) (i) acquires a stake of ten per cent or more of the share capital; or (ii) as a result thereof, effectively takes part in the management or control of a Spanish company, are subject to an administrative authorisation if carried out:

- in certain strategic sectors (objective restriction), including, among others, supply of fundamental inputs (e.g. energy, raw materials); or
- where the Investor is considered to be a “risky” person (subjective restriction), including: (i) Investors directly or indirectly controlled by the government of a third country; (ii) foreign Investors that have invested or participated in sectors affecting security, public order and public health (especially those listed above) in another Member State; and (iii) if there is a serious risk that the foreign Investor carries out criminal or illegal activities affecting public security, public order or public health in Spain.

For the purposes of FDI Control, Investor means:

- residents of non-EU or EFTA countries;
- residents of EU or EFTA countries whose real ownership corresponds to residents of non-EU or EFTA countries, or
- residents of other EU/EFTA countries may qualify (on a transitory basis until 31 December 2022) as foreign Investors if the investment is made in (i) companies listed in Spain; and (ii) unlisted companies if the value of the investment exceeds 500 million euros and, in both cases, if carried out in strategic sectors.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) website states that Spain is a signatory to 70 bilateral investment treaties (BITs) that are in force, and certain other treaties may contain other investment provisions.

The Energy Charter Treaty (ECT) is a multilateral investment treaty which entered into force in April 1998 and specifically addresses energy trade, transit and investment between its contracting parties, which include all EU states (except Italy). Discussions as to the modernisation of the ECT have been ongoing for several years focussing, in particular, on investment protection and “greening” the ECT.

These discussions have focussed on reducing the protections accorded to fossil fuels and explicitly protecting emissions reduction technologies (including hydrogen and CCUS). This should be kept under review. There are differing views as to whether hydrogen production and CCUS would be afforded protection under the current terms of the ECT, and to our knowledge the question has not been considered by an arbitral tribunal.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

Yes, on 18 and 22 February 2022, the Spanish Government Spanish launched:

- four calls for incentive programmes for the green hydrogen innovative value chain amounting to a total of €250 million. The funding will be allocated (i) for large electrolysers (€100 million); (ii) vehicles demonstration and validation (€80 million); (iii) industrial and experimental research (€40 million); and (iv) capacity building and technological advances in test and manufacturing lines (€30 million). Applications may be submitted until 7 June 2022.
- a call for public grant amounting to a total of €50 million for pioneering renewable hydrogen projects, with commercial viability, for local production and consumption in sectors that are difficult to decarbonise, such as industry and heavy transport. Applications may be submitted until 6 May 2022.

Certain regional governments have also launched additional grants.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

Different pilot projects have been deployed to examine and test the feasibility of green hydrogen production and its potential use in different sectors, such as the projects outlined below:

- [The Basque Hydrogen Corridor](#) aims at creating a hydrogen ecosystem, based in the Basque Country, which will enable progress to be made towards decarbonising the energy, industrial, residential and mobility sectors.
- [The Hydrogen Valley of Catalonia](#) which emerged as the region's response to the strategy launched by the European Commission in 2020, coordinated by the University Rovira I Virgili was designed with the aim of bringing together all the agents that make up the value chain of green hydrogen and driving forward the understanding, production and implementation of this energy vector.
- [H2Ports](#) is a pilot project located in the Port of Valencia that develops the transformation to green hydrogen of a reach stacker and a yard tractor in real operating conditions. The project includes the development of green hydrogen generation facilities at 350 bars, as well as the study and development of the green hydrogen supply logistics in the Port of Valencia.
- SUN2HY (Sun to Hydrogen) which consists of a pre-commercial full-scale demonstrator (TRL-6) for the conversion of solar energy into hydrogen by means of photoelectrochemical cells.
- BenorthH2 a green hydrogen production facility which aims at achieving the injection of hydrogen into the existing natural gas grid through a pipeline of more than 15 kilometres across eight municipalities of Bizkaia.
- H2Sarea, which intends to research and develop the necessary technological solutions for the safe distribution of hydrogen mixed with natural gas through the natural gas grid.
- Green Hydrogen Valley Platform of the Region of Murcia. This project intends to develop the production of green hydrogen in the Escombreras Valley (Murcia).

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are a number of projects in the pipeline, at different stages of development, including:

- [Lloseta industrial green hydrogen production plant](#), comprised within the "Power to Green Hydrogen Mallorca", which is powered by photovoltaic sources. The project entered into operation in March 2022 and envisages to produce at least 300 tonnes/year of green hydrogen.
- [Ibredrola's hydrogen project at Puertollano \(Ciudad Real\)](#), which aims to be one of the largest green hydrogen plants in Europe. It is expected to start operations in 2022 with a capacity of 20 MW and the green hydrogen produced will be used in a nearby Fertiberia's factory.
- [Coagener's hydrogen project at Campo de Gibraltar](#) (Cádiz) that aims to produce 80 tonnes/year of green hydrogen with a electrolyzing capacity of 1 MW from July 2023 for commercial purposes.

Last updated December 2022

Sweden

Ashurst collaborated with Schjødt in the preparation of this content. We are grateful for their input.

Policy and regulation

1. Is there a government hydrogen strategy or policy?

There is currently no government hydrogen strategy or policy. However, on 26 November 2021 the Swedish Energy Agency published a “national strategy on hydrogen, electro-fuels and ammonia” which is currently under review by the Ministry of Infrastructure. It is not clear if or when a final strategy will be adopted.

2. What are key goals and commitments included in the strategy/policy?

The proposed strategy indicates a goal of 5GW of hydrogen production by 2030 and 15GW of hydrogen production by 2045. The proposed strategy also includes the creation of financial incentives and a regulatory framework for hydrogen. However, the proposed strategy has been criticised by the market for setting goals that are too far in the future and not ambitious enough.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industry sectors most likely to be affected by hydrogen deployment are:

- the steel industry;
- heavy road freight;
- refineries and chemical industries; and
- fertilisers.

The power sector in Sweden is already largely based on clean energy (namely hydropower (45%), wind (17%) and nuclear (30%)) and Swedish households mainly rely on electricity because Sweden lacks a gas distribution network. Therefore, as the power and the heating sectors are already decarbonised, they will most likely not be affected by hydrogen deployment.

4. Who are the main regulators for the hydrogen market?

Sweden has not appointed an authority to be responsible for the hydrogen gas market. The Swedish Energy Agency (Energimyndigheten), the authority that drafted the proposal for a national strategy on hydrogen, is responsible for supervising traditional gas companies and their compliance with different regulations such as the new EU regulation concerning measures to safeguard the security of gas supply and access to natural gas transmission networks. As such, hydrogen market would likely come under their jurisdiction at present.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The proposed strategy focusses on renewable (green) hydrogen produced by electrolysis. However, as the proposed strategy has not yet been finalised it is not clear whether both blue and green hydrogen will be supported.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The proposed strategy does not currently include carbon capture.

7. Are there targets for the production of hydrogen?

The proposed strategy includes the following targets:

- 5GW of hydrogen capacity by 2030; and
- 15GW of hydrogen capacity by 2045.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

There are currently no direct incentive mechanisms in place other than negative incentives in the form of energy and CO2 taxes. However, there are a number of initiatives related to government funding.

Further, the research institute of Sweden is taking an active role in supporting the development of a sustainable society by providing active support to a large number of industry and research projects.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There are no existing national standards in place for the classification of hydrogen. However, as a member state of the European Union, Sweden relies on the EU classifications as outlined in the EU hydrogen policy.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

As Sweden has no legacy of gas use for household heating, there are currently no relevant regulations. The proposed strategy identifies that there is a need for a new regulatory framework regulating inter alia production, distribution, and storage of hydrogen.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

The European Union has established a framework for the screening of foreign direct investments into the European Union and the new regulatory framework will come into force in Sweden on 1 January 2023 and shall apply to investments implemented on or after 1 February 2023.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The Electronic Database of Investment Treaties (EDIT) website states that Sweden is a signatory to 79 bilateral investment treaties (BITs) that are in force. As Sweden is a member state of the European Union, there are also certain other treaties entered into by the European Union which contain protections for investors in Sweden.

The Energy Charter Treaty (ECT) is a multilateral investment treaty which entered into force in April 1998 and specifically addresses energy trade, transit and investment between its contracting parties, which include Sweden and all other EU states (except Italy). Discussions as to the modernisation of the ECT have been ongoing for several years focussing, in particular, on investment protection and "greening" the ECT.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

There are currently a number of national and EU support mechanisms which provide financing for hydrogen-related projects. This includes the following:

- [Klimatklivet \(the Climate Leap\)](#) - an initiative by the Swedish Environmental Protection Agency which is actively promoting a number of hydrogen projects and has set aside BSEK 2.8 for clean energy projects during 2022;
- [Industriklivet \(the Industry Leap\)](#) - an initiative by the Swedish Energy Agency which provides support for feasibility studies, research, pilot projects, demonstration projects and investment projects which aim to reduce industrial emissions and has set aside MSEK 909 for projects during 2022; and

Swedish Agency for Economic and Regional Growth - provides subsidies, loans and guarantees to SMEs.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being deployed in Sweden to examine and test the feasibility of clean hydrogen production and the use of hydrogen in different sectors. The main projects are within the steel industry and include the following:

- [Hybrit pilot project](#) - a pilot project for the production of green steel and the storage of hydrogen in Luleå in northern Sweden; and
- [Ovako](#) - a new hydrogen plant in Hofors, which is expected to be completed by the end of 2022, which will heat steel with hydrogen prior to rolling and is expected to generate 3,500 cubic meters of green hydrogen per hour.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in Sweden, but there are a number of projects in the pipeline, at different stages of development, including the following:

- [Hybrit Development](#) - a pilot project by SSAB, LKAB and Vattenfall which substitutes coal for hydrogen in the steel making process;
- [H2 Green Steel](#) - a pilot project which will produce green steel using hydrogen produced from wind and hydropower;
- [Spanish Grupo Fertiberia and Swedish Cinis Fertilizer](#) - are investing in two production plants in northern Sweden for the production of commercial fertilizers;
- [OKG](#) - a Swedish nuclear plant operator, is intending on producing and selling hydrogen;
- [BotnialänkenH2](#) - a project run by Uniper, ABB and the Port of Luleå which plans to establish a regional hydrogen hub in Luleå where hydrogen is produced from wind power, and where the hydrogen can both be used in the regional process industry or converted into fuel;
- [Volvo Group and Daimler Trucks](#) - are forming a joint venture for the development of fuel cells for their fuel cell electric vehicle trucks; and
- Hydrogen Refueling Stations - there are currently four hydrogen refueling stations in Sweden but this is expected to increase to 50 by 2025 as Nilsson Energy has announced that it will build 24 hydrogen refueling stations before the end of 2025 and a number of other projects are underway.

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Policy and regulation

1. Is there a government hydrogen strategy or policy?

The UAE unveiled its Hydrogen Leadership Roadmap on 31 October 2021. The Hydrogen Leadership Roadmap is part of the “UAE Net Zero by 2050 Strategic Initiative”, the first strategic 2050 initiative in line with the 2015 Paris Agreement announced by a country in the MENA region.

In September 2022, the UAE’s Ministry of Energy and Infrastructure (“MoEI”) signed an agreement with GHD in partnership with Fraunhofer-Gesellschaft to develop the UAE’s National Hydrogen Strategy. This strategy will form part of the Hydrogen Leadership Roadmap and will help establish the UAE’s hydrogen vision and inform its policy decisions.

As well as these national commitments, the Abu Dhabi Department of Energy (“DoE”) announced on 22 August 2022 that it intends to develop a Low-Carbon Hydrogen Policy and Regulatory Framework. The Abu Dhabi DoE expects to report on the outcomes of the policy and the regulatory framework before the end of 2022.

The policies, though announced, are not fully developed or detailed as yet and there is not currently any other published hydrogen strategy or policy for the UAE.

2. What are key goals and commitments included in the strategy/policy?

The Hydrogen Leadership Roadmap comprises three core objectives:

- unlocking new sources of value creation through exports of low carbon hydrogen, derivatives and products to key importing regions;
- creation of new hydrogen derivative opportunities through low-carbon steel; and
- development of sustainable kerosene as well as other priority UAE industries.

As outlined in the Hydrogen Leadership Roadmap, the UAE aims to support the low-carbon hydrogen business through five critical enablers:

- a clear regulatory framework backed by policies, incentives, standards, and certifications;
- best-in-class technology through value-add partnerships and the UAE domestic research and development structure;
- access to existing and new intergovernmental relationships to accelerate growth of a domestic ecosystem;
- readily available traditional land and infrastructure resources to support domestic production; and
- green financing within the UAE and in international capital markets.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industry sectors most likely to be affected by hydrogen deployment once implemented include:

- energy sector (storage and generation);
- oil and gas;
- fertiliser production;
- transport;
- steel production; and
- infrastructure (refineries, ports and terminals, fuelling stations).

There is an expectation that hydrogen will principally be exported from the UAE, rather than used as a domestic fuel source (however there are not full details as the strategy has not been formally published).

4. Who are the main regulators for the hydrogen market?

As the UAE is in the process of developing its Hydrogen Leadership Roadmap and related regulations, it is not yet clear which bodies will be primarily responsible for regulating hydrogen development in the country.

However, it is likely this would fall under the ambit of the MoEI (given this ministry is leading the development of the hydrogen roadmap) and/or the Ministry of Climate Change and Environment, as the Ministry responsible for the UAE Net Zero by 2050 strategic initiative which encompasses the Hydrogen Leadership Roadmap. At present, hydrogen-related projects may also deal with the relevant Emirate's Department of Economic Development (in respect of any foreign investment component) and Environmental Agency (for general permitting and approvals), as applicable.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The UAE is already well positioned to be a leader in clean hydrogen with natural competitive advantages for both blue and green hydrogen, including abundant hydrocarbons, existing large-scale hydrogen and ammonia production facilities, access to some of the world's most cost-competitive solar PV energy and large-scale carbon capture and storage capacities, which Abu Dhabi National Oil Company (ADNOC) already possesses and continues to advance in.

Green hydrogen is envisaged to play a significant role in UAE's domestic strategy to meet the UAE 2050 Net-Zero goals and which will also assist globally by exporting hydrogen. Green hydrogen production however remains in its infancy, requiring an international collaboration to accelerate its development.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

The UAE Ministry of Economy has identified carbon-capture technology as a promising sector for growth given rising industrialisation along with soaring investments toward introduction of emission control machineries. However, there is limited public information in respect of the pipeline of CCUS projects and investment.

The UAE currently has one CCUS project, Al Reyadah, which captures CO₂ from the flue gas of an Emirates Steel production facility, uses the captured CO₂ for enhanced oil recovery in ADNOC's nearby gas fields and then stores the CO₂ underground. ADNOC has announced plans to expand the capacity of this program by over 500%, capturing CO₂ from its own plants with the aim of reaching 5 million tonnes of CO₂ each year by 2030 and intends to incorporate CCUS technology at its Shah and Habshan-Bab gas plants.

7. Are there targets for the production of hydrogen?

There are not yet specific production targets set by the government. However, the UAE has set a target to conquer 25% of the global low-carbon hydrogen market by 2030.

Company specific targets have been announced at the industry level, however, and ADNOC has existing plans to increase hydrogen production to 500 kt per annum and is exploring several new growth opportunities. ADNOC is already a producer of over 300 kt per year of hydrogen in its downstream facilities, which is largely used for industrial purposes.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Incentives such as public ownership stakes, direct grants, and long-term contracts from public bodies for hydrogen purchases to accelerate the development of a future hydrogen economy in the UAE are envisioned for the initiative.

However, at the time of writing there are no formal incentive mechanisms or business models in place to support the production of hydrogen.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

There is currently no defined statement in the public domain regarding the classification or certification of low carbon and/or hydrogen from renewable resources.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The UAE has not yet established the legal and regulatory framework that is necessary to encourage and regulate the emerging hydrogen economy.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

Foreign investment in certain economic activities in the UAE is regulated and there is a “negative list” of certain sectors and economic activities that are not permitted or significantly restricted for foreign direct investment, which includes exploration and production of petroleum materials. There is also a positive list prescribed by the resolution for which up to 100% foreign ownership is accepted – this includes, broadly, permitted activities within the agricultural, manufacturing and services sectors. In respect of activities on neither the negative or positive list (including ownership of pipeline infrastructure and many other activities required for hydrogen projects), the general rule that there shall be no less than 51% local ownership applies.

Further, the Department of Economic Development within each Emirate of the UAE has discretion to specify which business activities will be open to 100% foreign ownership. The Department of Economic Development in each of Abu Dhabi and Dubai, for example, identify over 1,000 registered commercial and industrial activities, for which non-citizens, whether natural or legal persons, have the right to own economic licence, establish commercial companies with up to 100% ownership in the relevant Emirate. The positive list in Dubai currently includes green hydrogen production.

An approval and licensing regime is applicable to any such permissible foreign direct investment.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

Intending to promote its developmental goals, the UAE concluded 106 bilateral investment treaties, with most of its trade partners, which at a high level operate to:

- protect investments from all non-commercial risks like nationalization, expropriation, sequestration and freezing;
- allow the establishment of investments and licensing such investments;
- confirm the free transfer of profits and other returns in a freely transferable currency; and
- set the dispute settlement procedures between the investor and the State via amicable solution, local courts or international arbitration.

We are not aware of any treaties specific to hydrogen production and development in the UAE.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

In November 2021, His Highness Sheikh Mohammed Bin Zayed mandated ADNOC to explore potential opportunities in hydrogen with the ambition to position the UAE as a hydrogen leader. However, we are not aware of any other government grants or other government funding available for hydrogen projects at the time of writing.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

Practical steps also have been taken in terms of implementing pilot projects, as follows:

- [The Abu Dhabi Hydrogen Alliance](#) was created in January 2021, comprised of Mubadala, ADNOC and ADQ and the launch on 17 November 2021 of a new global renewable energy venture between ADNOC and TAQA.
- Dubai’s first green hydrogen plant was commissioned in May 2021. DEWA, in collaboration with Expo 2020 Dubai

and Siemens Energy, is implementing the green hydrogen project at DEWA's R&D Centre at the [Mohammed bin Rashid Al Maktoum Solar Park](#).

- DEWA, in partnership with Emirates National Oil Company, is studying building a hydrogen fuelling station in furtherance of the objectives of the Dubai Green Mobility Strategy 2030 to encourage the use of sustainable transportation, as well as the UAE's Hydrogen Vehicles System, which aims to develop the hydrogen economy in the UAE, and open up local markets to hydrogen vehicles.
- Complementing this pilot green hydrogen vehicle project is the development of the first set of domestic technical regulations regarding hydrogen vehicles by the Emirates Authority for Standardization and Metrology.
- ADNOC and German logistics company Hamburger Hafen und Logistik AG signed an agreement with ADNOC in March 2022 to test the transport chain for hydrogen from the UAE to Germany. A pilot delivery of low-carbon ammonia (produced by Fertigllobe, a partnership between ADNOC and OCI, at its Fertil plant in Abu Dhabi's Ruwais industrial complex) was unloaded in Germany in September 2022. This delivery was the first ever shipment of low-carbon ammonia to Germany and set an important milestone for the medium-term imports of green hydrogen.
- Emirates Global Aluminium ("EGA") has partnered with MoEI to become a member of the Hydrogen Leadership Initiative. The Initiative is dedicated to increasing research and development into the increasing use of hydrogen in industrial decarbonization. EGA's membership in the organization means it also becomes a member of the Abu Dhabi Hydrogen Alliance and the National Hydrogen Technical Committee.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

The UAE currently has 7 projects which are either completed or underway via the main stakeholders, such as the Abu Dhabi Hydrogen Alliance (ADNOC, Mubadala, & ADQ) and DEWA, including:

- the Mohammed bin Rashid Al Maktoum Solar Park in Dubai, the first solar PV and green hydrogen producing facility in the MENA region;
- the Fertil blue ammonia production plant in Abu Dhabi's Ruwais industrial complex;
- green hydrogen demonstration plant (initially for road transport, then expanding to e-kerosene synthesis and ocean shipping);
- establishing a UAE hydrogen hub in collaboration with BP;
- the UAE's first green ammonia plant powered by solar based electrolyzer facility developed by Helios and Abu Dhabi Ports (with a 2 GW green ammonia export facility developed by TAQA and Abu Dhabi Ports to be located in the same area); and
- Al Reyadah, a large-scale green hydrogen project enabling the first green steel produced in the MENA region.

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United Kingdom

Policy and regulation

1. Is there a government hydrogen strategy or policy?

Yes, a [Hydrogen Strategy](#) was published on 17 August 2021. This Strategy has since then been further developed and augmented, as discussed elsewhere in this guide.

2. What are key goals and commitments included in the strategy/policy?

Clean hydrogen is a key part of the UK Government's [Net Zero Strategy](#). In the [Energy White Paper](#), published on 14 December 2020, and subsequently in the [Hydrogen Strategy](#), published on 17 August 2021, the Government set out its aim to develop 5GW of low-carbon hydrogen production capacity by 2030 and for the UK to becoming a global leader in the development of clean hydrogen. The 5GW target was subsequently revised upwards to 10GW as part of the UK's [Energy Security Strategy](#), published in April 2022.

The Hydrogen Strategy acknowledges that the Government will need to take a leading role in developing the business models and regulatory framework for hydrogen. As such, the Government has also taken forward proposals for:

- a Hydrogen Business Model, to provide long-term revenue support to hydrogen producers;
- a UK Low Carbon Hydrogen Standard; and
- a Net Zero Hydrogen Fund (NZHF), which is intended to provide up to £240 million of government co-investment to support new low-carbon hydrogen production out to 2025. The NZHF opened to applicants in May 2022.

Strands 1 and 2 of the NZHF opened to applicants in May 2022 and July 2022 respectively.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

The industry sectors where clean hydrogen may displace fossil fuels in the UK, subject to pilot trials, include:

- the power sector;
- road freight;
- shipping and aviation; and
- heating.

Sectors where hydrogen is already being used, such as those that use hydrogen for industrial applications, are expected to switch to low-carbon hydrogen.

4. Who are the main regulators for the hydrogen market?

The Department for Business, Energy and Industrial Strategy has overall responsibility for the development of hydrogen policy and regulation.

Hydrogen falls within the ambit of the downstream gas regulatory regime, under the Gas Act 1986, and therefore in Great Britain the gas and electricity markets regulator, Ofgem, is responsible for issuing the licences required to transport and supply hydrogen by pipeline, and for the administration and enforcement of this licensing regime.

The upstream oil and gas regulator, the North Sea Transition Authority, has had its remit extended to facilitating the energy transition in the North Sea, and therefore has a role to play in relation to hydrogen, particularly in relation to the re-use of existing oil and gas infrastructure for the purpose of hydrogen production.

Other regulators also have responsibility for regulating various aspects of hydrogen production, transport and supply, including the Health and Safety Executive (in relation to safety issues) and environmental regulators (in England, this is the Environment Agency). The environmental permitting and decommissioning regimes are relatively complex, and which regulator is responsible for their enforcement depends on whether the activity/infrastructure is onshore or offshore, and in which part of the UK it is located.

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The Hydrogen Strategy supports both low-carbon hydrogen and renewable hydrogen – referred to by the Government as a “twin track” approach. However, the Strategy contemplates that initially at least, low-carbon hydrogen may take a leading role. The Strategy notes that CCUS-enabled methane reformation is currently the lowest cost low-carbon hydrogen production technology, and given the potential production capacity of CCUS-enabled hydrogen plants, the Government expects this route to be able to deliver a greater scale of hydrogen production while a UK hydrogen economy is being established during the 2020s.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

Since July 2019 the Government has been progressing a programme towards the deployment of carbon capture, usage and storage (CCUS) by developing the business models and regulatory regime for CCUS. A key component of the CCUS programme is the development of a business model and regulatory regime for the carbon transport and storage networks (T&S networks) that will be used to transport and store the carbon dioxide from emitters such as low-carbon (blue) hydrogen producers. It is envisaged that a transmission and storage operator will own and operate a T&S network. The revenue of T&S Co will be subject to an economic regulatory regime (ERR) overseen by an economic regulator.

The Government has selected two CCUS clusters to be initially developed using the ERR model described above: the HyNet North West ([HyNet](#)) Cluster and the Northern Endurance Partnership’s East Coast ([NEP](#)) Cluster. While both clusters will be available to be used by a large number of different carbon dioxide emitters, they will play a key role in the production of blue hydrogen. The HyNet Cluster will support the HyNet hydrogen plant which is expected to deliver 350MW of low-carbon hydrogen capacity by 2025, while the NEP Cluster will support hydrogen projects in the Net Zero Teesside and Zero Carbon Humber hubs, including the H2Teesside hydrogen project.

7. Are there targets for the production of hydrogen?

The UK’s target is to have 10GW of low-carbon hydrogen production capacity by 2030 for use across the economy.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

The Government is developing incentives through a Hydrogen Business Model (HBM). The HBM will involve support for hydrogen producers in the form of private law contracts between hydrogen producers and a government counterparty. A similar model (referred to as the Contracts for Difference regime) is already in place for renewable electricity generators and is also being developed for emitters of carbon dioxide who will connect to the carbon capture and storage networks described in question 6.

The HBM will be applicable across different production technologies, including the main types of production (natural gas reforming with CCUS, and electrolytic hydrogen) as well as other potential production technologies, such as hydrogen from biomass gasification with CCUS. The key features of the HBM contract (as set out in a consultation response of April 2022) include the following:

- price support to be provided under a bilateral contract between the hydrogen producer and a counterparty that will make price support payments to the producer;
- the price support will be a variable premium, calculated as the difference between a strike price and a reference price for each unit of hydrogen sold, with the strike price being the pre-agreed production cost of low-carbon hydrogen and the reference price being the producer’s achieved sales price (with a price floor set at the natural gas price); and
- a contract term of between 10 and 15 years.

The HBM contract heads of terms were published in April 2022. The Government intends to develop the terms and conditions for the HBM contract in 2022, so that the first HBM contracts can be awarded in July 2023.

The first allocation window for HBM contracts opened in July 2022. This allocation round – the Electrolytic Allocation Round – invited applications from developers of projects for the production of hydrogen using electrolysis. Producers

were invited to apply for both HBM contract support and also for NZHF support. Full details of the first Electrolytic Allocation Round are set out in the application guidance document. The Government is aiming to run a second Electrolytic Allocation Round in 2023, for contract award in 2024.

In the medium-term (likely to be from 2025), the Government intends to progress to competitive allocation of contracts (e.g. through an auction process).

CCUS-enabled hydrogen projects seeking support under a HBM contract are being selected through the “cluster sequencing” process, whereby carbon dioxide emitters (such as hydrogen producers) are selected to connect to a CCUS transport and storage network (described in question 6). CCUS-enabled hydrogen projects selected to proceed to the due diligence stage of the “phase-2 cluster sequencing process” were announced in August 2022.

The Energy Bill 2022-23, currently before Parliament, includes provisions required to provide the legislative framework for the HBM.

Existing producers of hydrogen looking to retrofit using carbon capture and storage (CCS) technology will not be eligible for support through the HBM, but may be eligible to apply for support through the separate Industrial Carbon Capture Business Model, which is intended to support industrial emitters of carbon dioxide who enter into arrangements to have their carbon dioxide transported and stored.

Some support for hydrogen used in transport is also available through the Renewable Transport Fuel Obligation (RTFO), a green certificate scheme for sustainable renewable fuels used in transport. The RTFO imposes an obligation on fuel suppliers to ensure that sustainable renewable fuel makes up a percentage of the volume of fuel they supply for transport. Two types of renewable hydrogen are supported under the RTFO. The first is hydrogen produced by electrolysis powered by renewable electricity. The second is biohydrogen produced from biological feedstocks, mainly biomethane via reformation.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

As part of taking forward the Hydrogen Strategy, the Government has developed a [UK Low Carbon Hydrogen Standard](#) that must be complied with by hydrogen producers seeking support under Government support schemes, including the NZHF and the HBM. The Standard defines what is meant by “low-carbon” hydrogen, by setting a GHG threshold for GHG emissions. Consignments of hydrogen derived from biogenic inputs must also meet sustainability criteria in addition to satisfying the GHG emissions threshold.

The Standard covers the methodology for UK production pathways only at this stage, but the Government intends to set up a hydrogen certification scheme by 2025 to underpin deployment of low-carbon hydrogen and support future international trade.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

The existing regulatory framework defines the requirements applying to different aspects of the hydrogen value chain, but there are areas where greater regulatory certainty is required. In particular, hydrogen falls within the definition of “gas” under the Gas Act 1986, which means that the existing regulatory framework that applies to downstream gas in Great Britain also applies to hydrogen. The application of the Gas Act 1986 regime to hydrogen means that the transportation, shipping (i.e. arranging for transportation) and supply of gas by pipeline are all activities which require a licence under the Gas Act 1986. Similarly, the health and safety regime that currently applies to downstream natural gas also applies to hydrogen.

As noted in the Hydrogen Strategy, while early projects can be expected to operate within existing regulatory regimes, new rules and regulations may be required to facilitate the further expansion of the market. In particular, regulatory changes will be required if a decision is made to proceed with using hydrogen in the existing gas grid, either as blended hydrogen or pure hydrogen.

The Hydrogen Strategy states that the Government will continue to work with industry and regulators in the early 2020s to identify and address regulatory barriers faced by first-of-a-kind hydrogen projects and consider changes needed to unlock hydrogen investment and deployment across the value chain.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

The National Security and Investment Act 2021 ([NSIA](#)), which came into force on 4 January 2022, contains a mandatory notification regime, backed up by criminal sanctions, for transactions involving the acquisition of a right or interest (typically a holding of more than 25%) in 17 key sectors. The regime applies to both foreign and UK investors. For relevant transactions, clearance must be obtained before closing. Certain activities in the energy sector are caught by the mandatory notification regime, including the ownership and operation of various gas infrastructure, such as gas distribution and transmission networks. Because pipeline transportation of hydrogen is covered by the Gas Act 1986 regime that applies to gas distribution and transmission, this means that the NSIA regime would also apply to hydrogen distribution and transmission.

The regime also includes a voluntary notification process (underpinned by a “call-in” power) for other transactions that may affect UK national security interests.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The United Nations Conference on Trade and Development (UNCTAD) [website](#) states that the UK is a signatory to 90 bilateral investment treaties (BITs) that are in force, and in addition certain other treaties may contain protections for investors in the UK. These can be accessed from the UK Treaties online [database](#) maintained by the Foreign, Commonwealth and Development Office, and UNCTAD’s Investment Policy Hub.

The Energy Charter Treaty (ECT) is a multilateral investment treaty which entered into force in April 1998 and specifically addresses energy trade, transit and investment between its contracting parties, which include the UK and all EU states (except Italy). Discussions as to the modernisation of the ECT have been ongoing for several years focussing, in particular, on investment protection and “greening” the ECT.

These discussions have focussed on reducing the protections accorded to fossil fuels and explicitly protecting emissions reduction technologies (including hydrogen and CCUS). This should be kept under review. There are differing views as to whether hydrogen production and CCUS would be afforded protection under the current terms of the ECT, and to our knowledge the question has not been considered by an arbitral tribunal.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

There have been a number of different funding initiatives targeted at different parts of the hydrogen value chain. The Low Carbon Hydrogen Supply Competition has provided funding to a number of pilot projects for the production of low-carbon hydrogen. Funding has been made available to various pilot projects for the use of hydrogen in sectors such as heating and transport (see question 10). The Net Zero Hydrogen Fund (NZHF), which is intended to provide up to £240 million of government co-investment to support new low-carbon hydrogen production out to 2025, was launched in May 2022.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of different pilot projects being deployed in the UK to examine and test the feasibility of clean hydrogen production and use in different sectors. One area that is of particular interest as it has the potential to create a large market for low-carbon hydrogen is heating, and this is being explored in the pilot projects outlined below.

[The HyDeploy demonstration project](#) is testing the potential for blending up to 20% hydrogen with natural gas in the existing gas grid. The project is being delivered by a consortium of partners, led by Cadent, a gas distribution network operator.

[The H21 programme](#) is funded by the regulator Ofgem and led by Northern Gas Networks (another gas distribution network operator) in partnership with other stakeholders, including the HSE. The focus of the H21 programme, which involves a number of different projects, is a complete conversion of the gas grid to 100% hydrogen.

In the Hydrogen Strategy, the Government has committed to supporting industry to conduct first-of-a-kind hydrogen heating trials, including a neighbourhood trial by 2023 and a village scale trial by 2025. The village trial will look

to build on learning from the neighbourhood trial, involving a larger and more diverse range of consumers, and conversion of existing local area gas infrastructure to 100 per cent hydrogen. These trials are intended to inform the Government's decision on the role of hydrogen in heating, a decision which the Government has committed to make by 2026.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in the UK, but there are a number of projects in the pipeline, at different stages of development, including:

- bp's H2Teesside hydrogen project that aims to produce 1GW of CCUS-enabled low-carbon hydrogen from 2027;
- bp's HyGreen Teesside project, to produce renewable hydrogen;
- ITM Power's Whitelee Windfarm Green Hydrogen Phase 1, which has secured government funding from the Energy Innovation Portfolio competition. The £9.4 million of funding is for a 10MW electrolyser and associated four tonnes of storage, and is the first phase in the development of the 20MW facility;
- the HyNet North West project, being developed by a consortium of different companies, which will produce, store and distribute low-carbon hydrogen from 2025;
- the Acorn low-carbon hydrogen project being developed by Pale Blue Dot Energy; and
- Project Mayflower, which has received finance from the Clean Maritime Demonstration Competition, funded by the Department for Transport and delivered in partnership with Innovate UK, to help develop around 20MW green hydrogen production for use at the Port of Immingham.

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Policy and regulation

1. Is there a government hydrogen strategy or policy?

There is currently no comprehensive hydrogen strategy for the United States. However, the Infrastructure Investment and Jobs Act (Infrastructure Plan) – which built upon the Energy Policy Act of 2005 (EPA) – contains a number of provisions aiding the advancement of hydrogen as an alternative energy source.

In addition, multiple federal and state agencies have overlapping authority to research and regulate hydrogen depending on its application. Principally, the US Department of Energy (DOE) released its [Hydrogen Program Plan](#) on 12 November 2020 which provided a strategic framework incorporating the research, development, and demonstration efforts of the Offices of Energy Efficiency and Renewable Energy, Fossil Energy, Nuclear Energy, Electricity, Science, and Advanced Research Projects Agency. This has been supplemented more recently by the DOE's September 2022 release of its draft National Clean Hydrogen Strategy and Roadmap (Strategy), which aims to advance hydrogen adoption and production within the US in the three following ways:

- targeting strategic, high impact uses, being sectors such as industry, heavy-duty transportation and long-duration energy storage;
- reducing the cost of clean hydrogen to \$1 per kg within one decade, with an interim goal of \$2 per kg by 2026; and
- focusing on the deployment of at least four regional clean hydrogen hubs introduced in the Infrastructure Plan and backed by \$8bn of funding, with at least one hub proposal from each of three production routes: fossil fuels, renewables, and nuclear energy. The intention is to co-locate hydrogen production technologies with other energy generation facilities to reduce the need for new long-distance infrastructure and lower the cost of early market growth. Concept papers from regional clean hydrogen hub projects seeking DOE funding were due by 7 November 2022.

Around the same time as the DOE's release of their new Strategy, the Inflation Reduction Act was signed into law in August 2022 and included \$369bn in energy and climate spending, introduced a clean hydrogen 10-year production tax credit and broadened the existing investment tax credit to apply to hydrogen projects.

Each state in the US has its own regulatory and financial landscape in relation to hydrogen with California, Texas and Louisiana generally recognized as being the most advanced in their low-carbon hydrogen policies. The focus of this summary is the federal landscape; should you require further state-specific information, please speak to your respective Ashurst contact.

2. What are key goals and commitments included in the strategy/policy?

The Infrastructure Plan established the Clean Hydrogen Research and Development Program (Program) to: (1) advance research and development and commercialize the use of clean hydrogen in the transportation, utility industrial, commercial, and residential sectors; and (2) demonstrate and commercialize the use of clean hydrogen in the transportation, utility, industrial, commercial, and residential sectors by 2040.

The Infrastructure Plan also added the following important provisions to the EPA:

- providing \$8 billion over four years for the creation of four Regional Hydrogen Hubs;
- requiring the Secretary of Energy to develop a technologically and economically feasible national energy strategy and roadmap to facilitate widescale production, processing, delivery, storage and use of clean hydrogen;
- providing \$500 million over four years to award multiyear grants and contracts for research, development, and demonstration projects to advance new clean hydrogen production, processing, delivery, storage and use equipment manufacturing technology and techniques; and
- providing \$1 billion to fund a clean hydrogen electrolysis program, focused on reducing the cost of hydrogen produced using electrolysis.

The more recent Strategy also sets goals for the US to produce 50 million tons of clean hydrogen per year by 2050, with interim targets of 10 million tons by 2030 and 20 million tons by 2040.

The Strategy also restated the Infrastructure Plan's requirement on the DOE to set a clean hydrogen production standard of less than 2kg of carbon dioxide-equivalent (CO₂e) per kg of H₂—however, the DOE more recently stated a proposal to double that standard to 4kg of CO₂ per kg of H₂.

The DOE is also currently studying hydrogen storage at scale, and has produced initial outlooks for underground storage within geological formations throughout the US.

3. Which industry sectors are most likely to be affected by hydrogen deployment?

It is expected that hydrogen will play the largest role in the following five sectors of the US economy:

- as fuel for buildings;
- as transportation fuel (with a growing focus on heavy-duty vehicles, rail, maritime and aviation sectors);
- as feedstock for industry and long-distance transport;
- as industrial fuel (with a growing focus on steel and cement manufacturing); and
- for power generation and grid balancing (particularly for large-scale power, off-grid distributed power, back-up or emergency power and long-duration energy storage).

Sectors where hydrogen is already being used, such as where it serves as feedstock or reactant in industrial processes, are expected to switch to low-carbon hydrogen.

4. Who are the main regulators for the hydrogen market?

There is no clear-cut answer to this question given the lack of comprehensive federal hydrogen strategy and the split between federal and state regulation. However, aligning with our main focus on the federal landscape in this chapter, the main federal agencies with the ability to influence the development of hydrogen industry and infrastructure at a federal level include: the Department of Energy ("DOE"), the Federal Energy Regulatory Commission ("FERC"), the Pipeline and Hazardous Materials Safety Administration ("PHMSA"), and the Environmental Protection Agency ("EPA").

5. Does the government hydrogen strategy or policy support the development of both low-carbon (blue) hydrogen and renewable (green) hydrogen?

The Infrastructure Plan defines "clean hydrogen" as hydrogen produced from any fuel source as long as it meets the carbon intensity requirement. This would include hydrogen produced from renewable, fossil fuel with carbon capture, utilization, and sequestration technologies, and nuclear.

6. If the government hydrogen strategy or policy supports the development of low-carbon hydrogen, to what extent is carbon capture and storage being taken forward?

Although still in its nascency due to costs, regulatory uncertainty, infrastructure, and technology needs, carbon capture utilization and storage (CCUS) continues to be a central focus for the US in its energy efforts. As part of the Infrastructure Plan, Congress took the following related measures:

- appropriated \$937 million for the DOE to fund carbon capture large-scale pilot projects over FY22-FY25 and an additional \$2.04 billion for the DOE to fund carbon capture demonstration projects over FY22-FY25;
- established the Department of Energy Program comprised of both a front-end engineering and design program for carbon dioxide transport infrastructure to enable deployment of CCUS technologies and a carbon dioxide infrastructure finance and innovation program to provide low-interest loans for carbon dioxide transport infrastructure projects; and
- provided \$310 million in grant funding for carbon utilization for use over FY22-FY26.

7. Are there targets for the production of hydrogen?

No. However, the Road Map to a US Hydrogen Economy, developed by a coalition of US energy sector players, estimates that hydrogen could account for 14% of US energy demand by 2050.

8. Are there any incentive mechanisms/business models in place to support the production of hydrogen?

Whilst the Infrastructure Plan contains no specific tax incentives, the following related tax incentives have been introduced by the Biden Administration:

- in March 2021, the American Jobs Plan included numerous proposals to expand tax credits for clean energy and suggested pairing investment in 15 low-carbon hydrogen demonstration projects with a new tax credit for low-carbon hydrogen production facilities where construction begins before 2026;
- in May 2021, the Treasury Department released the “Green Book” which proposed a new 6-year hydrogen production tax credit (PTC), starting at \$3 per kilogram (adjusted for inflation) of production of low-carbon hydrogen, for qualified facilities that begin construction before 2027; and
- in June 2021, the Clean Energy for America Act introduced additional major new tax incentives and credits for investment in clean energy facilities and for the production of electricity from clean energy and clean fuel.

9. Are there any standards in place for the classification and/or certification of low-carbon or renewable hydrogen?

The Infrastructure Plan defines “clean hydrogen” as hydrogen produced with a carbon intensity equal to or less than 2 kilograms of carbon dioxide-equivalent produced at the site of production per kilogram of hydrogen produced. Under the Infrastructure Plan the DOE, in consultation with EPA, is directed to establish a “standard” for measuring that carbon intensity in the context of hydrogen production. As at April 2022, the outcome of that consultation has not yet been published.

10. Does the regulatory framework clearly define the regulatory requirements relating to the production, storage, transportation or supply of hydrogen?

No, to achieve the level of hydrogen generation and deployment required to match ambitions, increased investment in research and development is crucial, as well as the introduction of a supportive regulatory framework at federal and state level.

11. Are there any foreign investment restrictions related to energy and infrastructure sectors?

The 1988 Exon-Florio Amendment to the Defense Production Act of 1950 empowers the president to block foreign acquisitions of US companies that threaten to impair national security. The president delegated authority to investigate transactions to the Committee on Foreign Investment in the United States (CFIUS). Congress subsequently enacted the Foreign Investment and National Security Act of 2007 on July 26, 2007 which formally established CFIUS including its mandated membership, established transaction-specific and general Congressional notification requirements and specifically included ‘critical infrastructure’ and ‘energy security’ within the concept of national security. Transactions that involve foreign governments, a threat to national security, or control of critical infrastructure are compulsorily subject to a 45-day formal investigation, except where the Secretary or Deputy Secretary of Treasury and the lead agency certify that there is no national security threat.

The Mineral Lands Leasing Act of 1920 limits the acquisition of rights-of-way for oil or gas pipelines, or pipelines carrying products refined from oil and gas, across onshore federal lands. These restrictions also apply to acquiring leases or interests in certain minerals (including coal and oil) on onshore federal lands. Citizens of other countries and foreign corporations may have up to a 100 percent stock ownership in a domestic company that owns such rights, interests, or leases, provided that the foreign investor’s home country reciprocates with rights to US companies.

12. What international treaties are in place that may offer protection to international investors in hydrogen projects in the jurisdiction?

The US is a signatory to various bilateral investment treaties (BITs) that are in force, and in addition certain other treaties may contain protections for investors in the US. These can be accessed from the online [database](#) maintained by the Trade Compliance Center.

Market developments and opportunities

13. Are there any government grants or other government funding available to hydrogen projects (including for research and development)?

In July 2021, the DOE announced \$52.5 million of funding for 31 projects to advance next-generation clean hydrogen technologies and to support the Hydrogen Energy Earthshot, the first in a series of initiatives with a stated aim of accelerating breakthroughs in more abundant, affordable, and reliable energy solutions within the decade which primarily seeks to reduce the cost of clean hydrogen by 80% to \$1 per 1 kilogram in one decade.

In addition, the Fiscal Year 2022 Budget (Budget) proposed that \$197.5 million is requested for supporting efforts to enable the widespread adoption of hydrogen and fuel cell technologies.

14. Are there any notable pilot/demonstration projects in place or planned for the production or offtake of clean hydrogen?

There are a number of pilot projects in the US, some of which are outlined below:

- the Yara/BASF ammonia plant in Freeport, Texas, has developed a pilot using low-carbon by-product hydrogen from nearby petrochemical plants instead of natural gas from steam methane reforming;
- Mitsui and CF Industries signed a memorandum of understanding in August 2021 to carry out various feasibility studies in respect of ammonia produced using blue hydrogen production in the US;
- Chesapeake Utilities Corp. is piloting hydrogen blending in a combined heat and power plant and is looking to inject hydrogen into its distribution systems in its Florida and Mid-Atlantic territories;
- a DOE-backed project called HyBlend is marshalling the resources of four national labs to identify technical barriers to injecting hydrogen into gas infrastructure and life-cycle emissions linked to hydrogen-natural gas blends;
- the University of California (UCI), Irvine in collaboration with SoCalGas, is running a demonstration project through its Advanced Power and Energy Program to convert excess renewable power to hydrogen and blend it into the natural gas system. SoCalGas is developing a “hydrogen home”, which will convert solar power into low-carbon hydrogen which can then be stored, blended, or used to power a fuel cell within the home and are also conducting research with a view to increasing hydrogen blending on the grid up to 20%;
- the California Energy Commission awarded \$7.3 million to Shell Hydrogen (as part of the wider Equilon Enterprises LLC) in December 2021 to deliver 8 of the 51 Shell hydrogen refuelling stations that have been proposed;
- Bloom Energy in California will begin offering electrolysers alongside hydrogen-powered fuel cells which is expected to produce the lowest cost clean hydrogen through electrolysis and intends to assist hard-to-decarbonise heavy industries in achieving net-zero emissions through the Bloom Electrolyser’s use of solid oxide technology delivering better efficiency by operating at high temperatures. Orders are currently being accepted, with commercial shipment expected in Autumn 2022; and
- SGH2 Energy Global, part of the Solena Group, announced that they had entered into the first and only long-term green hydrogen off-take agreement in the world to date in July 2021 under which they agreed to sell 3,850 tonnes a year of carbon-negative green hydrogen to refuelling stations across southern California. SGH2 is said to be in negotiations with major global energy companies to launch similar projects in Northern California, as well as across parts of Europe, Australasia, and South Africa.

15. Are there any commercial-scale clean hydrogen production projects in development or already operating?

There are currently no existing commercial-scale clean hydrogen production projects in the US, but there are a number of projects into which investment has begun, including:

- Mitsubishi Power Americas and Magnum Development's jointly-developed Advanced Clean Energy Storage project in Utah which aims to build a storage facility for 1,000 megawatts of clean power, partly by putting hydrogen into underground salt caverns;
- Bakken Energy and Mitsubishi Power America's acquisition and redevelopment of a synthetic natural gas plant in North Dakota into a blue hydrogen production facility, with the aim of connecting the hub by pipeline to other hubs throughout the US;
- a 20 megawatts electrolyser plant in Florida that will produce 20,000 tonnes per year of hydrogen from solar power;
- a 5 megawatts proton exchange membrane electrolyser project in Washington State that will provide renewable hydrogen for the Douglas County Public Utility District (Douglas County PUD) in Washington;
- Intermountain Power Agency's replacement of its coal units at the Intermountain Power Plant with a gas turbine combined cycle technology, which will initially be capable of utilizing 30% renewable hydrogen as a clean energy fuel and will reach 100% renewable hydrogen capability by 2045. This plant will supply stored renewable power to the Los Angeles basin and other power users throughout California and Utah; and
- first-of-a-kind nuclear-to-hydrogen projects in multiple state throughout the US.

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Ashurst