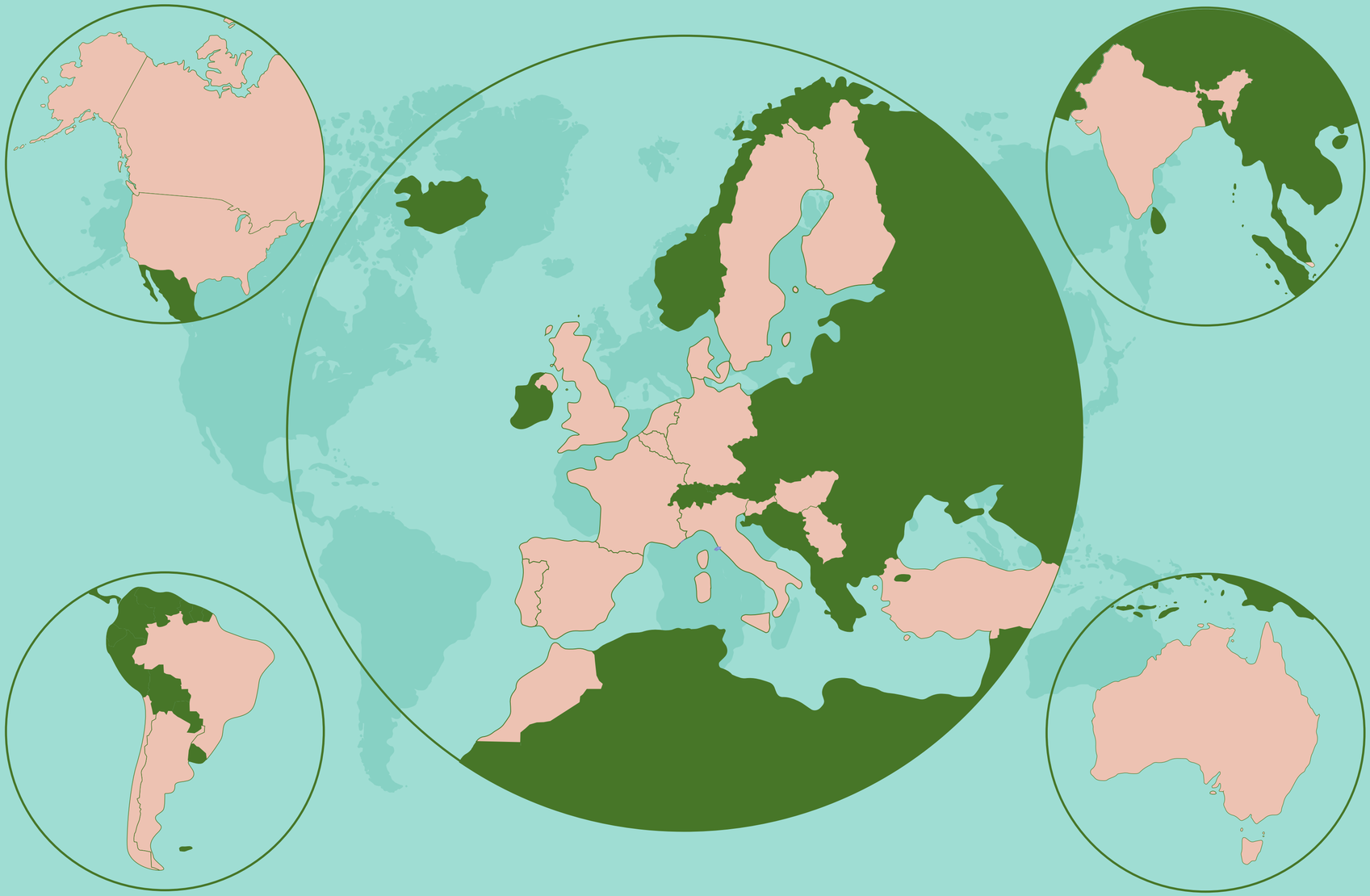
Bird & Bird

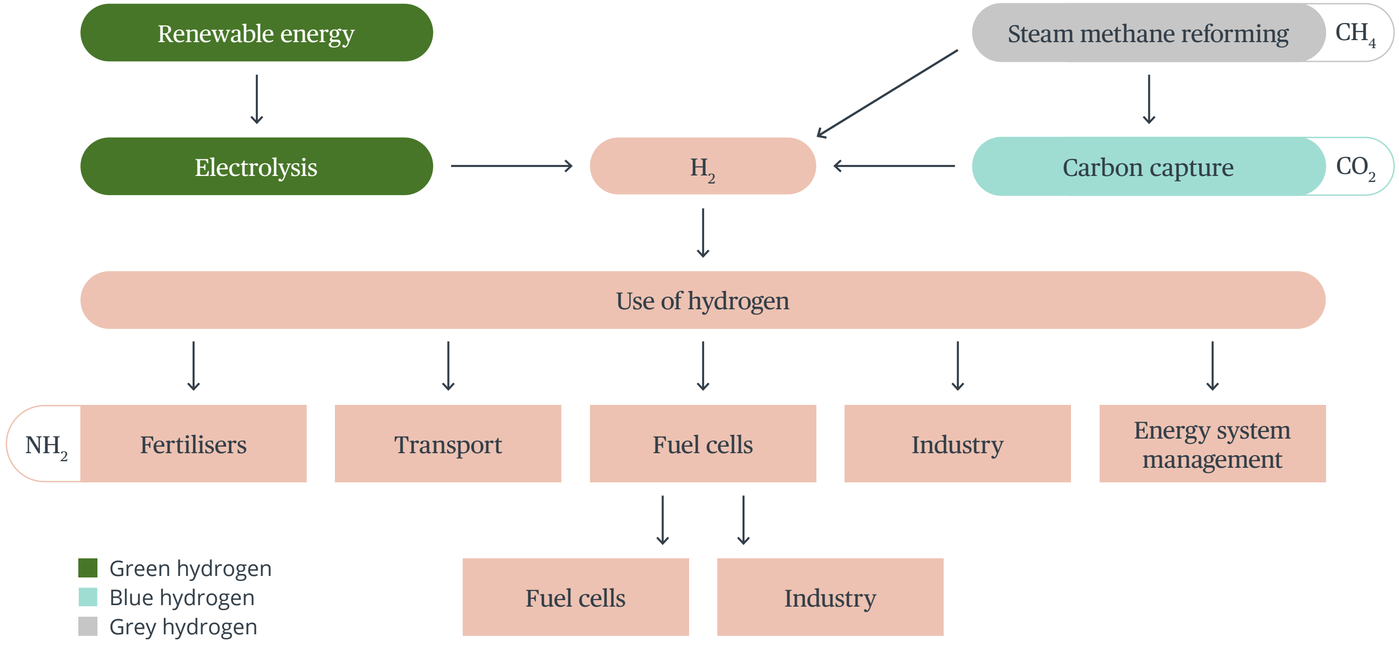
International *Green Hydrogen* Report 2024



Contents

Focus on hydrogen

Whether as an energy carrier, as energy storage for renewable energies, as a climate-neutral fuel in transport, as an essential element of sector coupling (dovetailing green electricity with the heat and mobility sectors as well as industry, or as a means of decarbonising CO2 sources (such as the steel or cement industry), hydrogen is clean and versatile.



Accordingly, the desires surrounding the use of hydrogen are growing – and with them the legal questions that arise in this context, as these are as diverse as the usability of hydrogen.

The legal issues

A successful energy transition can only be achieved by combining security of supply, affordability and environmental compatibility with innovative and intelligent climate protection. This requires an alternative option to the fossil fuels that are predominantly used today.

Hydrogen has a key role to play in the energy transition. In addition to numerous other advantages as a renewable energy carrier, the use of hydrogen makes it possible to significantly reduce CO2 emissions.

Our hydrogen-focused team has already successfully supported and strategically advised various projects *on the practical use of hydrogen technology.*

Green hydrogen is the petroleum of tomorrow

The flexible energy carrier is indispensable for the energy transition and opens new markets as part of the entire value chain: technologies, generation, storage, infrastructure and use including logistics and important aspects of quality infrastructure.

Our hydrogen-focused team has already successfully supported and strategically advised various projects on the practical use of hydrogen technology. We typically work in cross-jurisdictional teams and cooperate with technical consulting specialists where necessary.

Regulation

In the context of the production, transport, distribution and consumption of hydrogen, numerous regulatory provisions must be observed.

The key legal and economic issue is the legal qualification of “green hydrogen” and the development of standards enabling a real international green hydrogen market.

Furthermore, the double burden of certain levies and charges that apply in the context of energy storage and thus also the use of hydrogen.

Another key issue in terms of regulatory law is the development of a nationwide – or European – hydrogen infrastructure. Without a sufficient infrastructure, the full potential of hydrogen cannot be exploited.

If, in addition, subsidies are granted to develop an innovative technology or to fund a project, it is important to observe the subsidy law requirements for the proper use of the subsidies. In individual cases, this may justify, among other things, strict compliance with all obligations under national public and European procurement law regarding the tendering of contracts. In the event of non-compliance with the subsidy requirements, there is a risk that the subsidies will have to be repaid with interest.

In any case, the regulatory framework starts to offer viable business models, but the resulting obligations must be strictly observed. The regulatory framework is not entirely set and developers and investors have to observe the different national, European and international developments with attention.

The legal issues

Contracts

The implementation of hydrogen production or storage projects (e.g. power-to-gas plants) or infrastructure projects (e.g. the development of a hydrogen infrastructure) require a balanced and solid contractual basis. The complexity of the supply and off-take contracts required for these projects should be considered – also regarding investment and financing issues from the beginning. The contracts also have to integrate the regulatory requirements for green electricity supply, safety issues and authorization procedures.

Intellectual Property

Many promising projects in the field of hydrogen production, transport, or distribution start with a pioneering invention. For example, high-performance storage technologies need to be developed to be competitive and attractive to consumers. These inventions must be protected, through patent protection at national and international level. Likewise, your patents and trademarks should be effectively enforceable against any imitators. As of today, European companies are in a leading position with respect to patents in the hydrogen field.

Conversely, when developing new products and processes around hydrogen, you should consider the increasing density of third-party patents and also design your new product with a view to ensuring your “Freedom to Operate” as far as possible.

Establishment of Joint Ventures

For the success of your engagement, it is necessary that you place your cooperation with partners on a solid foundation under the respective company law. The establishment of a tailored joint venture or a common project company, to which know-how, industrial property rights, technology or services can be contributed in addition to financial resources, is a typical example. At the heart of this is the joint venture agreement, which must describe the common goal of the cooperation just as clearly as the respective services of the cooperation partners. The possibilities of the partners to influence the development of a company must also be regulated. In case of a common investment the mutual rights and obligations including lock-up periods, exit scenarios and management incentive packages are to be considered with attention.

All relevant contracts should be drafted clearly, practically and with foresight and take enough account of the special features of the technologies and their change or further development. We accompany and advise you in all necessary strategic decisions and the practical steps of setting up such a joint venture or a common company, whether in connection with research and development, production or distribution or a combination of both.

Project Finance

From venture capital and equity investments the path will quickly lead to more classic Project Finance structures – with European Hydrogen Bank and European and national investment banks ready to support the industry. The investment amounts needed will trigger an increasing involvement of traditional lenders, who will need careful advice on secure loan structures, collaterals and a due diligence.

Managing contractual and governmental dispute risk

Complex and innovative hydrogen projects, especially those of a cross-border nature, also require participants to identify and mitigate their risk as regards contractual counterparties, and also host governments or other state-entities whose actions have the potential to undermine the value and viability of a project.

Disputes with joint venture partners, suppliers, customers, and contractors require careful and strategic handling to ensure optimal outcomes. Operators and other stakeholders also need to be alert to the risk of claims from third parties impacted by projects and their operation, and/or claims for environmental damage. Cross-border investment in hydrogen projects also requires a consideration of the availability of investment treaty protections to safeguard cross-border investment from the harmful actions of governments or related bodies. This requires an awareness of the existence of such treaty protections and how they might apply to the proposed investing entities and the host state(s) under consideration.

Funding and Support Schemes

The European Union’s first auction from the European Hydrogen Bank marked a significant step towards scaling up renewable hydrogen production, with an initial €800 million, funded by the Innovation Fund and emissions trading revenues. Meanwhile, the UK’s inaugural Hydrogen Allocation Round (HAR1) allocated over £2 billion to 11 green hydrogen projects, setting a strike price for 15 years, aiming to stimulate the development of a competitive hydrogen market.

And beyond that. In addition to the topics highlighted as examples, a wide range of other questions can arise.

The uses of *green* hydrogen

The use of hydrogen is starting to gain momentum in a variety of sectors. Hydrogen is set to play an important role in the decarbonisation of sectors where emissions are hard to abate, such as *heavy goods vehicles*, *mining*, *rail* and *aviation*.

Aviation

Aviation accounts for 2-3% of global CO2 emissions and remains the fastest-growing source of greenhouse gas emissions. In 2023, CO2 emissions from aviation reached 80% of their pre-pandemic peak. Air travel is expected to double in the next 15 years meaning these numbers will continue to grow. Growth in aviation activity has historically outpaced efficiency improvements.

Technical decarbonisation measures such as low-emission fuels, aircraft and engine efficiency improvements, operational optimisation and demand constraints are needed to get the aviation industry on track with ambitious net-zero goals. The use of hydrogen fuel cells as a substitute to conventional aircraft propulsion systems offers a zero-emissions transportation solution and has already been safely used in aviation for a number of years. It is estimated that hydrogen has the potential to reduce aviation's CO2 emissions by up to 50% and is therefore an important technology to achieve the industry's decarbonisation goals. Sustainable Aviation Fuel ("SAF") includes fuel from a variety of sustainable sources, including green hydrogen. Suppliers are set to start delivering SAF from 2025 and hope to be able to reach 85% of all aviation fuel in EU airports by 2050. Hydrogen is included as part of this new fuel mix, with the International Air Transport Association ("IATA") predicting that the aviation sector will require an excess of 100 million tonnes of hydrogen as a fuel. Hydrogen is also emerging as a key player in the transformation of airport operations towards sustainability. It is being explored for non-aircraft energy users such as ground handling services and passenger transportation. The goal is to create a seamless, low-carbon ecosystem that supports airport activities and reduce air travel's environmental impact in the sky and on the ground.

Policy support

ReFuelEU Aviation initiative

The European Commission presented the "fit to 55" package on 14 July 2021, which includes proposals to make the EU's transport policies fit for reducing net greenhouse gas emissions to at least 55% by 2030. It included a proposal to ensure a level playing field for sustainable air transport, also known as the ReFuelEU Aviation Initiative. A political agreement on this initiative was reached in April 2023. The new rules will require, amongst other measures, fuel suppliers to supply a minimum share of SAF at EU airports which shall increase gradually each year, starting at 2% of overall fuel supplied by 2025 and reaching 70% by 2050.

Book and Claim System

The aviation sector and its supply chain have called for more time to establish the production infrastructure required to comply with SAF mandates within the ReFuelEU rules. They have suggested the importance of implementing a book and claim system to offer some financial respite during the initial stages of regulation enforcement. The book and claim system would enable airlines departing from airports without SAF access to buy it for utilisation by other operators in different locations. This way, they bear the additional cost of SAF without the need to physically use the fuel in flights where it's not feasible. The aviation sector contends that decoupling the purchase of SAF from its actual usage will tackle the expected supply issues while fostering the growth of the SAF industry.

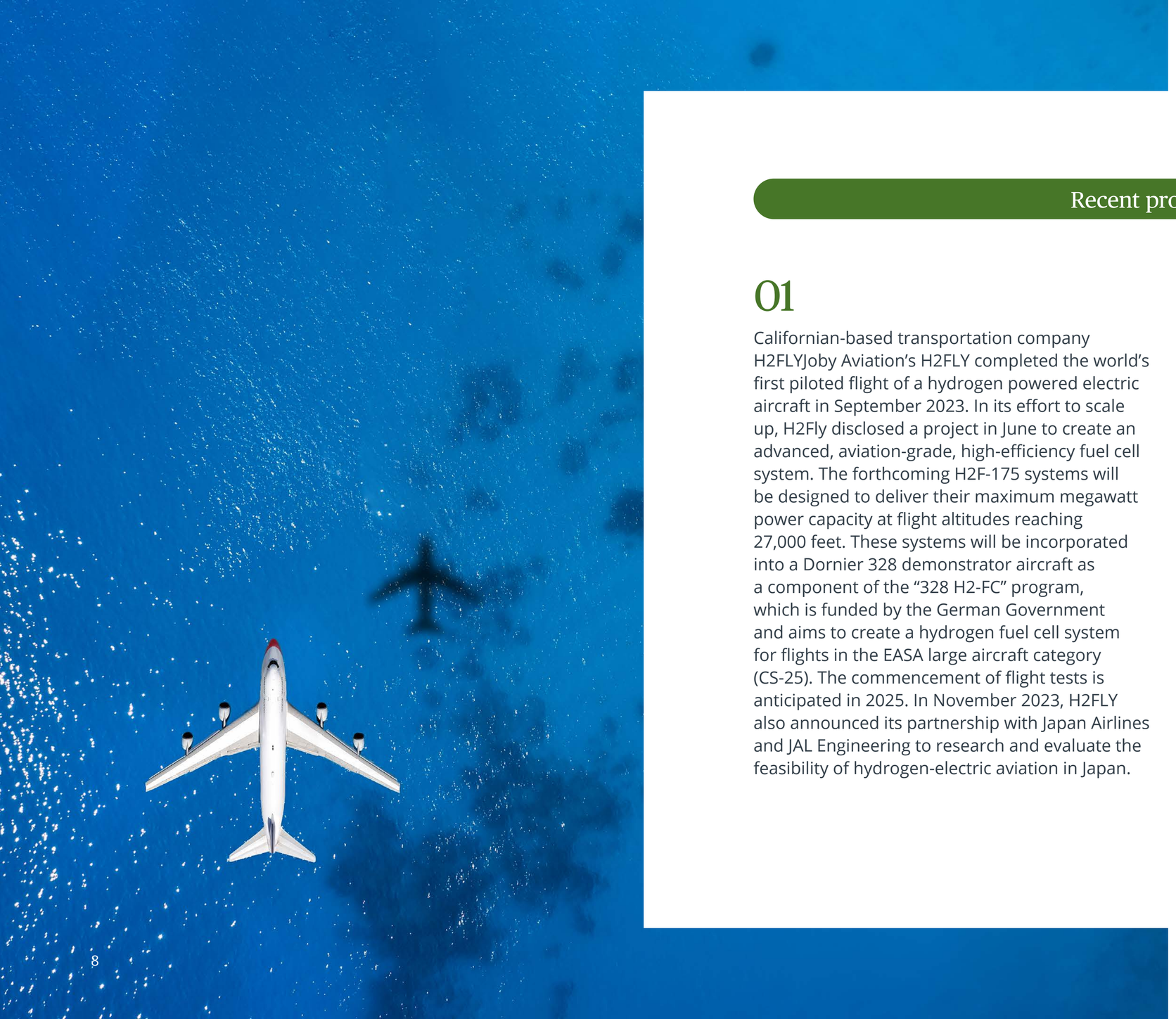
The European Commission will present a feasibility study on the book and claim system as a transitional strategy by July 2024.

Jet Zero Pledge and FlyZero Project

In 2021, the UK Government backed plans for the £15 million FlyZero project – a concept for a midsize aircraft powered by liquid hydrogen, led by ATI. The aircraft would allow up to 279 passengers anywhere in the world without producing any carbon emissions. FlyZero analysis concluded that a mid-size hydrogen aircraft could efficiently address 93% of existing long-haul scheduled flights and, therefore, the majority of emissions in this market sector. The UK Government has also dedicated £165 million to support SAF projects, with a plan to have at least five commercial SAF plants under construction by 2025.

Inflation Reduction Act

The production of SAF received significant backing following the enactment of the Inflation Reduction Act (IRA) in the United States in 2022, which allocated USD $3.3 billion in tax credits and a competitive grant programme to SAF. The IRA offers USD $1.25 per gallon ($0.33 per litre) for SAF produced, on the condition that the lifecycle emissions do not exceed half of those of fossil jet kerosene. An additional credit of one cent is granted for each percentage point by which the reduction in lifecycle emissions surpasses 50%.



Recent projects

01

Californian-based transportation company H2FLYJoby Aviation's H2FLY completed the world's first piloted flight of a hydrogen powered electric aircraft in September 2023. In its effort to scale up, H2Fly disclosed a project in June to create an advanced, aviation-grade, high-efficiency fuel cell system. The forthcoming H2F-175 systems will be designed to deliver their maximum megawatt power capacity at flight altitudes reaching 27,000 feet. These systems will be incorporated into a Dornier 328 demonstrator aircraft as a component of the "328 H2-FC" program, which is funded by the German Government and aims to create a hydrogen fuel cell system for flights in the EASA large aircraft category (CS-25). The commencement of flight tests is anticipated in 2025. In November 2023, H2FLY also announced its partnership with Japan Airlines and JAL Engineering to research and evaluate the feasibility of hydrogen-electric aviation in Japan.

02

The UK Civil Aviation Authority (CAA) announced the selected companies for its Hydrogen Challenge on 28 February 2024. These include Cranfield Aerospace Solutions, Exeter Airport Consortium, and ZeroAvia. The Hydrogen Challenge, launched in November 2023 with funding from the Regulator's Pioneer Fund, aims to leverage the potential of hydrogen as a zero-carbon emission aviation fuel.

Cranfield Aerospace Solutions is developing a hydrogen fuel cell drivetrain for aircraft, and plans to conduct ground testing and flight trials this year. The Exeter Airport Consortium will focus on reducing the environmental impact of aircraft turnarounds at Exeter Airport. ZeroAvia is developing hydrogen-electric engines for aviation and is already flying a prototype system in a Dornier 228 testbed.

The CAA will work with these companies to identify hazards, risks, and safety challenges associated with their projects.

Rail

The rail sector has traditionally been powered by diesel; however, the sector is making a move away from harmful gases towards hydrogen in a bid to decarbonise the network.

Although battery technology and electrification of existing railways is often a cheaper solution than producing hydrogen trains, hydrogen still offers a variety of advantages as a reliable, high performing, and cost-effective alternative. This is particularly true for non-electrified tracks longer than 100 kilometres where battery trains would not be feasible. In the EU, around 45% of all railway tracks are not yet electrified, and smaller regional lines often lack electrification due to high costs and lower traffic viability. The use of hydrogen fuel-cells will therefore play a key role in rail's transition to zero-emissions.

It is estimated that by 2030, one in five newly bought train vehicles could be operated by green hydrogen and many countries have ambitious plans to introduce green hydrogen in the rail sector. Some are already in operation, using hydrail, which uses a hybrid configuration of hydrogen fuel cells, batteries, and electric traction motors.

Recent projects and policy support

Alstom, a French multinational rolling stock manufacturer, appear to be taking the lead in the use of hydrogen for the railway sector after developing and deploying the world's first operational passenger hydrogen fuel cell train, the Coradia iLint, into passenger service in Lower Saxony, Germany in 2018. The Coradia iLint has operated in regular passenger service in Germany and Austria and by mid-2023 had covered more than 220,000 kilometres, although the project has not been entirely successful, with no new hydrogen trains being commissioned in future due to the expense. The Lower Saxony Regional Transport Company had invested over €93 million, with an additional €8.4 million from the German Government for the purchase and development of the trains, but concluded battery-electric trains would be more cost effective going forward.

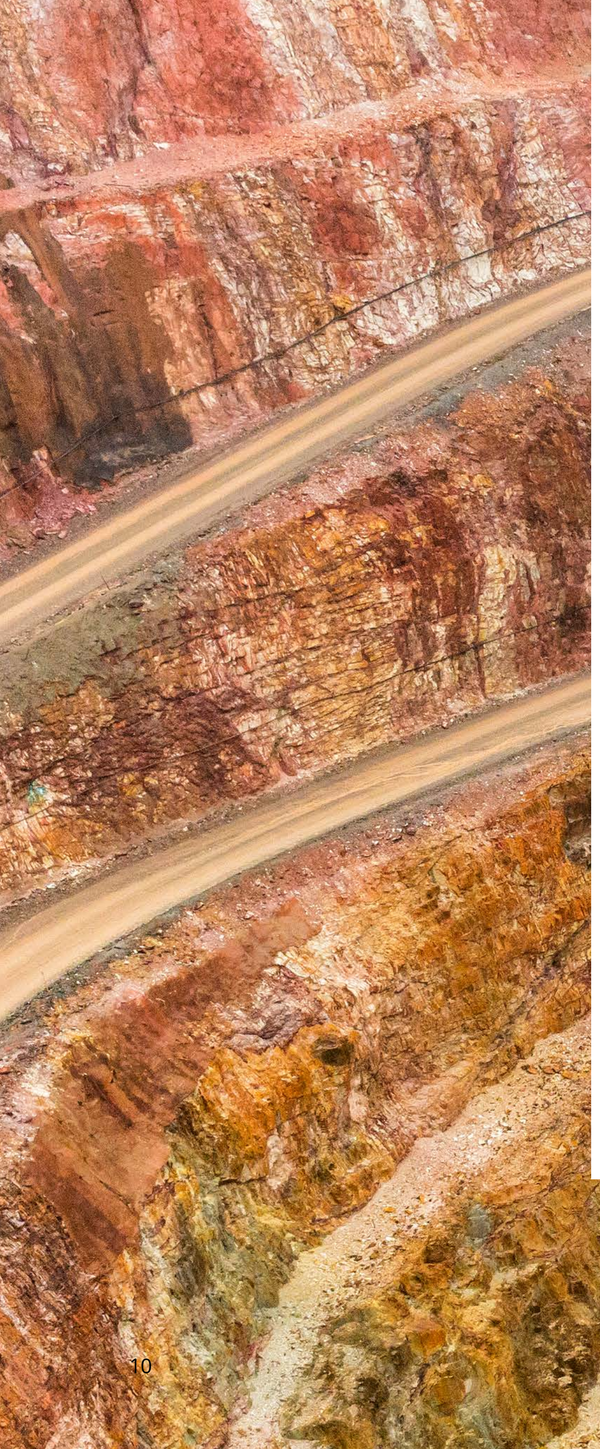
In 2021, the French Government allocated €47 million to support the development of hydrogen-powered trains in France also involving Alstom. The plan involves building 14 Regiolis H2 multiple units to operate in the regions of Auvergne-Rhône-Alpes, Bourgogne-Franche Comté, Grand Est and Occitanie. Alstom has also recently secured contracts to provide hydrogen trains in Puglia and Lombardy, Italy. This was backed by the Italian Government's allocation of €24m for hydrogen trains and an additional €276m for production, storage, and supply of renewable hydrogen.

Other companies have since followed in Alstom's steps with their own innovations. Spanish rail manufacturer Talgo, and nine other companies, are pioneering a world-first high-speed train powered by hydrogen fuel cells. This consortium, under the Hympulso project, is creating a dual-hybrid battery system for Talgo's 250 train model, swapping a diesel unit for one with green hydrogen cells. The project received a €6.5m grant from Spain's renewable hydrogen incentive Program.

In the UK, H2 Green, the hydrogen network operator and Eversholt Rail, a leading railway rolling stock owner, entered into an agreement to develop hydrogen supply solutions for the UK railway. The collaboration is working to establish the production and refuelling infrastructure necessary to support wide-scale deployment of hydrogen-powered rolling stock fleets.

Also in the UK, HydroFLEX, the UK's first hydrogen fuelled passenger train which can operate under electric, battery and hydrogen power has signalled a major step towards the UK's Net Zero targets. Ongoing trials of this development have been supported by a £750,000 grant from the UK's Department for Transport, which follows two years of development and over £1 million of investment by Porterbrook and The University of Birmingham.

In 2021, the French Government allocated a grant of €47 million to support the *development of hydrogen-powered trains* in France.



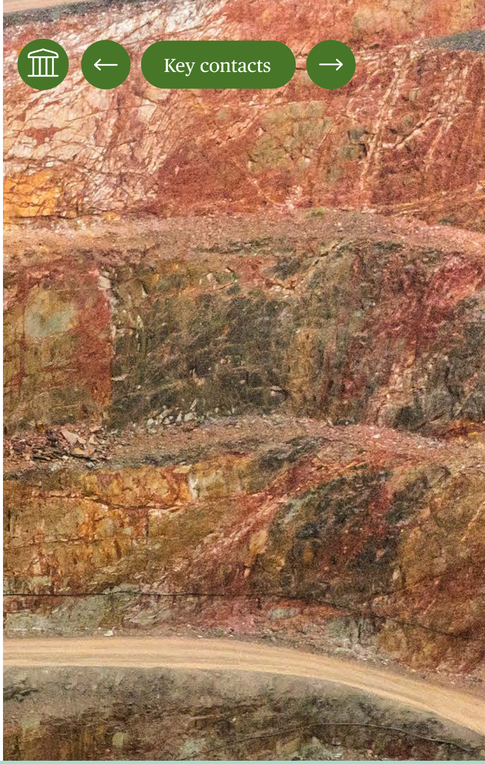
Mining

The mining sector is responsible for 4-7% of greenhouse gas (“GHG”) emissions globally and is facing pressure to decarbonise as companies strive to achieve net zero emissions by 2050.

Throughout 2023, we observed a rise in joint venture and collaboration agreements between mining companies and researchers focused on developing and testing green hydrogen technologies. However, like all investment areas, the pace slowed due to the increasing costs of capital.

There are two established hydrogen applications that are already assisting miners on the route to decarbonisation: (i) carbon-free fuel to displace diesel in heavy equipment such as haul trucks, and (ii) as a storage and power source for mining activities on site.

However, implementing these hydrogen applications (and funding research and development into other hydrogen applications) is costly and technically challenging, and the mining industry has called for firmly established financial incentives and a clearer regulatory landscape to support hydrogen investment decisions.



Green hydrogen is already assisting miners on the route to decarbonisation, either as carbon-free fuel to displace diesel in heavy equipment *such as haul trucks, or to generate electricity to power processing plant.*

Recent projects and policy support

01

Fortescue's Green Iron Commercial Plant – Fortescue Metals Group Ltd announced at the end of 2023 that it would be proceeding with a green metal project, an investment of up to US$50million, at their Christmas Creek iron ore mine in Western Australia. The Christmas Creek Green Iron Commercial Plant will use renewable energy and green hydrogen reduction technology together with an electric smelting furnace to produce up to 1,500 tonnes of high purity green iron suitable for use in almost any steel plant globally.

Fortescue notably has a number of other green energy projects underway, including an 80MW electrolyser and liquefaction facility in Arizona, USA with production capacity of up to 11,000 tonnes per annum of liquid green hydrogen, located strategically to contribute to decarbonising the heavy duty road transportation sector. The project notably anticipates qualifying for the Clean Hydrogen Production Tax Credit under the US Federal Government's Inflation Reduction Act (IRA) 2022.

A second 50MW green hydrogen project utilises Fortescue's own electrolyser technology in Australia targeting third party offtake and on-site refuelling which will utilise an existing grant under the Modern Manufacturing Initiative. The total of investment of both projects is approximately US$700million and serves as useful example to other miners that green hydrogen production can benefit both onsite activities and support diversification of income.

02

Partnership Agreements – As an example of mining companies investing indirectly in the hydrogen sector, in April 2023, we saw Carlton Power signing a partnership agreement for its Langage Green Hydrogen project to supply hydrogen fuel to two international mining and materials companies: Imerys and Sibelco. The Langage Green Hydrogen project is situated eight miles east of Plymouth, Devon and has received funding support from the DESNZ Hydrogen Business Model and the Net Zero Hydrogen Fund in the UK. Both Imerys and Sibelco have clay mining operations within five miles of the Langage site, and the hydrogen supply will help both companies advance their sustainability objectives.

In South Africa, Anglo American, ENGIE, Plug Power and Ballard Power Systems have been *working together on the nuGen Solution, a zero emissions haulage solution.*

Heavy-duty vehicles

Heavy-duty vehicles (“HDVs”) are the most challenging segment of the road sector for developing zero emission options due to their long journey distances and heavy payload requirements.

Some vehicles are in constant use and therefore require fast refuelling to meet operational requirements. HDVs are therefore focusing on hydrogen-powered fuel as it has faster refuelling times and a greater range, and their lower weight compared to batteries increases payload capacity. There are two different possibilities for the use of hydrogen in heavy goods vehicles, either using a fuel cell that uses hydrogen to generate electricity to power the electric motor or using hydrogen as a fuel for the combustion engine. Although hydrogen fuel cell electric trucks are more environmentally friendly than those using hydrogen combustion engines, both can help achieve a 100% reduction in CO2 emissions. Vehicles utilising hydrogen combustion engines are useful for long haul and off-road applications where charging infrastructure may be scarce. The refurbishment of heavy trucks with hydrogen fuel cells is another step towards sustainable transportation, offering a second life to existing vehicles while significantly reducing their carbon footprint and being much cheaper compared to new vehicles.

Recent projects and policy support

As part of the European Grean Deal, The European Commission has proposed new targets to reduce CO2 emissions in the use of heavy-duty vehicles to ensure the road transport sector contributes to the shift to zero-emissions mobility. The targets include phasing in stronger CO2 emissions standards for almost all new HDVs with certified CO2 emissions, compared to 2019 levels, specifically:

45%
Emissions reductions from 2030.

65%
Emission reductions from 2035.

90%
Emission reduction from 2040.

The policy further incentivises the uptake clean vehicle technologies, such as hydrogen-fuelled, for HDVs. The strategy also calls for international collaboration on hydrogen standards with international standardisation bodies and global technical regulations of the United Nations, including the harmonisation of automotive regulation for hydrogen vehicles. There are also several projects being funded by the EU Clean Hydrogen Partnership, such as H2Accelerate TRUCKS: a largescale deployment project to accelerate the uptake of Hydrogen Trucks in Europe with a budget of €110 million.

In the UK the government is investing up to £20 million in designing trials for electric road system and hydrogen fuel cell HDVs to establish the feasibility, deliverability, costs and benefits of these technologies in the UK. To further support the shift away from fossil fuels, the government is also consulting on the phase out date for the sale of new non-zero emission HDVs.

Recent projects

01

In the UK, manufacturer Tevva has added a hydrogen fuel cell system to its battery-electric HDV design. The 7.5 tonne truck will have a range of up to 500 kilometres, showing that hydrogen and electric-powered lorries will soon be mass produced in the UK. This will be the first of its kind to be manufactured in the UK.

02

German manufacturer MAN Truck & Bus will be the first European truck producer to launch a series with a hydrogen combustion engine. The MAN hTGX is designed for transporting heavy goods like construction materials or timber, useful in areas lacking sufficient electric charging infrastructure or where there is a lot of hydrogen already available. The company plans to deliver around 200 vehicles to customers in Germany, the Netherlands, Norway, Iceland and selected non-European countries as early as 2025.

03

DAF, a leading Dutch truck manufacturing company, is exploring the use of hydrogen as a means of decarbonising road transport. Working with Toyota and Shell, DAF's parent company PACCAR has begun trials with hydrogen-powered trucks with fuel cell technology in Los Angeles. Furthermore, DAF is developing an Internal Combustion Engine running on hydrogen which has transient capabilities, eliminating the need for a large energy storage system.

04

In a project which exemplifies the potential for long range HDV journeys with hydrogen, the Mercedes-Benz GenH2 truck, which is being developed for heavy-duty transport and long-haul applications, which will have a range of around 1,000 kilometres. The start of series production is planned for the second half of the decade, with customer trials taking place from mid-2024.

Working with Toyota and Shell, DAF's parent company PACCAR has begun *trials with hydrogen-powered trucks with fuel cell technology* in Los Angeles.

Hydrogen: *Recent updates* in Europe

On 20 June 2023, the long awaited *Delegated Acts to accelerate the European Union regulatory framework for renewable hydrogen*, extending the scope of renewable hydrogen, entered into force. This followed the conclusion of the scrutiny period for the European Parliament and Council.

These Delegated Acts are an important part of the EU regulatory framework for hydrogen that includes energy infrastructure investments and state aid rules, as well as legislative targets for renewable hydrogen in the industry and transport sectors. They guarantee that all renewable fuels of non-biological origin (RFNBOs) are produced from renewable electricity. The final texts remain unchanged from the draft acts proposed by the Commission on 13 February 2023.

The first act defines the conditions under which hydrogen, hydrogen-based fuels or other energy carriers qualify as renewable fuels of non-biological origin (RFNBOs). The second act provides a methodology for calculating life-cycle greenhouse gas emissions for RFNBOs.

Beyond defining renewable hydrogen in the EU, the first Act clarifies the principle of "additionality" for hydrogen set out in the EU's Renewable Energy Directive. The principle aims to ensure that the supplies of renewable hydrogen which are due to come on board by 2030 are connected to new, rather than existing, renewable energy production, encouraging an increase in renewable energy availability in the EU. The Act also sets criteria to ensure that renewable hydrogen is only produced when and where it is needed and outlines how producers can demonstrate compliance with the rules.

The second Act provides a framework for calculating the life-cycle greenhouse gas emissions for RFNBOs – emissions throughout the entire life cycle of the fuels (RFNBOs or recycled carbon fuels) – from the entire production and transportation chain including the used energy. This involves, emissions associated with taking electricity from the grid, processing, and transporting these fuels to the end-consumer.

The Delegated Acts' criteria will apply to any import of green hydrogen into the European Union. The certification in and outside Europe by voluntary but approved certification bodies will be important to grant this compliance. The Acts include a revision process scheduled for 2028.

On 8 December 2023, a final and provisional agreement was reached between the European commission, European Parliament and Council on the hydrogen and decarbonised gas package. This regulation and directive will shape the market for hydrogen transmission, distribution, and storage, facilitating the uptake of renewable and low carbon gases, including hydrogen. It aims to ensure security of supply and affordability of energy for all citizens in the EU, contributing to the EU's efforts to reach climate neutrality by 2050.

Renewable and low-carbon gases will help cut emissions in heavy-emitting sectors and support European industry competitiveness.

This agreement establishes a market design for hydrogen in Europe implementing rules in two phases, before and after 2033. In the ramp-up phase a simplified framework will apply with clear visibility about the future rules for a developed hydrogen market, covering access to hydrogen infrastructures, separation of hydrogen production and transport activities (so-called "unbundling") and tariff setting. A new governance structure in the form of the European Network of Network Operators for Hydrogen (ENNOH) will be established to promote dedicated hydrogen infrastructure, cross-border coordination and interconnector network construction. It will also be responsible for elaborating specific technical rules.

The package awaits a final deal on the Reform of the Electricity Market Design before finalisation, then the texts will be formally endorsed by the Council and the Parliament before they are officially published and come into force.

On 23 November 2023, the European Commission launched the first auction under the European Hydrogen Bank to support the production of renewable hydrogen in Europe.

This regulation and directive will *shape the market for hydrogen transmission, distribution, and storage,* facilitating the uptake of renewable and low carbon gases, including hydrogen.

It involved an initial €800 million of emissions trading revenues, channeled through the Innovation Fund. This auction facility, part of the Green Deal Industrial Plan (GDIP), announced on 1 February 2023, allows producers of renewable hydrogen to bid for support in the form of a fixed premium per kilogram of hydrogen produced. The premium is intended to bridge the gap between the price of production and the price consumers are currently willing to pay, in a market where non-renewable hydrogen is still cheaper to produce.

The support premiums awarded in the first pilot auction from the European Hydrogen Bank granting a 10 year support were announced on 30 April 2024. 132 projects have participated in the auction. The fixed premium for projects awarded in Spain (3), Portugal (2), Norway (1) and Finland (1) is ranging from €0.37 and €0.48 per Kg/H2. This price is similar to the average request under the first Danish auction (~€0.6, fixed premium) but far below the first UK HAR1 auction (~€8 Contract for Difference payment).

The Commission is also offering a new "Auctions-as-a-service" mechanism under the European Hydrogen Bank, allowing Member States to finance projects which have bid in the auction, but not been selected for Innovation Fund support due to budget limitations.

On 9 October 2023, the European Union's Renewable Energy Directive (RED III) was adopted as part of the "Fit for 55" package. It is another legislative effort of the European Union towards enhancing sustainable energy use and combating climate change. Member States shall bring the laws, regulations, and administrative provisions necessary to comply with RED III into force by 21 May 2025.

RED III emphasises renewable fuels of non-biological origin (RFNBOs), primarily hydrogen. By 2030, a combined sub-target of 5.5% for advanced fuels and RFNBOs in the transport sector is set, with a minimum requirement of 1% from RFNBOs, aiming to bolster the hydrogen economy. RED III also addresses the role of nuclear energy. The indirect acknowledgement within the framework of its provisions for hydrogen being produced by using nuclear power (as "other non-fossil fuel source") to count as part of the renewables targets in the industry sector.

The Delegated Acts criteria *will apply to any import of green hydrogen* into the European Union.

Country *profiles*

Australia

Australia has potential to become a global leader as a producer and exporter of green hydrogen.

Its key strengths include abundant natural resources, extensive renewable energy production capacity and storage resources, a proven track record in building large-scale energy industries and exporting energy, and proximity to high-demand economies, providing ease of access to key opportunities in regional markets.

In February 2024, the CSIRO, Australia's national science agency, and Standards Australia launched *HyStandards*.

Legal framework overview

A 2019 preliminary legal review commissioned by the Department of Industry, Innovation and Science identified approximately 730 pieces of legislation and 119 standards across Australia's jurisdictions that are potentially relevant to the hydrogen industry and supply chain development.

In November 2019, the Hydrogen Working Group, established by the Council of Australian Governments ("COAG") Energy Council, released the Australian National Hydrogen Strategy. The strategy aims to establish a clean, innovative and safe hydrogen industry in Australia, to position Australia as a major global player by 2030. The Strategy sets out 57 coordinated government actions to enable the industry to scale up quickly, including reviewing the existing legal framework as needed to support the industry by removing barriers to development and ensuring safety.

In July 2020, Australia adopted a suite of eight international standards for the safe use, transport and trade of hydrogen across Australia. In February 2024, the CSIRO, Australia's national science agency, and Standards Australia launched HyStandards, a new resource which helps industry participants identify the relevant Australian and international standards for hydrogen projects.

In December 2020, Hydrogen Australia (a division of the Smart Energy Council) launched its Zero Carbon Certification Scheme for renewable hydrogen, renewable ammonia and renewable metals – a world leading scheme to provide a guarantee of origin for hydrogen produced from 100% renewable energy and with zero carbon emissions.

A proposed GO scheme is being developed in Australia in light of the growing international and domestic demand for renewable energy and "clean" products.

On 28 October 2022, Energy Ministers agreed to amendments to the National Gas Law and Regulations to bring hydrogen blends, biomethane and other renewable gases under the national gas regulatory framework.

Legal framework overview (cont)

Previously, the National Gas Law (NGL) and the National Energy Retail Law (NERL) referred only to 'natural gas'. With projects underway to introduce hydrogen and biomethane into gas networks, this terminology has been updated to provide regulatory certainty to the emerging industry.

States and territories are helping to develop the industry by adopting the National Hydrogen Strategy and developing their own hydrogen strategies.

In July 2023, the Australian Government commenced a review of the National Hydrogen Strategy to ensure Australia remains on a path to be a global hydrogen leader by 2030 on both an export basis and for the decarbonisation of Australian industries. The review considers developments globally and in Australia since the original strategy was developed, including the impact of US' Inflation Reduction Act and other policies to support hydrogen emerging overseas. The consultation paper requested industry participants to make submissions on how Australian governments can ensure that Australia has a national strategy that is fit for purpose for its evolving hydrogen strategy.

South Australia also legislated the Hydrogen and Renewable Energy Act 2023 (SA) which coordinates hydrogen and renewable energy supply in the State, and provides clarity on government auctions for development rights on government land.

Funding & Support schemes

The Australian Government is continuing to work with the hydrogen industry in order to overcome barriers to development. Its main focus areas are building demand, achieving low-cost hydrogen at scale, and reducing delivery costs.

In 2018, the CSIRO released the National Hydrogen Roadmap. Its primary objective is to provide a blueprint for the development of the hydrogen industry in Australia, particularly in investments amongst industry, government, research and other stakeholder groups.

From 2015 to 2019, over $146 million of funding was invested by the Australian Government in hydrogen-related projects. Funds are administered through two key entities: the Australian Renewable Energy Agency ("ARENA") and the Clean Energy Finance Corporation ("CEFC").

In April 2020 ARENA launched a $70 million hydrogen funding round from which seven applicants were shortlisted. The shortlisted applicants have developed projects of 10 MW or larger electrolysers with various end uses, as inter alia transportation, gas injection or renewable ammonia production. The projects are powered by either on-site renewable generation, purchase of Renewable Energy Certificates or power contracted from a renewable Power Purchase Agreement ("PPA").

In May 2020, the Australian Government also launched the $300 million "Advancing Hydrogen Fund", administered by the CEFC. Through the fund, the CEFC is providing debt or equity finance to eligible large-scale commercial and industrial projects, typically requiring $10 million or more.

Between September 2020 and November 2021, the Australian Government committed $464 million as part of the "Activating a Regional Hydrogen Industry – Clean Hydrogen Industrial Hubs program", to fund the development of seven clean hydrogen hubs in regional Australia, as well as further studies. The hubs will be in ports, cities and regional areas, where producers, users and exporters of hydrogen could be co-located.

In 2024, Australian government plans to *invest $70 million* to develop the Townsville Region Hydrogen Hub in north Queensland.

Funding & Support schemes (cont)

In 2021 the Australian Government issued the Technology Investment Roadmap to achieve long term Emissions Reductions.

In the 2021-22 Federal Budget, the Government committed $565.8 million towards developing international partnerships to drive investment in Australian-based projects and accelerate supply chain growth to help deploy low emissions technologies and energy. Such international partnerships include the Australia-Germany Hydrogen Innovation and Technology Incubator ("HyGATE") Initiative, which opened a funding round in March 2022. HyGATE is administered by ARENA, on behalf of the Department of Industry, Science, Energy and Resources, which has teamed up with Germany's Federal Ministry of Education and Research, acting through Project Management Jülich (PtJ). In January 2022, the Government approved a $150 million (€95 million) program Australia Japan Clean Hydrogen Trade Program to support the country's hydrogen export industry and attract overseas investment in its hydrogen supply chains. The first round of the Program will focus on the export of clean hydrogen to Japan under the Japan-Australia Partnership on Decarbonisation through Technology.

Collaborative partnerships have also been announced with Singapore, the UK, the Republic of Korea and India.

In May 2023 ARENA established "Hydrogen Headstart", a $2 billion initiative to underwrite large scale hydrogen projects in Australia. The program aims to support two to three flagship projects providing up to 1 GW of electrolyser capacity. In late 2023, the Australian Government announced that six applicants had been shortlisted and invited to submit a full application in the next stage of the program.

The shortlisted applicants are:

- bp Low Carbon Australia Pty Ltd (H2Kwinana)
- HIF Asia Pacific Pty Ltd (HIF Tasmania eFuel Facility)
- KEPCO Australia Pty Ltd (Port of Newcastle Green Hydrogen Project)
- Origin Energy Future Fuels Pty Ltd (Hunter Valley Hydrogen Hub)
- Stanwell Corporation Limited (Central Queensland Hydrogen Project)
- Murchison Hydrogen Renewables Pty Ltd as trustee for Murchison Hydrogen Renewables Project Trust (Murchison Hydrogen Renewables Project)

Together, these applicants represent a total electrolyser capacity of more than 3.5GW across various end uses, placing them amongst the largest renewable hydrogen projects in the world.

Successful projects will receive a production credit delivered over ten years of operations to bridge the gap between the cost of producing renewable hydrogen and the market price.

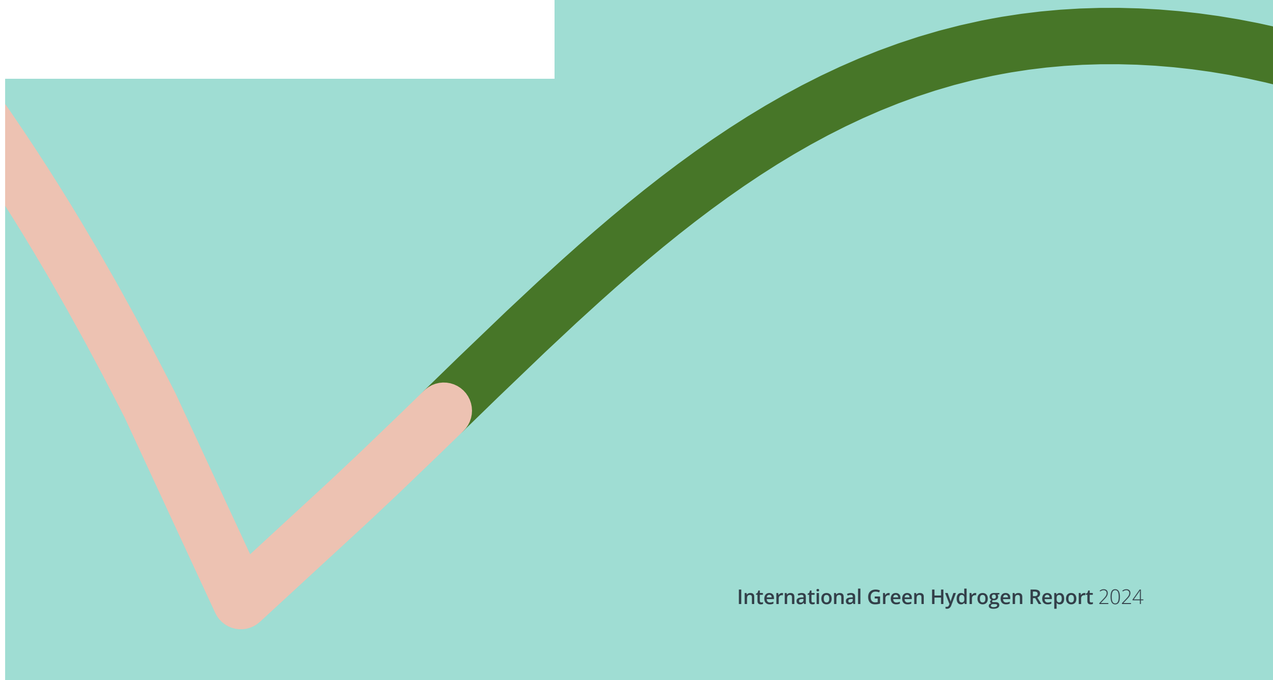
In 2024, Australian government plans to invest $70 million to develop the Townsville Region Hydrogen Hub in north Queensland.

AU$1.6 billion

Private sector investment

AU$1.27 billion

Public sector investment



With regard to key hydrogen industries:

01 Chemical feedstock is developing quickly, with projects to use clean hydrogen in existing facilities having been announced.

02 Steel production is developing more slowly, although several steel producers have announced an intention to use clean hydrogen. Clean steel is a priority under the National Hydrogen Roadmap.

03 Some players in the mining industry are exploring the possibility of hydrogen microgrids, with $103.6 million in government funding having been allocated to support pilots and deployment.

04 The transport industry is slowly advancing, with several refuelling stations and vehicles currently in operation, and additional projects having been announced with targets of operations in 2025. The Australian Government's Future Fuels Fund includes support for electric vehicle support infrastructure, including hydrogen fuel cell vehicles, and for heavy transport uptake.

05 Trials are underway to blend hydrogen into gas networks, with nine projects expected to be operational by 2025.

Up-coming evolution

The Australian hydrogen industry has gained momentum in the past couple of years. Private sector investment is growing, with over $1.6 billion committed, and public sector investment reached $1.27 billion in June 2021.

According to the latest government figures, Australia's pipeline of announced projects is in the order of $230-300 billion. However, Australia lags behind other nations in converting announcements into final investment decisions.

The significant cost gap between renewable hydrogen and high-carbon alternatives is a major barrier to advancing Australia's hydrogen industry. The recently announced $2 billion Hydrogen Headstart program is intended to support large-scale renewable hydrogen projects through competitive hydrogen production contracts.

Australia's export capacity is advancing, with investment and research being directed to support supply chains, for example, by investing in clean hydrogen hubs.

Some recent examples

The Western Australian Government announced in January 2021 that it has received 65 expressions of interest ("EOI") from Australia, Japan, Korea, India, Germany, Spain, the UK, France to produce and export commercial quantities of hydrogen from a new hub that may feature up to 270 MW from wind generation and to 1250 MW from solar photovoltaic installations located in the Oakajee Strategic Industrial Area ("SIA").

In February 2021, a joint venture was announced to develop hydrogen production and export facilities on the southern coast of Victoria.

In February 2021, the Queensland government announced a partnership with a Japanese engineering firm to complete a feasibility study into a green hydrogen production facility.

There is also increasing government recognition that with hydrogen shipping costs unlikely to significantly reduce over time, there will be a greater focus on domestic value-added use of hydrogen.

Argentina

Argentina has the potential to become one of the regional leaders in green hydrogen production.

With an unparallel combination of renewable energy sources, especially wind (the general average capacity factor for Argentina is 35% and in the Patagonia region it ranges between as much as 47% and 59%-) and solar (the northwestern region of Argentina is reported to have one of the highest levels of solar radiation in the world), land availability and access to freshwater.

Legal framework overview

Green hydrogen initiatives pose significant regulatory challenges, especially in South America, where related legislation is non-existent, generic, or outdated. Argentina has not defined a legal framework considering the green hydrogen value chain in its entirety.

Currently, the green hydrogen chain is subject to several non-specific pieces of legislation at national, provincial, and municipal levels.

The General Environment Act (Law No. 25675) which sets minimum standards for sustainable development requires that any activity that may degrade the environment must priorly obtain the approval of an environmental impact assessment and hire an insurance policy to cover any potential damages to the environment.

According to most provincial and municipal regulations, the activities related with water desalinisation and the electrolysis process would require obtaining a liquid effluent dumping permit, a gaseous emissions discharge permit and the registration as a hazardous waste producer.

Also, depending on the type of substances used, a registration in the Chemical Precursors Registry of the Secretariat of Integral Policies on Drugs ("Secretaría de Políticas Integrales sobre Drogas de la Nación Argentina" or SEDRONAR) may be required.

The interjurisdictional transportation of dangerous substances like gas or liquid hydrogen requires the prior authorisation of the Transport Regulatory Commission. This is regulated by MERCOSUR Decision No. 15/2019, which sets regional standards for the transport of said substances between member countries.

As a green hydrogen project may require considerable extensions of land, the regulations restricting the ownership or use of real estate by foreign natural or legal persons must be considered. In particular:

- The Rural Lands Law (Law No. 26737) which restricts the ownership and certain types of uses of rural land by foreigners. However, Emergency Decree No. 70/2023 repealed the Rural Lands Law in its entirety, including all the restrictions for the purchase of lands by foreigners. This would greatly simplify the acquisition of land by international companies to develop green hydrogen projects. It should be noted that the Decree's constitutional validity is being openly questioned, so its reforms may be subject to reversion by Congress; and
- The Border Security Zone Law (Decree-Law No. 15385/44) which requires the prior authorisation by the National Government for the ownership or use of land located in the country's border by foreigners.

For energy needed for the electrolysis process, the owner of the facility connected to the electricity grid must register as an agent of the Wholesale Electricity Market. In addition, given that the power will be obtained from a renewable energy power plant, if the power plant is owned by a third-party the project owner will have to enter into a power purchase agreement within the framework of the Renewable Energy Electricity Term Market ("Mercado a Término de Energía Eléctrica de Fuente Renovable" or MATER).

The National Government presented a new Hydrogen Bill to Congress in early 2023, *aimed at regulating the production and use of hydrogen* through a promotion regime designed to extend well into the 2040s, and leading up to the target year 2050.

Funding & Support schemes

The national government offers financing to suppliers of the growing wind and solar energy industry.

Since 2022, the Secretariat of Industry and Productive Development ("Secretaría de Industria Desarrollo Productivo"), formerly the Ministry of Productive Development, has promoted a program called "Green Prodepro" ("Prodepro Verde") which is a credit line for suppliers of renewable energy projects. The program provides for non-refundable contributions limited to AR$ 100,000,000 per project and 75% of the total project amount, as well as interest rate subsidies. Green Prodepro also offers direct technical assistance benefits by the National Institute of Industrial Technology ("Instituto Nacional de Tecnología Industrial" or INTI by its Spanish acronym), by means of quality certifications, lab test validations, project management and human resources training. The benefit of such technical assistance has an upper limit of AR$ 2.500.000 per project.

Argentina's Secretariat of Strategic Affairs ("Secretaría de Asuntos Estratégicos") has repeatedly emphasised the importance of European funding to support investments in green hydrogen. Throughout 2022 and 2023, Argentine delegations travelled to Luxembourg, Germany, France, and Spain to seek funding to produce green hydrogen. In May 2023, the Global Green Hydrogen Forum ("Foro Global del Hidrógeno Verde") was held in Bariloche, Province of Río Negro. It showcased a great number of projects, legislation, and potential investment opportunities within the industry, strengthening ties between the public and private sectors.

The Secretariat of Energy, dependent of the Ministry of Economy, started collaborating in early 2023 with other public science-oriented organisms to fund a series of "Strategic Energy Transition Projects", which consist of the energy-centric development of scientific technologies and human skills. The Federal Government has allocated close to AR$ 1 billion to these special projects. One example involves the development and assembly of a 1-megawatt alkaline electrolyzer to produce high purity green hydrogen using water and electricity from renewable sources. This project alone has received AR$ 150 million in funding.

Up-coming evolution

In May 2021, the Economic and Social Council ("Consejo Económico y Social"), introduced a working document called "Towards a National Hydrogen Strategy 2030", which consolidated different presentations made by members of the national cabinet, representatives of the private sector and embassies, academics and scientists.

With the understanding that Argentina can develop a leading role as a supplier of green hydrogen, the document aims to act as a roadmap to achieve public-private articulation and the involvement of all actors linked to the green hydrogen industry in the coming years. The goal is to reach a production of approximately 10 million tons of green hydrogen by 2030.

In February 2023, the Secretariat of Strategic Affairs formalised the Intersectoral Hydrogen Roundtable ("Mesa Intersectorial del Hidrógeno"), a multi-Ministry body composed of representatives of every area of the Federal Government, with varied powers aimed at promoting hydrogen initiatives and collaboration between the public and private sectors.

Furthermore, the National Government presented a new Hydrogen Bill to Congress in early 2023, aimed at regulating the production and use of hydrogen through a promotion regime designed to extend well into the 2040s, and leading up to the target year 2050. Focusing on its production, use in industrial processes, the development of value chains and the consolidation of production, transport, logistics and export hubs.

Up-coming evolution (cont)

The Hydrogen Bill includes concrete tax benefits such as early VAT reimbursement, accelerated repayment of income tax, compensation for loss of profits, deduction of financial liabilities and a Tax Certificate for the cancellation of federal taxes. Further, schemes of up to ten years of 0% export duties for green hydrogen projects and exemption of imports duties and statistical rate duties, fees and levies for the import of new capital goods, complete production lines, parts, components and spare parts.

One key benefit proposed within the Bill is the 20 years of fiscal stability granted to applicants. This means that, specifically for taxpayers with approved projects, no applicable taxes to the projects shall be raised in such a way that the total tax burden is affected. The Hydrogen Bill was entered into Congress for treatment in March 2023, and is yet to be approved.

In the second half of 2023, the Secretariat of Strategic Affairs updated its plans for the Hydrogen industry, developing the "National Strategy for the Development of the Hydrogen Economy". This strategy emphasises the importance of infrastructure and the production of green fuels as means to solidify the domestic market, and to place Argentina as a key exporter within the global stage.

This new Strategy expects 2050 production levels to reach a total five million tons, 80% of which will be destined for export. It also projects a total investment of US$ 90 billion in the Hydrogen industry.

The Province of Río Negro has set in place its own Green Hydrogen Strategy. This plan seeks to align the Province's general environmental policies with the development of the green hydrogen economy. It encompasses advanced industrialisation of the production chain, the promotion of green hydrogen exports, and the visibility of Río Negro as an attractive place for national and foreign investment.

In the private sector, YPF, the state-owned oil and gas company, created the H2AR Consortium ("Consorcio H2AR"), a collaborative workspace between private companies for the promotion and development of the hydrogen economy in Argentina. With more than 30 member companies, the H2AR Consortium has eight working groups across the hydrogen value chain, with the main objective of aligning efforts to define efficiencies and costs and give investment signals that activate the green hydrogen market.

Some recent examples

Within the framework of the 2021 COP-26 in Edinburgh, Fortescue Futures Industries announced an investment of US$ 8 billion over ten years for the development of wind farms, high-voltage transmission lines, a plant for the production of hydrogen and other green products and port infrastructure in the province of Río Negro.

Throughout 2023, Fortescue has been preparing to start its hydrogen operations in Río Negro, with the construction of installations and the acquisition of a key wind turbine farm nearby, which is aimed at compensating the power extracted from the local grid to feed the hydrogen project.

In September 2023, state-owned energy company ENARSA partnered with Santa Cruz Province's government to set up an experimental Green Hydrogen plant, aimed at developing human resources and key technologies for the Hydrogen production chain.

Given the Hydrogen Bill is still under review by Congress, many companies eager to invest and develop Green Hydrogen Projects remain largely on standby. While many of the investment plans are still on track, investors have stressed the need for a hydrogen law and a more clear and beneficial foreign exchange regulation.

This chapter was provided by Bird & Bird Plus firm Allende & Brea and authored by Marcos Patrón Costas.

ALLENDE
ALLENDE & BREA

Belgium

Hydrogen is certainly one of the energy sources that has attracted particular attention from the Belgian public authorities in recent years as Belgium already has over 613 km of hydrogen pipelines.

In its most recent report, the Belgian federal government identified several sectors in which renewable hydrogen molecules and derivatives will help to make climate neutral by 2050 to the extent that it would contribute to meeting the growing need for renewable electricity:

- Industry and heavy transport;
- The electricity sector, specifically during periods with little wind and sun;
- The building sector.

Belgium already has over *613 km of hydrogen pipelines.*

On this basis, the federal government expects that the total domestic demand for hydrogen molecules and derivatives is expected to increase to 125-200 TWh/year in Belgium by 2050.

As a result, the government has adopted a strategy with the following objectives:

- Positioning Belgium as a hub for the import and transit of renewable molecules in Europe;
- Strengthening Belgian leadership in hydrogen technologies;
- Establishing a robust hydrogen market ;
- Investing in cooperation, particularly within international organisations.

At this stage, the federal government already approved a €95 million grant to build and replace aging natural gas pipelines, as well as to develop approximately 150 km of pipelines for hydrogen transportation. The goal is to have these pipelines operational by July 31, 2026.

Legal framework overview

Belgium is a federal state, where legislative and administrative powers over energy matters and policy are divided among the federal and regional entities. As a result of this division of competences, there are four regulatory authorities active in the energy sector: the CREG (at the federal level), the VREG (in Flanders), the CWAPE (in Wallonia) and the BRUGEL (in Brussels).

The concrete division of competences among these entities is based on the following approach of the supply chain of energy: at the highest level, the producers oversee generating the energy; the energy produced is afterwards transported to a distribution system and is sold to end customers by suppliers. According to Article 6 (1) VII of the Special Law on Institutional Reforms of 8 August 1980, the federal state sets rules for large power plants, nuclear energy, offshore energy, electricity transmission, gas pipelines, and energy prices. The regional governments (Wallonia, Flanders and Brussels) are responsible for renewables, energy efficiency, distribution grids and supply of energy to end customers.

Legal framework overview (cont)

By analogy to the rules applicable to gas sector, the division of powers in the hydrogen sector is the following: whilst the federal state is responsible for large storage infrastructures, the transport and production of hydrogen (specifically in matters where technical and economic indivisibility requires homogeneous implementation at the national level), the regions are responsible for the distribution of hydrogen and its supply to end customers.

In accordance with this division of powers, the federal government has recently enacted a legislation on the transport of hydrogen by pipeline. This law sets out the procedure for appointing one single hydrogen network operator (HNO) in Belgium. The latter would be responsible to:

- Provide free, non-discriminatory access to the hydrogen transport network at regulated tariffs;
- Develop and implement an effective and responsible network development plan and in-vestment planning, and
- Guarantee the quality of the hydrogen transported by its network.

The HNO will have to comply with strict unbundling conditions:

- Vertical unbundling: it may not be active in or share any interest in the production or supply of hydrogen, natural gas, biogas, biomethane, other forms of synthetic methane or electricity to guarantee its independence from network users and prevent any discrimination against certain of these users;
- Horizontal unbundling: the hydrogen transport network operator may own and operate hydrogen storage infrastructures and terminals, as well as infrastructures for trans-porting and storing natural gas, biogas, biomethane, other forms of synthetic methane and electricity. However, these activities will have to be carried out in legal entities that are separate from the hydrogen transport activities in order to prevent any cross-subsidisation.

The HNO will have the monopoly to operate new hydrogen transport networks for a period of 20 years (subject to renewal). However, the operation of existing hydrogen networks by entities other than the HNO is authorized. Any owner of an existing hydrogen network may apply for the designation of the hydrogen transmission network operator as the independent operator of this facility.

At the time of writing, the HNO has not yet been designated. However, it is highly likely that Fluxys Belgium will be designated as the HNO.

In addition to the provision concerning the designation of the HNO, the law also sets out the rules applicable to the construction and the operation of hydrogen pipelines. It provides that:

- As soon as the HNO is appointed, the construction and operation of any hydrogen transport facility will require a permit (hydrogen transport permit) and only the HNO is authorized to obtain such permit. Prior to this date, the construction and operation of any hydrogen transport installation requires a transport authorization in accordance with the provisions of the law of 12 April 1965 applicable to gas.
- However, as a transitional measure, operators of existing hydrogen networks can apply for an extension of the transportation permit they obtained under the Gas law of 12 April 1965, including to expand their existing hydrogen network. However, this rule is transitional, and the King is empowered to repeal this regime so that only the HNO is authorized to apply and obtain a hydrogen transport permit.

Legal framework overview (cont)

As far as the distribution of hydrogen is concerned, the Flemish government has tabled a bill amending the Energy Decree of 8 May 2009 and aiming at introducing a regulatory framework for hydrogen distribution.

This bill provides that:

- The Flemish Government, after consulting the VREG, shall be responsible to appoint one operator in charge of the hydrogen distribution network in the Flemish Region. This operator will be appointed for a renewable term of 20 years.
- Building and operating a closed distribution network (i.e. set of pipelines used primarily for hydrogen distribution between a limited number of installations within a geographically defined industrial site) and a direct hydrogen pipeline (i.e. a hydrogen pipeline directly connecting one hydrogen producer to one hydrogen customer, different from the hydrogen producer) will also be permissible subject to a prior notification to or authorization of VREG.

At the Walloon region level, the development of a legal framework tailored to hydrogen is underway. However, the government is holding the process pending discussions on the future European Union “gas” package and the results of the work on the Walloon strategic plan for hydrogen.

Finally, there are no standard hydrogen sale and purchase agreement of hydrogen molecules enacted by a regulated authority, nor does such standard exist on the market.

On July 14, 2023, the federal government decided to make *€250 million available* to the HNO for the construction of a hydrogen connection with Germany and for the development of the hydrogen transmission network in and between the industrial clusters of Ghent, Antwerp, Mons, Charleroi and Liège.

Funding & Support schemes

There are numerous funding and support schemes in Belgium.

On July 14, 2023, the federal government decided to make €250 million available to the HNO for the construction of a hydrogen connection with Germany and for the development of the hydrogen transmission network in and between the industrial clusters of Ghent, Antwerp, Mons, Charleroi and Liège. The transmission system operator will be able to call on this financial support for an amount not exceeding 50% of the total project costs. Next to this specific funding scheme, the federal government has put in place Energy Transition fund designed to support research and development projects pertaining to the production, transport and storage of hydrogen and hydrogen-derived products. Usually, a call for proposal is published every year in October/November.

Funding & Support schemes (cont)

In the Walloon Region, the Recovery Plan includes €117.2 million to develop a Walloon “hydrogen” sector. Three areas have been planned to enable this deployment:

Project 46

Setting up a strategy and framework to encourage the deployment of green hydrogen in Wallonia

The aim of this project is to launch a service market on the three pillars to respond effectively to the challenges related to hydrogen. The market should be able to mandate a consortium that can support Wallonia in the legislative process linked to the future hydrogen package.

Project 47

Supporting the deployment of a Walloon “hydrogen” sector: research, green production and sectoral applications

This project has a budget of €102.2 million. It aims at financing sub-projects that cover the green hydrogen production chain as well as multiple applications of hydrogen as an energy vector in the form of e-methane, e-methanol, e-kerosene as well as the adaptation of devices (engines, hydrogen tanks, fuel cells, among others).

Project 48

Supporting the sectoral integration of green hydrogen in the transport or industry sectors within an energy chain linking production, possibly local transport and targeted use

The call for project was launched in July 2021, for a total budget of €25 million and resulted in the selection of 4 projects.

In Flanders, we have identified the following funding and support schemes:

01 The Ecology Premium Plus consists in a funding framework designed for enterprises that make ecological professional investments in Flanders. These enterprises may benefit from ecological aid in the form of an investment grant. To qualify for this support scheme, the company must realize its investments in the Flemish Region and entered into the energy policy agreement applicable to it on the submission date of the support application. The investments can be carried out by a company that belongs to the same group as the applicant.

02 There is also the Strategic Ecology Support designed for enterprises that wish to invest in ecological technologies, which do not fall within the scope of the Ecology Premium Plus. In addition, the ecological investment must be ‘strategic’, i.e., the project must offer a broad environmental or energy solution at company level with closed energy and material cycles and process-integrated solutions. The project must also strive for generic environmental or energy objectives. The Strategic Ecology Support is specifically designed for greater investment projects that, due to their unique business-specific character, cannot be standardised.

03 Finally, as part of the Flemish Recovery Plan, it was announced that funding allocation to specific projects relating to hydrogen will be considered and approx. €125 million would go to hydrogen.

Some recent examples & upcoming challenges

Both public and private actors in Belgium are increasing their contributions in the hydrogen sectors.

As explained in the introduction, the aim of the Belgian authorities is to position Belgium as a key player in the hydrogen market. Accordingly, several companies have received public subsidies both by the federal and the regional governments to further develop their projects in the hydrogen sector. For example:

- As part of a national call for proposals, the engineering company John Cockerill was granted a subsidy to develop a complete ecosystem around the Belgian hydrogen strategy, encompassing production capacities as well as a supply chain;
- The wire drawer Bekaert also received federal subsidies for the research and development of a technique for strengthening hydrogen transport pipelines;
- The IPFH (Intercommunale Pure de Financement du Hainaut) has received a subsidy of over € 7 million for the installation of a green hydrogen production unit on the Frameries Economic Activity Park (PAE);
- The von Karman Institute for Fluid Dynamics obtained significant funding for the construction of a Belgian center of expertise and testing dedicated to hydrogen technologies (H2) at the Cleantech District of the Porte Ouest de Charleroi. The ambition of the VKhyLab is to set up an open test center, coordinated and operated by the VKI, in collaboration with its partners present on the site, offering state-of-the-art equipment and unique and exceptional infrastructures to users who will be able to handle large volumes of hydrogen safely.

More recently, the federal government reiterated that making Belgium one of the largest hubs for hydrogen imports is a priority. A research project is currently ongoing (and has been financed by the federal government) to further investigate the available options to strengthen import routes to Belgium, and more specifically:

- The North Sea route: the government wishes to produce hydrogen on the Belgian coast with additional renewable electricity from the North Sea and has launched a study to examine how the electricity and hydrogen networks in the North Sea can complement each other.
- The Southern route: the aim is here to strengthen the import by pipelines from southern Europe and North Africa.
- The maritime route: This involves increasing the import of hydrogen derivatives by ship.

In parallel, several companies are increasing their investments of the hydrogen sector in Belgium. For example:

- In 2021, Luminus and IDETA announced the launch of a green hydrogen initiative in Wallonie Picardie. This initiative involves the development of four green hydrogen stations.
- More recently, in mid-May 2023, the Liège group John Cockerill announced that it had formed a joint venture with the French company Technip Energies. This joint venture is looking at a turnover of one billion euros by 2030 and wants to position itself as a reference for green hydrogen in Europe.

However, there are several challenges in the hydrogen industry in Belgium. The Belgian Hydrogen Council (a body formed by the regional clusters WaterstofNet and Cluster Tweed) has recently issued a report identifying the upcoming challenges in the hydrogen industry and advocates for competitive funding/support mechanism to further de-risk investments in hydrogen production, consumption and infrastructure. Regulatory changes both at the European level and at the Belgian level are expected to occur in the coming years (if not months) and companies are encouraged to monitor these changes as they could strongly impact their business plans.

Brazil

Brazil has the potential to become a major producer of green hydrogen, due to its abundance of renewable energy sources. In 2023, Brazil set a record for clean energy generation, with 93.1% of all energy generated coming from renewable sources. With a privileged scenario for the generation of solar, wind and biomass energy, the country is well placed to enhance the global transition towards a more sustainable and carbon-free economy.

Efforts to develop hydrogen-related technologies started in Brazil in early 2000s, with the creation of the Brazilian Hydrogen and Fuel Cell Systems Programme (“Programa Brasileiro de Hidrogênio e Sistemas de Células e Combustível”, or Procac by its Portuguese acronym) in 2002, later renamed as the Science, Technology and Innovation Program for the Hydrogen Economy (“Programa de Ciência, Tecnologia e Inovação para a Economia do Hidrogênio”, or ProH2 by its Portuguese acronym) in 2005. Since 2015, Brazil has been intensifying studies and research on sustainable hydrogen.

In 2021, the Energy Research Company (“Empresa de Pesquisa Energética” or EPE by its Portuguese acronym), linked to the Ministry of Mines and Energy (“Ministério de Minas e Energia” or MME by its Portuguese acronym), published the Technical Note “Bases for Consolidating the Brazilian Hydrogen Strategy”. This document addresses conceptual and fundamental aspects of the construction of the national hydrogen strategy and is divided into the following main sections: a) overview of the hydrogen market; b) technological routes and processes for generating hydrogen; and the costs and competitive aspects associated with hydrogen; c) challenges for the development of the hydrogen energy use market; d) the role of hydrogen in the energy transition; and, e) final considerations and implications for public policies.

Legal framework overview

There are a few Bills of Law that intend to regulate and provide incentives for the production of low-carbon hydrogen. Two of them have passed one step in the legislative process, pending two more steps of approval to become law.

On November 28, 2023, the Lower House of Congress passed the Bill of Law No. 2308/2023, which establishes the legal framework and incentives for low-carbon hydrogen. The bill brings important definitions for the renewable energy industry, such as the definitions of low-carbon hydrogen and renewable hydrogen.

In addition, the Bill of Law delegates to the regulatory sector the definition of the conditions under which water, electricity, natural gas, and inputs used in the production process, will be considered raw materials to produce low-carbon hydrogen and renewable hydrogen.

Legal framework overview (cont)

The Bill defines low carbon emission hydrogen as “hydrogen fuel or industrial input, collected or obtained from sources other than the production process, and which has GHG emissions, according to life cycle analysis, with an initial value less than or equal to 4 kgCO2eq/kgH2 (four kilograms of carbon dioxide equivalent per kilogram of hydrogen produced). The Bill defines renewable hydrogen as “hydrogen fuel or industrial input, collected or obtained from renewable sources, including solar, wind, hydraulic, biomass, biogas, biomethane, landfill gas, geothermal, tidal and oceanic”.

The Bill of Law is pending approval by the Senate and by the President.

On February 15, 2024, the Special Commission for Debating Public Policies on Green Hydrogen approved the Bill of Law No. 5816/2023, the most recent of which regulates the low-carbon hydrogen industry, its structure and sources of funding, and creates the Low Carbon Hydrogen Development Program (“PHBC”). This program includes the creation of the Low Carbon Hydrogen Sector Steering Committee (“CGHBC”), responsible for establishing guidelines and coordinating PHBC actions, with representatives from various ministries and regulatory agencies.

The Bill defines low carbon hydrogen as “hydrogen fuel or industrial input collected or obtained from various production process sources, and which has greenhouse gas (GHG) emissions less than or equal to four (4) kilograms of carbon dioxide equivalent per kilogram of hydrogen produced (kgCO2eq/kgH2)”. The Bill also defines green hydrogen as “hydrogen fuel or industrial input collected or obtained from renewable sources, including solar, wind, hydraulic, biomass, biogas, biomethane, landfill gas, geothermal and others to be defined by the government.”

The Bill of Law is pending approval by the Lower House of Congress and by the President.

Funding & Support schemes

The Bill of Law No. 5816/2023 proposes the creation of a certification system for companies producing different types of hydrogen, following international criteria.

In addition, the Bill of Law allows companies producing low-carbon hydrogen to issue incentivised debentures – debt securities that can be traded on the market to raise funds in exchange for interest payments. These debentures will be exempt from income tax for individuals.

The Bill also includes: regulatory incentives to reduce greenhouse gas emissions, the mandatory addition of low-carbon hydrogen to gas pipelines, the use of domestic goods, and the promotion of research and innovation. It proposes the creation of a competitive auction mechanism for the sale of surplus electricity for hydrogen production, and targets for the development of the domestic low-carbon hydrogen market. It also provides for priority treatment for low-carbon hydrogen ventures in Export Processing Zones (EPZs). Other amendments were partially accepted, such as those related to discounts and exemptions in the electricity sector, the inclusion of the concept of life cycle assessment, and the definition of renewable hydrogen.

Upcoming evolution

The main challenge that Brazil faces regarding green hydrogen is the cost of production and the lack of a hydrogen legal framework. The existence of different bills of law in Congress may delay the approval of an effective and economically sustainable legal framework.

To increase its competitiveness, it is essential that the texts under discussion are analysed swiftly, and that public policies are implemented to reduce the costs of the renewable sources associated with its production. In addition, it is crucial to ensure alignment with international certifications to increase value and credibility to the hydrogen produced in Brazil.

In April 2023, the Special Commission to Debate Public Policies on Green Hydrogen was created. This commission aims to discuss public policies related to green hydrogen over two years, seeking to promote its large-scale adoption as a clean energy technology, as well as evaluating policies that encourage its development, whether through renewable or low-carbon sources.

Recent examples

The research survey, 'Green Hydrogen Opportunity in Brazil', published on January 20, 2023, states that Brazil could earn US$30 billion a year from the green hydrogen market by 2050, of which US$20 billion would come from exports of the commodity.

As for research projects, a survey involving the National Electric Energy Agency ("Agência Nacional de Energia Elétrica" or ANEEL by its Portuguese acronym), the National Agency for Petroleum, Natural Gas and Biofuels ("Agência Nacional do Petróleo, Gás Natural e Biocombustíveis" ANP or by its Portuguese acronym) and the National Fund for Scientific and Technological Development ("Fundo Nacional de Desenvolvimento Científico e Tecnológico" or FNDCT by its Portuguese acronym) from 2013 to 2018 identified 91 projects related to hydrogen and fuel cells, with total funding of around US$6.8 million.

In January 2023, the first green hydrogen molecule in Brazil was produced in the state of Ceará, marking the initial phase of the pilot project at the Pecém Thermoelectric Complex (UTE Pecém), led by EDP Brazil.

AES Brasil has signed a pre-contract with the Pecém Complex to explore viability studies to produce up to 2 GW of green hydrogen and 800,000 tonnes of green ammonia annually, as part of its strategy to decarbonise the global energy matrix, focusing on exports to European countries.

The Suape Industrial Port Complex has launched a project to lease an area for the future installation of a green hydrogen industrial plant, with an approximate investment of US$3.5 billion, an electrolysis capacity of 1 GW and an area of 72.5 hectares. Green hydrogen will be produced by desalinating seawater, while the project also includes blue hydrogen production units, using methane steam to produce ammonia.

Recently, in February 2024, Petrobras announced an investment of US$ 18 million in a green hydrogen pilot plant in the State of Rio Grande do Norte, in cooperation with the Senai Institute for Renewable Energies, with a focus on evaluating the production and use of hydrogen through the electrolysis of water using solar energy. The plant, initially built for research and development, will be expanded to 2.5 MWp to supply the electrical demand of the pilot electrolysis unit, with the project expected to take three years and financial support of US$18 million.

This chapter was provided by Bird & Bird Plus firm CGM and authored by Paula Chaccur de Cresci.

Canada

Canada has established itself as a leader in the global hydrogen economy, marked by its pioneering advancements in hydrogen production and fuel cell technologies. Committed to the Paris Agreement's objectives, Canada aims for a 30% reduction in greenhouse gas emissions by 2030, with an ultimate goal of reaching net-zero emissions by 2050. Under the Hydrogen Strategy for Canada (the "Federal Hydrogen Strategy"), hydrogen is anticipated to meet up to 30% of Canada's end-use energy needs by 2050, playing a pivotal role in transitioning to a low-carbon economy by decarbonizing energy-intensive sectors such as transportation and manufacturing.

Fuelled by its abundant natural resources, dynamic energy sector, and strategic location, Canada is well-equipped to lead in clean hydrogen production, use and exportation. Canada is a federation in which hydrogen policies are developed by both the national federal government and provincial governments. The Federal Hydrogen Strategy, a joint initiative by the governments at all levels and industry stakeholders, outlines a framework for harnessing hydrogen to achieve net-zero emissions by 2050, while fostering economic growth, innovation and creating over 350,000 jobs.

Canada's funding for hydrogen development stems from government initiatives, private investments, and international collaborations. Federal and provincial incentive programmes along with public-private partnerships, bolster the country's hydrogen infrastructure and technology. Additionally, private sector investment and research grants further support the strategic execution of Canada's hydrogen ambitions.

Legal Framework Overview

Canada's legal framework for hydrogen currently consists of a combination of various federal and provincial laws, policies, and regulations. As technology advances and given the evolving nature of the hydrogen market, it is expected for federal and provincial governments to continue exploring opportunities to further support the growth of the hydrogen economy.

Production

At the federal level, hydrogen production is governed by National Resources Canada (NRCan), which is the federal entity responsible for energy regulation generally. The Clean Fuel Standard, a federal regulation that requires producers and importers to reduce the carbon intensity of transportation fuels, also promotes the production of low carbon hydrogen. The more detailed regulations regarding hydrogen production are governed at the provincial level.

Under the Hydrogen Strategy for Canada (the "Federal Hydrogen Strategy"), hydrogen is anticipated to meet up to *30% of Canada's end-use energy needs by 2050*

Environmental Assessments and Permits

Hydrogen projects in Canada may be subject to an environmental assessment under either or both the federal and provincial levels. Typically, if an environmental assessment is required by both the federal and provincial applicable authorities, these authorities may either collaborate or conduct a joint review to avoid duplication.

A hydrogen project may trigger a federal environmental assessment by the Impact Assessment Agency of Canada if it meets certain criteria. Hydrogen projects may also trigger provincial environmental assessments. In British Columbia, for example, hydrogen projects with certain production thresholds may require an environmental assessment.

In addition to environmental assessment approvals, specific permits may be required from federal, provincial, regional, and municipal government agencies. These will vary from one project to another and will be determined as the proposed project progresses in collaboration with the responsible regulatory agencies.

Transportation and Storage

Transport Canada governs the transportation of dangerous goods, including hydrogen, through the Transport of Dangerous Goods Regulations. While federal regulations provide an appropriate baseline for ensuring that hydrogen is safely stored and transported and that proper emergency response procedures are in place, provinces may impose additional requirements addressing hydrogen transportation and storage. Further, industry standards and best practices also provide guidance on hydrogen storage and transportation in Canada. Standards organisations such as the Canadian Standards Association work in conjunction with federal agencies to develop technical standards which cover various aspects of hydrogen transportation and storage such as emergency response procedures and leak detection and mitigation. Provincial laws can also apply to transportation and storage of hydrogen.

Funding & Support Schemes

In December 2020, the Government of Canada published the Federal Hydrogen Strategy which is a strategic directional document that illustrates how clean hydrogen can help Canada achieve net-zero emissions by 2050 and be positioned as a global, industrial leader of clean renewable fuels. Since issuing the Federal Hydrogen Strategy, the federal government has unveiled various funding initiatives and policies to grow and diversify the hydrogen sector. In June of 2021, the federal government launched a $1.5 billion Clean Fuels Fund with a call for proposals for projects aimed at increasing Canada's capacity to produce clean fuels, including hydrogen. The provinces followed suit and later released their own hydrogen strategies and unique hydrogen policy initiatives. Provinces have their own strategies and funding programmes, including: the British Columbia Hydrogen Strategy (2021), Alberta Hydrogen Roadmap (2021) and the Ontario's Low-Carbon Hydrogen Strategy (2022).

Upcoming Evolution

With the release of the Federal Hydrogen Strategy, the Government established the Strategic Steering Committee, chaired by NRCan, to lead the implementation of the Federal Hydrogen Strategy's recommendations. The timeline of Government-related initiatives to implement these recommendations is summarised below:

- Near-Term Investment – Laying the Foundation: From 2020 to 2025, the primary focus will be to establish the groundwork for Canada's hydrogen economy. This nvolves strategising and constructing new hydrogen supply and distribution networks to support early development HUBs in mature applications.
- Mid Term – Growth and Diversification: Efforts to stimulate the industry will be followed by growth and diversification of the sector from 2025 to 2030. With advancements in technology and the nearing of commercial readiness levels across a range of end-use applications, the utilisation of hydrogen will prioritise those applications offering the most compelling value propositions compared to other zero-emission technologies.
- Long Term – Rapid Market Expansion: Between 2030 to 2050, Canada will begin to experience the complete advantages of its hydrogen economy as the scale of implementations expands and the array of new commercial applications broadens. This growth will be facilitated by Canada's foundational supply and distribution infrastructure.

The Federal Hydrogen Strategy offers 32 recommendations which have been developed in consultation with stakeholders and that will inform the development of concrete actions across the hydrogen ecosystem. These recommendations represent sector-wide themes and have been proposed in the following eight pillars:

- Strategic Partnerships: Using new and existing partnerships to plan for the future of hydrogen in Canada.
- De-Risking of Investment: Encouraging investments by industry and governments through the establishment of funding programmes, long-term policies, and business models.
- Innovation: Taking initiatives to support further research and development.
- Codes and Standards: Adjusting existing and developing new codes and standards to keep up to date with the rapidly evolving industry and removing barriers to deployment, both domestically and internationally.
- Enabling Policies and Regulation: Incentivising the application of hydrogen and ensuring that it is integrated into clean energy roadmaps and strategies at all government levels.
- Awareness: Promoting awareness of hydrogen's safety, uses, and benefits at the national level.
- Regional Blueprints: Facilitating the development of regional hydrogen blueprints to identify specific opportunities and plans for hydrogen production and end us through the implementation of a multi-level, collaborative government effort.
- International Markets: Collaborating with international partners to ensure Canadian industries excel both nationally as well as internationally.

Recent Examples

Below are several recent instances of hydrogen development projects underway in Canada:

- On 25 October 2023, the McLeod Lake Indian Band and the Province of British Columbia signed a memorandum of understanding that lays the foundation for a proposed Tse'khene energy transition hub, which contemplates the development of multiple, on-reserve, low-carbon energy projects. The Tse'khene Hub will be located about 80-90 kilometres north of Prince George, British Columbia, on the Kerry Lake East Indian Reserve and is valued at approximately $7 billion dollars. The Tse'khene Hub will include a hydrogen production facility and will be one of the largest Indigenous energy projects in Canada. Construction of the facilities is expected to begin in May 2024 and completion is anticipated to be in 2026.
- On 7 February 2023, the Government of Nova Scotia issued an environmental approval to Canadian start-up EverWind Fuels for the development of its Point Tupper project, which will produce large-scale green hydrogen and green ammonia. EverWind Fuels expects the project will begin producing and exporting 200,000 tons annually in 2025. On 15 February 2024, EverWind released its Economic Impact Assessment for the project which found significant economic and environmental benefits from this project.
- On 25 February 2021, Evolugen and Gazifère Inc., an Enbridge company, announced they are collaborating to develop and operate an approximately 20-MW water electrolysis hydrogen production plant in the Outaouais region, in Quebec. Public participation sessions are currently underway with an expectation that construction will begin in spring of 2025.
- On 11 May 2021, Suncor and ATCO announced they were entering into a joint venture to build a hydrogen production facility, capable of producing 300,000 tonnes of hydrogen annually. The project is to be located near ATCO's Heartland Energy Centre near Fort Saskatchewan, Alberta. The project is expected to face an investment decision in 2024 and could be operational as early as 2028.

This chapter was provided by Bird & Bird Plus firm Cassels Brock & Blackwell LLP and authored by Jeremy Barretto.

Cassels

The Federal Hydrogen Strategy offers *32 recommendations* which have been developed in consultation with stakeholders and that will inform the development of concrete actions across the hydrogen ecosystem.

Chile

One of the main measures for Chile to become carbon neutral is the development of the green hydrogen (“H2V”) industry.

Chile has an enormous potential to efficiently produce H2V, mainly because of its high levels of solar radiation in the north, and its strong winds in the south, which provide an abundant source of renewable energy.

The Chilean government has developed a national strategy to encourage the production of H2V and to strengthen its role as an energy leader in the national and international market.

To this end, several steps have been taken by the Chilean government such as the development of a “National Green Hydrogen Strategy”, the regulation of the main aspects for the development of H2V projects, and the financing of a first round of projects with public funds led by the Production Promotion Corporation (“Corfo” for its Spanish acronym). In addition, Chile has signed international financing instruments with various organizations to support H2V production projects.

Legal framework overview

National Green Hydrogen Strategy (2020)

In November 2020, the Ministry of Energy published its National Green Hydrogen Strategy which identifies the potential of H2V projects to diversify Chile’s energy matrix and to generate new local development industries.

It also targets to adapt the current regulations, generate strategies for financial support, and coordinate incentives to attract local and international private efforts.

To position Chile in the international market, the strategy seeks to promote the H2V export industry and its derivatives.

The Ministry of Energy structured the strategy in three stages:

First stage (2020 - 2025)

Large-scale domestic consumption with established demand, by focusing on oil refineries, green ammonia, mining trucks, heavy-duty trucks, long-distance buses, and hydrogen injection into gas grids.

Second stage (2025 - 2030)

Extend the application of H2V in transport uses and start exporting, aiming to replace liquid fuels in road transport and gaseous fuels in gas distribution networks.

Third stage (2030 onwards)

Decarbonization of maritime and air transport, using hydrogen-derived fuels, both on local and international routes.

Legal framework overview (cont)

Specific regulation

The Ministry of National Assets issued a National Plan for the Promotion of Green Hydrogen Production on state-owned land.

This plan would allow the development of H2V projects by granting concessions for onerous use within state-owned land for up to 40 years.

The installed electrolyzer capacity of the targeted projects must be at least 20 MW, and they must be developed in three stages: (i) environmental studies and assessment; (ii) construction; and (iii) operation.

In addition to a bid bond, each applicant will be required to provide guarantees for each stage of the project to secure the fulfilment of their obligations.

The Chilean Ministry of Energy issued its *Green Hydrogen National Action Plan in 2023.*

Bill to promote the production and use of green hydrogen

A bill of law was submitted to the Chilean Congress on November 23, 2021. If approved, then (i) the concessionaires must incorporate the transport of H2V through concessional natural gas networks, which would promote the demand for H2V; and (ii) the National Petroleum Company ("ENAP" by its Spanish acronym) regulations will be modified, in order to allow ENAP to develop and participate in the H2V and the fuels obtained from it market.

This bill is being currently discussed in the Chamber of Deputies, as its first stage of the legislative discussion is ongoing. Afterwards, the bill as yet to be discussed by the Senate, if approved by the Chamber of Deputies.

Green Hydrogen National Action Plan 2023-2030

In 2023, Chilean Ministry of Energy issued its Green Hydrogen National Action Plan. The main target of this plan is to define a roadmap that collaborates to develop a sustainable green hydrogen industry by means of coordinating the actions between the governmental agencies.

For those purposes, this plan considers the elaboration of a "Sustainability Analysis", and the execution of measures to build a green hydrogen governance structure, so the green hydrogen industry may be developed in many different local territories along the country.

This plan also considers the creation of a "Sustainable Productive Development Budget Program", that seeks to strategically guide the State's efforts in the productive sphere to address unavoidable challenges such as decarbonization, resilience to the climate crisis and its socio-environmental impacts, and the sophistication and diversification of the country's sustainable production. This plan is organized to be developed in two stages: (i) from 2023 to 2026, aimed to rise investment signals and regulatory certainties; and (ii) from 2026 to 2030, aimed to execute productive development measures for the decarbonization, emphasizing the local/regional industrial development.

Before 2025, this plan considers setting a clear regulatory framework, to give legal certainty, attracting financial efforts and investment plans.

Funding & Support systems

National Green Hydrogen Strategy: Promotion of the domestic and export market.

In 2021, Corfo made the first funding round to leverage H2V projects for USD 50 million. It is expected to produce 45,000 tonnes of H2V per year, reducing 600,000 tonnes of CO2 annually.[2]

One of the targets of the National Green Hydrogen Strategy, is to reduce costs in Chile by achieving production at less than 1.5 USD/kGH2 by 2030[3].

One of the targets of the National Green Hydrogen Strategy, is to reduce costs in Chile by achieving production at less than *1.5 USD/kGH2 by 2030.*

Financing investment projects for productivity and sustainable development in Chile.

01 Support program for the green hydrogen industry in Chile

The Interamerican Development Bank and the Chilean Government signed an agreement to finance the development of the H2V industry in Chile in 2022 that included loans of US$400 million. The objectives are to contribute to the development of the H2V industry in Chile; increase investments in these projects; improve local capabilities, institutional and innovation capacities related to these projects; and promote the development of the Chilean regions where H2V production projects are installed.

02 Green Hydrogen Facility Project to support green, resilient, and inclusive economic development

US$200 million loan through the World Bank. This agreement was signed by the Chilean Government and the World Bank in 2022, and it was announced at COP27.

03 Green H2 Fund

In December 2022, Corfo signed the Green H2 Fund I. It consists of a venture capital fund focused on H2V, supported by Corfo and Greenvestment S.A. The committed amount is between US$100 million and US$120 million, which will be available for investments in (a) wind and photovoltaic energy generation, transmission projects, (b) H2V production plants, storage, compression, transport, (c) supply activities of H2V and/or any chemical product produced based on hydrogen, and/or (d) other non-conventional renewable energies. 80% will be funded by private contributors, and 20% by Corfo.

04 Development Bank of Latin America and the Caribbean (“CAF”)

The CAF approved, in December 2023, a USD 160 million financial plan for Chile. This plan will be executed by means of two loans:

- A USD 80 million loan is aimed at strengthening the management and budget execution capacities of regional governments. It will be executed by the Ministry of the Interior. The initiative contemplates the development of different actions to create favourable conditions for decentralization, including the development of rules and regulations to transfer competencies and powers to regional governments; and
- A second USD 80 million loan that will be executed by the CORFO, to implement the Support Program for the Development of the Green Hydrogen Industry.

[2] https://www.corfo.cl/sites/cpp/sala_de_prensa/nacional/26_05_2022_firma_hidrogeno_verde;jsessionid=eDsD7-QDwKp-b5YN9r6oGUh5f8-910IKZss-SQ-J-uBJiLtVflfd!114663455!-83799172

[3] https://energia.gob.cl/sites/default/files/estrategia_nacional_de_hidrogeno_verde_-_chile.pdf; p. 25.

Up-coming evolution

Stages of the National Green Hydrogen Strategy of the Ministry Energy

The issuance and public consultation of the Green Hydrogen National Action Plan was the first step that started this first stage of this Strategy.

The next milestone will occur in 2025, when the second stage of the National Green Hydrogen Strategy is expected to be launched.

Procedure under the "National Strategy" of the Ministry of National Assets

The schedule of the National Green Hydrogen Plan comprises the following: preparation of plans, registration, internal and external appraisal, delivery of bid bonds by the applicants, and review of the applications by the Ministry of National Assets.

Finally, between March 2023 and May 2023, the Ministry must issue a decree authorizing the granting of the concession of onerous use of the state-owned land where the awarded projects will be implemented. As of now, a concession of onerous use was granted to Pares&Alvarez, because of the first bidding process for these purposes. This concession was awarded for a 40-year period, and it will be use for the development of a green hydrogen production plant for the Calama mining district, owned by Susterra SpA.

Progress of the "Bill to promote the production and use of green hydrogen"

If approved, the concessionaires of natural gas distribution networks must incorporate a share of H2V into their network distribution.

To this end, the concessionaires will have to adapt the facilities and gas appliances that are currently used by their consumers, at their own cost and expense. However, the concessionaires may incorporate the costs of such adaptations in the annual profitability check carried out by the energy authority. The costs may be also taken into consideration in the preparation of the next tariff decree.

The second stage of the National Green Hydrogen Strategy is *expected to be launched in 2025.*

Some recent examples

In December 2021, Corfo awarded the first funds to finance projects to develop H2V plants in Chile.

The awarded proposals came from the following companies: (i) Enel Green Power Chile S.A., which will produce 25,000 tonnes of H2V per year in the Magallanes region; (ii) Linde GmbH, which seeks to generate 3,000 tonnes of H2V per year in the Valparaíso region; (iii) Engie S.A., which seeks to generate 3,200 tonnes of H2V per year; (iv) Air Liquide S.A., which aims to produce 60,000 tonnes of H2V per year in the Antofagasta region; (v) GNL Quintero S.A., which aims to generate 430 tonnes of H2V per year in the Valparaíso region; and (vi) CAP S.A., which aims to produce 1,550 tonnes of H2V per year in the Biobío region.

So far, only Engie S.A.'s project has a favourable environmental qualification resolution, granted in April 2022.

However, in 2022, the first industrial scale production of green hydrogen in Chile began its operation. This plant is called "Haru Oni" (which means "Strong winds", in "selknam", an indigenous language), and it's a "demonstration" plant. This means that has a scale big enough to generate final products aimed to be exported, but it doesn't have a proportion that allows Chile to lead a major change in this matter.

During 2023 a Walmart distribution center was inaugurated in Santiago. This project was developed with Engie S.A., and it considered an investment up to USD 15 million. In a first stage, this project aims to allow the replacement of 200 forklifts lead-acid batteries by hydrogen energy cells.

In addition, in 2023 two green hydrogen production plant projects were entered into the environmental impact assessment system of the Environmental Assessment Service: (i) the development of a green hydrogen generation plant in Quintero, Valparaiso, owned by GNL Quintero S.A., aimed to generate 660 tonnes of H2V per year; and (ii) the development of a green hydrogen production plant for the Calama mining district, owned by Susterra SpA, aimed to generate 89,880 kilograms of H2V per year.

This chapter was provided by Bird & Bird Plus firm Cariola Díez Pérez Cotapos and authored by Martín Astorga, Gonzalo Jiménez and Miguel Oritz.

Cariola Díez Pérez-Cotapos

Denmark

Denmark has ambitions to become a leader in green hydrogen associated technologies. And with good reason, as Denmark has great export and business potential in the area. The Danish Government reached a broad political agreement, known as the “Power-to-X” strategy (PtX), on 15 March 2022 on the development and promotion of hydrogen and green fuels. PtX covers several technologies, all of which are based on the fact that power is utilised to produce hydrogen. The agreement includes a goal of building an electric electrolysis capacity of 4-6GW by 2030.

The PtX strategy plays a significant role in meeting Denmark’s ambitious long-term goal of climate neutrality by 2050, as well as the international climate goals to which Denmark has committed itself in the EU and through the Paris Agreement. The objective for the strategy is to integrate green hydrogen into the energy system so that it supports the existing supply sectors. This includes establishing a hydrogen infrastructure so that Denmark and Europe can compete globally.

Legal framework overview

There is no comprehensive legal regulation covering green hydrogen in Denmark. The European Commission has put forward a proposal for common rules for the internal markets for renewable gas, natural gas and hydrogen, COM (2021) 803 final. However, it’s the assessment of the Danish Ministry of Climate, Energy and Utilities that there’s a current need for regulation of the Danish hydrogen market, which is why it’s not possible to wait for the EU regulation to be in place.

A new regulation of hydrogen has *entered into force on 1 January 2023* based on a proposed bill to amend the Danish Gas Supply Act.

A new regulation of hydrogen has entered into force on 1 January 2023 based on a proposed bill to amend the Danish Gas Supply Act. The amendment ensures that piped hydrogen is regulated by the Gas Supply Act, which means that the provisions of the Act apply to both methane-based gas and now hydrogen gas. The purpose of the amendment is to create the framework to establish a hydrogen infrastructure (transport and storage) that will help support the green transition and promote the development of PtX. It’s expected that the hydrogen infrastructure will be developed from clusters, i.e., smaller clean hydrogen systems, but the law will also apply to hydrogen injected into the gas system. However, this requires that the hydrogen has a proper quality.

Funding & Support schemes

The PtX strategy contains a new support-model consisting of a grant scheme of DKK 1.25 billion to be distributed via a PtX tender. The funds will be used for hydrogen production, as well as better framework conditions for producers.

The purpose of the PtX tender is to support industrialisation and scaling up of PtX production in Denmark to reduce the costs associated with green hydrogen production. This will promote Denmark's business and export potentials within the PtX area. When PtX products are used to replace fossil fuels, they can contribute to lowering CO2- emissions both in Denmark and in the rest of the world. The PtX tender is also expected to promote commercialisation and scale-up of PtX technologies that can support the green transition nationally and internationally.

The PtX tender was launched in April 2023 based on the political agreement from March 2022. At the end of October 2023, the Danish Energy Agency identified six winning projects, distributed among four different companies, which can now truly begin their production of green hydrogen in Denmark. The companies have applied for more than four billion Danish kroner, more than three times the budgeted funds.

The winners of the tender are Plug Power Idomlund Denmark, European Energy/Vindtestcenter Måde K/S, European Energy/Padborg PtX ApS, Electrochaea/Biocat Roslev, and European Energy/Kassø PtX Expansion ApS. The five winners have been awarded their entire bids, but since there is a remaining amount in the funding pool, HyProDenmark/Everfuel will also be offered a reduced bid.

Up-coming evolution

The Danish Energy Agency has initiated a market dialogue with current and potential PtX players to uncover how a hydrogen infrastructure best supports both producers and users of hydrogen to provide the best opportunities for the continued development of a PtX industry in Denmark. The market dialogue contributes to the further planning and development of the hydrogen infrastructure of the future by, among other things, identifying the expected geographical location of future PtX facilities.

It's clear that the hydrogen industry has a great need to establish hydrogen infrastructure in the form of hydrogen pipes. The actors on the market expect pipe-borne hydrogen infrastructure to transport most of the quantities produced, and the share is expected to increase during the period. From 2030 onwards, more than 87% of the hydrogen production from pure hydrogen projects is expected to use pipe-borne infrastructure.

By 2030, Denmark wants to have 4-6 GW electrolysis capacity, which the PtX strategy will contribute to. This would put Denmark amongst Europe's top three European countries.

The Danish Energy Agency has initiated a market dialogue with current and potential PtX players to uncover how a hydrogen infrastructure best supports both producers and users of hydrogen *to provide the best opportunities for the continued development of a PtX industry in Denmark.*

Some recent examples:

Both public and private actors are already making noteworthy contributions to hydrogen projects and have ambitions for the future. A few examples are:

01 Ørsted and Skovgaard Energy has signed a letter of intent stating that they will develop a PtX-facility producing hydrogen, e-methanol, and e-kerosene (jetfuel) with a total electric electrolysis capacity of up to 3GW. The first phase is based on power from onshore windfarms and solar parks but later also offshore wind farms. The first phase will have an expected electrolysis capacity of 150 MW and will be powered by onshore wind farms and solar parks. Skovgaard Energy has already started the development of both the PtX project and the associated onshore wind farms and solar parks, which could enable the project to be implemented quickly if the regulatory process goes according to plan.

02 A cooperation between GreenGo Energy and Ringkøbing-Skjern Municipality will develop a green energy park called Megaton, to be operational before 2030 based on renewable hybrid solar and wind energy with an electric electrolysis capacity of 2GW. The ambition is an annual production of over one million tons of green fuels (green ammonia /e-methanol). In connection with the Megaton Energy Park, GreenGo Energy will apply to the Ringkøbing-Skjern municipality for several specific areas to install solar panels and wind turbines. That part of the project will start in 2024.

03 "Green Fuels for Denmark" is a project run by a consortium consisting of Ørsted and several major Danish logistics companies. It aims to produce renewable hydrogen to power heavy road trucks and e-methanol to ocean-going vessels or ferries and in the second phase also e-kerosene (jetfuel) The total capacity is expected to be 1.3GW by 2030.

04 HØST is a PtX-project aiming to use wind and solar power to produce green ammonia used for both artificial fertilisers and fuel and is expected to make Denmark self-sufficient in ammonia for fertiliser production. The facility is planned to be operational by the end of 2026.

05 H2 Energy plans to construct a large PtX facility operational by 2025 that will convert green electricity into hydrogen, which can be used directly by trucks and other heavy land transport. H2 Energy has now obtained environmental approval for its large-scale green hydrogen production facility in the Danish city Esbjerg. According H2 Energy, the planned facility will support the decarbonisation as well as creating approximately 60 permanent jobs and up to 700 jobs during the construction phase.

06 Green Hydrogen Hub Denmark aims to be the first fully commercially viable, 100% green, large-scale hydrogen production, storage, and Compressed Air Energy Storage (CAES) solution storing hydrogen in large caverns created in salt deposits suitable for storage.

07 The development of PtX is the reason for Aarhus to now host the 3rd edition of a Symposium in May 2024. The setup includes interesting activities and several knowledgeable speakers, and will provide the newest insights on technology for PtX.

08 Gas Storage Denmark, the owner and operator of Lille Torup gas storage facility, is working on plans to convert two of the caverns into hydrogen storage and one cavern for compressed air storage.

09 HySynergy is a project by the company Everfuel with the purpose of establishing a large-scale production and storage facility of green hydrogen as zero-emission fuel for mobility and industrial partners. By the completion of the project's third phase in 2030, the total capacity will be 1GW. Everfuel expects to deliver their first shipment of green hydrogen to Crossbridge Energy's refinery in the first quarter of 2024. After that, the ambition is to scale up to 300 MW of electrolysis by 2026 (producing 120 tons of hydrogen per day) and 1 GW in the third phase around 2030.

An important 2024

2024 represents a pivotal year for PtX in Denmark. There are immense potentials at stake, all contingent upon political agreements e.g. offshore wind tenders and energy parks. In the Danish city of Kassø, a grand PtX facility is being created to produce green methanol, with its subsequent discharge through Aabenraa Port to A.P. Møller-Maersk's vessels. The facility itself has a capacity of 52 MW and, at full expansion, has the capability to yield 42,000 tons of green methanol annually. The plan is to inaugurate the facility as early as 2024, setting a pioneering example and revolutionising Danish ports and Denmark.

Finland

Finland's aim to become carbon neutral by 2035 and carbon negative during the following decades is one of the most ambitious targets in the world.

Hydrogen is an integral part of the national energy and climate strategy. In addition to the national Government resolution on hydrogen published in 2023, Finland has a new hydrogen strategy produced by the Finnish H2 Cluster and developed in collaboration with officials, industry unions, and companies involved in the entire hydrogen value chain.

In November 2020, Business Finland (the Finnish Government organisation for innovation funding and trade, travel, and investment promotion) published a national hydrogen roadmap that analyses Finland's strengths and opportunities in the hydrogen field. The roadmap serves as a basis for developing the hydrogen policy and determining the role of hydrogen in the national energy and climate strategy. Investments in power-to-X technologies play a key role in Finland's Recovery and Resilience Plan, published in 2021 and updated with EU approval in 2023.

Legal framework overview

As a member state in the European Union, the development of sector integration and the hydrogen economy in the EU is strongly reflected on a national level. However, Finland doesn't have a comprehensive legislative framework for the use of hydrogen as an energy carrier as provided for in the proposals generated by EU's "Fit for 55" climate package of July 2021. At present, the legislation in place solely governs hydrogen's use for industrial purposes i.e., production, storage, safety, as well as distribution obligation.

Hydrogen compliant and future-proof legislative planning, including e.g., sustainability system requirements and voluntary schemes for certification of compliance with EU RFNBO methodology, is fortunately on the national agenda. RED III and the RFNBO delegated regulations are being diligently examined by actors on the Finnish market and further EU level specifications are anticipated with enthusiasm, e.g., EU level legislation concerning low-carbon hydrogen.

Finland's target, to become carbon neutral by 2035 and carbon negative by 2050, *is some of the most ambitious targets in the world.*

Funding & Support schemes

On 16 December 2021, the Government issued a decree that allows support to energy investments under Finland's Recovery and Resilience Plan in 2022-2026. The Decree entered into force on 16 December 2021 and remains in force until 31 December 2026. It's the national plan for utilising the funding from the EU's Recovery and Resilience Facility (the RRF), at the heart of the implementation of REPowerEU. The aim is to promote energy investment and energy infrastructure projects that reduce greenhouse gas emissions in Finland and support the country's 2035 carbon neutrality target.

The amount of available funding reserved under Finland's Recovery and Resilience Plan is €483.2 million. The Decree's content is largely in line with the Government Decree on general terms and conditions for granting energy aid in 2018-2022, but it also lays down provisions on the general and special conditions on implementing projects and granting aid in accordance with Finland's Recovery and Resilience Plan.

The amount of available funding will total about *€520 million*.

For example, the funding criteria include special requirements on the use of the EU's Recovery and Resilience Facility, such as compliance with the "do no significant harm" principle. According to this principle, investments should not cause significant harm to environmental objectives. The Ministry of Economic Affairs and Employment made the first six aid decisions in October 2022. By the end of 2023, it had granted funds to a total of 56 projects, with the total grant sum being €377,974,972.

In the current round of applications for energy investments under Finland's Recovery and Resilience Plan, the focus is on clean transition investments. Aid can be granted for large-scale renewable energy projects in the demonstration phase with a priority in technical feasibility, and/or projects along the hydrogen value chain for renewable hydrogen production. The investments must be completed by 30 June 2026.

In addition to the budget allocated under Finland's Recovery and Resilience Plan, Finland also has a budget for national energy aid. The Ministry of Economic Affairs and Employment has reserved a budget of €14.1 million in national energy aid for 2024. The priorities of the budget are production of renewable energy, renewable hydrogen and fuels refined for it, energy saving or more efficient production or use of energy, utilisation of waste heat or the transition towards a low-carbon energy system in other ways. At least €10 million will be allocated to investments promoting energy saving and energy efficiency. Aid will no longer be granted to energy efficiency projects related to buildings and their common building services engineering, and regarding renewable energy, aid will only be granted to projects using new technology. In this context, new technology refers to new kinds of solutions that have not yet been widely piloted in Finland. The 2024 national energy aid budget is considerably tighter than that of the previous year (€253.1 million in 2023). With a tightening of the budget by over €200 million, in 2024, aid will only be granted for investment projects of up to €5 million.

Funding & Support schemes (cont)

Other national funding mechanisms include the Finnish Climate Fund (Ilmastorahasto), which was set up by the Finnish government during its February 2020 climate summit. The Fund focuses on investing in large-scale targets with significant climate and environmental impacts. The investment is limited to funding self-supporting projects which can be realised earlier or at a larger scale with the Fund's investment. The Fund also verifies that the investment target fulfils the minimum criteria set for environmental objectives in the EU Sustainable Investment Regulation before making an investment. By September 2023, the Fund had made 22 investment decisions amounting to €164,9 million.

In addition, some EU loans can be applied for directly through Finnish entities. Through Business Finland, companies can apply for IPCEI (Important Project of Common Interest) on Hydrogen Industry-loans. The IPCEIs on hydrogen cover funding of the full clean hydrogen value chain from renewable and low-carbon hydrogen production to storage, transmission and distribution, and hydrogen application, notably in industrial sectors.

Through Finnvera, companies can apply for a Climate and Environmental Loan for clean hydrogen production, supply (at commercial side), and on-site storage to develop the energy sector, as well as the deployment of low carbon technologies. The loan has been implemented in cooperation with the European Investment Fund with the support of the InvestEU Guarantee Programme. The loan amount through Finnvera is €150,000-2,000,000 per financing project.

Naturally, companies looking to fund their hydrogen projects can apply for loans directly from the European Union under various grants. These include, but are not limited to, the Innovation Fund, the Hydrogen Bank, Horizon Europe, the European Partnership for Hydrogen Technologies, and the Connecting Europe Facility (CEF).

As part of the Sustainable Growth Programme, the Finnish Government allocated *€150 million* in public funding to projects related to hydrogen technology and carbon capture and utilisation.

Up-coming evolution

Finland has a proactive history in the field, both research organisations and companies have been active in developing fuel cell applications and utilisation of hydrogen. They also have a full and working value chain for hydrogen and decades of experience in large-scale industrial use of hydrogen. Hydrogen is currently produced for the needs of industries such as oil refining, mainly from natural gas, the share of renewables is currently very limited. In addition, hydrogen arises as a by-product of certain industrial processes.

However, alternative gases, e.g., mixing of hydrogen with natural gas, synthetic gas, bio- and gases produced from recycled raw materials and clean hydrogen have been given a key role in supporting the transformation of energy systems and bring solutions to energy transmission, storage, and flexibility needs. Finland looks at hydrogen in the energy market from the same starting point as other solutions that promote the integration of energy systems. Promotional activities are to be directed to hydrogen production methods that utilise zero-emission electricity (or are low-emission). This requires clean power generation technologies, strong European electricity transmission connections and innovation investments in the development of hydrogen technology. Moreover, it is equally important to make necessary adjustments in different laws and regulations so that the large-scale hydrogen production, transport, storage, and use can take place in the most efficient way.

As illustrated by many actors, the key barrier to scaling up the hydrogen market is the ‘causality dilemma’ between supply, demand, and infrastructure. In the current landscape this translates to lack of transparency and trust in the market, and many players find themselves having to wait and see. Despite this, there is a positive and supportive buzz focusing on strong players, innovative technology, and cooperation. There are also several factors that make Finland well positioned to be a European leader in the hydrogen economy. These include its abundance of renewable energy potential and natural resources, leading technology in clean hydrogen and its derivates as well as stable and well-planned infrastructure. Further, Finland has a modern, smart and robust electricity grid. Clean energy potential is distributed across Finland and it is anticipated that hydrogen production can well be deployed across both the north and south of Finland.

As illustrated by many actors, the key barrier to scaling up the hydrogen market is the ‘causality dilemma’ of *“which came first - the chicken or the egg?”* between supply, demand, and infrastructure.

Some recent examples

Finland has a great opportunity to create a wide range of new businesses throughout the entire hydrogen value chain. Both private and public actors are already making significant contributions to hydrogen projects.

A few of these initiatives are:

Finland has *a new hydrogen strategy,* produced by the Finnish H2 Cluster, and developed in collaboration with officials, industry unions and companies involved in the entire hydrogen value chain.

01 Gasgrid Finland joined the European Hydrogen Backbone (EHB) initiative in April 2021 which supports the achievement of carbon neutrality targets. To meet the REPowerEU's 2030 hydrogen targets, the accelerated EHB vision involving 31 gas infrastructure companies from 28 countries shows that by 2030, almost 28,000 km of pipeline could emerge and by 2040, 53,000 km.

02 Gasgrid Finland and Fingrid, Finland's transmission system operator for electricity, are running a joint research project involving envisaging scenarios for the development of Finland's hydrogen economy and energy transmission system based on summaries of viewpoints gathered from stakeholders on the development of the hydrogen economy. In addition, the project is studying the feasibility of building a hydrogen infrastructure, transmission network and developing the foundations for a hydrogen market and sector integration. The goal is to find cost-effective infrastructure development paths for the Finnish energy system.

03 The international hydrogen infrastructure development projects promoted by Gasgrid together with its collaboration partners including Nordic Hydrogen Route, Nordic-Baltic Hydrogen Corridor and Baltic Sea Hydrogen Collector were included on the Projects of Common Interest (PCI) list by the EU Commission in November 2023. The PCI listing means that the EU regards these three hydrogen projects for the Baltic Sea region as playing a key role in the achievement of European energy policy objectives.

04 In Finland, several projects have spotted the Gulf of Bothnia as a potential hydrogen valley. It has great resources for sustainable hydrogen production, industry needing hydrogen for decarbonisation, technological know-how and excellent infrastructure. The international network, umbrella brand and collaboration platform called BotH2nia, established in April 2021 for promoting and building a large-scale hydrogen economy around the Gulf of Bothnia, maintains active research, advisory and development network.

05 Ren-Gas is developing six Power-to-Gas projects in six different Finnish cities with the target of producing e.g., green hydrogen forming part of a country wide power-to-gas fuel production and distribution network for heavy road and maritime transportation. According to Ren-Gas' assessment, their renewable fuels production is expected to reduce the reliance on fossil fuels in heavy road and maritime transportation and potentially save up to 250 million litres annually.

06 Finnish project developer Flexens and KIP Infra Oy are developing a facility with a hydrogen production capacity of approximately 300-350 megawatts in the city of Kokkola on the west coast of Finland. The planned facility would certify a strengthened energy and ammonia self-sufficiency for Finland. Production of mainly green hydrogen and green ammonia is meant to start running at the end of 2027. Further, Copenhagen Infrastructure Partners, Flexens, and Lhyfe have formed a partnership for the development and construction of an integrated energy island solution enabling large-scale offshore wind and green hydrogen production in Åland islands.

07 Green North Energy is planning a green hydrogen and ammonia production plant in Naantali, Finland. The purpose is to focus on green ammonia which is expected to play a major role in the future, especially as a marine fuel to be a carrier of hydrogen for the needs of the current market and to create the possibility for new markets. The plant is scheduled to be in production in the coming years, improving Finland's security of supply.

08 Blastr Green Steel and Inkoo Shipping are cooperating in land and harbour development in Inkoo, Finland. The aim is to optimise the design of our planned ultra-low CO steel plant and integrated hydrogen facility. Blastr will utilise Inkoo Shipping's land area to optimise the layout design of the planned ultra-low CO steel plant and both parties will jointly develop the harbour to enhance sea cargo facilities related to the project.

09 P2X Solutions, a Finnish pioneer in green hydrogen and Power-to-X technology, is building an industrial scale green hydrogen production plant in Harjavalta, aiming at a total of 1 GW of hydrogen production capacity by 2031. When commissioned, the facility will produce green hydrogen for e.g., industrial needs by using electricity produced from renewable energy sources and as by-products it generates oxygen and thermal energy needed by industries. P2X is also partner for Oulun Energia for a planned hydrogen production plant in the city of Oulu, the project development phase launched in the early 2024. The company received in late December 2021 approximately €26 million grant for new energy technology and large-scale demonstration projects from the Ministry of Employment and the Economy of Finland. In addition, the Climate Fund has granted the company a capital loan of €10 million. The foundation stone of P2X Solutions green hydrogen production plant was laid in Harjavalta on 20 January 2023.

The amount of available funding reserved under Finland's Recovery and Resilience Plan is *€483.2 million*.

France

France considers hydrogen as an important lever for reconciling climate action with industrial ambition and aims to become a “leader” in carbon-free hydrogen as stated by Bruno Lemaire Minister of the Economy, Finance and Industrial and Digital Sovereignty.

France was one of the European frontrunners in formulating policies to develop hydrogen for decarbonization, publishing its first hydrogen plan in 2018, followed by a larger, €8.9 billion plan in 2020, closely following plans released by the European Commission.

France, as Europe, has set itself an ambitious goal in the context of energy transition: to reduce national greenhouse gas emissions by 55% by 2030 and to achieve carbon neutrality by 2050. This involves a major transformation of its territories, particularly in the transportation, industry, and energy sectors, which alone account for 60% of greenhouse gas emissions.

The French strategy for hydrogen deployment focuses on applications where hydrogen is key for deep ecarbonized on, including refineries and the chemical industry as well as steel production, and the mobility sector. The political priority is to develop a domestic industry sized to meet national demand, which is seen as a more secure sourcing strategy than relying on imports.

Legal framework overview

The French legal framework for the development of renewable hydrogen has significantly evolved in 2023, driven by European regulations and national legislative texts.

With the enactment of ordinance dated 17 February 2021, a commitment was made to implement a support scheme for the production of carbon-free, renewable, or low-carbon hydrogen through water electrolysis. This scheme aims to provide benefits to carbon-free, renewable, or low-carbon hydrogen production units located in France, either through operating support or investment incentives. The ordinance, now incorporated in the Energy Code, delegated the formulation of competitive procedures for awarding these subsidies to a subsequent decree.

Over two years following the initiation of this commitment, the French government conducted a public consultation in June 2023, regarding the draft decree issued in accordance with Ordinance, establishing the procedure for granting subsidies for the production of ecarbonized hydrogen. On 1 September 2023, following the conclusion of this consultation, a decree was published, establishing a new project funding mechanism benefiting low-carbon and ecarbonized hydrogen production.

The decree supplements the regulatory part of the Energy code to add a chapter dedicated to hydrogen, including provisions on the competitive procedures for renewable or low-carbon hydrogen producers seeking public support. The decree specifies the different phases of the bidding and the obligations and commitments of bidding candidates.

Following the publication of the decree, the government has launched a consultation to support the production of low-carbon hydrogen.

Simultaneously, to accelerate the development of renewable energies and encourage investments, a predictable regulatory framework, which means more legal certainty for investors, was presented with the publication of two acts passed in 2023: the Renewable Energy Production Act (10 March 2023) and the Green Industry Act (23 October 2023). These two acts adjust several provisions relating to hydrogen.

The Renewable Energy Production Act includes various aspects relevant to the deployment of hydrogen production from renewable sources. Indeed, the Multiannual Energy Program (“Programmation pluriannuelle de l’énergie” or “PPE”), relating to the development of renewable and recovered energies now also covers the production of renewable or low-carbon hydrogen. It also enables the French energy regulatory commission (CRE) and gas and electricity distribution network organizing authorities to contribute to the deployment of renewable or low-carbon hydrogen production facilities. It also enshrines the possibility of using individual or collective self-consumption to produce the renewable electricity needed to produce renewable hydrogen.

This first step as part of the definition of a legal framework is a strong signal for investors, project developers and industrialists.

The Green Industry Act includes two main provisions that could encourage the development of hydrogen production:

01 Firstly, the act provides that projects for renewable energy production facilities and the production of renewable or low-carbon hydrogen may be recognized as being of public interest within the framework of a compatibility procedure with urban planning documents;

02 Secondly, the new rules regarding public consultation or debate in certain areas are likely to accelerate the deployment of hydrogen production projects.

Funding & Support schemes

A new national hydrogen strategy was expected in France by the end of 2023.

The initial strategy has been a driving force behind the development of the hydrogen industry in France, thanks in particular to funding from the France 2030 public investment program. Notably, it supported research into hydrogen production technologies through initiatives like the “Priority Research Program and Equipment for Decarbonized Hydrogen” (PEPR H2). With a budget of €83million, the PEPR (priority research program and equipment) led by CEA and CNRS coordinates the upstream research part of the strategy. Through the 17 R&D projects already funded, it addresses scientific and technological challenges throughout the entire hydrogen value chain: from its low-carbon production to its use in heavy mobility and industry, storage and/or transport in gaseous, liquid or solid form.

Additionally, financial assistance was extended for the demonstration of these new technologies, exemplified by the “Hydrogen Technology Bricks and Demonstrators” call for projects run by French Environment Agency ADEME. The strategy has also facilitated the inaugural industrialization of large scale hydrogen production under the auspices of the European IPCEI Program (or “Projet Important d’Intérêt Européen Commun” (PIIEC).

Moreover, unveiled in 2020, the Multiannual Energy Program (“Programmation pluriannuelle de l’énergie” or “PPE”), set up for the periods 2019-2023 and 2024-2028, provides for an increase in financial support for the French hydrogen sector.A review of PPE is expected in 2024.

As planned, a National Hydrogen Council was set up at the beginning of 2024 to ratify a revision of the French hydrogen strategy.

The revision is currently on sustaining and expediting the execution of long-term hydrogen production and utilisation projects. In line with this objective, and subject to its final adoption after consultation, it provides for the creation and maintenance of several public support schemes:

- Support for industrialization projects through the “Première Usine” call for projects operated by Bpifrance
- Introduction of carbon contracts for difference (CCfDs) awarded through calls for tender;
- Launch of a study on the creation of a bonus/malus mechanism to reduce the climate impact of nitrogen;
- Extension of the incentive tax mechanism for the use of renewable energies in transport to low-carbon hydrogen;
- Support through existing schemes: CORAC (air), CORAM (automotive), CORIFER (rail), CORIMER (maritime), and the “Hydrogen technology bricks and demonstrators” call for projects.

At the end of 2020, the French Government has announced it would set aside €9bn to support deployment of low-carbon hydrogen in France. In 2023, the French Government made €4bn available (as part of the €9bn public support) for a low-carbon and renewable hydrogen production through auctioned contracts for difference (CfDs), to provide 1 GW of electrolysis capacity.

This mechanism will be used to support projects not only for the initial investment phase but also throughout their lifetime. It will set a price for a kilogram of low-carbon hydrogen over a ten-year period that is guaranteed to be competitive with grey hydrogen, using a CfD awarded through a transparent, non-discriminatory auction reflecting European’s best practice. The government’s support for hydrogen production should be divided into three auctions. Expected in 2024, the first will unlock 150 MW of production capacity.

Some recent examples

In 2023, several projects were announced, for the production, transport and storage of carbon-free hydrogen. These include large-scale projects such as the Air Liquide Normand'Hy project which involves of building an electrolyser with a capacity of at least 200 MW in the Port-Jérôme industrial zone in Normandy (investment of €400 million) and HyVence, a project to install photovoltaic panels over 500 hectares in Fos-sur-Mer to produce 800 Gwh per year, which will then be converted into hydrogen on site in quantities of up to 15,000 tons a year (investment of €700 million).

On 29 June 2023, Qair and the Agence Régionale Energie Climat (Arec) d'Occitanie announced the start of construction of their "Hyd'Occ" renewable hydrogen production unit. By the end of 2024, Hyd'Occ will produce renewable hydrogen through alkaline electrolysis of water, at low temperature and low pressure. Mainly intended for maritime, port and mobility uses within a 200 km radius, the green hydrogen produced on a large scale will be delivered by container via the multimodal logistics hub at Port-La Nouvelle. It will be the largest green hydrogen plant in France. Production will be around 6,000 tons per year by hydrolysis.

On 22 November 2023, Haropa Port (merger of ports of Le Havre, Rouen, Paris) and Verso Energy, a specialist in renewable energies, signed an agreement to set up an industrial unit to produce low-carbon hydrogen and synthetic fuels in the Haropa Port's port area in Grand-Quevilly. It represents an investment of €500 million. The plant is scheduled to come on stream by 2029.

In December 2023, a preliminary consultation was concluded about the H2V's project to develop a 600MW green hydrogen production unit in Fos-sur-Mer (Marseille). It represents an investment of €910 million and will avoid the emission of 840,000 tons of CO2 each year. In January 2024, HysetCo, the joint venture owned by Air Liquide, Idex, Toyota, STEP, Kouros and TotalEnergies, and dedicated to the development of hydrogen mobility, has announced that it has received the authorisation from the Paris Prefecture of Police to deploy a new fleet of accessible hydrogen-powered taxis.

On 25 January 2024, Airbus and Qair announced the signing of a memorandum of understanding to jointly structure the sustainable aviation fuel (SAF) industry. The partnership will involve identifying commercial opportunities and sharing technical and economic data with a view to developing a sustainable aviation fuel unit and with a significant focus on establishing an e-fuels production facility in Lannemezan, Hautes-Pyrénées, slated for operation by 2030.

France has a central role to play in the *decarbonisation of aviation*.

€300 million have been allocated so far in 2020 to projects ranging from the Hyperion hydrogen propulsion project, to the Majestic wing efficiency project, which hopes to *reduce aircraft emissions by up to 5%*.

Germany

Germany is following through on its ambitious plan to become a leader in green hydrogen associated technologies. In particular, the German Government is aiming for an electrolysis capacity of at least 10GW by 2030. An additional 10GW is to follow by 2040. Since adopting the National Hydrogen Strategy in 2020, the Government has put an even greater emphasis on the role of hydrogen in the German energy transition.

The German Government aims to become the leading market for hydrogen technologies with an electrolysis capacity of *10 GW by 2030*.

The increasingly bold targets of the Government are reflected in the 2021 and 2023 updates of the National Hydrogen Strategy, "NHS". The latest update calls for swifter permitting and building procedures. Hydrogen is to be used across all sectors and a range of different applications. The focus lies on two areas: Ramping up production capacity to bring consumption costs down, and supporting German firms to develop hydrogen (application) technologies. At the same time, the mapped out major sites of production, consumption, storage and import within Germany are to be connected in the near term, i.e. until 2032, through a "hydrogen core grid" (Wasserstoff-Kernnetz).

The NHS is complemented by other strategies. The updated "power station strategy" promotes investments in "H2-ready" gas power stations, which will transition from gas to green hydrogen between 2035 and 2040. In particular, it plans for a rapid tendering process to kickstart the expansion of the hydrogen industry. A separate import strategy for hydrogen is currently being drafted.

To implement these strategies and incentivise the desired growth, the government delves deep into its toolbox, which includes financing funds, both at national and EU level, streamlining planning and permitting procedures, coordinating administrative cooperation as well as Bund-Länder (i.e. between national/federal and state level) cooperation, unified EU standards and certifications as well as world-wide international partnerships to import green hydrogen or the electricity from renewables necessary to produce it.

In addition, the Länder (states) run their own projects, for which they make available additional funds. Some even have their own "state hydrogen strategy", e.g., Bavaria.

Legal framework overview

A consistent and complete legal framework covering all main aspects of the hydrogen value chain is being developed. While the rules governing the infrastructure itself apply to every category of hydrogen, those relating to the financing and the acceleration as well as simplification of procedures usually narrow the scope to green hydrogen only.

The hydrogen supply networks have been regulated in the Energy Industry Act (Energiewirtschaftsgesetz, EnWG) since the amendment of the act in 2021. The transport of hydrogen, grid connection, grid access and unbundling, among others, are addressed by the respective EnWG rules, which at their core mirror the framework in place for electricity and gas. While mandatory rules include the cooperation between different hydrogen grid operators, further regulation, including regarding non-discriminatory grid access and transparency, is voluntary. Greater security of imputed costs, especially to network fees, but also to expected returns, is a strong incentive for grid operators to voluntarily submit to the regulation.

The legal basis for establishing the new "hydrogen core grid" has been in the Energy Industry Act since December 2023.

Following the respective rules, the Federal Network Agency (Bundesnetzagentur) is expected to approve the first plan of the hydrogen core grid, which the transmission system operators are submitting, by the end of July 2024. The hydrogen core grid, as a first stage, is planned to be operational by 31 December 2032.

Simplifications in building planning law in 2023, namely in the "Baunutzungsverordnung", BauNVO, have led to a removal of the building plan (Bebauungsplan) requirement for electrolysers.

The recently passed act establishing a register for guarantee of origin of gas (and others), "Herkunftsnachweisregistergesetz", HkNRG, regulates the issuance, transfer and invalidation of "green energy" certificates proving that hydrogen originates from renewable energies. However, there are European efforts to regulate this topic, especially the definition of "green" hydrogen, which may impact the national legislation.

The tendering process for green hydrogen based power plants or storage facilities, which funding options and subsidies rely on, is regulated in the Renewable Energy Act, "Erneuerbare-Energien-Gesetz", EEG 2023.

The EEG also introduced a definition of "green" hydrogen which mainly depends on the manufacturing process – only the use of renewable energies which themselves were not funded under the EEG is permitted. This is to exclude "double" funding of green hydrogen. For reasons of better transparency and of a more detailed specification of the requirements, also in differentiation to other categories of hydrogen (i.e. grey etc.), a regulation of the German Government entered into force in July 2021.

As swift action is imperative given the target dates of the hydrogen strategy, lengthy permitting procedures for green hydrogen plants are to be streamlined. A government draft from 28 June 2023 tackles the procedure according to the Federal Immission Control Act, "Bundesimmissionsschutz-gesetz", BImSchG.

Regarding electrolysers specifically, the government is also revising the 4th Ordinance on Installations which require a Permit, "4. BImSchV", which complements the BImSchG. According to the draft from November 2023, electrolysers up to a certain output, which in general still are subject to approval, are to be excluded from the BImSchG permit requirement. For the other electrolysers, a simplified procedure is to be applied.

Hydrogen pipelines may also fall within the scope of the Wind-Energy-at-Sea Act, "Windenergie-auf-See-Gesetz", WindSeeG and must comply with the respective planning and permitting requirements. The act also includes specific provisions regarding electrolysers using offshore wind. The respective tendering process and possible subsidies are to be regulated by way of an ordinance.

The acceleration and simplifying of building and permitting processes for green hydrogen infrastructure are – indirectly – also addressed in the Liquefied Natural Gas (LNG) Act, "LNG-Beschleunigungsgesetz", LNGG. The law requires LNG plant operators to transition their infrastructure to hydrogen if they want to operate beyond 31st December 2043.

Funding & Support schemes

To fund green hydrogen projects, various funding sources can be tapped into. These exist both at national and EU level and are in line with the respective National Hydrogen Strategy and the EU strategy on hydrogen, the objectives of the REPowerEU Plan, the Green Deal Industrial Plan and the renewable hydrogen targets established in the Renewable Energy Directive. The government estimates that the planned funds for green hydrogen total several billion euros.

In particular:

Of greater relevance will be the funding scheme of the Renewable Energy Act and the tendering process it sets out. In the 2023 update to the Renewable Energy Act's funding regime, "innovative concepts" regarding hydrogen are particularly emphasised. Funding in combination with a tendering process is also planned according to the Wind-Energy-at-Sea Act, and for hydrogen fuelled or hydrogen-ready gas-fired power plants.

All electricity required to produce green hydrogen is completely exempt from grid-charges according to the Energy Financing Act, "Energiefinanzierungs-gesetz", EnFG.

"H2-readiness" is also promoted by funding schemes. The subsidisation of Combined Heat and Power (CHP) plants with an installed electrical output of 10 MW or more depends on whether the plant is H2-ready according to the CHP Act, "Kraft-Wärme-Kopplungsgesetz", KWKG 2023.

Green hydrogen plants fall within the scope of the Greenhouse Gas Emissions Trading Act, "Treibhausgasemissionshandelsgesetz", TEHG and benefit from the EU Emissions Trading System (EU ETS).

Upcoming evolution

German industry players will increase hydrogen production by building the required plants (power-to-gas plants, electrolysis plants, hydrogen liquefiers) over the next few years. Start-ups, SMEs and other companies that manufacture fuel cells, develop electrolysers or run an electrolysis plant have already or are in the process of receiving investment grants. Companies in energy-intensive industries, especially steel and chemical, are to be compensated for additional costs if they use climate-friendly production processes through "carbon contracts for difference" between them and the state.

Government financing also extends to scientific research. The federal government has already set up three hydrogen flagship projects (H2Giga, H2Mare and TransHyDE), four "Kopernikus projects" and an interministerial research campaign ("Hydrogen Technologies 2030"), which bundles various research measures).

Tenders for hydrogen-fuelled or hydrogen-ready gas plants as well as the tendering process for green hydrogen based power plants or storage facilities will offer significant subsidies.

Over 1.800km of hydrogen lines merging into the hydrogen core grid are planned to be built, including through retrofitting and repurposing existing gas pipelines, by 2027/2028. The hydrogen core grid is to be expanded to include a comprehensive framework for an integrated grid – going beyond its core and connecting additional, possibly all, consumers, producers, storage facilities, etc. to the grid. A mandatory comprehensive "grid development plan" for both hydrogen and gas together will be introduced, which transmission system operators must develop jointly and periodically. The goal is to align the sectors, increase coherence in the energy system and push the further integration and ramp-up of electrolysers and hydrogen power plants.

Some recent examples:

01 The transition from fossil fuels to renewables poses a particularly challenging scenario for the steel and chemical industry. Notably, the steel manufacturer ThyssenKrupp is implementing the project “tkH2Steel“ to use hydrogen in its steel manufacturing process by the end of 2026 and thereby contribute to the decarbonisation of the steel value chain.

02 In Bremerhaven, the city is planning to test whether the ferry “Weserfähre” may run on hydrogen in 2024.

03 In February 2024, the city of Görlitz announced that is it developing the very first “hydrogen tram”.

04 A project has been initiated to replace the fossil fuel-based hydrogen used by the Heide oil refinery near Hamburg with carbon-free hydrogen produced from renewable energy sources using an adjacent 30MW electrolysis plant.

05 In 2024, a 60MW electrolysis plant is going to be commissioned on the site of the bp refinery in Lingen. The aim is to produce green hydrogen which will be used to produce fuels and replace 20% of the currently produced fossil fuel-based hydrogen.

06 Through the support of the German firm Siemens, which is developing “P2X” converters, Germany aims to become one of the main exporters of technologies for converting electrical energy into chemical, liquid or gaseous energy sources, such as hydrogen.

07 The German NHS also seeks to import substantial quantities of hydrogen from partner countries. For example, Australia and Germany announced a partnership to assess the feasibility of a hydrogen supply chain and opened expressions of interest to involve the Australian industry.

08 The German government chose 62 German hydrogen projects to receive a total funding of more than €8 billion in the framework of the IPCEI on Hydrogen. The projects cover the entire value chain from hydrogen production, transport and industry application.

The German government chose *62 German hydrogen projects to receive a total funding of more than €8 billion* in the framework of the IPCEI on Hydrogen. The projects cover the entire value chain from hydrogen production, transport and industry application.

Hungary

The Hungarian Government adopted its National Hydrogen Strategy ("Strategy") in May 2021 for the introduction of clean hydrogen technologies to the domestic market and for establishing background infrastructure for the hydrogen industry. The Strategy aims to pave the way for the hydrogen economy and thereby facilitating the achievement of decarbonisation goals and providing an opportunity for Hungary to become an active participant of the European hydrogen sector.

Looking towards the long term, the Strategy prioritizes the development of "green" hydrogen produced with the use of electricity from renewable resources, primarily solar power plants. Nuclear electricity generation in Hungary also provides a carbon-free option for hydrogen production.

The Strategy covers the period up to 2030 but looks ahead to 2050 and focuses on five main areas:

01 significantly increase the production of low-carbon and decentralized hydrogen;

02 decarbonization of industrial consumption through utilizing low-carbon hydrogen to enhance the environmental sustainability of industrial processes and product usage, with a shift to carbon-free hydrogen usage in the longer term.

03 introduce hydrogen in transportation as a clean alternative fuel;

04 establish an electricity and natural gas infrastructure that supports the transition to carbon neutrality by reconstructing existing infrastructures and utilizing intersectoral synergies;

05 capitalize on industrial and economic development opportunities.

Production of large volumes of low-carbon and decentralized carbon-free hydrogen

Within the framework of this objective, the Strategy aims to produce large volumes of low-carbon and carbon-free hydrogen by 2030, with a target of 36,000 tonnes per year. This includes 20,000 tonnes of low-carbon hydrogen and 16,000 tonnes of "green" and other carbon-free types. The Strategy also seeks to transition from high-carbon "grey" hydrogen currently used in industries to low-carbon alternatives, ultimately reducing emissions.

The Strategy expects the domestic electrolysis-based hydrogen production capacity to reach 240 MW by 2030, requiring an investment of approximately EUR 290-370 million. With the installation of these capacities, it is anticipated that green and blue hydrogen production technologies will account for 15% of the total hydrogen production, eventually replacing current fossil fuel-based production by 2050.

Priority measures related to this objective include the reconstruction of existing production methods, promotion of carbon-free alternatives, the establishment of electrolysis centres for pilot projects, creating a European system for hydrogen origin guarantees, and the monitoring of new production technologies through international collaborations.

Industrial decarbonisation

The industrial decarbonization objective focuses on transitioning from carbon-intensive processes to low-carbon and eventually carbon-free hydrogen usage. By 2030, low-carbon hydrogen will be integrated into petrochemical and chemical industries, gradually replacing “grey” hydrogen. Pilot plants producing carbon-free hydrogen are expected to be operational by the 2020s, with industrial usage significantly decarbonized by 2050. Within the framework of this objective, Hungary also plans to establish two hydrogen valleys by 2030, facilitating the transition to clean hydrogen usage in regions with robust industrial activity.

Priority measures to achieve this objective include promoting low-carbon hydrogen production, supporting hydrogen valleys, researching carbon capture solutions, facilitating industrial heat demand, exploring new financial mechanisms, and aligning Strategy with state-owned and stakeholder initiatives.

Green transportation

The Strategy aims to accelerate the shift towards clean traffic methods, particularly through hydrogen usage, while gradually reducing dependence on fossil fuels, primarily in heavy-duty vehicles such as trucks, waste collection vehicles and city buses.

To achieve this objective, priority measures include the establishment of hydrogen refuelling networks, with 20 refuelling stations projected by 2030 and a rapid increase thereafter, promoting fuel cell buses and waste collection vehicles, launching the “Green Truck” project, and exploring hydrogen propulsion in railroad and water transportation post-2030.

Electricity and natural gas support infrastructure

Hungary’s Strategy for electricity and natural gas infrastructure focuses on enhancing sector integration, particularly seasonal energy storage, to facilitate the transition to carbon neutrality. The Strategy also explores Power-To-Gas plants for producing carbon-free hydrogen and examines the feasibility of introducing hydrogen into natural gas networks to connect to the European hydrogen backbone. Future considerations include exploring carbon-free hydrogen for cooling and heating after 2040.

Priority measures in this regard include the establishment of a down-regulation capacity of at least 60 MW and enabling a 2% blending ratio in the natural gas system, with plans for expansion. Pilot projects will prepare the infrastructure for clean hydrogen utilization, promote above-ground storage solutions, and introduce hydrogen-based applications in electricity services.

Taking advantage of industrial and economic development opportunities

Hungary aims to capitalize on industrial and economic development opportunities by leveraging domestic competencies and aligning with industrial trends to boost competitiveness. Key objectives include promoting the production of “blue” hydrogen, expanding electrolyser manufacturing capacity through international partnerships, and integrating renewable energy generation into electricity-related applications. Additionally, the Strategy focuses on turning domestic knowledge into export opportunities, particularly by enhancing component development and supporting small and medium size enterprises in production and manufacturing. Seizing system integration opportunities in transportation-related applications and promoting applications in the defence industry are also priorities.

Priority measures include regarding the objective include the establishment of a domestic manufacturing base, increasing electrolyzers capacity, seizing system integration opportunities, and supporting defence industrial applications within the so-called Zrínyi 2026 plan. These efforts aim to enhance competitiveness and facilitate market penetration while capitalizing on domestic demand and capabilities.

Legal framework overview

Hungary, to date, does not have a comprehensive legal framework for hydrogen projects specifically. However, establishing a supportive regulatory environment for hydrogen projects is outlined as a priority objective in the Strategy. As a first step, minimum provisions have already been introduced in Act XL of 2008 on Natural Gas ("Hungarian Natural Gas Act"), particularly within the framework of the hydrogen regulatory test framework, the connection to transmission and distribution pipelines, as well as metering and accounting.

The Strategy aims to produce large volumes of low-carbon and carbon-free hydrogen by 2030, *with a target of 36,000 tonnes per year.*

As of 1 January 2023, the Hungarian Energy and Public Utility Regulatory Authority ("HEPURA") may operate an energy regulatory test environment, which aims to encourage, inter alia, the injection of hydrogen into functioning natural gas infrastructure and to support the development of pure hydrogen networks on the basis of functioning natural gas infrastructure. This initiative aims to encourage the integration of hydrogen into existing natural gas infrastructure and support the development of clean hydrogen networks. The amendment also allows the HEPURA to operate a testbed for energy regulation to fulfil its tasks related to enforcing energy policy objectives and sustainable development requirements. These tasks include safeguarding and enhancing security of supply, protecting the interests of users, and promoting effective and sustainable competition in the natural gas market, as well as supporting gas-side developments related to hydrogen integration.

Additionally, effective 1 January 2024, the Hungarian Natural Gas Act has been amended to allow for the injection of hydrogen gas up to 2% (n/n). However, the detailed rules are yet to be issued.

Funding & Support schemes

Hungary's Strategy implementation involves six prioritized projects aimed at realizing its primary objectives, supported by professional measures scheduled across three timelines until 2030 with a total of around EUR 345 million envisaged to be allocated as follows:

- Green Truck Programme for making freight traffic greener (around EUR 102 million);
- Green Bus Programme Plus for making public services, concerning transportation at the local level, greener (around EUR 51 million);
- Establishment of hydrogen valleys in Hungary to promote the establishment of interconnected networks of the hydrogen value chains within the given geographical regions (around EUR 38 million);
- Hydrogen Highway Project for creating a foundation for carbon-free hydrogen production, transportation, and energy storage (around EUR 77 million);
- Blue Hydrogen Project for reducing the carbon footprint of industrial hydrogen usage (around EUR 51 million); and
- Research, development, and innovation in service of the establishment of a hydrogen economy (around EUR 26 million).

Upcoming evolution

Three main stages are envisaged for the policy actions:

- 2021 to 2023: Establish the framework, develop the operational plans, including the launch of electrolysis-based hydrogen production and initial comprehensive projects.
- 2024 to 2025: Launch of developments across all strategy pillars, emphasizing the building of domestic manufacturing capacities and the reduction of carbon footprint in various industries.
- 2026 to 2030: Beginning of the partial decarbonization of existing industrial hydrogen usage; acceleration of the transition to clean transportation; and the establishment of the hydrogen refuelling station network and preparation of natural gas infrastructure for clean hydrogen uptake.

Beyond 2030, further advancements in hydrogen technology are anticipated, including expansion into the natural gas network and the cooling-heating sector. This involves monitoring new production technologies, supporting carbon dioxide capture solutions, and promoting hydrogen propulsion in various transportation sectors. Post-2040, preparations for integrating clean hydrogen into gas distribution networks and examining its potential uses in cooling/heating demand satisfaction are planned.

The overarching plan entails that by the year 2030, 12% of the total hydrogen production will be derived from low-carbon sources, commonly referred to as “blue hydrogen”, while an additional 3% would be sourced from green hydrogen, aligning with the priority objective of promoting sustainable and environmental-friendly practices within the hydrogen sector.

Recent examples

As part of Hungary’s commitment to the deployment of hydrogen projects, two green hydrogen plants have already been established: one in Kardoskút and another in Bükkábrány.

The Kardoskút hydrogen plant was initiated by Magyar Földgáztároló Zrt., which is part of the state-owned MVM Group, in collaboration with four universities and a research institute, at a cost of around EUR 6.5 million. Out of this amount, the Hungarian Government allocated around EUR 6.5 million. The hydrogen plant has a nominal capacity of 2.5 MW and consists of an electrolysis system and associated hydrogen gas preparation technology. This system utilizes electricity to split tap water into hydrogen and oxygen, which are then pressurized and stored. Consequently, the produced hydrogen can be sold as a raw material or used as a gas feedstock for natural gas via gas-fired compressors.

This storage method allows excess electricity generated by renewable sources in the electricity system to be stored in large quantities, up to hundreds of megawatts, as hydrogen for extended periods, even months, and recycled as electricity on demand.

The Bükkábrány hydrogen plant was initiated by Bükkábrányi Fotovoltaikus Erőmű Projekt Kft. in cooperation with the University of Szeged. As the hydrogen plant has been established alongside one of the country’s largest solar parks, its primary objective is to regulate overproduction cycles of the 22 MW solar power plant through hydrogen production, while also serving as a platform for scientific monitoring.

As another testament to Hungary’s dedication to hydrogen utilization, after nearly three years of installation, the first hydrogen filling station serving only green hydrogen was handed over to the public on 19 January 2024. The station, which is a joint project between HUMDA (Magyar Mobilitás-fejlesztési Ügynökség Zrt.) and Linde Gas Hungary, is capable of refuelling both buses and trucks at 350 bar and cars at 700 bar, allowing the tanks of up to two buses to be fully refilled sequentially before the compressor needs to re-pressurize the buffer tanks. Concurrently with the hydrogen filling station’s inauguration, a Caetano H2.City Gold hydrogen fuel cell bus was also commissioned.

Hungary’s Strategy implementation involves six prioritized projects aimed at realizing its primary objectives, supported by professional measures scheduled across three timelines until 2030 with a total of around *EUR 345 million envisaged to be allocated.*

India

India has set itself an ambitious target of becoming energy independent by 2047 and achieving net zero emissions by 2070.

This objective underlines India's flagship green hydrogen program, titled as the National Green Hydrogen Mission, 2023 (National Green Hydrogen Mission). This was introduced by the Ministry of New and Renewable Energy, Government of India (MNRE), which focuses on capacity building to produce at least 5 million metric tonnes (MMT) of green hydrogen per annum by 2030, with a potential increase of up to 10 MMT. In India, it is estimated that 5 MMT hydrogen is consumed each year by various industries. Therefore, green hydrogen production has a ready market which can aim to replace fossil fuel-based industrial consumption to a carbon neutral system in the near future.

India already boasts one of the largest renewable energy footprints in the world, which sets it at a significant advantage in terms of competitive input cost for production of green hydrogen.

With the global electrolysers' market set to add an estimated 200GW of capacity by 2030, and as India *estimates capacity addition of 125GW of renewable energy by 2030,* India's cost of production and cost of capital for green hydrogen will be one of the lowest in the world.

INR 197 billion

Estimated outlay

Legal framework overview

While the regulatory regime for green hydrogen is still at a nascent stage, the National Green Hydrogen Mission is the flagship vision document which looks at the development of green hydrogen ecosystem, and the roles that multiple Indian Government ministries will need to play to achieve this.Key highlights of the National Green Hydrogen Mission include:

Key highlights of the National Green Hydrogen Mission include:

- The MNRE will formulate schemes for financial incentives to support production, utilisation and development of green hydrogen;
- The Ministry of Power (MOP) will implement policies and regulations to ensure delivery of renewable power to green hydrogen facilities, for reducing the cost of production;
- The Ministry of Petroleum and Natural Gas will facilitate consumption of green hydrogen in refineries and city gas distribution; and
- Development of an online portal setting out the relevant legislations and standards and facilitating time bound approvals for hydrogen production, storage and use.

Legal framework overview (cont)

The MOP has introduced the Green Hydrogen Policy, 2022 (Green Hydrogen Policy), which most significantly states that renewable energy consumed for production of green hydrogen will count towards the renewable purchase obligations of the obligated entity.

The Energy Conservation (Amendment) Act, 2022, is another step in the same direction of obligating consumption from non-fossil sources, as it places a minimum consumption obligation on designated consumers.

In addition to these, various states in India (such as Odisha and Madhya Pradesh) have already included development of green hydrogen as part of their renewable energy policies. This allows them to build synergies with the enabling infrastructure, as well as lay down incentives for the green hydrogen industry. Recently, states such as Rajasthan and Andhra Pradesh have produced dedicated green hydrogen policies.

One of the keys to development of the green hydrogen industry in India will be the evolution of the supporting legislations (especially the financial legislations and regulations). To that end, the Securities and Exchange Board of India (Issue and Listing of Non Convertible Securities) Regulations, 2021, has included the concept of 'green debt security'. This facilitates access to public markets for the development of green infrastructure. While at present, the ambit of green debt security does not necessarily include green hydrogen projects, in our view, this will be called out specifically in the near future.

Funding & Support schemes

The Indian Government has an established model for funding of 'sunrise sectors' especially in public infrastructure. One of the key models is the competitive bidding route through viability gap funding (a Central financial assistance mechanism), in the form of capital subsidy. This was the main stimulus to the initial boom of the renewable energy sector in India.

The National Green Hydrogen Mission seeks to de-risk private investment from various sources and provide an estimated outlay of INR 197 billion. This includes an outlay of INR 175 billion for SIGHT programme (see below), INR 4.6 billion for pilot projects, INR 4 billion for research and development and INR 3.8 billion towards other mission components. The MNRE has been entrusted to formulate schemes and guidelines for implementation of these components.

In 2022, the Indian Government issued the Framework for Sovereign Green Bonds (Framework), in order to tap the market borrowings for mobilising resources for green infrastructure projects. The Framework has been designed as per the International Capital Market Association (ICMA) Green Bond Principles, 2021, with four key components: (i) use of proceeds; (ii) project evaluation and selection; (iii) management of proceeds; and (iv) reporting. The Framework has been designed to support India's goal of having 500GW non-fossil energy capacity by 2030.

The Indian Government has an *established model for funding* of sunrise sectors especially in public infrastructure.

Funding & Support schemes (cont)

The Framework states that all eligible green expenditures will be in the form of investment, subsidies, grants-in-aid, or tax foregone (or a combination of some or all of these). They can also be in the form of select operational expenditures, research and development, or expenditures in public sector projects that help in reducing the carbon intensity of the economy and enable India to meet its Sustainable Development Goals (SDGs).For the purposes of the National Green Hydrogen Mission and the policies and programmes issued under it, the MNRE, has strict limits on what it considers 'green'. In August 2023, it notified that hydrogen produced will only be considered 'green' if the greenhouse gas emissions arising from the production of such hydrogen (be it through electrolysis or the conversion of biomass) is no greater than 2 kilograms of carbon dioxide equivalent per kilogram of hydrogen produced, calculated as an average over the preceding 12 months.

The Strategic Interventions for Green Hydrogen Transition (SIGHT) has been contemplated under the National Green Hydrogen Mission. Initially, two distinct financial incentive mechanisms are envisaged: (i) support for domestic manufacturing of electrolysers; and (ii) incentives on production of green hydrogen.

As a part of the SIGHT programme, in July 2023, the MNRE issued tenders for 450,000 metric tonnes of green hydrogen production. The Solar Energy Corporation of India (SECI) has issued tenders for 1,500 MW of electrolyser manufacturing capacity under SIGHT. Under the same programme, projects have been awarded for the production of green hydrogen to several companies for varying capacities and prices, including Reliance Industries, Greenko, ACME, Welspun New Energy, United Phosphorous Limited and Bharat Petroleum. Similarly, projects for the manufacturing of electrolysers have also been awarded to bidders such as John Cockerill Green Hydrogen Solutions, Jindal India, and Adani New Industries, amongst others.

The Indian Government has included the production of electrolysers and green hydrogen within the Production Linked Incentive Scheme (PLI Scheme) – a scheme for boosting domestic manufacturing under the Make in India vision. Under the PLI Scheme, budgetary outlays of INR 130.5 billion and INR 4.4 billion have been provided towards the production of green hydrogen and the manufacturing of electrolysers, respectively.

The Green Hydrogen Policy, in addition, sets out the following incentives:

- Waiver of inter-state electricity transmission charges for producers of green hydrogen for 25 years (for projects commissioned before 2030);
- Priority-based electrical connectivity to be provided to the green hydrogen industry;
- Land in renewable energy parks to be provided for manufacturing of green hydrogen; and
- Establishment of manufacturing zones dedicated to green hydrogen production.

Some of these aspects are within the legislative domain of states (and not the Union) and so implementing these policy decisions will depend on corresponding regulatory/policy actions by the various states, which should come forth soon.

Recently, in February 2024, the MNRE has also released guidelines for the implementation of pilot projects in the mobility, steel and shipping sectors under the National Green Hydrogen Mission.

Up-coming evolution

India's green hydrogen industry is placed at the cusp of the green transition boom, with ever-developing renewable energy capacity addition, and the evolving policy landscape designed to incentivise green hydrogen production. The development of support infrastructure as well as ready offtake market in other industries will operate as key accelerators to India's energy transition goals, establishing India as a leading green hydrogen producer.

India's green hydrogen industry is placed at the *cusp of the green transition boom,* with ever developing renewable energy capacity addition and the evolving policy landscape designed to incentivize green hydrogen production.

The National Green Hydrogen Mission lays down a vision for fossil based industries to transition into net zero emission in the following manner:

- **Steel –** carbon credits and imposition of market barriers on carbon steel; blending proportion of non-carbon steel to be proportionately increased as cost of production of green hydrogen reduces.
- **Transport –** introduction of hydrogen highways to facilitate heavy-duty and long-haul vehicles' transition to green hydrogen as fuel; refueling stations to be developed.
- **Shipping –** at least two ships will be retrofit to run on green hydrogen by 2027.
- **Green Hydrogen Hubs –** in order to reduce transportation and logistical barriers, cluster-based production and utilization model to be developed in initial years.

Some recent examples

01 On 1 March 2024, Larsen & Toubro commissioned its first domestically manufactured electrolyser in Hazira, Gujarat. The electrolyser is capable of producing 200 Nm3/Hr of hydrogen, with a rated power capacity of 1 MW, expandable to 2 MW.

02 On 25 September 2023, Indian Oil Corporation, in collaboration with Tata Motors, unveiled India's first green hydrogen-powered bus. More of these buses are expected to be put into operation in the near future.

03 NTPC Green Energy Limited and the Syama Prasad Mookerjee Port signed an MoU for the development of a green hydrogen hub at the port located in Kolkata.

This chapter was provided by Bird & Bird Plus firm AZB & Partners and authored by Qais Jamal, Pranjal Bhattacharya, Upasana Soni and Shreya Mukherjee.

AZB & PARTNERS
ADVOCATES & SOLICITORS

Italy

According to the Integrated National Energy and Climate Plan, green hydrogen is considered to have a key role in reaching the target of reducing Italian greenhouse gas emissions by at least 30% (40% at European level) by 2030, compared to 1990.

The 2021 Italian National Plan for Recovery and Resilience, named “Italia Domani”, *establishes a series of practical measures to overcome the legal uncertainty* surrounding the development of green hydrogen projects.

Legal framework overview

Hydrogen was recognised by the Italian government as a renewable energy source in 2016. However, the Italian legal framework covering production, exploitation and connection of hydrogen is still imprecise, posing challenges for industrial proponents and hydrogen producers.

No legal distinction exists between authorisation for fossil fuel-based hydrogen production and green hydrogen from electrolysis, resulting in the same level of restrictions being imposed. Additionally, local public authorities may require different requirements for land use too.

The discrepancies between the legal areas may lead to uncertainty when developing and implementing hydrogen projects. Clear legislation is needed to define the framework for authorisation processes and incentive systems.

However, some progress has been made recently and certain decrees have already been adopted by the Italian government with the aim to speed up the development of the green hydrogen projects.

Funding & Support schemes

Hydrogen production by electrolysis is still costly, but equipment developers and suppliers are currently seeking to adapt their technologies to provide affordable green hydrogen. With this in mind, national and European financial support schemes have either already been implemented or are in the process of being defined.

Investments required to achieve the Italian new green deal objectives should reach the quota of €50 billion up to 2030. This far, the 2021 Italian National Plan for Recovery and Resilience provides allocation of €1 billion to achieve the purported hydrogen-linked reforms.

Up-coming evolution

The Italian Government is still drafting guidelines for a National Hydrogen Strategy to develop the Italian hydrogen industry, to enhance its attractiveness for producers and investors and to strengthen the Italian industry in the European hydrogen market.

The 2021 Italian National Plan for Recovery and Resilience, named “Italia Domani”, establishes a series of practical measures to overcome the legal uncertainty surrounding the development of green hydrogen projects, which shall be implemented throughout the five years’ period 2021-2026.

Investments required to achieve the Italian new green deal objectives should reach the *quota of €50 billion up to 2030*.

In particular, the Italian government planned to enact two comprehensive legal frameworks, the first one regulating, among others:

(i) safety matters in the fields of production, transportation, storage, and application of hydrogen;

(ii) an accelerated authorization procedure for the building and management of small-sized hydrogen plants;

(iii) regulation of participation of hydrogen plants to grid infrastructures;

(iv) issuance of guarantees of origin for renewable hydrogen;

(v) coordination of the 10-year development plan to be implemented by the national and the other European TSOs in order to develop common standards for the transport of hydrogen through existing or dedicated pipelines.

A second reform will include tax measures to incentivize the production and use of green hydrogen and implement the EU Directive 2018/2001 (RED II Directive). The purpose of this overall reform is to allow the use of hydrogen in rail and road transportation and in hard-to-abate industrial applications, then to support R&D hydrogen-focused activities and the creation of hydrogen valleys.

In this regard, there have been some recent updates. In September 2022, a decree was issued to regulate certain favour provisions for the production of green hydrogen plants using renewable energy sources for electrolysis.

Furthermore, in October 2022, a decree was issued regarding the creation of hydrogen valleys in abandoned industrial areas and the utilization of hydrogen in hard-to-abate sector.

In addition, the so-called Decreto Semplificazioni (dated 14 February 2023) has provided a faster procedure for the development of green hydrogen, referring exclusively to the state the EIA examination of projects for plants that produce energy from this source.

The new European Renewable Energy Directive No. 2023/2413, known as ‘RED III’, provides that “renewable fuels of non-biological origin (RFNBOs)”, obtained by combining green hydrogen and carbon dioxide, must account for at least 1% of the transport fuel mix by 2030 and that, by the same date, 42% of all hydrogen used in European industry shall be produced using renewable energy. This share shall rise to 60% by 2035. Italy shall implement the RED III directive within 18 months from its enactment, occurred on 20 November 2023.

Italian National Plan for Recovery and Resilience (“NRRP”)

NRRP provided €50 million, to the so called “Flagship Projects” aimed at establishing hydrogen valleys, considered particularly significant for a given area, and €450 million, to set up hydrogen production plants in abandoned industrial areas. The goal is to 52 hydrogen valleys, 10 of which within 2026. In line with this, 6 memorandums of understanding have been entered into between the State and the regions. The majority of the projects shall be located in the South, in Sicily and Sardinia.

One of these projects located in Apulia region, is undergoing construction.

Morocco

Morocco's objective is to create an economic and industrial sector around green hydrogen. This is, to consolidate its energy transition by contributing to the reduction of gas emissions and supporting the decarbonisation of partner countries.

The impetus is built on several factors, such as the potential renewable energy resources in Morocco offers as well as the expertise acquired by the Kingdom over the last 10 years. This led the King of Morocco, Mohamed VI, to give his instructions to develop a "Moroccan offer" in green hydrogen. Moreover, some Moroccan regions benefit from both solar and wind deposits which allow the continuous production of electricity and can enable Morocco to become an exporter of hydrogen, according to the World Energy Council.

€90 billion

Green hydrogen investments by 2050

Legal framework overview

There is not yet a specific legal and regulatory framework for the use of Hydrogen in Morocco. Despite this, Morocco was the first African and Arab country to establish its green hydrogen roadmap on the development of the production of green hydrogen.

Therefore, the law n°13-09 on renewable energies, as amended by law n°58-15, applies to green hydrogen. This law establishes a legal framework for the construction and operation of electric energy production facilities from renewable energy sources, specifying the general principles they must follow and the applicable legal regime including sales and exports.

In addition, the Government issued the "Moroccan Offer" circular at the beginning of March 2024, which sets out its plan for the development of the green hydrogen sector in Morocco.

The circular maps out the scope of the plan, the real estate to be allocated to green hydrogen investments, the infrastructure to be developed, the incentive measures, the investor selection procedure, and the procedure to enter into an agreement with the Moroccan State.

These incentives will benefit integrated projects that span the entirety of the supply chain to produce green hydrogen and its derivative products, from the production of renewable energy to the transformation of green hydrogen into derivative products and the associated logistics.

If investors are only developing specific segments of the production line, they are not eligible but can still apply for benefits offered by other national investment schemes, such as the Moroccan Investment Charter. The investors who are beneficiaries under the Moroccan Offer scheme can develop products for the Moroccan domestic market or for export purposes.

Any potential investor shall submit its investment offer to the Moroccan Agency for Solar Energy (MASEN), which shall review the offer and assess the investor's resources and experience. If an offer is accepted, negotiations with the State may commence for the allocation of land and for preliminary feasibility studies.

Following these initial stages, the State will invite the successful investor to enter into an agreement for Front End Engineering and Design (FEED) Studies, outlining various aspects including land allocation, stakeholder relations and the conditions and deadline for the State's final investment decision.

Legal framework overview (cont)

If the FEED Studies results are positive, the State and the Investor shall enter into a framework investment agreement, which will have to be approved by the Green Hydrogen Investment Committee.

Throughout the approval process, MASEN will have a broader role in assisting investors, including sharing information relating to the Green Hydrogen Moroccan Offer, sharing relevant information with companies, facilitating formalities for investors, and introducing investors to relevant Moroccan stakeholders.

Up-coming evolution

In the Moroccan Roadmap for Green Hydrogen, Morocco wishes to position itself as a strategic partner of European countries who are involved in the decarbonation process by becoming an exporter of hydrogen.

According to the "Moroccan Offer" circular, the Government has ordered several studies to achieve this goal, including those already underway: (i) for large port infrastructure projects, (ii) for the development of national hydrogen and gas pipeline networks, and (iii) for the storage of green hydrogen by way of salt caverns.

It has also stated that 300,000 hectares of publicly owned land will initially be made available, with each investor able to occupy between 10,000 and 30,000 hectares per project. Further down the line, the State is planning to make available 1,000,000 hectares of publicly owned land.

In a recent interview the Minister for Energy Transition, Laila Benali, reiterated the importance of private investment for the Kingdom when commenting on the "Moroccan Offer", with the State needing to triple its annual investment in renewable energies.

In January 2024 Italy allocated funds for a feasibility study on the "Green Corridor". The project aims to streamline the transportation of green hydrogen from Morocco to the port of Trieste, which would then be redistributed to Central and Eastern Europe via the Transalpine Pipeline.

It is estimated that the green hydrogen industry in Morocco could face a demand between 13.9 terawatt hours (TWh) and 30.1 TWh in 2030, which could reach between 67.9 TWh and 132.8 TWh in 2040 and 153.9 TWh and 307.1 TWh in 2050.

In 2030, most of the demand will be for raw material, likely from exports and industry, although lower demand may emerge in the transport sector.

In 2040, demand is expected to increase in the transport sector due to increased use of synthetic fuels as they become more competitive with conventional fuels. Thus by 2050, demand appears to be largely split between its use as a feedstock in industry, in transport and the essential share in exports.

The production of green hydrogen in Morocco will help accelerate the decarbonation of its industry and strengthen the security of its supply of energy and non-energy inputs.

Funding & Support schemes

The development of the green hydrogen industry in Morocco would require a total investment of MAD140 billion (approx. €13 billion) to MAD1,000 billion (approx. €90 billion) between 2020 and 2050 to meet the potential demand by 2050.

To enhance investments, the Moroccan roadmap for hydrogen foresees that direct support may be provided in the form of public-private partnerships, direct funding through bilateral or multilateral partnerships, and preferential tax treatment.

The roadmap also states that some tools and actions will be aimed at securing financing for the industry such as investment guarantees, untied financial loan guarantees, and export credit guarantees.

Some recent examples

01 In 2022, Total Eren announced a MAD100 billion (approx. €9.2 billion) megaproject for the production of green hydrogen and ammonia in the Guelmim-Oued Noun region. It would harness both solar and wind power to generate over 10 gigawatts (GW) of energy. The project received approval from the Unified Regional Investment Commission (CRUI) on 25 November 2021. Already, topographical studies covering an area of over 170,000 hectares, an analysis of renewable resources, and preliminary designs were completed by January 2022. The project is expected to be commissioned in 2027.

02 In December 2022, the state-owned company OCP (Office Chérifien des Phosphates) launched a MAD130 billion (approx. €13 billion) investment plan to shift towards the manufacture of green fertilisers, renewable energy production and seawater desalination. This would allow the OCP to become a major player in the energy and desalination markets.

03 Within the Morocco-German partnership, Germany provided a €38 million grant to develop an ambitious project to produce green hydrogen from renewable sources.

04 This project, the first of its kind in Morocco and Africa, involves the construction of a hybrid photovoltaic and wind power plant to supply a green hydrogen plant with an electrolysis capacity of approximately 100 megawatts (MW). The site is expected to be put into commercial operation between 2024 and 2025.

05 In April 2023, the Chinese energy engineering procurement and construction contractor Energy China International Construction Group signed a memorandum of understanding with Saudi conglomerate Ajlan Bros and Morocco's Gaia Energy to build a green hydrogen project in Morocco.

06 The Project would be a green ammonia plant with future output of 1.4 million tonnes per annum — produced from approximately 320,000 tonnes of green hydrogen — with a 2GW photovoltaics solar plant as well as a 4GW wind power project.

07 In January 2024, Moroccan electricity and water utility ONEE signed a deal with renewable energy companies Nareva and GE Vernova to conduct a feasibility study, replacing fuel with green hydrogen to operate a 99MW power plant located in Laayoune.

Netherlands

The Netherlands is a fast mover on the hydrogen market. According to the Dutch Government's Strategy on Hydrogen, green hydrogen is essential for achieving the national energy transition goals and maintaining energy-intensive industries.

The Netherlands set up the National Hydrogen Program which originates from the overall Dutch Climate Agreement. Central to the Government's vision on hydrogen is the message that CO□-free hydrogen is a necessary link in a sustainable energy system. They aim to have a Hydrogen production capacity of 500MW by 2025, and 3-4GW by 2030.

The Netherlands is the *first country* to issue green hydrogen certificates.

A letter by the Dutch Minister of Climate mentions that it considers the realisation of a national transport network for hydrogen is of great importance for the development of a sustainable hydrogen chain and thus the sustainability of Dutch energy and raw material consumption.

Legal framework overview

The Dutch Gas Act does (currently) not foresee in regulation of Hydrogen. There is currently a strong demand from the market for clarity on the regulatory framework. The letter mentioned above sets out the regulation on the market structure for Hydrogen, which is a first step. A division is made between the production of Hydrogen by means of electrolysis which the Minister clearly thinks it is a task to be performed by the market itself rather than that he sees it as a government task. Only where the market fails to develop such facilities, grid operators will be allowed to develop these.

There is a similarity between the structure of the gas and electricity grid and the envisaged set up for Hydrogen. The national Hydrogen infrastructure shall be developed and operated by Hynetwork Services (HNS) a subsidiary of Gasunie, for which the existing gas network will be re-used.

As with the gas grid, the national infrastructure shall be operated exclusively by the grid operator (HNS), and it is the idea that local Hydrogen networks developed by private parties can apply for an exemption by ACM hence not falling under the HNS regime.

The Government has earmarked a subsidy up to €750 million for the development of the transmission grid. The Minister indicates that a phased roll out of the development is foreseen based on the needs of the market. The goal of the rollout plan is to create a transmission grid that runs into the major industrial clusters, connecting them, providing access to storage facilities and connects the Netherlands with neighbouring countries whereby the development hydrogen supply and demand and the demand for transportation capacity the system perspective and the international demand shall be decisive.

Green Hydrogen certificates

The Netherlands is the first country to issue certificates for green Hydrogen. Vertogas B.V. the company that also issues Guarantees of Origin for green gas has developed a certification system appropriate for green Hydrogen and now also issues certificates for green Hydrogen. Now the Green Hydrogen Certificates are only for the NL as we are waiting for an EU system.

The Dutch Government aims to have a Hydrogen production capacity of *500MW by 2025, and 3-4GW by 2030.*

Subsidies and grants

Subsidy and financial instruments available at national and European level for hydrogen projects are:

- the scheme Scaling up Fully Renewable Hydrogen Production via Electrolysis (OWE)
- SDE++ (also for electrolysis, see VOLTH2 project)
- Green powerNL
- IPCEI; and
- EU Innovation Fund.

Green Hydrogen certificates

The Netherlands is the first country to issue certificates for green Hydrogen. Vertogas B.V. the company that also issues Guarantees of Origin for green gas has developed a certification system appropriate for green Hydrogen and now also issues certificates for green Hydrogen. Now the Green Hydrogen Certificates are only for the NL as we are waiting for an EU system.

There are currently around *165 projects for green Hydrogen* under development in the Netherlands

Up-coming evolution

According to the Dutch National Climate Agreement, the ambition is to scale-up electrolysis to 500MW between 2022 and 2025; and 3GW to 4GW between 2026 and 2030. In the national “Energy and Climate Plan 2021-2030”, the program for hydrogen is further explained. Amongst others, price reductions for electrolysis and renewable energy are needed for mass production of hydrogen, and it must be assessed how electrolysis installations can contribute to the incorporation of renewable energy in the energy system and what consequences this will have for the infrastructure.

A phased roll out of a full operational market and regulatory framework is foreseen whereby the early development phase runs from 2025 until 2027, the second phase from 2028 to 2029 and a third phase as from 2030. During the early development phase, it is anticipated that no EU framework will be in place and the Netherlands will adapt a hybrid regulated third party access system. During the second phase EU law will have to be adopted and implemented in national laws in the Member States after which in the third phase full a Dutch law framework will be operational with regulated third-party access and tariffs and rules set by ACM, the regulator.

There are currently around 165 projects for green Hydrogen under development in the Netherlands which shows the appetite of private parties for green Hydrogen.

Portugal

Portugal has very competitive conditions for the installation of a green hydrogen production industry, both for domestic use and for export, due to the countries' low costs of electricity production and abundant solar resources.

In order to take advantage of these benefits, the Portuguese Government has been active and committed to the incorporation of green hydrogen into the economy, which is primarily reflected in the approval of the recent measures to increase the production of biomethane and renewable hydrogen. Also the deployment of innovative hydrogen-based and cost-competitive electricity projects in industrial sectors and, at the same time, aimed at facilitating permit granting procedures, as a precondition for accelerating renewable projects.

These measures were approved in the framework of the Roadmap towards Carbon Neutrality, through which Portugal has committed itself to ensuring, by 2050, the decarbonisation of the Natural Gas Network and to making the production of green hydrogen one of the priorities of the country's energy and industrial policy.

Legal framework overview

Although the hydrogen market is still at an early stage of development, with no clear and complete legal framework that regulates all activities in the sector yet, the Portuguese Government has already taken important steps in creating a regulatory framework that provides some stability to the development of projects and stimulates the demand for green hydrogen.

The Government has made a very relevant effort to amend the existing legislation aiming to increase not only the production, but all businesses associated to the green hydrogen sector, which necessarily need stability to be developed.

It was in this setting that the legislator enshrined new solutions in the revised law on the organisation and functioning of the (new and renamed) National Gas System. It currently foresees a simplified procedure of prior registration for access to the activity of production of renewable gases, which may be considered approved within 30 days.

This fundamental diploma, amended in 2020, also created the regulatory conditions for the decarbonisation of the Natural Gas Network, setting the technical and regulatory requirements for the injection of hydrogen (and methane) into the transport and distribution networks. It is estimated that the national public network is almost ready to receive 20% of direct injection of green hydrogen without major investments.

More recently, in line with the measures recommended by the European Commission to simplify and reduce the time limits for licensing procedures, the Government has adopted several measures to accelerate the entry into operation of projects aimed at the production of hydrogen by electrolysis from water. In fact, for a transitional period of two years (until 14th April 2024, if the term is not extended), these projects are now exempted from pollution prevention control and subjected to a faster proceeding of prior control for the respective urban licensing.

Legal framework overview (cont)

In addition, projects now have a set of more favourable conditions created by a legal framework which prescribes that: .

01 Since 18th April 2022, gas retailers whose supply exceeds 2000 GWh per year are obliged to incorporate in their supply a percentage of not less than 1% of biomethane or hydrogen by electrolysis from water in volume of natural gas supplied;

02 This year, the Government will launch a centralised purchase system for biomethane and hydrogen produced from water electrolysis through an auction, which is actually a mechanism to support the production of gases of renewable origin, as it enables the acquisition of these gases by the wholesale supplier of last resort (CURg);

03 Hydrogen produced from renewable energy sources is taken into account in the minimum shares for use of energy from renewable sources in gross final consumption of energy, which the Government recently set at 49% in 2030;

04 The system for issuing guarantees of origin is now extended to gases from renewable sources, giving the right for producers to request REN the issue and trade of such certificates.

This does not imply, however, that renewable hydrogen projects are exempted from compliance with a set of diplomas relating to environmental and industry matters that imply obtaining several opinions and authorisations from the Portuguese Environmental Agency (“APA”) and the Agency for Innovation, depending on the characteristics of the project and the environmental impacts that it might produce.

In June of 2023, the EU Commission has adopted two delegated acts to supplement the Renewable Energy Directive (2018). The acts establish the criteria under which hydrogen or fuel produced from electricity can qualify as renewable and the methodology for calculating life-cycle greenhouse gas emissions for renewable fuels of non-biological origins, which is essential to assess whether they comply with EU’s thresholds. These rules bring certainty to the investors, allowing the market players across Europe and the ones interested in establishing commercial relations in this field to be on the same page.

Finally, although it is anticipated that the European commission will very soon establish more specific criteria for the implementation of hydrogen self-consumption projects, it is relevant to note that these kind of projects were already enabled by the relevant applicable legislation, thus opening doors within the sector of gases of renewable origin, to what, nowadays, is a dynamic and growing reality in electricity.

Portugal also *offers investors incentives* to promote and attract investment in the hydrogen sector.

Funding & Support schemes

Despite the legislation that has been adopted to regulate the hydrogen sector, both at European and national level, hydrogen market is still at an early stage of development, with no developed markets or pricing system to guide the decisions of economic agents. In parallel, the challenges associated with the economic viability of the projects are also known. These derive largely from the scarcity and high cost of the electrolysers needed to produce green hydrogen from water electrolysis and the lack of scale in the supply and demand side markets.

This is why, although hydrogen projects are mainly financed by private investors, the European Union has put in place several mechanisms of support for investment and production. The most promising is the recently announced European Hydrogen Bank ("EHB"), that aims to support investments to connect hydrogen supply and demand during its scale-up phase and to enable cost-efficient and predictable purchase and sales of renewable hydrogen from within and outside the European Union. On top of that, the Clean Hydrogen Partnership, a public private partnership supporting research and innovation activities in hydrogen technologies in Europe, has already opened its Call for Proposals for 2024, which seeks to support projects focused on the development of hydrogen technologies across the whole hydrogen value chain. €113.5 million will be made available in this domain.

Portugal also offers investors incentives to promote and attract investment in the hydrogen sector, most of which may be granted under the Recovery and Resilience Plan (Plano de Resiliência e Recuperação, PRR), from 2021 to 2026. Portugal 2020 and Portugal 2030 – both programs established through two agreements with the European Union, covering the period from 2014 to 2027 – or through other programs and mechanisms that the Government may decide to launch, within the possibility not expressly foreseen in the decree of law applicable to the National Gas System (and that may include different tariff treatment and/or other production support mechanisms).

In this framework, it is worth highlighting the way the Portuguese government designed the PRR, placing the production of green hydrogen as one of the priorities of the country's energy and industrial policy. It plans to allocate more than €4 thousand million from the RRP to the climate transition agenda, in which projects related to innovation, energy transition, export capacity and creation of skilled jobs are at the forefront of eligibility. Besides meeting the most of these markers, green hydrogen industrial projects are a priority in this context and, consequently, there are already €400 million allocated to be injected on these, beyond the indirect benefits of programs with a larger scope that might also be taken advantage of. It is also worth mentioning that the support granted under this program consists, in most cases, of non-refundable subsidies.

In what concerns direct public subsidies planned in the short and medium term, the national competent authority (IAPMEI) has already launched two competitive procedures aimed at financing the above-mentioned mobilisation agendas and the "green agendas", in which hydrogen projects raised funds of €1 billion. Under the first competitive procedure, €102 million were allocated, for a total of €229 million of investment, in 25 new projects representing an installed capacity of 106 megawatts (MW) and which are already in motion.

The second procedure, with an allocation of €83 million , received a total of 39 applications for green hydrogen projects, nine for biomethane and one to produce both renewable gases. In total, the applications submitted aim to add 443 MW of production capacity, corresponding to a requested funding amount of €353 million for a total investment of €906 million.

The Minister of the Environment and Climate Action announced that there will be a new competitive procedure to promote hydrogen and renewable gases, in the context of REPowerEU, that is planned to allocate €70 million to the selected projects.

Further, the Minister of the Environment and Climate Action will launch in 2024 the first auction intended to provide financial support for producers of gases from renewable sources over a ten year period, setting the price they will receive for injecting renewable gases into the grid. This auction, which was initially scheduled to be launched in the second half of 2023, now follows the launch of the hydrogen production auction which opened on 23 November 2023. This aimed at accelerating the production of ten million tons of hydrogen by 2030 in the European Union, and under which 800 million euros in subsidies are made available to renewable hydrogen producers with projects in the European Economic Area (EEA).

Portugal has committed itself to ensuring, by 2050, *the decarbonization of the Natural Gas Network* and to making the production of green hydrogen one of the priorities of the country's energy and industrial policy.

Upcoming evolution

Portugal aims for a 49% share of renewables in final energy use by 2030, in all sectors, not just electricity. The goal is 5.5 GW of green hydrogen capacity by the end of the decade to promote the decarbonisation of heating and transport. This goal, set after the revision of the initial plan, is more than twice as high as the previous one, underlining Portugal's commitment regarding green hydrogen and showcases that climate and energy action is a first-hand priority.

There's currently five hydrogen valley projects in progress in Portugal, as the country holds a great position in this domain, surpassed only by some of its European counterparts. Located in Sines, the most ambitious one already has investments of €10,6 thousand million under way and gathers the potential to reach €22 thousand million by 2035. The project focuses on the production of renewable gases and green ammonia for exportation. Besides Sines, in which there are located two of these, the projects are scattered across the country – Lisbon, Leiria and Aveiro.

It is also important to mention the H2med project launched by France, Spain and Portugal, which later assembled the firm support of Germany, to interconnect the hydrogen networks of the Iberian Peninsula to Northwest Europe. This green energy corridor connecting these three countries with the European energy network would allow Europe to be supplied with affordable green hydrogen by 2030. This project, in the end of 2023, was catalogued as a Project of Common Interest (PCI), being a key infrastructure project aimed at completing the European internal energy market and help the EU to achieve its energy and climate objectives. In addition, the Portuguese Government announced the Program for Climate Action and Sustainability – Sustainable 2030 in October, which is going to allow Portugal to invest about €3,1 thousand million from the EU Cohesion Fund, to cope with the challenges posed by the energetic and climate transition, aiming to reach carbon neutrality by 2050.

This chapter was provided by Bird & Bird Plus firm Sérvulo & Associados and authored by Mark Bobela-Mota Kirkby and Catarina Pita Soares.

Serbia

Serbia's legal framework for the green hydrogen currently encompasses two laws: Law on Energy, ("Official Gazette of the RS", no.145/2014, with the subsequent amendments, "Law on Energy"), and the Law on Use of Renewable Energy Sources ("Official Gazette of the RS", no. 40/2021, with the subsequent amendments, "Law on Use of RES").

Production of hydrogen is regulated as an energy activity which may be performed by a public company, private company i.e., other legal entity, and entrepreneur having a licence for performing the energy activity. Furthermore, the use of renewable hydrogen is classified as a renewable energy source. Finally, the Law on Use of RES declares that to increase the use of energy from renewable sources, technologies in early development that use the new renewable sources, such as renewable hydrogen, can be incentivised. Renewable hydrogen can be used in the field of thermal energy, traffic, and natural gas in accordance with the provisions of the Law on Use of RES and the Law on Energy.

It is noteworthy that the group of experts prepared draft Hydrogen Strategy ("draft Strategy") with the main aim to stress the need for an integrated approach in steering the ongoing and future development of Serbia's energy sector towards the use of hydrogen. The draft Strategy is not the source of law. However, it is important since it defines specific objectives to be achieved in the field of utilization of hydrogen.

The first is legislation, the second is strengthening human resources and capacities for research and development of new technologies, followed by decarbonization of the energy, transport, industry, and agriculture sectors and hydrogen production in new facilities.

Additionally, draft Strategy contains the recommendations for the amendments of the legislation relevant for the hydrogen production. For example, the draft Strategy suggests: (i) adopting the appropriate standards for the quality of hydrogen and gas, (ii) adopting a methodology for monitoring and certifying the production of renewable hydrogen between the countries of the Energy Community and the EU, (iii) defining the incentive environment for the use of hydrogen (tariffs, tax and customs benefits, favourable credit lines, etc.).

Having said the above and considering that the Serbian Government is committed to contribute to greenhouse gas emissions emission reduction on a global level since it adopted the global climate change agreement (Paris Agreement which came into force on 4 November 2016), it can be expected that more thorough legislation related to use of hydrogen will be adopted in the upcoming years.

Funding & Support schemes

The Law on Use of RES stipulates that the Serbian Government, on the proposal of the Ministry of Mining and Energy, determines incentive measures for the production, transport, storage, and use of renewable hydrogen that is used in the field of thermal energy, traffic, and natural gas. Incentives to produce electricity from renewable sources are implemented in a certain incentive period through the system of market premiums and the system of feed-in tariffs and relate to the price of electricity, the assumption of balance responsibility, the right to priority access to the system and other incentives prescribed by law.

Additionally, draft Strategy provides that the incentive environment for the use of hydrogen should be defined.

Although currently there are no specific incentive measures, it is reasonable to expect that the Serbian Government will incentivise the use of hydrogen, because the faster energy transition is an imperative for the Serbian Government, which defined a 13.2 % greenhouse gas emissions reduction by 2030 compared to 2010

Upcoming evolution

According to the draft Strategy, Serbia should start producing hydrogen from renewable energy sources by 2025 and increase production to 5,100 tons by 2035 and 20,600 tons by 2050.

The first phase of Serbia's hydrogen transition, until 2025, should achieve the development of 10 MW of electrolysis plants using renewable energy, while the goal of the second phase, until 2030, is 100 MW of capacity and an output of 50,000 tons of hydrogen.

Draft Strategy also stipulates that hydrogen should be produced in renewable power plants with a total installed capacity of 100 MW (80 MW in wind farms and 20 MW in solar power plants), to use 270 GWh to generate about 5,100 tons of hydrogen per year, all by 2035.

With hydrogen technologies expected to reach market maturity after 2030, it is a realistic option for Serbia to be actively involved in hydrogen gas pipeline systems, but also to have its own distribution network. In the same period, it is also realistic to expect the development of hydrogen infrastructure, including 20 hydrogen filling stations along the main highways, in air traffic, and in river transportation, according to the outline.

By 2050, Serbia's annual hydrogen output should reach about 2.5 million tons, of which 25% from renewable energy sources, 35% from biomass, 40% from coal (based on hydrogen production from genetically modified organisms), and 10% based on new technologies to produce hydrogen from waste. According to authors of an outline of Serbia's hydrogen strategy, produced hydrogen is to be used in transportation (28%) and industry (24%), as support to microgrid and nanogrid electricity systems (22%), and in households (16%).

Recent examples

In January 2023, Serbia agreed to signing of the memorandum on cooperation in the field of hydrogen development with the United Arab Emirates, thus continuing cooperation in the field of renewable energy sources. In 2022 Hungary and Serbia signed a memorandum of understanding on cooperation in the green hydrogen sector. The memorandum refers to the production, storage and transport of hydrogen produced from renewables and cooperation on joint projects. This document should be the base for Hungary to share with Serbia its strategies and regulations, as well as investment plans and projects,

In January 2024, Serbia signed the memorandum on investment in renewable energy sources with the Chinese companies Shanghai Fengling Renewable Co Ltd and Serbia Zijin Copper, a local subsidiary of Zijin Mining. China has agreed to invest 2 billion euros ($2.18 billion) in Serbia to build wind and solar power plants and a hydrogen production facility. This is the biggest investment in renewable energy in the Balkan country to date. The entire project should be completed by 2028.

Serbian oil and gas company NIS, which majority owner is the Russian company Gazprom Neft, announced in 2023 the public call for the design and technical documentation development for the construction of a hydrogen production plant in the vicinity of its Elemir gas refinery (Banat region in the Serbia's northeast).

This chapter was provided by Bird & Bird Plus firm Bojanovic & Partners (BOPA) and authored by Vladimir Bojanović, Tanja Dugonjić and Aleksandra Stojanović.

BOPA.

Singapore

At the COP27, Singapore submitted its strengthened long-term low emissions development strategy (“LEDS”) with a clear goal to achieve net zero emissions by 2050. Additionally, it submitted its updated 2030 nationally determined contributions (“NDCs”) to reduce its emissions to 60 million tonnes of carbon dioxide equivalent in 2030.

An important development to achieve these targets is the formalisation of Singapore’s National Hydrogen Strategy in October 2022.

Under Singapore’s National Hydrogen Strategy, Singapore aims to develop hydrogen as a major decarbonisation pathway to support the transition to net zero by 2050. Hydrogen will also complement and diversify Singapore’s power mix alongside solar, imported electricity and other potential low-carbon energy sources.

Under Singapore’s National Hydrogen Strategy, Singapore aims to develop hydrogen as a major decarbonisation pathway to support the *transition to net zero by 2050.*

Legal framework overview

Singapore does not have a specific legislative framework for the use of hydrogen as an energy resource, and the current regulatory regime only governs its use for industrial purposes.

The main regulations governing the use of hydrogen in Singapore is the Fire Safety Act 1993, which stipulates that hydrogen is a highly “flammable material”, so licenses are required for its storage, import, transportation, dispensation and conveyance over pipelines. Further, hydrogen is deemed a “dangerous substance” under the Workplace Safety and Health (Major Hazard Installations) Regulations 2017, which is Singapore’s workplace health and safety laws, mandating enhanced safety measures for occupiers of premises that process, manufacture or store hydrogen in bulk.

We anticipate that laws regulating the deployment, import and use of hydrogen will soon be developed, to complement the Government’s push towards adopting hydrogen as an energy source. Studies are also being conducted by the Government to refine regulations in this space.

Funding & Support schemes

In February 2024, the Government announced that a new Future Energy Fund with an initial injection of S$5 billion will be set up to help build critical infrastructure to shift Singapore's energy reliance to low-carbon electricity. This includes building capabilities in the generation, storage and delivery of hydrogen, to prepare Singapore for hydrogen deployment.

With a view to encourage private sector innovation in low-carbon energy technologies, the Government awarded S$55 million under the Low-Carbon Energy Research Funding Initiative ("LCER") to fund 12 research, development and demonstration projects. A further S$129 million will be set aside for Phase 2 of LCER which will be disbursed in 2024, with hydrogen being a key focal area for funding.

Some recent examples

A key thrust of Singapore's National Hydrogen Strategy is to experiment with the use of advanced hydrogen technologies that are on the cusp of commercial readiness.

Ammonia is currently one of the most technologically ready hydrogen carriers with an established international supply chain for industrial use. As a low or zero-carbon fuel, ammonia may also have multiple end-use pathways for power generation and bunkering. The Energy Market Authority of Singapore ("EMA") and the Maritime Port Authority of Singapore ("MPA") have shortlisted six proposals for a lead developer that will work with the Government to build, own and operate an end-to-end low or zero-carbon ammonia power generation and bunkering solution in Singapore. The project aims to build up local capabilities in ammonia handling to catalyse low or zero-carbon ammonia supply chain in Singapore and will provide the Government an opportunity to work closely with industry to develop and refine policies and regulations on the safe utilisation of ammonia and hydrogen.

With 95% of electricity being generated from natural gas, Singapore has also taken steps to transition towards using hydrogen in CCGTs.

Singapore's first best-in-class hydrogen-ready power plant is expected to be developed by 2026. Owned by the Keppel Infrastructure group, the Keppel Sakra Cogen Plant is a CCGT power plant designed to co-fire with 30% hydrogen content and has the capability of shifting to run entirely on hydrogen in the future.

Additionally, in January 2024, EMA awarded local generation company YTL PowerSeraya the right to build, own and operate a hydrogen-ready CCGT by end-2027. The CCGT will have the capacity to use up to 30% hydrogen, with the ability to become operationally 100% hydrogen-compatible in the future. This award forms part of EMA's inaugural "Centralised Process Framework" for new generation capacity which can fire on hydrogen.

Up-coming evolution

01

Experiment with the use of advanced hydrogen technologies at the cusp of commercial readiness – Through such pathfinder projects, the government aims to enter collaborations with industry players, and identify and address any technical, safety and regulatory issues that may arise.

02

Invest in research and development works to advance hydrogen technologies – The LCER programme is an example of such investment into research and development.

03

Pursue international collaborations to enable supply chains for low-carbon hydrogen – This will incorporate the development of Guarantee of Origin certification methodologies (to measure and display key attributes of how and where a unit of hydrogen is produced including its carbon intensity), ensuring that methodologies are interoperable across jurisdictions, and building a trading and financing ecosystem to facilitate global trade of low-carbon hydrogen.

04

Undertake long-term land and infrastructure planning – This will likely involve changes to land use laws and planning polices administered by the Urban Redevelopment Authority (“URA”).

05

Support workforce training and development of Singapore’s broader hydrogen economy – Upskilling and reskilling of Singapore’s workforce will be required, particularly workers in the energy & chemicals, chemical storage marine bunkering, power generation and aviation sectors.

These key initiatives, if judiciously followed through, *will likely place Singapore in a pole position to establish itself as a regional hydrogen hub* and possibly to lead regional efforts in setting hydrogen standards and best practices. Depending on technological developments, *hydrogen could supply up to half of Singapore’s power needs by 2050.*

Slovenia

Legal framework overview

Slovenia's legal framework for hydrogen use, production, funding, and support schemes is regulated by three primary legislative acts covering alternative fuels (in the field of transport, grid and promotion of renewable energy) and various governmental policies. However, no specific or overarching act regulates hydrogen solely.

- Act on Infrastructure for Alternative Fuels and Promotion of the Transition to Alternative Fuels in Transport provides rules for the national alternative fuel transport framework, sets targets for the establishment of appropriate infrastructure, regulates technical requirements for refuelling points (alongside operators), and determines the sources and means of financing measures to promote the transition to alternative fuels.
- The Gas Supply Act provides a framework for gradually adapting hydrogen to the grid. Following this, a Ten-year Transmission Development Plan for the Gas Transmission Network from 2024 to 2033 was adopted, which prescribes actions and activities for intake of 0, 2, 5, and up to 10 % hydrogen in the grid.
- The Act on the Promotion of the Use of Renewable Energy Sources provides a framework for supporting (incentivising) production facilities and the production of gaseous fuels (including hydrogen).

The Government adopted the National Energy and Climate Action Plan ("NEPN") in 2020, which was restated in the Slovenian Long-Term Climate Strategy 2050. NEPN's targets concerning hydrogen until 2030 are (i) to support the implementation of pilot projects to produce hydrogen to reach 10 % together with synthetic methane in the transmission and distribution network, and (ii) to provide an appropriate supportive environment for the introduction of hydrogen for road transport. The target for 2040 is to gradually increase hydrogen share to represent around 7 % of fuel use.

Funding & Support schemes

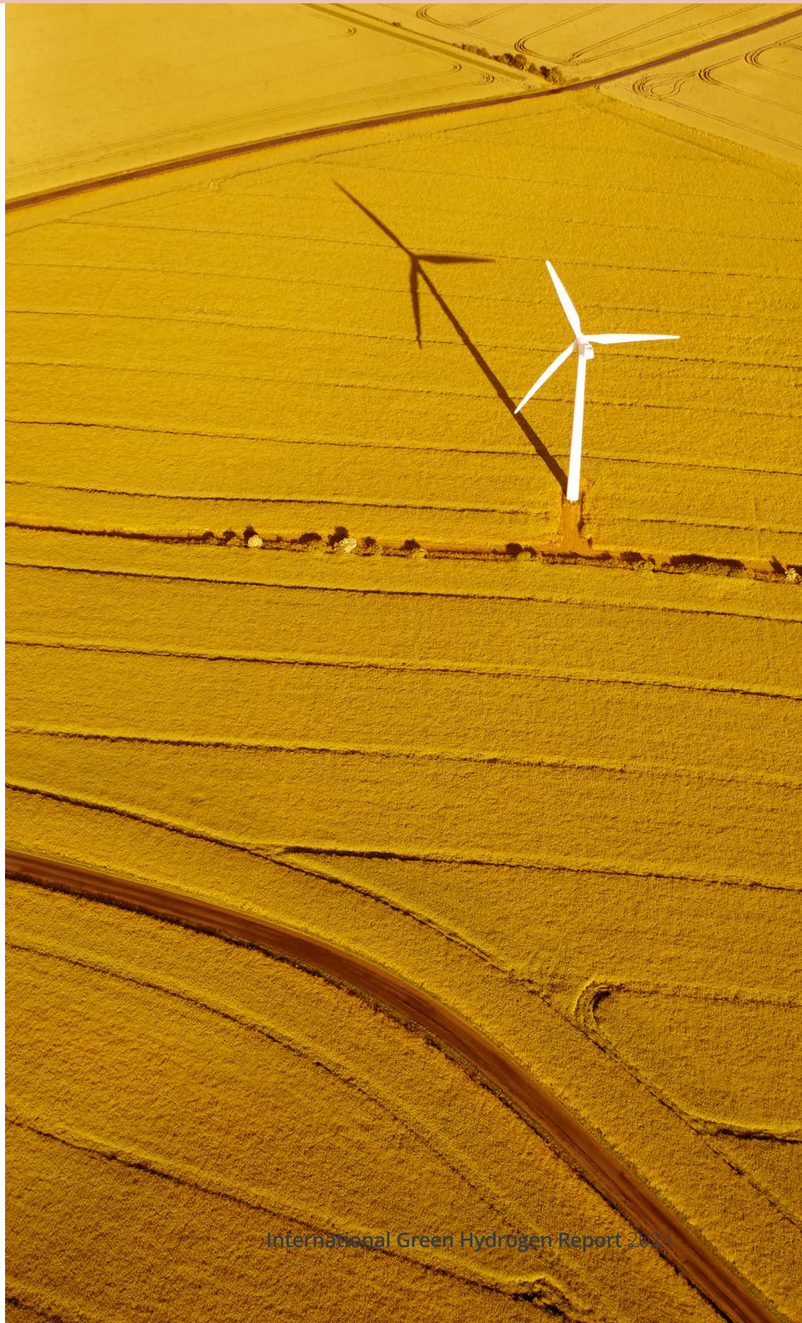
The Ordinance on the Climate Change Funding Programme 2023-2026 (“Ordinance 2023/2026”) provides amounts for financing and co-financing alternative fuel projects, including hydrogen. The Ordinance 2023/2026 further provides funding for public transport vehicles and (publicly or private) refuelling facilities for green hydrogen vehicles, however, funding is not solely for hydrogen projects. The Ordinance 2023/2026 provides for the concerned period (i) a total of EUR 104.2 million for zero-emission vehicles and supply infrastructure, (ii) a total of EUR 1.5 million for co-funding of renewable energy projects and (iii) a total of EUR 15 million for incentives for citizens for new investments in renewable energy.

For example, the Slovenian Environmental Public Fund issued in 2023 a grant for financial incentives for municipalities to invest in the purchase of new environmentally friendly vehicles and two calls for tender for affordable loans to finance citizens’ environmental investments (hydrogen vehicles).

Upcoming evolution

In the Action Programme for the Alternative Fuels in Transport 2022-2023 (“Action Programme”), a target of 2 % share of all newly registered vehicles (cars, freight vehicles and busses) in the year 2030 to be hydrogen-powered is set. Action Programme notes that the most significant obstacles are the enlargement of hydrogen refuelling infrastructure, the modest supply of hydrogen vehicles on the market, and their high price compared to other vehicles. On the other hand, the Action Programme notes that by raising public awareness and planned incentives for research and innovation of hydrogen technologies and infrastructure, the prices should fall. The main target is to make more accessible hydrogen vehicles and supply infrastructure to maintain Slovenia’s position among producers and suppliers for the vehicle industry.

The Government expects (as provided in NEPN) that by 2030 in Slovenia, (i) more companies (especially in heavy industry) will start using hydrogen instead of fossil fuels in their production facilities, (ii) investment in research and development will increase up to 3 % of GDP, and (iii) more hydrogen will be produced with water electrolysis from electricity peaks from renewable sources of energy (cross-sector merging, power-to-gas).



Recent examples

01 The North Adriatic Hydrogen Valley is a cross-border consortium of 37 partners across Slovenia, Italy and Croatia participating in creating a dedicated hydrogen valley. The project started on 1 September 2023 and will last 72 months. The project concept covers the entire chain of renewable hydrogen use, from its production, storage and distribution to its end use in various sectors, notably industry, land and maritime transport. The plan is to provide 5,000 tonnes of green hydrogen per year.

02 In December 2023, the Institute of Chemistry received approval for the Demonstration and Training Centre for Carbon-Free Technologies, which will house two laboratories, one of which will be the Hydrogen Technology Laboratory.

03 In October 2023, approval and agreement to start the Slovenian-Japanese project on hydrogen technologies was granted. The project is currently in a phase of proposals for cooperation.

04 The RES HUB project concerning the construction and purchase of a public hydrogen filling station with a hydrogen plant in Kranj is expected to commence soon. This project should enable the implementation of Slovenia's commitment to NATO and provide an independent source of green hydrogen to the Armed Forces as well as the community.

05 The H GreenTECH was a cross-border area project of Slovenia and Austria. Its goal was to bring together regional strengths in research and development potential for the hydrogen and hydrogen technology sector and provide companies with access to infrastructure and new technological developments.

06 Companies SALONIT ANHOVO and ECUBES have a few projects for the storage and use of hydrogen in the industry (estimated amount is EUR 45 million) in cooperation with the municipality. The project is to set up an electrolyser for hydrogen production from renewable energy sources, hydrogen storage, large battery storage, a large hydrogen refuelling station), a fleet of trucks and a gas/hydrogen cogeneration plant is envisaged.

07 In Ljubljana, the urban transport provider issued a public procurement for buses that run on green hydrogen, and the city's energy provider outlined the start of hydrogen use (production and distribution). By the first quarter of 2025, two hydrogen charging stations will be established to facilitate refuelling for Ljubljana's hydrogen-powered urban transport buses.

08 Generally, in Slovenia, the economy is increasingly interested in using and developing hydrogen or hydrogen-related technologies. Namely, there has been remarkable progress in developing innovative portable, mobile, and stationary hydrogen fuel cells that are more cost-effective and have better energy density. Further, in September 2023, a Slovenian company collaborated on the first four-seater aircraft powered by liquid hydrogen flight, marking a significant milestone. Another company developed screws (bolts) which are now widely used in the hydrogen-powered vehicles. Finally, in the glass-making industry, a company uses more than 60 % hydrogen in its glass melting processes, thereby reducing the direct carbon footprint of melting by over 30 % compared to standard methods.

This chapter was provided by Bird & Bird Plus firm Law firm Kavčič, Bračun & Partners, o.p., d.o.o. and authored by Simon Bračun, Katja Černivec and Žiga Hrovat.

KBP

Spain

Spain, benefitting from a large deployment of renewable projects, is resolutely committed to green hydrogen as a vector for the ecological transition and the decarbonisation of the EU.

The Spanish Government has set ambitious goals as to the implementation of hydrogen projects, including *a 4 GW installed capacity of electrolysers from renewable energy sources by 2030.*

Legal framework overview

Green hydrogen does not benefit from a single legal framework, so is subject to a wide range of applicable set of rules, from chemical and industrial regulations to environmental and power sector laws. In this context, a diverse regulatory framework for hydrogen from renewable sources is being developed and/or amended to fit green hydrogen specificities.

Given this, sponsors of hydrogen projects in Spain should consider the following regulations:

- Regarding the power generation and evacuation activities, required for the electrolysis process, the legislation on the Spanish Power Act (Law 24/2003, of 26th December) and the Environment Law (Law 21/2013, of 9th December), and other implementing regulations.
- Regarding the generation of hydrogen through electrolysers, industrial and environmental legislation, as well as any other legislation which applies to facilities involved in the production of inorganic chemicals like hydrogen or ammonia.
- Regarding hydrogen storage, the industrial legislation and any other standards and regulations applicable to the storage of this inorganic chemical products.
- Regarding the transport of hydrogen through the gas pipeline infrastructure, hydrocarbon legislation (Law 34/1998, of 7th October) and any other specific applicable regulations.

Given the complex governmental structure of the Kingdom of Spain (with different layers of competent authorities), sponsors of hydrogen projects should consider national, regional and local regulations applicable to the development of hydrogen, industrial and power facilities.

€500 million

Has been exclusively allocated to hydrogen developments

Upcoming evolution

The new climate context has driven the implementation of measures and packages throughout the European Union which have affected the Spanish regulation. The increase in climate ambition at the European level, the need to strengthen strategic autonomy and the progress achieved thanks to the Recovery, Transformation and Resilience Plan (PRTR) (i.e. the Spanish instrument for the management of the NextGeneration EU funds) have fuelled an update of the National Integrated Energy and Climate Plan ("PNIEC"), originally drafted in 2021.

The update sets objectives consistent with the emission reductions adopted at European level. Specifically, for the implementation of hydrogen projects, the updated PNIEC takes the ambitious goals set in the original PNIEC to another level, and increases the envisaged installed capacity of electrolysers from renewable energy sources by 2030 from 4GW to 11GW, mainly for industrial purposes.

According to the Spanish Ministry of Economy, Spain was fourth in the ranking of recipient countries for automotive or clean hydrogen projects in 2022. Spain concentrates approximately 20% of the renewable hydrogen projects announced throughout the world, only behind the United States, and is the second European country in the use of green hydrogen, only behind Germany. In addition, the European Commission has selected among the hydrogen projects of common European interest (IPCEI) four Spanish projects in the IPCEI Hy2Tech Technology wave and seven in the IPCEI Hy2Use Industrial Uses wave.

An addendum to the Recovery, Transformation and Resilience Plan (PRTR) was approved on 6 June 2023 by the Spanish Government, being approved by the European Commission on 2 October 2023 and by ECOFIN (the Economic and Financial Affairs Council) on 17 October 2023 (the "Addendum"). This Addendum triggers the second phase of the Spanish Recovery Plan by updating the disbursement schedule including additional transfers and loans, as well as the associated milestones and targets. It aims to maintain the pace of investment in clean energy in Spain in the coming years.

According to the new disbursement schedule, Spain is entitled to receive seven disbursements and pre-financing of approximately €1.4 billion associated with the REPowerEU program. The Strategic Project for the Recovery and Economic Transformation ("Proyecto Estratégico para la Recuperación y Transformación Económica" or PERTE) of Renewable Energies, Renewable Hydrogen and Storage (ERHA) will be receiving around €4,200 million from such program in the coming years. Likewise, the commitment to renewable hydrogen is evidenced by doubling the investment foreseen in the initial plan with the incorporation of an additional €1,600 million for the development of the value chain, new pioneering projects, the creation of hydrogen valleys and the support of projects of common European interest (IPCEI).

Within the framework of the Recovery Plan, Spain has also created the program for pioneering and unique renewable hydrogen projects (Program H2 Pioneers) which grants subsidies to new innovative renewable hydrogen projects. The first edition of the program awarded €200 million among 37 hydrogen projects, and the second edition of the program has awarded €150 million among twelve hydrogen projects, which have a total electrolysis capacity of 309 MW and will mobilize an investment of more than €500 million.

Some recent examples

Spain is in a privileged position to stand out for its hydrogen valleys. These are ecosystems where companies and professionals interested in developing the technologies involved in the development of hydrogen coexist. The collaboration between the parties is due to the huge investment needed in the technology for the production, storage and distribution of the hydrogen valleys. Hydrogen valleys have benefited from €200 million from the NextGeneration EU funds in 2023.

Cepsa, Iberdrola, Enagás, Endesa, Naturgy, Fertiberia, ArcelorMittal, Reposto and DH2 Energy are the main players leading the development of the hydrogen valleys or clusters in Spain.

Besides from leading the "Andalusian Hydrogen Valley"- one of the largest projects of its kind in Europe – Cepsa is also working with the Port of Rotterdam to create the first green hydrogen maritime corridor between northern and southern Europe, between Algeciras and Rotterdam.

As part of Spain's commitment to the deployment of hydrogen projects, a first Nation-wide consortium (called "Shyne" – Spanish Hydrogen Network) was launched in 2022. The consortium, which includes 33 of the most important players in the Spanish energy market, as well as industrial and transport companies, is led by incumbent operators such as Repsol, Enagás, Iberia and Navantia. The consortium plants to develop projects in a dozen autonomous regions, with a combined investment of €3,230 million. The main project of the consortium is the Tarragona Hydrogen Network (T-HYNET), which aims to supply approximately 50% of the hydrogen needed by the chemical hub of Tarragona.

In addition, Repsol is leading important regional initiatives to promote the creation of hydrogen valleys, such as the Hydrogen Valley of Cataluña (H2ValleyCat), promoted by Repsol and Enagás; as well as the Hydrogen Valley of the Region of Murcia, where Repsol is one of the main promoters.

Similarly, Iberdrola is developing 90 initiatives in renewables and green hydrogen with an investment that will reach €15 billion and alliances with more than 150 SMEs and large companies. In addition to its 20MW electrolysis plant in Puertollano (Ciudad Real), the company plans to invest €2 billion up to 2027 to create other hydrogen production facilities. Iberdrola is also leading alongside BP Spain has the Hydrogen Cluster of the Valencian Region (HyVal) at its refinery in Castellón.

As part of Spain's commitment to the deployment of hydrogen projects, *a first Nation-wide consortium (called "Shyne" - Spanish Hydrogen Network)* was launched in 2022.

Sweden

Sweden is a member state of the European Union (EU). As such, the national development of sector integration and the hydrogen economy is heavily influenced by the wider developments in the EU.

Legal framework overview

Currently, hydrogen legislation in Sweden solely governs its use for industrial purposes i.e., production, storage, transport, and safety. No further legislative framework for the use of hydrogen as an energy carrier (as provided for in the proposals generated by the EU's "Fit for 55" climate package of July 2021) is currently in place; however, hydrogen compliant and future-proof legislative planning is on the national agenda, together with the potential adoption of a national plan which prioritises hydrogen and minimises permitting times.

To contribute to the national climate targets and to further facilitate and stimulate the green transition, the Swedish Government appointed a working group in 2015, collecting private and state actors that believe in Sweden's ambition to be one of the world's first fossil free welfare states. The working group has a mission to propose relevant steps for an accelerated green energy transition. Simultaneously in 2017, the Swedish Government enacted a political framework which established a long-term goal of net-zero greenhouse gas emissions by 2045, and to then achieve negative emissions.

On 21 January 2021, the working group released a report on hydrogen: "Hydrogen Strategy for Fossil Free Competitiveness". The findings of the report gave an overview of the current state of green hydrogen in Sweden and new possibilities for the use of hydrogen. The report of the working group was largely supported by Swedish industry.

Following this report, on 11 February 2021 the Swedish Energy Agency was instructed by the Swedish Government to propose a general strategy for hydrogen. The proposal for a Swedish Green Hydrogen Strategy (Sw. Nationell Strategi för Fossilfri Vätgas) was presented by the Swedish Energy Agency on 26 November 2021. The strategy mapped out current developments in the hydrogen sector and highlighted that the legislative projects contained in the EU's "Fit for 55" climate package will be shaping the content of future legislation while bringing inevitable changes to the national regulatory landscape.

Funding and Support schemes

The numerous initiatives and goals of the Swedish government have resulted in two major funding schemes and several others. The schemes began with a goal of lowering greenhouse gas emissions and have since come to prioritise hydrogen.

In 2015, the Swedish Environmental Protection Agency started administering funds as part of the Climate Leap (Sw. Klimatklivet), a funding scheme for investments that decrease greenhouse gas emissions. Since 2022, Climate Leap prioritises investments in vehicles, refuelling stations and hydrogen production. The available funds were kr3100 million (€270 million) for 2023 with additional funds for each year until 2026. Any project receiving funding will need to be finalised by 30 April 2028. The next round of applications is set to open shortly.

In 2018, the Swedish Energy Agency received additional instructions to oversee the Industrial Leap (Sw. Industriklivet), a funding scheme which aims to facilitate a lowering of processing related greenhouse gas emissions from Swedish industry. Support may be given for research, feasibility studies, pilot and demonstration projects, detailed design studies and investments. During 2024, the Industrial Leap has an allocated budget of kr1457 million (€130 million) and may finance projects that continue until 2031. The Industrial Leap was later included in Sweden's recovery plan following the Covid-19 pandemic and The Recovery and Resilience Facility (RRF) of the EU. Other initiatives include the following:

01 The Swedish Energy Agency has a sector specific support scheme relating to energy efficiency and green hydrogen. The support scheme strategy node, with the help of Svea Vind Offshore AB, aims to support green hydrogen production by developing cooperations and new business models with other companies and initiatives in the energy sector.

02 Applications and support to Companies to seek funding to projects linked to the hydrogen IPCEI (Important Project of Common European Interests) is provided by the Swedish Energy Agency. The call for IPCEI applications closed in 2021 but the continued information, coordination, and planning activities for the hydrogen IPCEI in Sweden continue until 2027.

Upcoming Evolution

Hydrogen has historically been an important resource in the processing industry. Most of it is used within industry, primarily within the chemical- and refining industry. In Sweden, the majority of hydrogen is used close to the site of production, as such there is a limited network of pipelines for its transportation. Despite these conditions, Sweden is in a good position to lead the green hydrogen development as Sweden currently has a 98% fossil free energy production. The proposed Swedish Green Hydrogen Strategy sets a clear focus on the development of green hydrogen.

The proposed Swedish Green Hydrogen Strategy recognises the importance of green hydrogen as a key tool for supporting the green transition of industries and the energy systems as it can be used in hard to electrify industries and act as a form of energy storage, especially if the production of hydrogen utilises off-peak hours. Promotional activities are to be directed to hydrogen production methods that utilise zero-emission electricity, making the use of the Swedish grid favourable. Moreover, it is equally important to invest in the general electricity capacity in Sweden, including grid connections, and to make necessary adjustments in different laws and plan for such changes. This, along with shortening permitting times for environmental permits, is key to the continued development of green hydrogen in Sweden.

Finally, while it is unlikely that the current Swedish Government will adopt the proposed Swedish Green Hydrogen Strategy in its entirety, the proposed strategy has already showed some results in the form of further instructions from the Swedish Government for the Swedish Energy Agency in August 2022 to draft a national plan for the development of charging and hydrogen refuelling infrastructure. The final report was published on 1 November 2023 and contains proposals for 55 measures in a number of areas that the Swedish Energy Authority identify as important for facilitating the development of charging infrastructure and hydrogen refuelling infrastructure. During 2024, the Swedish Energy Agency will continue the work together with the Swedish Government to further coordinate, analyse and monitor the development of green hydrogen.

Some recent examples

Sweden has a central role to play in the decarbonisation of hard to decarbonise sectors, such as heavy industries and freight transport.

Swedish state-owned companies LKAB and Vattenfall, together with SSAB, conducts research and development to transform the Swedish iron ore and steel industry. The joint venture HYBRIT aims to create a fossil free steel production line using fossil free energy and green hydrogen. The project has received €143 million for a demonstration facility in industrial and commercial scale of a complete production line of fossil free steel as part of EU's Innovation Fund. In addition, the Swedish Government, through the Swedish Energy Agency, has provided an additional kr3100 million (€78 million) since 2015, including funds for an underground green hydrogen storage pilot facility.

In a separate joint venture between the Swedish state (through Sweden's Innovation Agency, the Swedish Transport Administration, and the Swedish Energy Agency) and the vehicle industry (through Scania CV, AB Volvo, Volvo Personvagnar and FKG) – project name FFI – a total of kr259 million (€23 million) of funding has been granted to two projects researching combustion engines utilising hydrogen and limiting emissions of such engines.

Uniper, a producer of green hydrogen in Sweden since 1992, was recently granted fundings of kr134 million (€12 million) from the Swedish Energy Agency for its pre-study within its project SkyFuelH2, which is run together with Sasol ecoFT. Project SkyFuelH2 is researching the possibility of building a Swedish production facility for sustainable aviation fuel.

On 28 November 2023, it was announced that two large scale hydrogen infrastructure projects, Nordic Hydrogen Route and Baltic Sea Hydrogen Collector, operated by the Swedish energy infrastructure company Nordion Energi AB and the Finnish public company Gasgrid Finland Oy, was included on the European Commission's list of Projects of Common Interest (PCI). The former project aimed to accelerate the development of a hydrogen economy by building cross-border hydrogen infrastructure between Sweden and Finland and create an open hydrogen market by 2023. The latter project aims to develop offshore hydrogen pipelines in the Baltic Sea to transport green hydrogen produced by wind power and other renewable energy sources. This makes the project the first of its kind.

In June 2023, the Swedish company H2 Green Steel (H2GS AB), was authorised by the Swedish Land and Environment Court to build a large-scale green steel mill. The green steel will be produced from sponge iron, made by reducing iron ore with hydrogen. The production is scheduled to commence by the end of year 2025 and H2 Green Steel has already signed offtake agreements with several actors, such as the German automotive companies Porsche, Mercedes-Benz and ZF, the Swedish automotive and truck manufacturers Volvo Group and Scania, the leading home-furnishing manufacturer Ingka Group (IKEA) and the Swedish energy company Fortum.

The Swedish Energy Agency has a *sector specific support scheme* relating to energy efficiency and green hydrogen.

Turkey

The “National Energy and Mining Policy,” introduced by the Ministry of Energy and Natural Resources (the “MENR”) in 2017, considering global and regional developments, focuses on key aspects such as energy security, nationalization, and market predictability. Embracing a “more domestic, more renewable” approach, the policy places sustainability at the forefront.

The primary objective is to enhance the share of domestic and renewable energy sources in Türkiye’s energy portfolio, which is achievable through the adoption of more efficient, environmentally friendly, and domestically produced technologies. By diminishing reliance on imported energy, the policy aims to curtail costs while concurrently ensuring energy supply security through the diversification and nationalization of energy resources.

As the energy sector, which is an emission-intensive sector, will be one of those that will be most affected by the “Paris Agreement”, Türkiye is determined to use its energy resources effectively, efficiently and in a way that will have the least possible impact on the environment, within the framework of sustainable development goals.

In this context, Türkiye has declared hydrogen one of the priority areas due to its potential contribution to the sustainable energy future. Main purpose is to create a carbon zero economy model using hydrogen in line with Türkiye’s economic development and net zero carbon emission target by 2053.

Türkiye has the great capacity to generate hydrogen and innovate in technology over the short, medium, and long term due to its abundant renewable energy resources and relatively lower expenses for setting up renewable energy-powered facilities compared to other countries in Europe.

Türkiye’s vision is to play a leading role worldwide in the production and use of green hydrogen by developing domestic and national advanced technologies; and its mission is to create an effective value chain from the production of green hydrogen to its final use based on domestic and national technologies, and to contribute to the 2053 net zero target.

Consequently, Türkiye is regarded as a *strong player* in the global hydrogen market.

Legal framework overview

Hydrogen was officially recognized for the first time as an alternative fuel whose use should be encouraged through the Energy Efficiency Law published in the Official Gazette on May 2, 2007.

Subsequently, in 2011, a regulation regarding hydrogen fuel cell vehicles was introduced.

Moreover, on May 2, 2019, the "Regulation on Rules and Procedures for Enhancing Energy Efficiency in Transportation" was issued, promoting hydrogen among the clean energy fuels that will be encouraged as an alternative to fossil energy sources in the projects by the Ministry of Transport and Infrastructure.

On January 19, 2023, the MENR has introduced the "National Energy Plan of Türkiye", which outlines initiatives to blend natural gas with hydrogen and synthetic methane as parts of the efforts to decrease emissions to achieve Türkiye's net zero target by 2053 and the use of hydrogen energy for on-site consumption and to meet the needs of the industry initially. An electrolyser capacity of 5.0 GW is targeted to be reached by 2035. It is considered that hydrogen, as a complement to electrification-oriented development, will make a great contribution to the manufacturing sector's achievement of net zero emission on targets, with its potential uses, including as a raw material, fuel, energy carrier and energy storage material.

On January 19, 2023, the "Türkiye Hydrogen Technologies Strategy and Roadmap" was also introduced by the MENR. This initiative seeks to develop a strategic roadmap for implementing a domestic and national support program, focusing particularly on research and technology development, and emphasizing the importance of indigenous advancement in hydrogen technologies.

To regulate the hydrogen sector and foster the development of a hydrogen ecosystem, there is a discussion of either drafting an individual hydrogen market law or adding specific provisions to be served as the basis for the creation of the regulatory framework for hydrogen to the existing Natural Gas Market Law (Law No. 4646), the Electricity Market Law (Law No. 6446) or the Law on the Utilization of Renewable Energy Sources for the Purposes of Generating Electrical Energy (Law No. 5346).

Funding & Support scheme

During the "Hydrogen Exploration Conference" organized by the MENR on January 15, 2020, it was emphasized that hydrogen production would be driven by four primary advantages, which are as follows:

- Integration of greater amounts of renewable energy into the system,
- Transitioning the heating sector to carbon-free methods,
- Utilizing CO capture technologies to produce hydrogen from domestic coal,
- Enhancing the use of boron compounds for hydrogen storage purposes.

In the conference, which highlighted the importance of employing storage technologies to balance electricity generation from renewable sources, it was proposed that blending 2–6% hydrogen into natural gas distribution lines could be one effective method. Implementing this approach could introduce an additional 1 to 3 billion cubic meters of hydrogen into the system in Türkiye.

Research conducted by the Science, Technology, and Innovation Policies Board of the Presidency of the Republic of Türkiye, highlights the critical role of developments in hydrogen technologies. Hence, the Board developed the "Hydrogen Technologies Policy Recommendations Report" in May 2021 and offered technological/supportive solutions.

The "Medium-Term Program (2024–2026)", which was introduced by the Presidency of Strategy and Budget on 6 September 2023, highlights that necessary steps will be taken in all sectors to attain 2053 net zero emission targets in accordance with the resource-efficient and competitive green transformation policies in the EU, which is Türkiye's main export market.

Funding & Support scheme (cont)

Additionally, Türkiye will:

- Continue to support green technology R&D projects, especially in agriculture, industry, transportation and energy sectors, with a view to establishing a green transformation infrastructure, and develop an investment ecosystem of technologies that contribute to emission reduction, such as green hydrogen and energy storage,
- Develop a medium-term strategy for low-carbon growth en route to achieving the net zero emission target. This involves assessing the additional investment required by various sectors for green transformation and devising support mechanisms to uphold their competitiveness.
- Enhance accessibility to climate finance while considering the needs of the private sector. The focus will be on prioritizing transformative investments that enhance efficiency, generate high added value, curtail greenhouse gas emissions, and promote the development of green skills.

The 12th Development Plan (2024-2028) issued by Presidency of Strategy and Budget also states that investments in the production of fuels and chemicals, particularly hydrogen and ammonia, through green technologies will be supported.

Upcoming evolution

For the development of a domestic green hydrogen market, Türkiye will primarily focus on harmonizing of the existing legislation and the development of the technical standards that align with international standards for the production, distribution, storage, and end-use of green hydrogen. Identifying and addressing gaps in the value chain, from hydrogen production to its ultimate utilization will also be take place within the agenda.

Türkiye's primary targets concerning hydrogen are defined as follows:

01 Reduce the cost of green hydrogen production to less than $2.4/kgH2 by 2035 and less than $1.2/kgH2 by 2053;

02 To ensure that the installed power capacity of the electrolyser reaches 2 GW in 2030, 5 GW in 2035 and 70 GW in 2053.

Türkiye's primary targets for making policies concerning hydrogen are defined as follows:

01 Review the current legislation and make it suitable for hydrogen production, transportation, storage and use;

02 Develop an incentive mechanism for the use of domestic components in the production and storage of green hydrogen;

03 Develop certificate programs for green hydrogen and ensure their traceability;

04 Encourage R&D and P&D for the development and production of domestic and national technologies (electrolyser, fuel cell, etc.);

05 Engage in public and private sector partnerships to encourage commercial demand and investments;

06 Cooperate internationally on issues related to industry, technology, standards and certification development, supply chain and trading opportunities;

07 Promote widespread use of green hydrogen in all relevant industries, especially those where carbon emissions are difficult to reduce (chemistry, iron and steel, transportation, glass, ceramics, etc.);

08 Increase the production and share of renewable energy to increase green hydrogen production;

09 Ensure continuity in employment by training qualified labour in hydrogen technologies;

10 Contribute to the gradual decarbonization of the heating sector by blending hydrogen into existing natural gas lines;

11 Use domestic resources, particularly boron, in hydrogen storage;

12 Export excess green hydrogen and ammonia to other countries, especially to the European market, with our domestic technologies

Recent examples

01 As the Scientific and Technological Research Council of Türkiye continues its multifaceted efforts to combat climate change, two pivotal projects have been initiated in Türkiye, aligning with the global shift towards hydrogen.

02 These projects include the establishment of Türkiye's inaugural hydrogen valley and the country's first domestic green hydrogen plant with the largest capacity.

03 "HYSouthMarmara Hydrogen Shore Project" and the "South Marmara Hydrogen Coast Platform Guided Project," were introduced on April 27, 2023. These endeavours mark significant advancements in Türkiye's hydrogen strategy.

04 The budget for the hydrogen valley project amounts to 36.8 million euros, with a notable contribution of 7.5 million euros, the largest single grant from Europe to Türkiye to date. The project's objective is to provide alternative resources across various sectors, ranging from fertilizer to textiles, heating to electronics, and even automotive to space industries. Upon completion, the project seeks to decrease fossil fuel usage in these sectors, thereby facilitating a small-scale decarbonization process.

05 The South Marmara Hydrogen Coast Platform project has been focused on producing a minimum of 500 tons of green hydrogen annually at Enerjisa's (one of the largest energy companies based in Istanbul/Türkiye, operating in electricity generation, distribution, and sales) site. Beyond hydrogen production, the project also aims to manufacture derivatives such as methanol and ammonia, which Türkiye currently imports, using green methods. This initiative will bolster Türkiye's domestic production capabilities and reduce dependence on foreign sources for these crucial resources.

06 Türkiye and Germany have announced the signing of a memorandum of understanding on the establishment of pipelines for the transportation of green hydrogen produced in Türkiye. In this context, a task force has been established, with experts convening to explore opportunities in this domain. The two countries also signed an agreement on joint action to combat climate change and agreed to committing to regular high-level discussions. They are also exploring avenues for joint investment.

This chapter was provided by Bird & Bird Plus firm BTS&Partners and authored by Gozde Kuscuoglu, Selin Beceni and Ilke Okan.

BTS&PARTNERS

United Kingdom

In November 2020, the UK Government published its Ten Point Plan for a Green Industrial Revolution (the 'Ten Point Plan') which outlined its commitment to driving the growth of low carbon hydrogen and established an ambition for five gigawatts (GW) of low carbon hydrogen production capacity in the UK by 2030.

This was followed up by a detailed Energy White Paper published in December 2020 and a UK Hydrogen Strategy published in August 2021, which provided a roadmap for the development of the hydrogen economy to meet this ambition.

The British Energy Security Strategy was then published in April 2022, increasing the UK's aim for low-carbon hydrogen production capacity to 10 GW by 2030, with at least half of that coming from green hydrogen production. The much-anticipated Energy Act 2023 ("the Act") was also introduced on 26 October 2023, which, amongst other measures, provides a legislative framework to enable the future provision of procedures to fund hydrogen production and provide revenue support contracts.

In the Government's Hydrogen Strategy Delivery Update published in December of 2023, the Government set out a refreshed roadmap and delivery timeline out to 2035, key policy developments from August to December 2023, and updates regarding the Government's Hydrogen Allocation Rounds one and two (see more detail in our Funding & Support schemes section below).

Future developments include a consultation on the design of a hydrogen levy on gas shippers following the passing of the Act, the launching of a low carbon hydrogen certification scheme for hydrogen produced domestically from 2025 and plans to run annual allocation rounds for electrolytic projects and potentially alternative technologies between 2025-2030.

The British Energy Security Strategy was then published in April 2022, *increasing the UK's aim for low-carbon hydrogen production capacity to 10 GW by 2030.*

Legal framework overview

Previously, the UK did not have a well-defined legal framework for hydrogen projects. Key laws which impacted, and still impact, green hydrogen projects, but do not specifically refer to green hydrogen, were included in specific industry-related legislation. For example, the Town & Country Planning Act 1990, the Environmental Permitting (England and Wales) Regulations 2016 (as amended), the Health and Safety at Work Act 1974, and the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009.

Energy Act 2023

The Act received Royal Assent and became law on 26 October 2023, over a year after the Energy Bill was introduced in July 2022.The Act is the most significant piece of UK energy legislation in over a decade, and is seen as crucial for the UK to meet its net zero targets across various sectors. The Act introduces revenue support business models for both low carbon hydrogen and carbon capture, and storage (CCS) projects, which are among the key provisions of the Act.

The Act is seen as a positive step forward for the UK hydrogen market. The Act establishes a structure for the licensing, operation, and funding of the first series of new hydrogen projects in the UK. The enactment of the Act has been eagerly awaited by developers and potential investors in UK hydrogen.

Revenue Support Contracts

The Act authorises the allocation of funds through various business models. It also allows the Secretary of State for Energy Security and Net Zero to enable its nominee (the Low Carbon Contracts Company (LCCC)), to enter into the appropriate business model contracts. The types of revenue support contracts included in the new Act are outlined in Part 2, Chapter 1. For hydrogen, this includes three arrangements for (i) production (ii) transport and (iii) storage. The Secretary of State has the authority to designate which counterparty will enter into revenue support contracts and can approve any deviations from the standard terms and conditions. The Secretary of State may also appoint an “allocation body” to oversee the process relating to the allocation of hydrogen revenue support contracts.

The Hydrogen Production Business Model was published in draft in August 2023 and will be delivered through a Low Carbon Hydrogen Agreement contract between a government appointed counterparty and a hydrogen producer.

Hydrogen Levy

The Government’s initial idea of introducing a hydrogen levy on consumer bills was met with substantial opposition from consumers. As a result, the Government decided to shift this responsibility to gas shippers holding a licence under the Gas Act 1986 or the Gas (Northern Ireland) Order 1996. The Secretary of State is authorised under the Act to appoint a hydrogen levy administrator to make provision for such gas shippers to make levy payments to it.

The Hydrogen Production Revenue Support (Directions, Eligibility and Counterparty) Regulations 2023 (the “2023 Regulations”)

The 2023 Regulations is the first piece of secondary legislation arising from the Act. It specifies the eligibility criteria for revenue support, mandating that hydrogen production must comply with the Low Carbon Hydrogen Standard (LCHS) and meet an ‘additionality requirement’ to be eligible for support. They also grant the Secretary of State the right to withdraw an offer to contract if it has not been accepted in writing by the eligible ‘low carbon hydrogen producer’. Note that the Act defines ‘low carbon hydrogen producer’ as “a person who produces hydrogen which in the opinion of the Secretary of State will contribute to a reduction in emissions of greenhouse gases”.

In common with many other jurisdictions, *the UK does not have a well-defined legal framework* for hydrogen projects specifically.

Hydrogen Transportation

Although hydrogen was previously classified as a gas under the Gas Act 1986, the Gas Act 1986's provisions have been explicitly broadened to include the licensing of pipelines for hydrogen transport. Those developing hydrogen pipelines will therefore need gas transporter licenses for the transmission and distribution of the molecules. The Secretary of State has powers under the Act to grant, extend or modify a gas transporter licence to those which it has "designated" for the development of hydrogen pipeline projects under the Act.

The UK Hydrogen Strategy has identified regulatory frameworks as something to be addressed, including network delivery, safety and other standards, planning and project regulation and future market regulation.

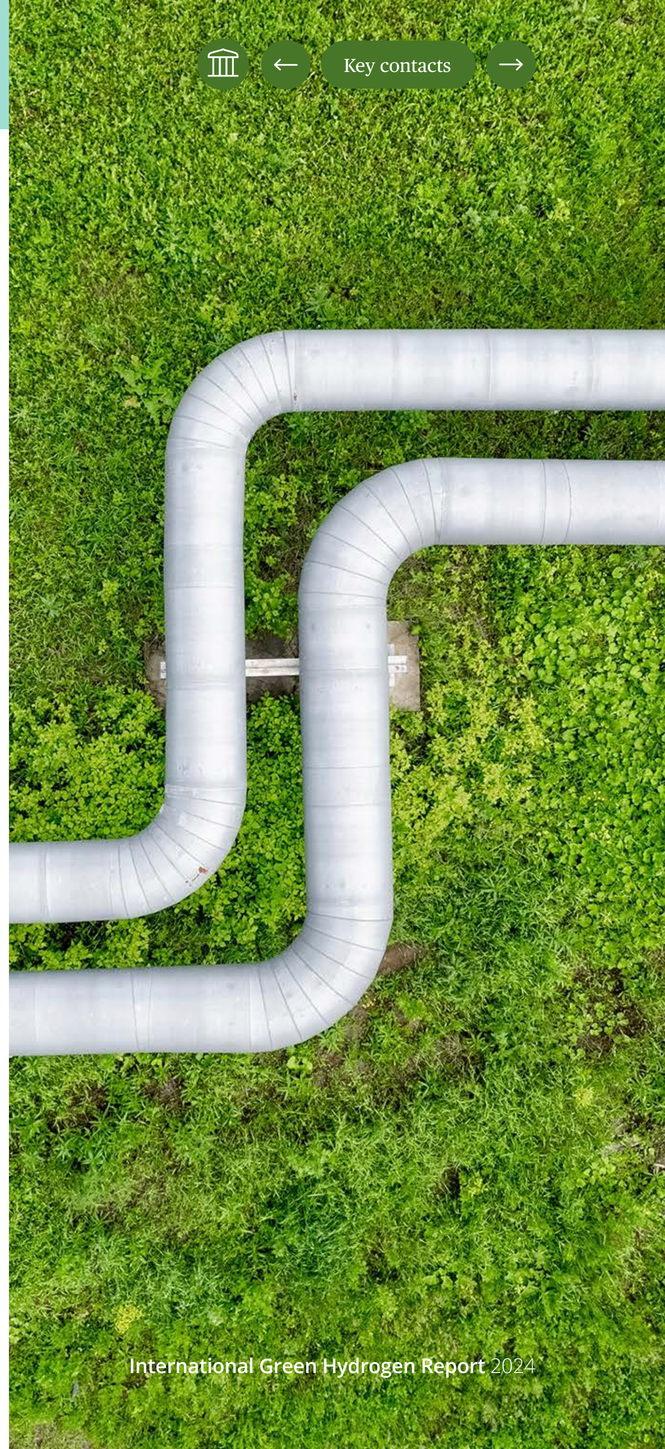
Designation is likely to be given where such project is likely to be appropriate for specific conditions described within the Act to be included in the gas transporter licence, and that the project is likely to result in value for money.

Hydrogen Storage

Similarly with hydrogen production and transportation, the Act grants powers to offer revenue support for hydrogen storage projects, however aside from granting the Secretary of State the right to designate who will be an appropriate contract counterparty, most of the detail is left to be outlined in secondary legislation.

Final Thoughts

Whilst the Act provides a positive and important development within the UK hydrogen market, there is a considerable amount of practical specifics that still need to be detailed in subsequent legislation for many hydrogen projects to become a reality.



Funding & Support schemes

The UK Hydrogen Strategy sets out that the drive to increase the UK's hydrogen production capacity will be supported by a Net Zero Hydrogen Fund of £240 million and up to £100 million through a Low Carbon Hydrogen Business Model for new hydrogen production facilities. By 2030, the government expects that there will be up to £9 billion of private investment in the industry.

Net Zero Hydrogen Fund ("NZHF")

The NZHF is worth up to £240 million and aims to reduce financing costs with grant funding which will be delivered between 2022 and 2025. The NZHF has been designed to support all forms of hydrogen production, provided projects meet certain eligibility requirements.

The strategy provides a timeline for the evolution of policy as follows:

01 **Strand 1:** DEVEX (development expenditure) for FEED studies and post FEED costs.

02 **Strand 2:** CAPEX (capital expenditure) for projects that do not require revenue support through the hydrogen business model.

03 **Strand 3:** CAPEX for non-CCUS enabled projects that also require revenue support through the hydrogen business model.

04 **Strand 4:** CAPEX for CCUS-enabled projects that require revenue support through the hydrogen business model.

15 successful applicants from the first competition round of strands 1 and 2 have been allocated £37.9 million to support their low carbon hydrogen projects.

Low Carbon Hydrogen Business Model ("HBM")

The objective of the HBM is to provide long- term certainty to investors through revenue support. The government intends to proceed with a contractual, producer-focused business model, applicable to a range of hydrogen production pathways. It has been modelled on the Contract for Difference ("CfD") for low carbon electricity: to provide a variable premium price support model where the subsidy is the difference between a 'strike price' reflecting the cost of producing hydrogen and a 'reference price' reflecting the market value of hydrogen. The model will set a reference price based on the producer's achieved sales price, with a floor at the natural gas price, and a contractual mechanism to incentivise the producer to increase the sales price and thereby reduce the subsidy.

Funds for the allocation of HBM contracts will go to both electrolytic and CCUS-enabled projects, with up to £100 million for green hydrogen production capacity operational by 2025.

In 2022 the first HBM/NZHF Electrolytic Allocation Round (HAR1) was launched, which offered either HBM revenue support only or joint HBM revenue support and CAPEX support through the NZHF. This resulted in 11 successful projects, totalling 125MW capacity. The second round (HAR2) was launched in December 2023, with the application window running to April 2024. HAR2 aims to award contracts for up to 875MW of capacity in 2024.

The UK government has set out its intention to increase its ambition for the following two allocation rounds, with an aim to deliver up to 1.5GW of electrolytic hydrogen, up from 1GW in the first two rounds.

Low Carbon Hydrogen Standard

The Low Carbon Hydrogen Standard sets a maximum threshold for greenhouse gas emissions of 20g CO_2e/ MJLHV of produced hydrogen or less for the hydrogen to be considered low carbon. The standard is used to ensure that hydrogen production supported by government schemes and policies that apply the standard, such as the NZHF and HBM, is sufficiently low carbon. The most recent version of the standard was published in December 2023.

Up-coming evolution

The UK Hydrogen Strategy provides a roadmap for future policies that will detail exactly how the government will deliver on its ambitions. The strategy provides a timeline for the evolution of policy as follows:

01

Early 2020s: Networks to be delivered through the existing regulatory and legal framework, but wider standards (e.g. safety and purity) will be updated, critical deployment barriers will be addressed and appropriate planning and permitting regimes put in place.

02

From 2025-2027: An initial network regulatory and legal framework should be in place, including potentially on blending in the gas grid, system operation and a gas billing methodology in place.

03

Late 2020s: A more established regulatory environment in place with a long-term regulatory and legal framework to support network expansion, a long-term system operator and all of the necessary regulations, codes and standards addressed.

04

Mid-2030s: With the domestic environment well established, the roadmap looks to trading hydrogen outside the UK, with the aim for a framework in place enabling cross-border pipeline and shipping trade.

Evidence given in the most recent UK Hydrogen Strategy delivery update suggests that the 10GW ambition for the hydrogen economy could directly support over 912,000 jobs and leverage up to £11 billion in private investment in UK hydrogen by 2030. The original report indicates this could rise to 100,000 jobs by 2050. – though this is based on the 5 GW ambition which has now been doubled – and up to 100,000 jobs by 2050. The UK Hydrogen Sstrategy also also suggests that by 2030 hydrogen would be worth £900 million of the UK economy, rising to £13 billion by 2050, albeit this includes all hydrogen types.

In relation to wholesale energy markets, under the Brexit trade and co-operation agreement, the parties agree to co-operate and access the actions needed to facilitate the integration of gas from natural sources, which would include the development of blended hydrogen through the natural gas system.

£240 billion

Net Zero Hydrogen Fund

£100 million

Low Carbon Hydrogen Business Model

Evidence given in the UK Hydrogen Strategy and subsequent updates suggests that the hydrogen economy could directly support *over 12,000 jobs by 2030 and up to 100,000 jobs by 2050.*

Some recent examples

In addition to the schemes outlined above there are a wide variety of existing and planned smaller funding sources for projects related to hydrogen. The Hydrogen Supply Competition (£33 million) has already provided funding for five demonstration projects on hydrogen production. Two green hydrogen production focused projects awarded these funds include Gigastack, a project which will use polymer electrolyte membrane (PEM) electrolysers manufactured by ITM Power, and Dolphyn which aims to produce green hydrogen from floating offshore wind in deep-water locations.

The Low Carbon Hydrogen Supply 2 competition ran in 2022, offering up to £60 million to support development of innovative hydrogen technology. The five winners of follow-on funding received a total of £19.4 million to progress their novel technologies towards commercial use. Additionally, 22 Phase 1 projects have published feasibility studies, highlighting the diverse work across the UK and the new knowledge they have produced. These applications are currently under assessment.

Equinor are also developing the H2H Saltend project in the Humber which has was selected for funding through the Phase-2 of the government's cluster sequencing process. The project envisions a hub comprising of a 600 MW hydrogen production plant, CCUS and hydrogen storage in the industrial region able to supply local steel, chemical manufacture, and power generation. Planning permission was granted in February 2024. The UK Government has since launched Track-2 of the Cluster Sequencing process to identify two additional clusters which may also use CCUS and hydrogen storage.

Larger projects include BP's plans for a major green facility at Teesside, in Northeast England, alongside the planned blue hydrogen plant there. In March 2022 EDF, and its hydrogen-focused subsidiary Hynamics, announced a plan to build a green hydrogen electrolysis plant also at Teesside initially for 30-50 MW production of hydrogen but scaling up to 500 300 MW, powered by offshore wind. In addition, the German energy company Uniper has proposed constructing a green hydrogen facility with a capacity of 500MW at the site of the soon-to-be decommissioned Ratcliffe coal-fired power station, slated for completion by 2030.

Further hydrogen specific funding sources are the Hydrogen storage and distribution supply chain collaborative R&D competition (£4.35 million), the Industrial Hydrogen Accelerator competition (£26 million), Hy4Heat competition (£25 million) and the Hydrogen for Transport Programme (£23 million). There are also several CCUS, industrial and transport decarbonisation & fuel switching funds which could be used for hydrogen related projects.

United States

The US Department of Energy (DOE) considers “clean hydrogen” (as defined in the Legal framework overview below) an important part of the Biden administration’s goal to achieve 100% clean electricity by 2035 and total carbon neutrality by 2050.

Specifically, the DOE believes that clean hydrogen can help decarbonise sectors such as transportation, manufacturing, and chemical industries that would otherwise find it difficult to rely on green energy.

Specifically, the DOE believes that clean hydrogen can help decarbonise sectors such as transportation, manufacturing, and chemical industries that would otherwise find it difficult to rely on green energy. The DOE has established a Hydrogen Program, led by the Office of Energy Efficiency and Renewable Energy (EERE) and the Hydrogen and Fuel Cell Technologies Office (HFTO), to regulate and assist the development of all aspects of the burgeoning hydrogen economy. If the Hydrogen Program is fully realised, the DOE estimates that the hydrogen industry would create 100,000 new jobs by 2030 and reduce CO2 emissions by 10% by 2050[1].

The US has provided substantial funding for hydrogen development in recent years. In 2021, the Bipartisan Infrastructure Law (BIL) allocated US$9.5 billion for “clean hydrogen” with US$8 billion going towards developing regional hydrogen hubs (“H2Hubs”), US$1 billion marked for investment in reducing costs of hydrogen produced by electrolysis, and US$500 million earmarked to support the manufacturing of clean hydrogen equipment.

In August 2022, the US passed the Inflation Reduction Act (“IRA”) and created production tax credits (“PTC’s”) for “qualified clean hydrogen.” The credits last until 2032 and are worth as much as US$3/kg (with inflation adjustments in future years) for hydrogen produced with less than 0.45kg of CO2 emissions per kg of hydrogen. Lower rates are also available for production emitting up to 4 kg of CO2e per 1 kg of hydrogen. Additionally, hydrogen production facilities using on-site renewable energy can claim the PTC’s available for renewable energy production (up to 2.6 cents/kWh with inflation adjustments in future years). The IRA also includes several other funding mechanisms that can apply to clean hydrogen projects, including loans and grants for the manufacture of hydrogen fuel cell vehicles, tax credits for clean hydrogen aviation fuels, tax credits for energy storage projects, and grants for projects designed to reduce emissions at American ports.

[1] U.S. National Clean Hydrogen Strategy and Roadmap (energy.gov)

Legal framework overview

Like most other countries, the legal framework for clean hydrogen in the US is developing in real time as the industry grows.

The BIL defined "clean hydrogen" as hydrogen produced with resulting carbon emissions at the site of production equal to or less than 2kg per kg of hydrogen. The IRA defines "qualified clean hydrogen" as hydrogen produced through a "process that results in a lifecycle greenhouse gas emissions rate of not greater than 4 kilograms of CO2e per kilogram of hydrogen." In June 2023, the DOE released guidance for a Clean Hydrogen Production Standard (CHPS)[2] that proposes adopting the IRA definition, reasoning that it is achievable for facilities that meet the IRA target at the site of production but may have additional upstream or downstream emissions. The CHPS will be reviewed within 5 years.

In addition to the DOE and its subagencies (EERE and HFTO), several other agencies have actual or potential authority to regulate hydrogen. However, while recent activity has begun to flesh out regulations, the DOE has noted that these efforts have not been closely coordinated and thus gaps within the framework are unclear.

Environmental

The Environmental Protection Agency (EPA) has authority to regulate all substances having an impact on human health and the environment, which includes hydrogen under the EPA's Mandatory Greenhouse Gas Reporting Program. However, other sources of authority for the EPA primarily relate to hydrogen produced as a byproduct of fossil fuel regulation and therefore may need to be expanded to capture all clean hydrogen production.

Transportation

The transport of hydrogen via pipelines is regulated by the Pipeline and Hazardous Materials Safety Administration (PHMSA), a subagency of the Department of Transportation. PHMSA has promulgated safety standards for "pipeline facilities and the transportation of gas," among other regulations. However, the existing regulations were created for natural gas and may need to be updated to account for risks unique to transporting hydrogen.

Storage

The Occupational Health and Safety Administration (OSHA) has issued regulations concerning gas and liquid hydrogen storage touching on safety, location and design of facilities, electrical systems, maintenance, etc.

State Regulations

In addition to the federal framework, developers and investors should be aware of any state-level regulations and funding opportunities that exist. With a nation as large and diverse as the United States, and with many important policies being governed at the state level, it should be expected that incentives and programmes for green hydrogen – together with the attendant opportunities for commercial participants –will vary widely across states. At the moment, California and Texas are among the states with the most well-developed hydrogen regulatory frameworks and offer their own incentives for green hydrogen projects[3]. While most other states have very few laws regulating hydrogen specifically, they will likely develop these regulations as clean hydrogen projects become more common.

Like most other countries, the legal framework for clean hydrogen in the US is *developing in real time* as the industry grows.

[2] U.S. Department of Energy Clean Hydrogen Production Standard (CHPS) Guidance

[3] Sheppard Mullin Launches California Green Hydrogen Readiness Assessment – How Prepared Are You and the State? | Energy Law Blog (energylawinfo.com)

Funding & Support schemes

As mentioned above, the IRA provides a PTC of up to US$3/kg of hydrogen produced. Because these credits are available until 2032, only projects that started in 2023 will benefit from the full ten years of credits. To qualify for the full amount of the credit (US$3/kg of hydrogen), projects must, in addition to meeting the emissions requirement above, satisfy prevailing wage and apprenticeship requirements set by the Secretary of the Treasury. These PTC's are transferrable starting in 2023 (subject to various requirements and limitations), opening the clean hydrogen market to new investors. Alternatively, hydrogen energy storage technology and hydrogen production facilities may qualify for the investment tax credit (ITC).

The DOE has the authority to distribute the US$9.5 billion allocated to clean hydrogen projects under the BIL, including the US$8 billion earmarked for H2Hubs. On 13 October 2023, DOE announced its selection of 7 regional H2Hubs to receive up to US$7 billion[4]. The hubs are expected to produce 3 million metric tonnes (MMT) of hydrogen per year. These funds will be distributed through cooperative agreements with DOE under which both DOE and the recipients share responsibility for the direction of the projects. The remaining funds will be available for use by the Hydrogen Demand Initiative (H2DI)[5] consortium led by the Energy Futures Initiative to organise a market for clean hydrogen.

On 13 March2024[6], the DOE announced 52 projects across 24 states that would receive US$750 million in support of the "Hydrogen Shot." Launched 7 June 2021, the Hydrogen Shot aims to eliminate the gap between the cost of hydrogen produced by natural gas (US$1/kg) and hydrogen produced by renewable energy (over US$5/kg) by reducing the cost of green hydrogen to US$1/kg by 2031. And in December 2023, the DOE issued a Funding Opportunity Announcement (FOA)[7] on behalf of HFTO to support the H2@Scale Initiative, which aims to advance affordable hydrogen production, transport, storage, and utilisation. A total of US$59 million is expected to be made available to applicants who applied by the 22 March 2024 deadline.

[4] Biden-Harris Administration Announces $7 Billion For America's First Clean Hydrogen Hubs, Driving Clean Manufacturing and Delivering New Economic Opportunities Nationwide | Department of Energy

[5] The Future Of Hydrogen: DOE And Moniz Start Setting Up A Demand Market (forbes.com)

[6] Biden-Harris Administration Announces $750 Million to Support America's Growing Hydrogen Industry as Part of Investing in America Agenda | Department of Energy

[7] DE-FOA-0003213_MOD_2_Advance_National_Clean_Hydrogen_Strategy.pdf

The DOE has the authority to distribute the US$9.5 billion allocated to clean hydrogen projects under the Bipartisan Infrastructure Law, including the US$8 billion earmarked for H2Hubs.

According to the FOA, the DOE is looking to fund the following to further this goal:

01 Components for hydrogen fuelling of medium and heavy-duty vehicles.

02 Standardised hydrogen refuelling stations.

03 Hydrogen fuel cell powered port equipment.

04 Proposals addressing permitting and safety for hydrogen.

05 Reports addressing equitable hydrogen technology community engagement.

Up-coming evolution

DOE, in collaboration with other government agencies, released its National Clean Hydrogen Strategy and Roadmap in June 2023. The Roadmap calls for 10 MMT of clean hydrogen per year by 2030, 20 MMT per year by 2040, and 50 MMT per year by 2050. The three strategies described by the Roadmap to achieve these goals are:

01 **Strategy 1:** Targeting initial deployment of clean hydrogen in sectors where limited alternatives for decarbonisation exist, such as industrial sectors, heavy-duty transportation, and long-term energy storage.

02 **Strategy 2:** Reduce the cost of clean hydrogen through the Hydrogen Shot program discussed above. Through this program, DOE plans to spark private investment and resolve inefficiencies and vulnerabilities throughout the supply chain.

03 **Strategy 3:** Investing in regional hydrogen hubs through the H2Hubs programme discussed above. Regional hubs will connect producers with end users in close proximity and allow rapid upscaling in important markets. Offshore wind facilities and ports are identified as examples of potential centres around which to base H2Hubs.

Some recent examples

In March 2022, Green Hydrogen International (GHI)[8], joined by ABB Energy Industries in March 2024[9], announced plans for Hydrogen City, Texas, an integrated green hydrogen production, storage, and transport hub. The project is anticipated to be powered by 60 GW of solar and wind power and produce over 2.5 billion kilograms of hydrogen per year, which will be used for green ammonia, sustainable aviation fuel and other products.

In June 2022, the DOE issued a US$504.4 million loan guarantee to finance Advanced Clean Energy Storage[10], a hydrogen and energy storage facility in Delta, Utah. The facility will capture excess renewable energy and store it as hydrogen by combining 220 MW of alkaline electrolysis with two 4.5 million barrel salt caverns to store clean hydrogen. The project is expected to start production in 2025[11].

On 14 December 2022, Florida Power & Light Co, a subsidiary of NextEra Energy Inc., broke ground on the Cavendish NextGen Hydrogen Hub, a solar powered electrolysis project capable of producing approximately 11 tonnes of hydrogen per day. The first clean hydrogen plant of its kind in Florida, this project was completed in February 2024.

[8] Green Hydrogen International Announces Hydrogen City, Texas – The World's Largest Green Hydrogen Production and Storage Hub (prnewswire.com)

[9] The Engineer – ABB joins team for 2.2GW Hydrogen City project in Texas

[10] ADVANCED CLEAN ENERGY STORAGE | Department of Energy

[11] Chevron Building Solar-to-Hydrogen Plant in California Oil Field | Rigzone

This chapter was provided by Bird & Bird Plus firm Sheppard Mullin and authored by Tony Toranto and Abigail Sharkey.

SheppardMullin

Key contacts

Sibylle Weiler
Head of Hydrogen

France
T +33 14 268 6016
E sibylle.weiler@twobirds.com

Tim Macmillan
Partner

Australia
T +61 29 226 9812
E tim.macmillan@twobirds.com

Kevin Munungu
Senior Associate

Belgium
T +32 2282 6019
E kevin.munungu@twobirds.com

Thomas Thorup Larsen
Partner

Denmark
T +45 2075 2749
E thomas.larsen@twobirds.com

Laura Huomo
Partner

Finland
T +35 89 6226 6215
E laura.huomo@twobirds.com

Dr. Matthias Lang
Partner

Germany
T +49 211 2005 6000
E matthias.lang@twobirds.com

Dr. Hermann Rothfuchs
Partner

Germany
T +49 89 3581 6000
E hermann.rothfuchs@twobirds.com

Dániel Arányi
Partner

Hungary
T + 36 1301 8920
E daniel.aranyi@twobirds.com

Key contacts

Pierpaolo Mastromarini
Partner

Italy
T +39 06 6966 7000
E pierpaolo.mastromarini@twobirds.com

Boris Martor
Partner

Morocco
T +33 14 268 6320
E boris.martor@twobirds.com

Sandra Seah
Partner

Singapore
T +65 6428 9429
E sandra.seah@twobirds.com

José de Santiago Forn
Partner

Spain
T +34 91 790 3202
E jose.desantiagoforn@twobirds.com

Mattias Lindberg
Partner

Sweden
T +46 85 063 2018
E mattias.lindberg@twobirds.com

Sophie Dingenen
Partner

The Netherlands
T +31 20 852 9540
E sophie.dingenen@twobirds.com

Michael Rudd
Partner

United Kingdom
T +44 207 415 6174
E michael.rudd@twobirds.com

Further key contacts

Marcos Patrón Costas
Partner, Allende & Brea

Argentina
T +54 11 4318 9943
E mpatron@allende.com

Paula Chaccur de Cresci
Partner, CGM

Brazil
E Paula.chaccur@cgmlaw.com.br

Jeremy Barretto
Partner, Cassels

Canada
E jbarretto@cassels.com

Martín Astorga
Partner, Cariola Díez Pérez-Cotapos

Chile
T +56 22 360 4047
E mastorga@cariola.cl

Gonzalo Jiménez
Partner, Cariola Díez Pérez-Cotapos

Chile
T +56 22 360 4047
E gjimenez@cariola.cl

Qais Jamal
Partner, AZB & Partners

India
E qais.jamal@azbpartners.com

Mark Bobela-Mota Kirkby
Partner, Sérvulo & Associados

Portugal
T +35 12 1093 3000
E mak@servulo.com

Vladimir Bojanović
Managing Partner, Bojanović & Partners

Serbia
E Vladimir.Bojanovic@bopa.rs

Simon Bračun
Managing Partner, Law firm KBP

Slovenia
E Simon.Bracun@kbp.si

Gozde Kuscuoglu
Partner, BTS & Partners

Turkey
E gozde.kuscuoglu@bts-legal.com

Tony Toranto
Partner, Sheppard Mullin

United States
T +1 858 720 7432
E Ttoranto@sheppardmullin.com

Bird & Bird

Our sectors

Automotive
Aviation & Aerospace
Defence & Security
Energy & Utilities
Financial Services
Life Sciences & Healthcare
Media, Entertainment & Sport
Retail & Consumer
Technology & Communications

One firm.
Your firm.

twobirds.com