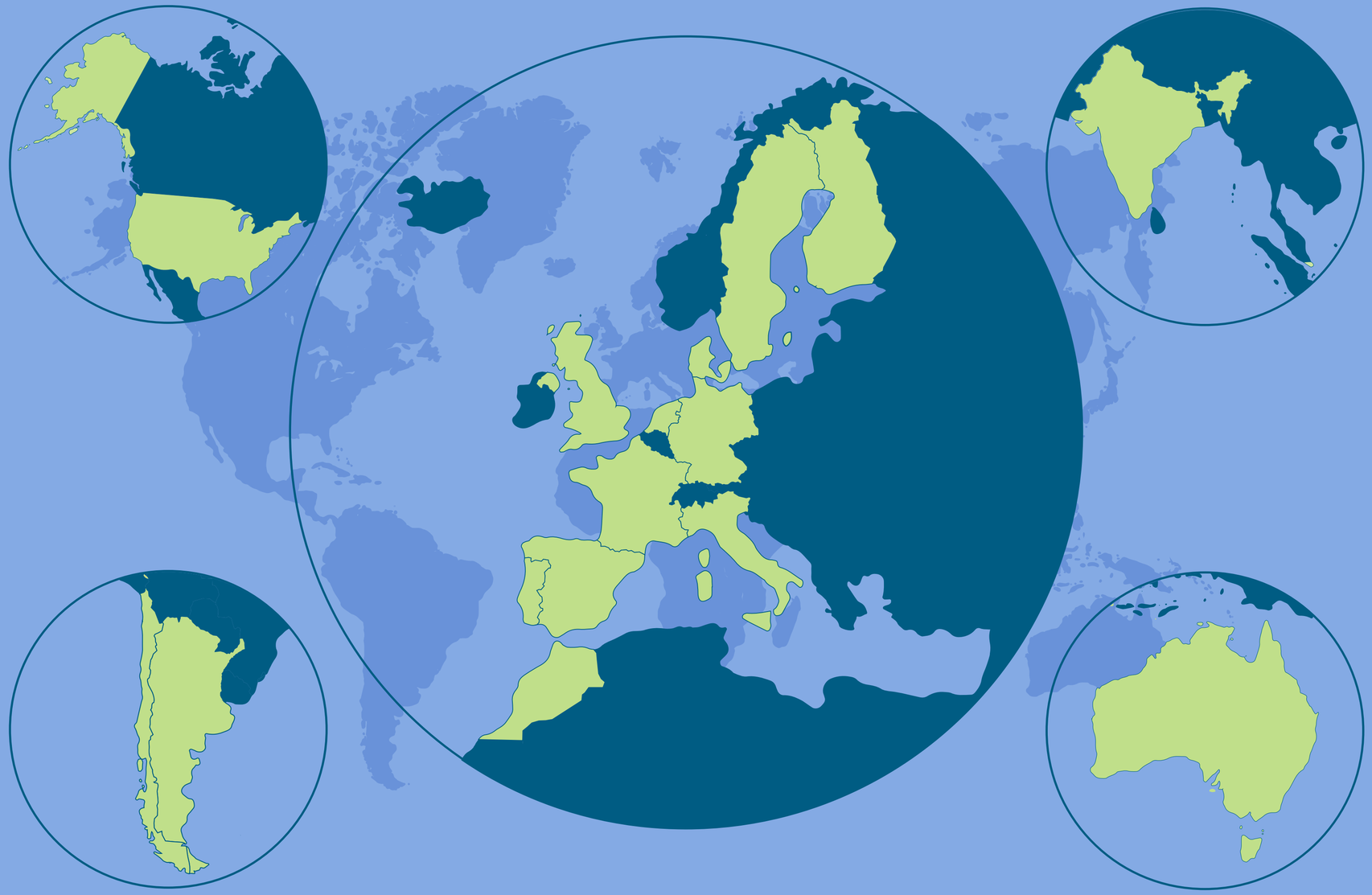
Bird & Bird

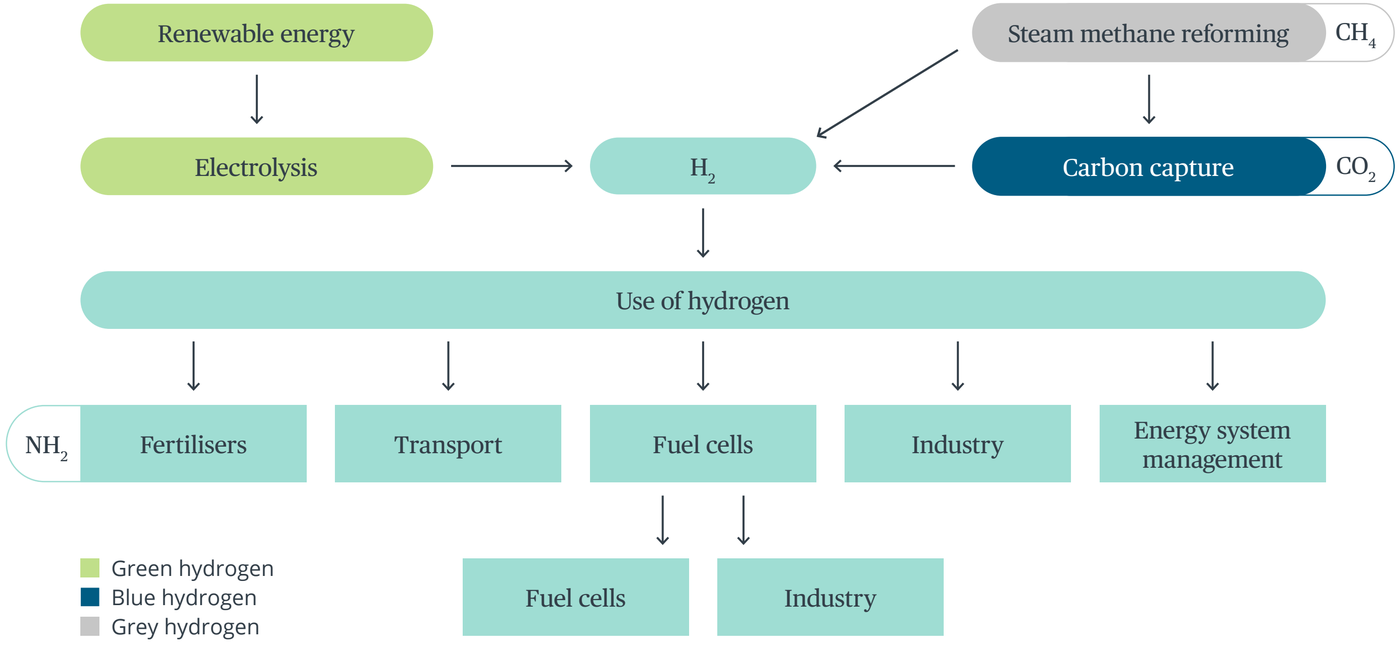
International *Green Hydrogen* Report 2023



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.

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.

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 is considered the fastest-growing source of greenhouse gas emissions. Air travel is expected to double in the next 15 years meaning these numbers will continue to grow.

The aviation industry needs a solution for decarbonisation, especially as many airlines have 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.

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 includes a proposal to ensure a level playing field for sustainable air transport, also known as the ReFuelEU Aviation Initiative. The draft regulation proposes that fuel suppliers must distribute an increasing share of SAF, including green hydrogen, over time to increase the number of airlines using SAF and help to reduce emissions from the aviation industry.

EU Sustainable Aviation Fund and Green Labelling

As the European Parliament pushes for greener aviation fuels, they have proposed creating a Sustainable Aviation Fund from 2023-2050, to help accelerate the decarbonisation of the sector and support investment in SAF, which includes hydrogen after MEPs updated the proposed definition of sustainable aviation fuel to include hydrogen as part of a sustainable fuel mix. To further promote decarbonisation and inform the public, by 2024 the Commission will develop an EU labelling system on the environmental performance of aircrafts, operators and commercial flights.

UK FlyZero project

In 2021, the UK Government backed plans for the £15 million FlyZero project, led by ATI, a concept for a midsize aircraft powered by liquid hydrogen. The aircraft would allow up to 279 passengers anywhere in the world without producing any carbon emissions.

UK Aerospace Technology Institute ("ATI") Programme

The UK Government are investing over £110 million to develop cutting edge technologies that could enable hydrogen powered aircraft. Through the Aerospace Technology Institute ("ATI") Programme, the UK Government and industry are backing new zero-carbon technologies to open up a future of emission free flights.

It is estimated that hydrogen has the potential to *reduce aviation's CO_2 emissions* by up to 50%.

Recent projects

Recently we have seen the start of a number of projects, showing the potential for hydrogen use in the aviation sector:

01

ZeroAvia is working to enable scalable, sustainable aviation by replacing conventional engines with hydrogen-electric powertrains. Hyflyer, one of ZeroAvia's major projects, aims to promote the expansion of zero emission aviation in commercial aircraft. In 2021, ZeroAvia announced a collaboration with Alaska Air Group to develop a hydrogen-electric powertrain to fly a 76-seat regional aircraft. Alaska Airlines have ambitious goals to achieve net-zero carbon emissions by 2040 and are taking steps in the right direction.

02

Vertical Aerospace, a UK-based electric aircraft manufacturer are part of the Aerospace Technology Institute ("ATI") Programme, and are working to develop high-end lightweight batteries, as well as projects led by Rolls-Royce to develop the building blocks of a liquid hydrogen combusting jet engine, which would enable flight without carbon emissions.

03

Airbus signed a partnership with CFM International (the 50/50 joint company between GE and Safran Aircraft Engines) to collaborate on a hydrogen demonstration program that will take flight around 2025. The program will ground, and flight test a direct combustion engine fuelled by hydrogen, ready to enter into service of a zero-emission aircraft by 2035.

04

Furthermore, in November 2022, Airbus revealed that it is developing a hydrogen-powered fuel cell engine, which is being considered a potential solution to equip its zero-emission aircraft that is due to enter service by 2035.

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.

Hydrogen offers a variety of advantages as a reliable, high performing, and cost-effective alternative. The use of hydrogen fuel-cells will 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. So far, the Coradia iLint has successfully operated in regular passenger service in Germany and Austria and covered more than 220,000 kilometres. The Lower Saxony Regional Transport Company donated €81 million for the purchase of the trains. Alstom's development of the Coradia iLint was also funded with €8 million from the German Government as part of the National Innovation Program for Hydrogen and Fuel Cell Technology ("NIP").

In 2021, the French Government allocated a grant of €47 million to support the development of hydrogen-powered trains in France which also involved Alstom who planned to build 14 Regiolis H2 multiple units to operate in the regions of Auvergne-Rhône-Alpes, Bourgogne-Franche Comté, Grand Est and Occitanie. French National Railways has a goal of removing diesel operation completely by 2035, and the introduction of hydrogen will help to reach this.

Since then, other companies have followed in Alstom's steps with their own innovations. H2 Green, the hydrogen network operator and Eversholt Rail, a leading railway rolling stock owner, entered into an agreement to develop hydrogen solutions for the UK railway. The collaboration will work 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. The 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.

In 2022 we saw a number of joint venture and collaboration agreements between mining companies and researchers in relation to developing and trialling green hydrogen technologies. 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.

The use of hydrogen power for mining vehicles will allow the industry to tackle climate change and move towards making mining operations carbon neutral. Furthermore, integrating hydrogen into a microgrids offers a storage solution and a fuel source for mining activities which is a good option for decarbonising power sources. Green hydrogen technologies however are notably costly and technically challenging to develop and we expect the development and collaboration to continue.

The UK Government has announced that it will launch a new £40 million Red Diesel Replacement Competition to fund the development and demonstration of innovative technologies that enable Non-Road Mobile Machinery (“NRMM”) used for quarrying, mining, and construction to switch from red diesel to hydrogen or other low carbon fuels.

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 Metals Group have plans to replace their existing fleet of diesel coaches at its Christmas Creek iron ore mine in Western Australia with ten hydrogen fuel-cell powered coaches. The Government of Western Australia has announced its aim to have hydrogen widely used in mining haulage vehicles by 2030.

02

Other states in Australia are also at the forefront of the transition to hydrogen use in mining. For instance, the Government of South Australia is working with the minerals sector to investigate the opportunities for hydrogen in remote mining. The Queensland Government is also supporting a range of significant hydrogen projects, including mining and infrastructure solutions provider Orica and Korean power generator East–West Power Corporation (“EWP”) on the development of a H2-Hub in Gladstone and Aurizon and Anglo American’s study into using hydrogen-powered trains for bulk freight on Aurizon’s Moura and Mount Isa Rail corridors.

03

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. This is a hydrogen-powered ultra-class mine haul truck, which marks the first time a truck of this size and load capacity has been converted to run on hydrogen, that will be produced on-site in hybrid combination with a battery. The fuel cell hauler is active at Anglo American’s Mogalakwena Platinum mine.

04

In February 2023, the UK Government approved the use of the world’s first digger powered by a hydrogen combustion engine on UK roads and used on industrial sites, showing that the reality of hydrogen for the mining sector is not too far away.

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. Both can help achieve a 100% reduction in CO2 emissions.

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 large-scale 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 lorry's will soon be mass-produced in the UK. This will be the first of its kind to be manufactured in the UK.

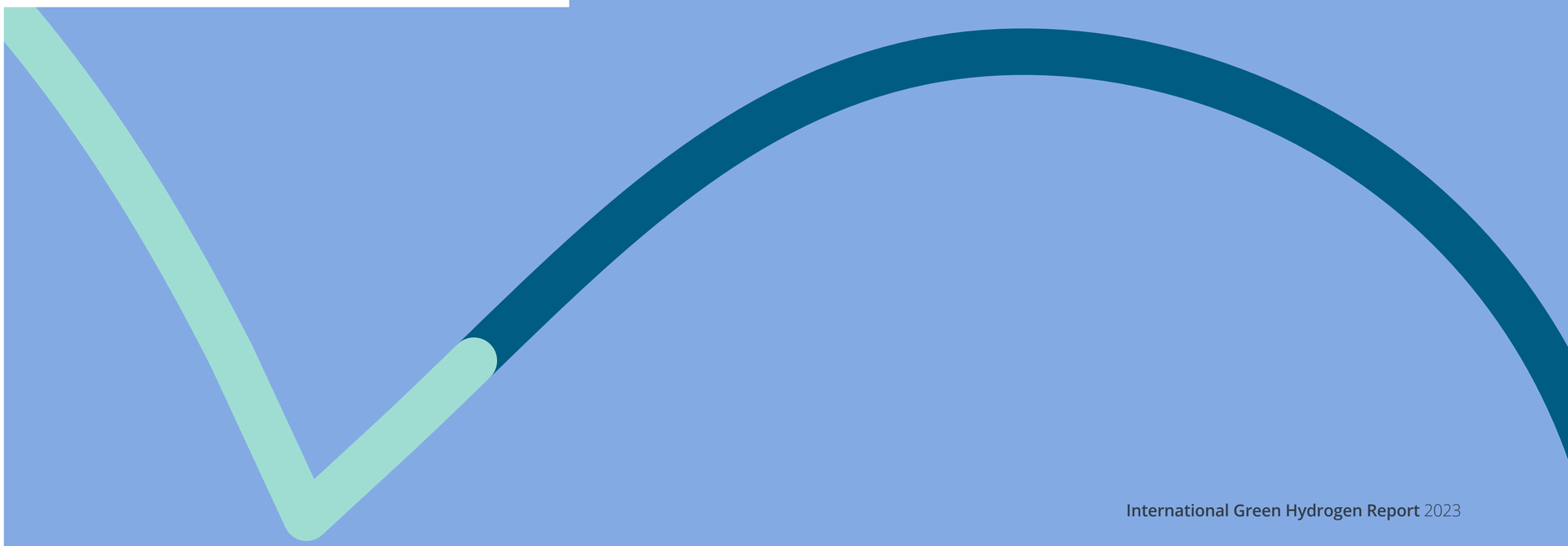
02

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 of a large energy storage system.

03

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.

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

The European Commission has published its legislative **"Package on Hydrogen and Decarbonized Gas Markets"** ("Package"), including new rules aiming to develop a hydrogen market in the EU. It should clarify the legal concepts within the EU's energy regulatory framework.

The draft Gas Directive includes definitions of renewable and low-carbon hydrogen, in line with the proposed amendments to Renewable Energies Directive II in this respect:

- renewable hydrogen is defined as hydrogen that (i) is produced using renewable sources other than biomass; and (ii) achieves a 70% GHG emission reduction compared to fossil fuels;
- low-carbon hydrogen is defined as hydrogen produced from non-renewable sources, and that meets a GHG emission reduction threshold of 70% compared to fossil-based hydrogen.

The European Parliament and Council must now consider the proposed Regulation and Directive for their adoption and they are entitled to modify the proposals (for example to include further incentives and more flexible rules for low-carbon hydrogen). The final legislation is still to be adopted.

The EU taxonomy policy will also play a significant role in particular with respect to the taxonomy compatibility of certain energy sources such as nuclear power and gas. In its Delegated Act, presented on 2 February 2022, the European Commission foresees that gas plants will have to use renewable energy or hydrogen as of 2035 in order to keep a status as taxonomy aligned projects.

On 1 February 2023, the European Commission announced a Green Deal Industrial Plan ("GDIP") to enhance the competitiveness of Europe's net-zero industry and the development of the green skills of the EU workforce. The plan consists of four pillars, all relevant for hydrogen technologies and their applications: a predictable and simpler regulatory framework, faster access to funding, enhancing skills and an ambitious open trade agenda.

The GDIP includes an auction facility for supporting the production of renewable hydrogen through the European Hydrogen Bank with an indicative initial budget of €800 million. It will offer a "fixed premium" per kg of green hydrogen, subsidising domestic EU production over a 10-year period. This pilot auction will be followed by further forms of actions to support hydrogen production.

On 23 February 2023, the European Commission has proposed two long awaited Delegated Acts to accelerate the European Union regulatory framework for renewable hydrogen, extending the scope of renewable hydrogen. The two Delegated Acts on so-called renewable fuels of non-biological origin ("RFNBOs"), define what qualifies as green hydrogen and its derivatives (green ammonia or green methanol) in the European Union.

To avoid that renewable energy is solely used for the production of renewable hydrogen, the first act set up the additionality criterion to be complied with to demonstrate that hydrogen produced is renewable. In other words, RFNBOs can only be produced from "additional" renewable electricity.

The Delegated Acts introduced two main situations where hydrogen can be considered renewable, enabling a greater geographical spread of hydrogen production facilities. Hydrogen can be renewable when there is as 'direct connection', i.e., the hydrogen production facility is connected directly to a new renewable electricity installation, and does not use electricity from the grid and when there is a grid connection, but the electricity used is "demonstrably" renewable (following Delegated Acts' rules).

The Acts also set up temporal and geographical correlation conditions: renewable hydrogen is only produced when enough local renewable energy is available, and this electricity must be matched with electrolysers in terms of time and location. If the emission intensity of electricity in a bidding zone, for a producer who has concluded Corporate PPAs, is below a fixed amount (18 grams of CO2-equivalent per megajoule), the additionality criterion is not required.

On 23 February 2023, the European Commission has proposed two long awaited *Delegated Acts to accelerate the European Union regulatory framework for renewable hydrogen*, extending the scope of renewable hydrogen.

Exceptions to the rules are granted if the electricity taken from a local grid in a bidding zone that already has a 90% renewable mix (for the moment this criterion is only matched in two of the Swedish bidding zones) or if the electricity used is consumed during the imbalance settlement period.

A transition period is implemented to allow first movers in the renewable hydrogen sector to be exempt from certain additionality requirements even up to 2038 if the installation came into operation before 1 January 2028.

In addition, the time correlation between renewable energy production and its use for hydrogen is made on a monthly basis until 2030 and on a much stricter hourly basis as from 2030. Member States are allowed to introduce stricter rules about such timely correlation as of July 1st 2027.

The second Delegated Act refers to the calculation of greenhouse gas – 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. Recycled carbon fuels shall reduce greenhouse gas emissions for at least 70%, compared to fossil fuels they replace.

The Delegated Acts refer to the Renewable Energy Directive, which does not qualify Nuclear Power as Renewable.

Under the Hydrogen and gas markets decarbonisation package proposed in December 2021 which is still under discussion, the Commissions suggested to integrate a "low carbon hydrogen" definition. Such low-carbon hydrogen could be produced from non-renewable sources (such as Nuclear) that reduce at least 70% of greenhouse gas emissions in comparison to fossil natural gas. However, the methodology to calculate such a 70 % emission savings is not to be expected before end 2024.

The Delegated Acts have to be approved or rejected (with no amendment possible) by the European Parliament within two months, eventually to be prolongated for another maximum two-month period.

The acts foresee a revision process in 2028.

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 objective of the two Delegated Acts is also to help channel EU funds towards renewable hydrogen, as well as to guide the approval of national state aid schemes.

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 July 2020, Australia adopted a suite of *eight international standards* for the safe use, transport and trade of hydrogen across Australia.

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 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.

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.

Legal framework overview (cont)

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

In 2023, the Australian Government will be leading 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 decarbonization of Australian industries. The review of the Strategy will take account of 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 Strategy sets out *57 coordinated* government actions to enable the industry *to scale up quickly*.

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 AU$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 AU$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 AU$300 million "Advancing Hydrogen Fund", administered by the CEFC. Through the fund, the CEFC shall provide debt or equity finance to eligible large-scale commercial and industrial projects, typically requiring AU$10 million or more.

Between September 2020 and November 2021, the Australian Government committed AU$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.

The Australian Government is continuing to work with the hydrogen industry in *order to overcome barriers to development.*

Funding & Support schemes (cont)

In 2023, Australian Government will invest AU$49 million in Queensland state to develop a green hydrogen hub in Queensland.

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 AU$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 AU$150 million (€95 million) program, the 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.

Up-coming evolution

The Australian hydrogen industry has gained momentum in the past couple of years. Private sector investment is growing, with over AU$1.6 billion committed, and public sector investment reached AU$1.27 billion in June 2021. Project announcements indicate that by 2025, over 100 MW green hydrogen could be being produced in Australia.

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

AU$1.6 billion

Private sector investment

AU$1.27 billion

Public sector investment

In 2023, Australian Government will invest *AU$49 million* in Queensland state to develop a green hydrogen hub in Queensland.

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.

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 and 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.

The National Energy Resources Australia ("NERA") unveiled in February 2021 an AU$1.85 million investment in 13 regional hydrogen technology clusters over the six Australian States.

One of the world's largest renewable hydrogen power stations is to be built in Pilbara, Western Australia.

The Australian subsidiary of the French company ENGIE is the main player in this project, which has received AU$47.5 million (€32.7 million) from the Australian Renewable Energy Agency ("ARENA"). The total budget is AU$87 million (€60 Million) and is expected to be completed by 2024. It includes a 10 MW electrolyser to produce hydrogen.

Fortescue Future Industries Group has announced plans to build a 500 MW electrolyser in Queensland. The electrolyser, located at the Gibson Island site in Brisbane, could eventually produce up to 70,000 tonnes of green hydrogen per year. The site already houses an ammonia production plant, so some of the hydrogen produced could be used to decarbonise this production. The funding agency ARENA has already announced AU$13.7 billion (€8.9 billion) to support Fortescue's FEED study with Australian chemical company Incitec Pivot Limited ("IPL"), which operates the ammonia plant.

In 2023-24, the Tallawarra B project will be Australia's first net-zero emissions dual-fuel, gas-hydrogen power plant, and will provide over 300 MW of dispatchable capacity in New South Wales, coinciding with the retirement of the Liddell coal-fired power plant in the Hunter Valley.

Argentina

Argentina has the potential to become one of the regional leaders in green hydrogen production due to an unparallel combination of renewable energy sources, specially wind (the general average capacity factor for Argentina is 35% and in the Patagonia region it ranges between as much as 47% and 59%[1]) 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. In this sense, Argentina has not defined a legal framework considering the green hydrogen value chain in its entirety.

Currently, the green hydrogen chain is subject to the 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 and insurance policy to cover any potential damages to the environment.

According to most provincial and municipal regulations, the activities related with water desalinization and the electrolysis process would require the obtention of a liquid effluents 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 by its Spanish acronym) may be required.

The interjurisdictional transportation of dangerous substances like gas or liquid hydrogen require the prior authorization of the Transport Regulatory Commission and subject to the General Regulation for the Transport of Dangerous Substances by Road.

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, and the Border Security Zone Law (Decree-Law No. 15385/44) which requires the prior authorization by the National Government for the ownership or use of land located in the country's border by foreigners.

With respect to the 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 by its Spanish acronym).

[1] https://library.wwindea.org/listing/argentina/

Funding & Support schemes

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

In 2022, the Ministry of Productive Development ("Ministerio de Desarrollo Productivo") launched 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$ 60,000,000 per project and 70% of the total amount of the project and interest rate subsidies of up to 800 bps of the applicable interest rate.

In addition, Argentina's Secretariat of Strategic Affairs ("Secretaría de Asuntos Estratégicos") has repeatedly emphasized the importance of European funding to support investments in green hydrogen. During 2022, Argentine delegations travelled to Luxembourg, Germany, France and Spain to seek funding for the production of green hydrogen.

Up-coming evolution

In May 2021, the Economic and Social Council ("Consejo Económico y Social"), a governmental body which purpose is the promotion and development of green hydrogen and renewable energies, 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.

The National Government recently announced that it will introduce a new Hydrogen Bill during the first months of 2023, which will aim to promote and regulate the production and use of hydrogen through a 30-year promotion regime, focusing on its production, use in industrial processes, the development of value chains and the consolidation of production, transport, logistics and export hubs.

The Hydrogen Bill would include concrete tax benefits such as early VAT reimbursement, accelerated amortization of income tax, compensation for loss of profits, deduction of financial liabilities and tax exemption on the distribution of dividends; schemes of up to 10 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. In addition, it is expected that the Hydrogen Bill will exempt hydrogen projects from the mandatory repatriation of export proceeds rule that is currently in force, allowing them not to repatriate up to 30% of their total export proceeds and up to 100% of their incremental export proceeds.

With respect to the private sector, it is worth highlighting the initiative of YPF, the state owned oil and gas company, which 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.

The goal is to reach a production of approximately *10 million tons* of green hydrogen by 2030.

Some recent examples

Within the framework of the 2021 COP-26 in Edinburgh, the Australian company Fortescue Futures Industries announced an investment of US$8 billion over 10 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.

Days later, US-based MMEX and SIEMENS announced an investment in the Tierra del Fuego Province to install a US$500 million wind farm and electrolysis plant to generate 55 tons of hydrogen per day, equivalent to 160 MW of power.

While both companies affirmed that the investment plans are still on track, they 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

Australian company *Fortescue Futures* Industries announced an investment of *US$8 billion* over 10 years.

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 in order 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.

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.

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

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.

[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 first stage of the National Green Hydrogen Strategy is expected to start in 2023.

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.

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 first stage of the National Green Hydrogen Strategy is *expected to start in 2023*.

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 in the Valparaíso region; (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 favorable environmental qualification resolution, granted in April 2022.

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 leaders 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 on 15 March 2022 regarding the development and promotion of hydrogen and green fuels.

The agreement is better known as the "Power-to-X strategy". Power-to-X (hereafter "PtX") covers several technologies, all of which are based on the fact that power is utilized to produce hydrogen. The agreement includes a goal of building an electric electrolysis capacity of 4-6 GW 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 is the assessment of the Danish Ministry of Climate, Energy and Utilities that there is a current need for regulation of the Danish hydrogen market, which is why it is not possible to wait for the EU regulation to be in place. A new regulation of hydrogen has thus 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* 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 therefore apply to both methane-based gas and now hydrogen gas. The purpose of the amendment to the law is, among other things, to create the framework for the establishment of a hydrogen infrastructure (transport and storage) that will help support the green transition and promote the development of PtX. It is 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. The funds will be used for a government tender for hydrogen production, as well as better framework conditions for producers. The PtX tender is expected to be implemented as follows:

- Market-based tender, aiming for the cheapest and largest hydrogen production for the budget.
- Winners of the tender are determined by selecting the lowest bids for premiums until the budget is depleted.
- Only hydrogen production produced from renewable energy sources and meeting EU requirements for documentation of green PtX fuels is eligible for the grant.
- The funds are granted for a 10-year period and all the funds (DKK 1.25 billion) are implemented in a single tender round if sufficiently attractive bids are received, cf. below.
- A safeguard mechanism is put in place to ensure that supply does not result in very low hydrogen production and capacity due to high bid prices. In addition to a general bid cap to provide certainty against very high bid prices, a lower, budget-controlling bid cap will be set, which is a prerequisite for the entire budget to be allocated if sufficiently attractive bids are received. Alternatively, two bidding rounds will be held. The bid ceilings will be set by the Danish Energy Agency.

The purpose of the PtX tender is to support industrialization and scaling up of PtX production in Denmark and thereby 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, PtX can in several different ways 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.

Up-coming evolution

The Danish Energy Agency has initiated a market dialogue with current and potential PtX players. The market dialogue will uncover how a hydrogen infrastructure best supports both producers and users of hydrogen in order to provide the best opportunities for the continued development of a PtX industry in Denmark that can unleash the great potentials of renewable energy. 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.

The market dialogue made it clear that the hydrogen industry has a great need for the establishment of 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 percent of the hydrogen production from pure hydrogen projects is expected to use pipe-borne infrastructure.

From 2030 onwards, *more than 87 percent of the hydrogen production* from pure hydrogen projects is expected to use pipe-borne infrastructure.

Some recent examples:

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

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 3 GW with a first phase based on power from onshore windfarms and solar parks but later also offshore wind farms.

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 2 GW. The ambition is an annual production of over 1 million tons of green fuels (green ammonia/e-methanol).

03 "Green Fuels for Denmark" is a project run by a consortium consisting of Ørsted, and a number of major Danish logistics companies aiming at producing 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 1.3 GW by 2030.

04 HØST is a PtX-project aiming to use wind and solar power to produce green ammonia used for both artificial fertilizers and fuel and is expected to make Denmark self-sufficient in ammonia for fertilizer 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.

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 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 1 GW.

Finland

Finland's target, to become carbon neutral by 2035 and carbon negative by 2050, is some of the most ambitious targets in the world. Although Finland does not have a separate hydrogen strategy, hydrogen is considered to be an integral part of the national energy and climate strategy.

Business Finland (the Finnish Government organization for innovation funding and trade, travel, and investment promotion) published in November 2020 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. Furthermore, investments in power-to-X technologies play a key role in Finland's Recovery and Resilience Plan, published in May 2021.

Legal framework overview

As the main context is to view Finland 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, as for many other countries, Finland does currently not 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. Hydrogen compliant and future-proof legislative planning is fortunately on the national agenda.

In order to contribute to the national climate targets and to further facilitate and stimulate the hydrogen economy and advancement of new technologies pursuant to the EU Hydrogen and Sector Integration Strategies, the Ministry of Economic Affairs and Employment appointed a working group in July 2020 tasked with identifying the needs, opportunities and obstacles of energy sector integration, and to assess the possibilities for promoting the hydrogen economy and Power-to-X technologies. The final report of the working group on sector integration was published in June 2021 highlighting 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.

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 will allow support to energy investments under Finland's Recovery and Resilience Plan in 2022-2026. 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. Upon the adoption of the decree, calls for applications related to the energy system transformation and industrial energy solutions of the Sustainable Growth Programme can be opened. The amount of available funding will total about €520 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 related to the implementation of projects and the granting of 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 related to 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 Government Decree will enter into force on 16 December 2021 and remain in force until 31 December 2026.

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. The first application round for energy investment subsidies under the Sustainable Growth Programme for Finland will take place from 20 December 2021 to 4 March 2022. Funding will be available for energy infrastructure projects, new energy technology, production and storage of low-carbon hydrogen, carbon dioxide capture and use, and investments to reduce carbon use and electrify industrial processes. The aim is to reduce Finland's greenhouse gas emissions, support Finland's carbon neutrality targets and encourage businesses to adopt renewable energy and new energy technology.

Funding will be directed to national projects and projects linked to the hydrogen IPCEI (important Project of Common European Interest). The call for IPCEI applications closed 4 July 2021. The projects will support the objective of the government to achieve a carbon neutral Finland by 2035.

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 – a full and working value chain for hydrogen, and decades of experience in large-scale industrial use of hydrogen is already present. In Finland, 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 gas 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 utilize zero-emission electricity (or are otherwise 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 is 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’ of “which came first – the chicken or the egg?” between supply, demand, and infrastructure. In the current landscape this translates to lack of transparency and trust in the market, hence, many players find themselves being in a mode of “wait-and see”. Despite this, there is a positive and supportive buzz focusing on strong players, innovative technology, and cooperation.

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

As stated in the national Hydrogen Roadmap, hydrogen offers for Finland great opportunity to create wide range of new businesses throughout the entire hydrogen value chain. To showcase the level of determination both private and public actors are already making significant contributions to hydrogen projects. Just to mention a few of these initiatives:

The Finnish gas transmission system operator, Gasgrid Finland, joined the European Hydrogen Backbone ("EHB") initiative in April 2021 that 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. Furthermore, Gasgrid Finland and Fingrid, Finland's transmission system operator for electricity, launched a joint research project that has been running from 2021, to enable the hydrogen economy. The final report of the project is expected to be published in the summer of 2023. The joint project involves 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 transmission network and developing the foundations for a hydrogen market and sector integration.

The joint project by Gasgrid Finland and Fingrid is being run as part of a consortium known as Hydrogen and Carbon Value Chains in Green Electrification ("HYGCEL"), which includes several Finnish companies and universities. Business Finland has awarded a grant for the HYGCEL project consortium, which has a budget of over €10 million and which is estimated to be running up until 2024.

Gasgrid Finland carried out in fall 2021 a study on the potential of hydrogen economy and hydrogen market development. The analysis shows that Finland has significant potential in the hydrogen economy of the future, both as a hydrogen producer and as an export country. According to the analysis, the green hydrogen supply potential is of ~ 50 TWh/y by 2030, although this requires delivering on its vast onshore wind potential with 20 GW under development and 90 GW of grid applications received.

A national company-led Hydrogen Cluster was established in in April 2021 to accelerate hydrogen economy and exports of hydrogen-related solutions.

In Finland, several projects have spotted the Gulf of Bothnia as a potential hydrogen valley. In the region, there are great resources for sustainable hydrogen production, industry needing hydrogen for decarbonisation, technological know-how and excellent infrastructure. With this potential in mind, an international network, umbrella brand and collaboration platform called BotH2nia was established in April 2021 for promoting and building a large-scale hydrogen economy around the Gulf of Bothnia.

P2X Solutions, a Finnish pioneer in green hydrogen and Power-to-X technology, intends to build Finland's first green hydrogen production plant in Harjavalta. When commissioned, the facility will produce green hydrogen for e.g., industrial needs by using electricity produced from renewable energy sources. The planned production facility has a capacity of 20 MW and as by-products it generates oxygen and thermal energy needed by industries. 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.

P2X Solutions and an energy company Savon Voima are carrying out preparatory studies for the construction of an industrial-scale green hydrogen and electro fuels production facility in Savon Voima's Joensuu power plant area. According to preliminary plans, the capacity of the power plant would be 30-50 MW and would generate up to 15-20 percent of Joensuu's district heating needs as a side stream.

In addition to the above there are a myriad of R&D projects, both concluded and under development, steered by the leading universities, such as LUT University (Lappeenranta-Lahti University of Technology LUT).

Business Finland has awarded a grant for the HYGCEL project consortium, *which has a budget of over €10 million* and which is estimated to be running up until 2024.

France

The French Government unveiled its national hydrogen strategy in September 2020. €7 billion of public support will be granted for the next 10 years, including €2 billion from the “Big Green Recovery Plan”, a component of the national “Recovery Plan” (“Plan de relance”). In addition to these investments, the France 2030 plan, announced in February 2022, brings the State’s investment in hydrogen to €8.9 billion. France aims to achieve carbon neutrality by 2050 and to halve the industrial sector carbon emissions in the next 10 years.

To reach these objectives, green hydrogen is one of the solutions identified to massively decarbonize high emitting industries. On that account, France aspires to become a world leader in green technology for the production of decarbonised hydrogen as stated by Bruno Lemaire Minister of the Economy, Finance and Industrial and Digital Sovereignty.

Legal framework overview

In accordance with the November 2019 Energy and Climate Law, the so-called “Hydrogen Ordinance” dated February 17th, 2021 (n°2021-167) grants hydrogen an independent legal status. This detailed legal framework aims to promote the French hydrogen sector development, in particular by referring to three different types of hydrogen (renewable hydrogen (“hydrogène renouvelable”) dissociated from low carbon hydrogen (“hydrogène bas-carbone”) and from carbonaceous/ fossil hydrogen (“hydrogène carboné”)).

To be qualified as renewable hydrogen, hydrogen must be produced (1) either by electrolysis using electricity produced by renewable energy sources or by any other technology using exclusively one or more renewable energy sources, and (2) whose production process does not exceed a greenhouse gas emission threshold.

In addition, the Hydrogen Ordinance provides for guarantees of origin and unprecedented guarantees of traceability for renewable and low-carbon hydrogen to give clearer information to buyers and useful input to suppliers.

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

€8.9 billion

Public support for the next 10 years

Legal framework overview (cont)

On 24 August 2021, the Law to combat climate change and strengthen resilience to its effects (the "Climate and Resilience Law") dated 22 August 2021 was published. According to the Climate and Resilience Law:

01 Local authorities are entitled to take part in the development of hydrogen, and to develop, operate or delegate the development and operation of hydrogen facilities in the same way as renewable energy projects (article L. 2224-32 of the General Code of Local Authorities).

02 Municipalities and their groupings may participate in the capital of a public limited company or a simplified joint stock company whose corporate purpose is the production of renewable or low-carbon hydrogen in the same way as companies whose corporate purpose is the production of renewable energy (article L. 2253-1 of the General Code of Local Authorities.

03 For hydrogen projects awarded by calls for tender and benefiting from a public support mechanism, the Administration may waive its right to organise a competitive bidding procedure relating to occupation of the public domain (article L. 2122-1-3-1 of the General Code of Local Authorities).

Funding & Support schemes

The Hydrogen Ordinance provides that renewable and low-carbon hydrogen producers are eligible for a support scheme in the form of investment aid ("CAPEX"), operating aid ("OPEX"), or a combination of both.

A tender process will be carried out depending on economic and environmental criteria, and will be open to any producer established in a Member State of the European Union's territory or within the European Economic Area.

However, the regulatory texts implementing the Hydrogen Ordinance are still awaited to detail the public support mechanism for hydrogen, the rules applicable to the guarantees of origin and the traceability mechanism.

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.

The 2030 plan sets out three key measures for green hydrogen industry: (1) to install enough electrolysers to make a significant contribution to the decarbonisation of the economy; (2) to develop clean mobility, particularly for heavy vehicles; and (3) to foster the development of a clean hydrogen industry in France.

France are set to have a new national hydrogen strategy by the end of 2023.

This strategy revolves among others around three major steps; (1) pooling hydrogen hubs production to reduce costs and encourage the development of low-carbon industrial activities; (2) access to decarbonised electricity for these hubs is also a major issue, therefore large electrolysers will need to be able to enter into competitive long-term contracts with electricity suppliers; (3) control of hydrogen-related equipment that will enable France to secure a crucial position in a rapidly growing global market.

In addition to the support mechanism and local calls for projects, decarbonized hydrogen projects will be funded through the PIA (Investment for the future program) and the IPCEI (important project of common European interest). Within the 41 projects selected in the first IPCEI ,10 are French, making France the most represented country of this IPCEI.

France are set to have a new national hydrogen strategy *by the end of 2023*.

Some recent examples

As stated in the national Hydrogen Roadmap, France has a central role to play in the decarbonisation of aviation. French aviation companies benefiting from State aid and thus €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%.

The Airbus fleet represents approximately 45% of all aircraft in circulation. However, in November 2022, Airbus revealed that it is developing a hydrogen-powered fuel cell engine, which is being considered a potential solution to equip its zero-emission aircraft that is due to enter service by 2035.

CFM International (the 50/50 joint company between GE and Safran Aircraft Engines), agreed in February 2022 to collaborate on a hydrogen demonstration program that will take flight around 2025. The program will ground and flight test a direct combustion engine fueled by hydrogen, ready to enter into service of a zero-emission aircraft by 2035.

In January 2022, Air Liquide Normandy, 100% owned by Air Liquide, obtained the authorisation to operate a plant with a capacity of 200 MW. It will produce 28,000 tons of hydrogen per year, by electrolysis of water, for industrial and heavy-duty mobility applications in Normandy. The commissioning of the plant is expected in 2025.

Moreover, in June 2022, Lhyfe (a pioneering green hydrogen producer) and Chantiers de l'Atlantique (one of the world's leading shipbuilding companies) have signed a Memorandum of Understanding for the development of offshore hydrogen production platforms. The two companies will collaborate on offshore renewable hydrogen production projects with on-grid or off-grid wind farms and plan to develop green hydrogen production solutions with a minimum capacity of 100 MW. These will be installed on existing fixed structures or mounted on seabed foundations or floating platforms.

H2V is developing a 600 MW green hydrogen production unit in Fos-sur-Mer (Marseille), which will be developed in six 100 MW units between 2026 and 2031, on a 36-hectare site in the industrial-port area. Together with Ascométal electric steelworks, H2V Fos should produce 84,000 tons per year of renewable hydrogen by water electrolysis and avoid the emission of 750,000 tons of CO2 each year. It represents an investment of €750 million. HysetCo is a joint venture created by Air Liquide, Idex, STEP, Kouros and Toyota, and dedicated to the development of hydrogen mobility.

It owns the largest fleet of hydrogen taxis in the world, operated by Hype. The objective is to achieve zero emissions for taxis and VTC for the Paris Olympic Games in 2024. In May 2021, TotalEnergies SE acquired 20% stake in HysetCo; it plans to make its network of service stations available to Hysetco to expand hydrogen use.

MET 5 and Clean HY2 Infra Fund managed respectively by French Hy24 S.A.S. and Mirova S.A., signed their €200 million investment in green hydrogen pioneer Hy2gen AG in partnership with CDPQ and Technip Energies. It has been the biggest private investment in the Green Hydrogen Field.

The capital will be used for the construction of facilities in several jurisdictions across and outside Europe, producing green hydrogen-based fuels – or "e-fuels" – for maritime and ground transport, aviation and industrial applications. Production sites are located in France, Germany, Canada and Norway.

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 has ambitions to become a leader in green hydrogen associated technologies. In 2020, the German Government adopted its National Hydrogen Strategy ("NWS") to achieve this. In Autumn 2021, the new German Government was elected, who quickly turned the focus of the German energy transition to Hydrogen. The German Government aims to become the leading market for hydrogen technologies, with an electrolysis capacity of 10 GW by 2030.

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

Legal framework overview

There is no consistent and complete legal framework covering the hydrogen value chain in Germany, whereas renewable energy is supported under the EEG ("Erneuerbare Energien Gesetz"). Initially, statutory feed-in tariffs were paid by the grid operators who took off the electricity. Meanwhile, only small plants still benefit from feed-in tariffs, whereas other installations have to sell the electricity and can receive additional support as a 'market premium' payable by the grid operator.

The EEG 2021 framework benefits to hydrogen storage and plans inter alia that the payment of the EEG-surcharge ("EEG-Umlage") shall be reduced to zero for electricity consumed by a green hydrogen production installation, irrespective of its intended use, from 1 January 2022 onwards. Further to that, the revised EEG 2021 expressly refers to "green" hydrogen-dependent on its manufacturing process and privileged contrary to other categories of hydrogen (i.e. grey etc.). For reasons of better transparency in this context, a regulation of the German Government entered into force on 20 July 2021.

The regulation defines in more detail the requirements for hydrogen to be qualified as "green" hydrogen in the sense above and in differentiation to other categories of hydrogen. Notably, the regulation expressly stipulates that the requirements for green hydrogen will be adapted as soon as the European Union adopts any deviating requirements for green hydrogen.

On 27 July 2021, an amendment of the Energy Industry Act ("Energiewirtschaftsgesetz") entered into force, setting the legal framework for a pure hydrogen grid infrastructure.

Up-coming evolution

German industry players are aiming to turn into green hydrogen production by building the required plants (power-to-gas plants, electrolysis plants, hydrogen liquefiers) over the next years.

Gas network operators have started planning for a separate gas grid, partially drawing on existing gas pipelines.

Some recent examples:

01 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 30 MW electrolysis plant.

02 In 2024, a 60 MW electrolysis plant shall 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.

03 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.

04 The German NWS 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.

05 The German Government announced in May 2021 that it has chosen 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.

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.

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) introduced by the Ministry of New and Renewable Energy, Government of India ("MNRE"), which aims capacity building to produce at least 5 million metric tonne ("MMT") of green hydrogen per annum by 2030, with the 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.

In the 2021-22 Federal India already boasts of having 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.

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 contemplates the development of green hydrogen ecosystem vis-à-vis the interaction between several ministries of the Government of India and consequent role allocation.

INR 197 billion

Estimated outlay

Key highlights of the National Green Hydrogen Mission include:

- The MNRE will formulate schemes for financial incentives to support production, utilization 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 online portal setting out the relevant legislations and standards, 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 provides 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 direction to obligate 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 in order to build synergies with the enabling infrastructure as well as lay down incentives for the green hydrogen industry.

Further, one of the keys to development of the green hydrogen industry in India will be 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' thereby facilitating the access to public markets for development of green infrastructure. While at present, the ambit of green debt security does not per se include green hydrogen projects, in our view, this clarity is due 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, which was practically 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 provides an estimated outlay of INR 197 billion, including 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 mobilizing 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 500 GW non-fossil energy capacity by 2030. The Framework states that all eligible green expenditures will be in the form of investment, subsidies, grant-in-aids, or tax foregone (or a combination of some or all of these) or select operational expenditures, research and development, 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").

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 per information available in the public domain, it is understood that the Indian Government intends to include 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.

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 2025);
- 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 Union) and so implementation of these policy decisions will depend on corresponding regulatory/policy actions by the various States, which should come forth soon.

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

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 incentivize 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, consequently 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 In 2022, the Maharashtra State Power Generation Co. Ltd. issued bids for development of green hydrogen project of capacity 20 nm3/hr including ground mounted solar power plant of 500 kWac capacity.

02 In April 2022, Indian Oil Corporation Ltd., Larsen & Toubro ("L&T") and ReNew Power announced the signing of a binding term sheet for formation of a joint venture to develop green hydrogen projects in India.

03 On May 12 2022, GAIL (India) Limited awarded a contract to set up one of the largest Proton Exchange Membrane ("PEM") Electrolyser in India. The project is to be installed at GAIL's Vijaipur Complex, in Guna District of Madhya Pradesh, and would be based on renewable power.

04 On July 26 2022, the Oil and Natural Gas Corporation Limited signed a memorandum of understanding with Greenko ZeroC Private Limited to pursue opportunities in green hydrogen and green ammonia.

Some recent examples (cont)

05 In August, 2022, Jindal Stainless (Hisar) Ltd. has partnered with Hygenco India Private Limited to install a green hydrogen plant, thereby being the first stainless steel plant in India to install a green hydrogen plant.

06 In 2022, the ACME Group signed a memorandum of understanding with the Government of Karnataka to invest INR 520 billion for development of green hydrogen and green ammonia plant.

07 As per the information available in the public domain, it is understood that the Ministry of Railways, Government of India is planning to run 35 hydrogen fueled trains under Hydrogen for Heritage.

This chapter was provided by Bird & Bird Plus firm AZB & Partners and authored by Qais Jamal, Pranjal Bhattacharya, Upasana Soni and Shreya Mukherjee. hydrogen strategy by the end of H1 2023.

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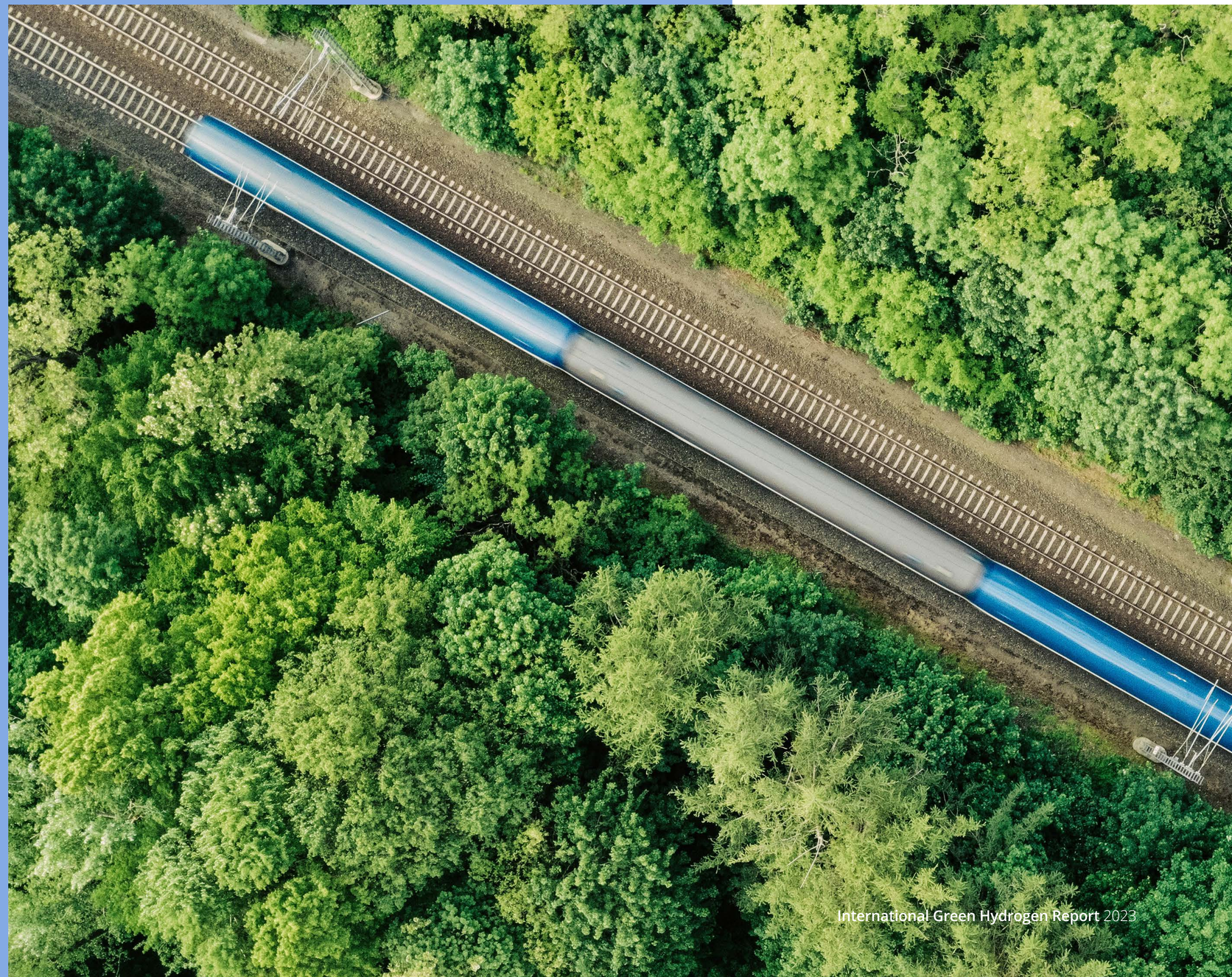


Italy

According to the Italian 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, but the Italian legal framework covering production, exploitation and connection of hydrogen is still imprecise, which has often proven to be an impediment for the industrial proponents and hydrogen producers.

For instance, no legal provision differentiates between authorisation procedures to produce fossil fuel-based hydrogen and to produce green hydrogen obtained through electrolysis process, which leads to the same level of restrictions being imposed. Therefore, local public authorities may require different requirements for land use.

These discrepancies between the legal areas concerned may lead to uncertainty to develop and implement hydrogen projects. Clear legislation is needed to define the framework for authorisation processes and incentive systems.

Despite this, progress has recently been made, and the Italian Government has adopted decrees with the aim of speeding up development of green hydrogen projects.

Funding & Support schemes

Hydrogen production by electrolysis is still costly, but equipment developers and suppliers are looking to adapt their technologies to provide affordable green hydrogen. In that perspective, national and European financial support schemes have been already implemented or are in the process of being defined.

The investments that are required to reach Italy’s new green deal objectives should reach the quota of €50 billion up to 2030. So far, the 2021 Italian National Plan for Recovery and Resilience has allocated €1 billion to achieve the hydrogen-linked reforms.

Up-coming evolution

The Italian Government is drafting guidelines for a National Hydrogen Strategy to develop the Italian hydrogen industry which will help enhance its appeal for producers and investors, and strengthen Italy's position 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 will be implemented from 2021-2026. The Italian Government plan to pass 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.

On the other hand, 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 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.

There have been recent updates in this respect; in September 2022 a decree regulating certain favour provisions for green hydrogen plants production using renewable energy sources for the electrolysis has been issued.

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

Finally, 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.

Italian National Plan for Recovery and Resilience ("NRRP")

NRRP has provided €50 million for so-called "Flagship Projects" in order to establish hydrogen valleys in areas considered particularly significant and €450 million to realise hydrogen production plants in abandoned industrial areas. The goal is to create 10 hydrogen valleys by 2026. To achieve this, 6 memorandums of understanding have been entered into between the State and the regions. To date, one of these projects, located in Apulia region, is under construction.

The goal is to create *10 hydrogen valleys by 2026.*

Morocco

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

This impetus is built on a number of factors such as the potential in renewable energy resources in Morocco as well as the expertise acquired by the Kingdom over the last 10 years. The King of Morocco, Mohamed VI, gave instructions to develop “Moroccan offer” in green hydrogen. Some Moroccan regions benefit from both solar and wind deposits, which allows 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.

However, the Moroccan roadmap for green hydrogen has made a clear statement, as it aims to establish a specific legal and regulatory framework for green hydrogen in the next few years, aiming to foster private investments.

Up-coming evolution

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

It is estimated that the green hydrogen industry in Morocco could face a demand between 13.9 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 and will likely come from exports and industry. Lower demand may emerge in the transport sector. In 2040, demand is expected to increase mainly in the transport sector when synthetic fuels are used for transport sector 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 140 billion dirhams (approximately €13 billion) to 1,000 billion dirhams (approximately €90 billion) between 2020 and 2050 to meet the potential demand by 2050.

To enhance investments, the Moroccan roadmap for hydrogen predicts 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

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

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 and electrolysis capacity of approximately 100 MW.

The site is expected to be put into commercial operation between 2024 and 2025.

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

Singapore

At COP27, Singapore submitted its strengthened long-term low emissions development strategy ("LEDS") with a clear goal to achieve net zero emissions by 2050, and also its updated 2030 nationally determined contributions ("NDCs") to reduce its emissions to 60 million tonnes of carbon dioxide equivalent in 2030, after peaking its emissions earlier.

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.

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 be developed in due course, 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.

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.*

Funding & Support schemes

With a view to accelerate the technical and economic viability of 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, with hydrogen being a key focal area for funding.

In July 2022, the National University of Singapore’s Centre for Hydrogen Innovation was launched, with the aim of making green hydrogen a commercially viable green energy source. The Centre received a total investment of S$25 million, of which S$15 million is from Temasek, which is the government’s investment firm. In the first phase of its research and development, the Centre will focus on hydrogen carriers and the global supply chain for hydrogen and will subsequently aim to study the production of hydrogen locally. To build up the hydrogen economy and develop the workforce, training programmes ranging from short courses to degree programmes will also be developed.

Some recent examples

The Energy Market Authority of Singapore (“EMA”) and the Maritime Port Authority of Singapore (“MPA”) have issued an Expression of Interest (“EOI”) 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 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 operate on fuels with 30% hydrogen content and has the capability of shifting to run entirely on hydrogen in the future.

Additionally, from January 2023 onwards, EMA announced that all new and repowered fossil fuel-fired generation units must be at least 30% hydrogen-compatible, with the ability to become operationally 100% hydrogen-compatible in the future.

Under Singapore’s National Hydrogen Strategy, the government has affirmed that hydrogen has the potential to be adopted across the following sectors as a low-carbon fuel or feedstock:

01 **Maritime Sector –** To meet the goals outlined by the International Maritime Organization, hydrogen, as well as hydrogen-carriers such as ammonia offers a pathway to decarbonise the shipping industry.

02 **Power Sector –** Hydrogen can contribute to the deep decarbonisation of the power sector alongside Carbon Capture Utilisation and Storage (“CCUS”), solar, and green electricity imports. Hydrogen fuel could be blended with natural gas to fuel the Combined Cycle Gas Turbines (“CCGTs”) currently used to generate electricity today.

03 **Industry Sector –** Low carbon or green hydrogen can replace brown hydrogen as a critical feedstock for industry processes (e.g. in the refineries). Hydrogen can be used to replace natural gas for embedded heat and electricity generation.

04 **Aviation Sector –** Near-term efforts to decarbonise involve the extensive use of hydrogen to produce sustainable aviation fuels for aircraft. For the longer term, the aviation industry plan is to move towards hydrogen propulsion for future aircraft.

05 **Mobility Sector –** Battery electric vehicles (“BEVs”) are still projected to remain the more economically viable, cleaner-energy vehicle technology instead of Hydrogen Fuel Cell electric vehicles (“FCEVs”). A possible exception is the heavy vehicle segment, where FCEVs could be more economically viable than BEVs by 2050.

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.

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.*

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, being therefore 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 heterogeneous regulatory framework for hydrogen from renewable sources is being developed and/or amended to fit green hydrogen specificities.

On that basis, sponsor of hydrogen projects in Spain should consider the following regulations:

- As regards to the **power generation and evacuation activities**, as required for the electrolysis process, the legislation on the Spanish Power Act (Law 24/2003, of 26 December) and the Environment Law (Law 21/2013, of 9 December), and other implementing regulations.
- As regards to 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.
- As regards to **hydrogen storage**, the industrial legislation and any other standards and regulations applicable to the storage of this inorganic chemical products.
- As regards to the **transport of hydrogen** through the gas pipeline infrastructure, hydrocarbon legislation (Law 34/1998, of 7 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 shall 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

Some recent examples

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.

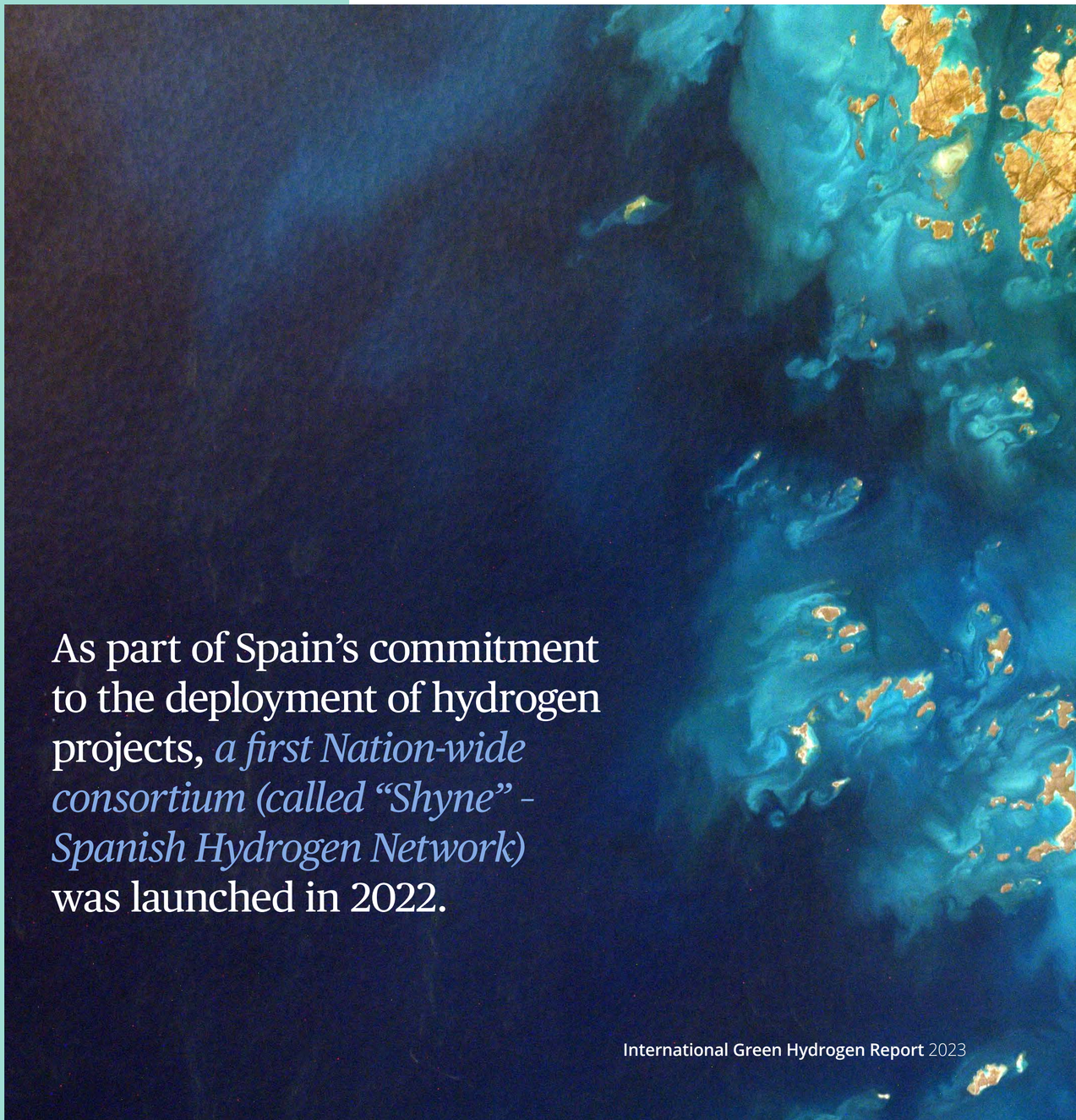
Similarly, and considering the strong commitment of the Spanish Government and power producers to deploy large scale hydrogen production facilities, some major electrolyzers manufacturers have publicly announced their intention to build and operate large scale electrolyzers manufacturing premises in Spain, which are due to be operating in 2023.

In this regard, Iberdrola – another key player in the deployment of hydrogen projects in Spain and abroad, has announced the development of 90 projects relating to the generation and storage of green hydrogen that could represent an investment close to €15,000 million.

ACCIONA Energía and Plug Power recently presented their joint venture project Valle H2V Navarra to the regional authorities of Navarra for building an industrial-scale green hydrogen production facility in Rocaforte, Sangüesa. A total associated investment of €87 million is expected and, once built, the facility will reach a planned annual capacity of 3,880 tonnes of green hydrogen per year.

Furthermore, CEPSA, the leading Spanish oil company, plans to invest €3 billion in one of the largest green hydrogen projects in Europe, which is expected to produce 300,000 tonnes of hydrogen per year. This project will comprise two 2 GW electrolysers in the harbour cities of Huelva and Algeciras, the first of which will be operational in 2026 and the second in 2027.

Last but not least, BP Spain has announced the Hydrogen Cluster of the Valencian Region ("HyVal") at its refinery in Castellón. Led by BP and under public-private collaboration, this initiative focuses on the development of up to 2 GW of electrolysis capacity by 2030 to produce green hydrogen.



Sweden

Sweden's development in the hydrogen economy is influenced by the wider developments in the European Union. While legislation only governs industrial use at present, plans for future-proofing legislation and national prioritization of hydrogen are on the agenda with notable initiatives in hard-to-decarbonize sectors, such as heavy industries and freight transport.

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.

Legal framework overview

Sweden is a member state of the European Union. As such, the national development of sector integration and the hydrogen economy is heavily influenced by the wider developments in the European Union. Currently, hydrogen legislation in Sweden solely governs the use of hydrogen 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 an effort to minimise permitting times.

In order 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 leading up to the UN Climate Accord in Paris with the aim of collecting private and state actors that believe in Sweden's declared ambition of being 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 for the climate 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. These two funding schemes began with general goals of lowering greenhouse gas emissions and have over time 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, the climate leap prioritises investments in vehicles, refuelling stations and hydrogen production. The available funds were SEK 2 800 million (c.a. €250 million) for 2022 with additional funds for each year until 2026. Any project receiving funding will need to be finalised 30 April 2026. 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 2023 the industrial leap has an allocated budget of SEK 1 354 million (c.a. €120 million) and may finance projects that continue until 2030. 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, EnergHy, with the help of Svea Vind, 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 4 July 2021 but the continued information, coordination, and planning activities for the hydrogen IPCEI in Sweden continue until 2027.

03 Up to SEK 462 million (c.a. €42 million) are further available for the purchase of heavy freight vehicles and certain work machines that are run by fuel cells, such as hydrogen fuel cells, during 2023.

Upcoming Evolution

Hydrogen has historically been an important resource in the processing industry and most if it (c.a. 180 000 ton) is used within industry, primarily within the chemical- and refining industry. Most of the hydrogen being produced in Sweden is used close to the site of production and as such there is a limited network of pipelines for the transportation of hydrogen. 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. As such, 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 utilize 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 being able to plan for such changes. This, along with shortening permitting times for environmental permits, are key to the continued development of green hydrogen in Sweden.

Finally, while it is unlikely that the new 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 infrastructure and hydrogen refuelling infrastructure. The final report is expected to be published 1 November 2023.

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 under the name 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 SEK 668.6 million (c.a. €60 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 SEK 25.9 million (c.a. €2.3 million) of funding has been granted to two projects researching combustion engines utilising hydrogen and limiting emissions of such engines.

On the private side Uniper, a producer of green hydrogen in Sweden since 1992, has recently announced Project AIR which is run together with chemical industry company Perstorp. Project AIR includes plans on a new electrolysis facility which is targeted to have a capacity of 25 MW – a large leap from Uniper's existing electrolysis facility which has an effect of 0.7 MW.

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

The Netherlands

The Netherlands is becoming a fast mover on the hydrogen market. According to the Dutch Government 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 CO2-free hydrogen is a necessary link in a sustainable energy system. The Dutch Government's ambition is to reach a hydrogen production capacity of 500 MW by 2023 and 3 to 4 GW 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 that 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 the 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 goverment 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 will be developed and operated by Hynetwork Serivces ("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 excusively 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 devlopment 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 neighboring 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. At the moment the Green Hydrogen Certificates are only for the Netherlands as we are waiting for a EU system.

Up-coming evolution

According to the Dutch National Climate Agreement, the ambition is to scale-up electrolysis to 500 MW between 2022 and 2025; and 3 GW to 4 GW 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 until 2025, the second phase from 2025 to 2030 and a third phase as from 2031. 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 currenlty around 165 projects for green hydrogen under development in the Netherlands which shows the appetite of private parties for green hydrogen.

The 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 5 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 Energy Bill was also introduced in July 2022, which includes clauses to enable the future provision of measures to fund hydrogen production and provide revenue support contracts.

Currently, the main use of hydrogen in the UK is in industrial petrochemical manufacture, and it is predominantly produced from fossil fuels. However, the government has identified this sector as a focus for the transition to green hydrogen.

To date, green hydrogen production has been limited to localised demonstration projects, such as BIG HIT in Orkney. Little hydrogen is transported away from central production sites.

The UK Hydrogen Strategy acknowledges that the majority of UK hydrogen use to date does not use green hydrogen. It uses the term 'low carbon hydrogen' or 'zero carbon hydrogen' and highlights work by British companies including ITM Power, Johnson Matthey and Ceres Power in developing technology for low or zero carbon hydrogen. It also identifies near-future hydrogen production projects, including green-hydrogen production associated with existing offshore windfarms to power electrolysis.

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

In common with many other jurisdictions, the UK does not have a well-defined legal framework for hydrogen projects specifically. The UK's gas hydrogen sector is subject to the legislative requirements of the Gas Act 1986 and is regulated by the Office of Gas and Electricity Markets ("Ofgem") as part of the existing gas network used principally for the supply of natural gas.

Key laws which will currently have an impact on green hydrogen projects include:

Planning

Hydrogen production and storage projects are not currently included as Nationally Significant Infrastructure Projects ("NSIP") under the Planning Act 2008, though this may change in the future. Where a project does not qualify as an NSIP, planning approval from the Local Planning Authority would be required under the Town & Country Planning Act 1990.

Environmental

Under the Town and Country Planning (Environmental Impact Assessment) Regulations 2017, an Environmental Impact Assessment would be required before a facility for chemical products (which would include hydrogen). Any hydrogen production plant is also likely to require a separate environmental permit under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) for the production of inorganic chemicals.

Health and Safety

There is a wide range of health and safety regulations which developers and operators of hydrogen projects need to consider. The primary piece of legislation is the Health and Safety at Work Act 1974, but consideration of the following should also be included: the Management of Health and Safety at Work Regulations 1999, COMAH, the Dangerous Substances and Explosive Atmospheres Regulations 2002, the Pressure Systems Safety Regulations 2000, the Pressure Equipment (Safety) Regulations 2016, and the Equipment and Protective Systems for Use in Potentially Explosive Atmospheres Regulations 2016.

Transportation

Gas and liquid hydrogen are both classified in UN Class 2.1 and are therefore treated as dangerous goods in the UK. Transportation of dangerous goods is regulated through the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009.

Hydrogen is currently limited to 0.1% (by volume) in Great Britain's natural gas networks, as outlined in the Gas Safety (Management) Regulations 1996. The Government is undertaking a study to understand the case for hydrogen blending of up to 20% hydrogen (by volume) into the gas networks and are targeting a decision in 2023. Currently, it is expected that necessary upgrades to the UK's national transmission system could deliver a 2% blend by 2024 and a 20% blend by 2027. To undertake key activities in the gas network, transporters of hydrogen will require a licence, or licence exemption, as part of the licencing system established by the Gas Act 1986. Metering and billing rules for gas are currently set up under the Gas (Calculation of Thermal Energy) Regulations 1996.

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

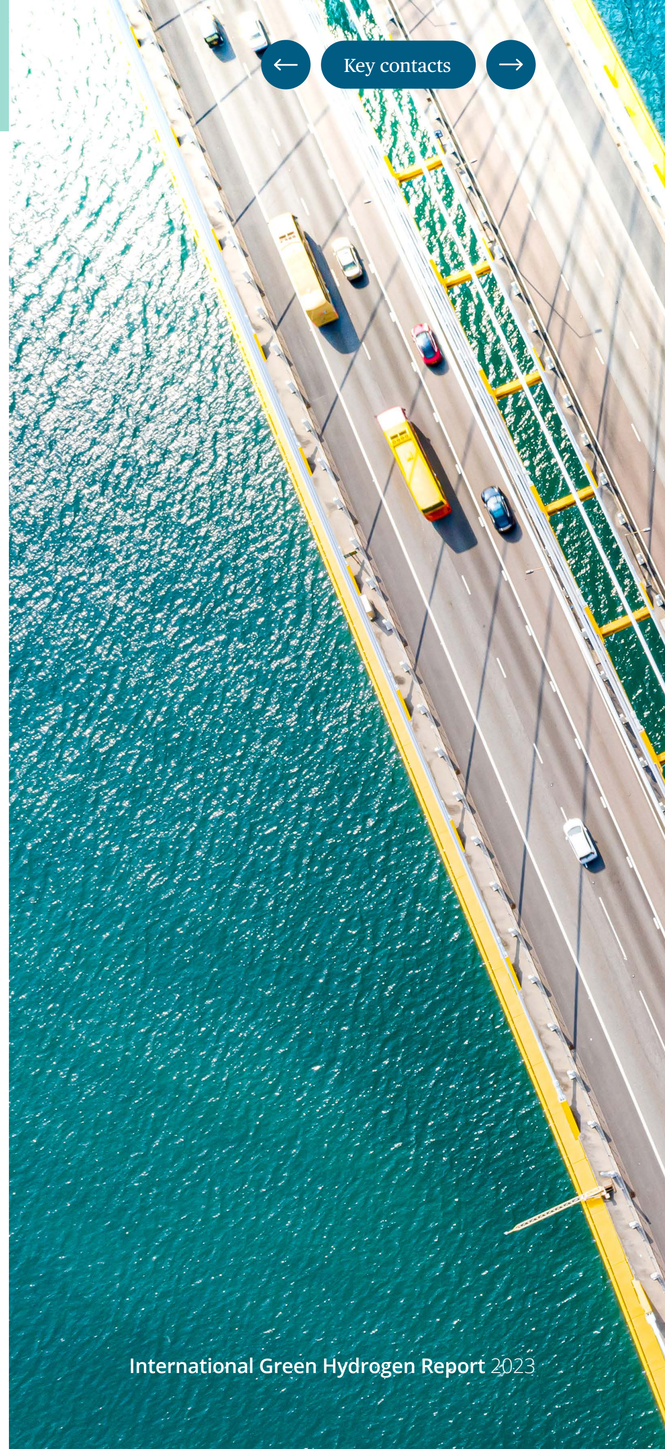
Use in Vehicles

Hydrogen powered buses have already been tested, approved, and are in operation in the UK. Registered vehicles are subject to standard Ministry of Transport ("MOT") testing, and this will apply to all hydrogen-powered vehicles. The UK has limited regulation for certain types of "L category" motorcycles using hydrogen combustion and hydrogen fuel cells and the first hydrogen fuel cell vans received certification at the end of 2022 for 24-month customer trials on public roads from January 2023.

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.

Hydrogen refuelling station developers and operators will need be cognisant of the same planning, environmental and health & safety regimes outlined above. The storage and handling of hydrogen in tanks will need to meet local land use zoning requirements and the storage and handling will need to comply with safety and hazardous substance requirements.

As can be seen, an operational and economic barrier to the deployment of hydrogen production is the lack of a dedicated regimes for all of the above areas. Currently, hydrogen project developers must navigate the existing legislative framework that applies to gases generally and this situation creates numerous gaps and uncertainties. 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, and sets out a timeline for when these will be in place (further details of which are below).



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.

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. The process continues through 2023, with contract award expected from July 2023. Up to 250 MW of capacity is to be allocated for this round to fund projects becoming operational by the end of 2025. There are plans of a further Electrolytic Allocation Round in 2023 to award contracts in 2024.

Low Carbon Hydrogen Standard

Published in April 2022, 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.

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 UK Hydrogen Strategy suggest that the hydrogen economy could directly support over 9,000 jobs by 2030 – though this is based on the 5 GW ambition which has now been doubled – and up to 100,000 jobs by 2050. The strategy 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 suggest that the hydrogen economy could directly support *over 9,000 jobs by 2030* – though this is based on the 5 GW ambition which has now been doubled – *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 was run in 2022, offering £60 million to support development of innovative hydrogen technology. These applications are currently under assessment.

Equinor are also developing the H2H Saltend project in the Humber which has 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.

Larger projects include BP's plans for a major green hydrogen 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 MW, powered by offshore wind.

Further hydrogen specific funding sources are 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 decarbonize 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 decarbonize 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 realized, the DOE estimates that the hydrogen industry would generate US$140 billion in revenue and create 700,000 new jobs by 2030 and reduce CO2 emissions by 16% by 2050.

The US has provided substantial funding for hydrogen development in recent years. In 2021, the Bipartisan Infrastructure Law invested US$9.5 billion in “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 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 also 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.

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 definition of "clean hydrogen" is not yet settled. The Bipartisan Infrastructure Act 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. Conversely, 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 CO_2e per kilogram of hydrogen." In September, 2022, the DOE released draft guidance for a Clean Hydrogen Production Standard (CHPS) that proposes adopting the IRA definition, reasoning that the higher threshold allows for greater flexibility to reduce emissions up and down the supply chain and that a stricter requirement would slow the development of the nascent clean hydrogen industry. However, the DOE also notes that this CHPS would only be guidance and would not be binding.

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 programs 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 networks and offer their own incentives for green hydrogen projects. 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.

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 starting in 2023 will benefit from the full ten years of credits. In order to qualify for the full amount of the credit ($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 up the clean hydrogen market to new investors.

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. DOE issued its Funding Opportunity Announcement (FOA) for H2Hubs on September 22, 2022. Initial concept papers were due November 7, 2022 and final applications are due April 7, 2023. DOE plans to distribute between US$6 and US$7 billion (in increments of US$400 million-US$1.25 billion) of the H2Hubs appropriations for 6-10 hubs. Projects must produce at least 50-100 tons of hydrogen per day and the Bipartisan Infrastructure Law requires DOE to select at least one project that produces clean hydrogen through fossil fuels, one that does so utilizing renewable energy, and one that does so using nuclear energy. 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.

In addition to the H2Hubs FOA, on December 23, 2022, DOE issued a Notice of Intent (NOI) to issue an FOA for US$750 million in support of the "Hydrogen Shot." Launched June 7 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.

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

01 R&D of hydrogen carriers with a focus on reducing costs and improving performance over current hydrogen gas/liquid transportation systems.

02 Development of onboard storage systems for liquid hydrogen to improve viability of hydrogen fuel cells in medium and heavy duty vehicles.

03 Development of liquid hydrogen fueling stations for heavy duty vehicles with a focus on increasing the flow rate for quicker fueling.

04 Development of membrane electrode assemblies to reduce costs and improve durability and performance of fuel cells to be used in heavy and medium duty vehicles.

Up-coming evolution

DOE, in collaboration with other government agencies, released its draft National Clean Hydrogen Strategy and Roadmap in September 2022. The draft Roadmap calls for 10 million metric tonnes (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 decarbonization 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 program 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 centers around which to base H2Hubs.

Some recent examples

In December 2022, Air Products and Chemicals and AES Corp. announced plans to develop a green hydrogen plant in Texas with the capacity to produce over 220 tons of hydrogen per day. The project will include 1.4 GW of wind and solar generation capacity on site and is estimated to cost US$4 billion.

On December 14 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 tons of hydrogen per day. This project is expected to be operational at the end of 2023 and, if all goes well, NextEra plans to invest further in green hydrogen facilities.

On January 5 2023, DOE announced that it had received 79 initial concept applications for H2Hubs projects. Of these 79, 33 were encouraged to submit full applications by the April 7 2023 deadline (although the 46 applicants who were “discouraged” may still submit full applications). DOE expects to select the recipients of H2Hubs funds in Fall 2023.

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

SheppardMullin

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.

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.

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 in order to increase the production of biomethane and renewable hydrogen and 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.

We recall that these measures were approved in the framework of the Roadmap towards Carbon Neutrality, through which 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.

Legal framework overview

Although the hydrogen market is still at an early stage of development – which is why there is not yet a clear and complete legal framework that regulates all activities in the sector –, 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.

In fact, the Portuguese Government has made a very relevant effort to amend the existing legislation aiming precisely to potentiate 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 organization and functioning of the (new and renamed) National Gas System, which currently foresees a simplified procedure of mere 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 decarbonization 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. 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

In the second half of this year, the government shall launch a centralized purchase system for biomethane and hydrogen produced from water electrolysis through a competitive procedure – 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 pertaining 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.

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.

Funding & Support schemes

Despite the legislation that has been adopted to regulate the hydrogen sector, both at European and national level, it is public knowledge that the 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, derived 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, in most cases, financed by private investors, the European Union has put in place several mechanisms of support for investment and production, of which 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.

In parallel, 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 above mentioned 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, 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. In this framework, it is planned to allocate more than €2.5 billion from the RRP to the so-called "industry mobilisation agendas", in which projects related to innovation, energy transition, export capacity and creation of skilled jobs are at the forefront of eligibility. Now, as it is easy to understand, green hydrogen industrial projects make the most of these markers, so it is anticipated that they will grab a huge slice of this €2.5 billion "funding envelope". 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 amounting to 1 billion euros. As the negotiation phases are very close to their end, it is expected that the contracts with "Recuperar Portugal" will be signed soon, thus allowing the future start of the implementation of the projects.

Moreover, as stated above, in the second half of 2023, the Minister of the Environment and Climate Action shall launch the first auction intended to provide financial support for producers of gases from renewable sources, with the procedure documents to be made public by May 30.

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

Up-coming evolution

Portugal aims for a 49% share of renewables in final energy use by 2030, in all sectors, not just the electricity sector. The goal is 2.5 GW of green hydrogen capacity by the end of the decade to promote the decarbonization of heating and transport.

Portugal also plans to develop two valleys, one in the North of Portugal, in which the Bondalti project for the production of renewable gases and green ammonia assumes a prominent position, providing for an investment of €2.4 million in the years to come, and another in Sines, already being launched.

It is estimated that the creation of an industrial cluster in the field of green hydrogen could attract investments of €7 billion to Portugal by 2030.

Despite the steps that have already been taken, it is expected that, in the near future, new legislation will be issued to promote self-consumption of green hydrogen, as well as energy storage that will allow the efficient implementation of large projects.

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

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