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Global Hydrogen Guide: Emerging Policy & Regulatory Initiatives

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1/
Introduction

1/ Introduction

Hydrogen is the most abundant chemical substance in the known universe. Although the concept of a 'hydrogen economy' is not a new one, it has gathered momentum in recent years with hydrogen touted as the clean molecule the world needs to secure a sustainable energy future. Hydrogen is clean-burning, can be produced from renewable sources of power, and is a potential substitute for fossil fuels. It therefore has a promising role to play in the global effort to address the effects of climate change, particularly in fossil fuel-intensive sectors such as steelmaking and heavy transport.

Pure hydrogen is produced using a chemical reaction, and has three primary uses: fuel, heat and as a feedstock. Versions of the ideal hydrogen economy vary, but all feature the use of 'green' hydrogen, which is produced from renewable electricity.

There remain immense challenges to realise the vision of a hydrogen economy. Substantial demand-side and supply-side investment is required, and a need for proactive government policy and forward-looking regulatory initiatives.

As this guide demonstrates, there is already a groundswell of activity in pursuit of a hydrogen economy by both the public and private sectors around the globe. What is striking is the significant interconnectivity of action and collaboration across regions – the hydrogen economy is a truly, and necessarily, global ambition.

White & Case's Global Hydrogen Guide provides an overview of the impressive emergence of policy and regulatory initiatives being pursued around the world, as well as a snapshot of the emerging global hydrogen development activity.

This guide seeks to assist in enhancing a broad based understanding of the emerging global market for hydrogen—an ambition to "see the whole board"!

This guide contains the following sections:

- **Chapter 1: Introduction** – an introduction to this guide;
- **Chapter 2: The Hydrogen Economy** – background on the concept of the hydrogen economy, and its role in the broader energy transition;
- **Chapter 3: Emerging Policy and Regulatory Initiatives** – a snapshot of the emerging policy and regulatory initiatives around the world in support of the development of a hydrogen economy; and
- **Chapter 4: Global Hydrogen Development Activity** – a snapshot of activity in global hydrogen development around the world.

White & Case is a truly global law firm, uniquely positioned to support our clients in achieving their highest global ambitions in the pursuit of a hydrogen economy.

2/

The Hydrogen Economy

2/ The Hydrogen Economy

2.1 Introduction

Hydrogen's potential application in industries traditionally dominated by fossil fuels has led to commentators labelling it the 'silver bullet' in the fight against the effects of climate change. The key question is whether it can be scaled up effectively and globally. Hydrogen's potential applications have been well-known for decades. It was touted as a mass replacement for hydrocarbons such as oil and gas as early as the 1970s following the oil crisis, and since the 1990s as awareness of climate change has grown.

In order for the hydrogen economy to thrive, government support will be important in leading the transition by addressing the key challenges for the hydrogen economy. This includes the development of clear regulatory frameworks, supporting investment in transport and storage infrastructure, and helping to lower the cost of electrolysers.

As this guide demonstrates, many governments around the world are already stepping up to lead the hydrogen transition.

Bloomberg's New Energy Finance (**BNEF**) March 2020 'Hydrogen Economy Outlook' concluded that hydrogen has the potential to reduce up to a third of global emissions from fossil fuels and industry, provided a significant scaling-up occurs. The cost of this scale-up has been estimated at around US$150 billion of cumulative government subsidies by 2030. Investment in storage infrastructure of US$637 billion by 2050 is said to be required. In order for 'green' hydrogen to become economically viable, electrolyser manufacturing must substantially increase to allow costs to fall, renewable energy prices must remain low, and significant investment in storage infrastructure is required.

2.2 Hydrogen production

Pure hydrogen can be produced via a chemical reaction. There are numerous means of doing so, and each method has different advantages.

Brown hydrogen

In this method, brown coal is 'gasified' to create a synthesis gas of carbon monoxide, carbon dioxide, hydrogen and steam from which hydrogen is extracted. However, several greenhouse gases remain, meaning brown hydrogen is not carbon-neutral.

Grey hydrogen

Currently responsible for 70% of global production, 'grey' hydrogen is produced by applying steam reformation to natural gas. Here, methane in the natural gas reacts with steam to cause a reaction by which hydrogen (and carbon dioxide) is produced.

Blue hydrogen

When the CO_2 from grey or brown hydrogen is captured and stored, it is known as 'blue' hydrogen. While adequate carbon capture and storage ("CCS") capacity is required for this method, and it is currently more expensive and less efficient to produce than grey hydrogen, it is considered an important step in the energy transition.

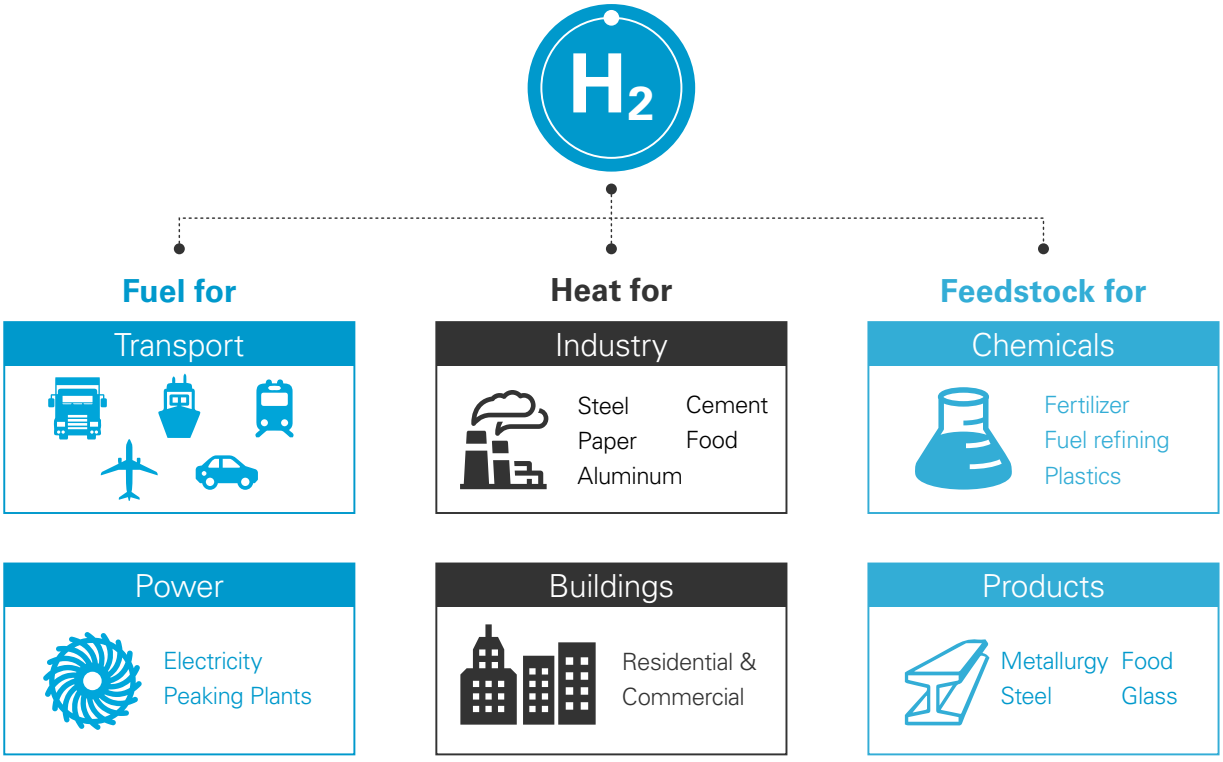
Green hydrogen

Renewable or 'green' hydrogen is produced by splitting H_2O molecules into hydrogen and oxygen, using electricity from renewable sources to pass a current through water. This method results in zero carbon emissions throughout the production process.

2.3 Hydrogen's uses

Overview

Hydrogen has a wide variety of potential uses, as demonstrated by the below diagram.



Source: Bloomberg's New Energy Finance (BNEF) March 2020 'Hydrogen Economy Outlook'

Manufacturing processes in hard-to-abate industry sectors

Industrial processes such as steelmaking, cement production and ammonia synthesis have historically been the domain of fossil fuels due to the high energy density provided by these molecules. Where its potential is unlocked by lower production costs, hydrogen can be used as a fossil fuel substitute due to its properties as a molecular fuel.

Power generation

Hydrogen's potential applications in power generation are twofold:

- first, green hydrogen may be used as a feedstock for hydrogen-fired turbine power stations, which would generate clean and dispatchable power; and
- second, where combined with large-scale geological storage and renewable energy facilities, hydrogen could be produced from excess renewable power that might otherwise have been curtailed. It could then be stored, potentially used in grid stabilisation or transported for use as a feedstock in the process described above.

If both these applications are embraced, a zero-carbon electricity network could be powered by a hydrogen supply chain.

Fuel cells

Fuel cell technology is a fast-growing alternative to battery-powered vehicles. While batteries store and release electricity to provide power, fuel cells rely on a chemical reaction between hydrogen and water to create an electrical current that powers vehicles. The only by-product of this process is water or steam (H2O).

Heavy transport

Hydrogen may be more economically feasible for heavy transport than passenger vehicles. This is especially so given the current market dominance of batteries over fuel cells (and the likelihood that battery technology continues to improve). Hydrogen's higher energy density means fuel cells have a greater power density than lithium-ion batteries. This is conducive to long-distance transport because the range of a fuel cell vehicle can be easily increased by adding more hydrogen tanks to the same fuel cell stack (given sufficient space), giving fuel cells a marginal cost advantage over batteries.

Ammonia production

In addition to fuel cell-powered heavy transport, hydrogen can be used as a raw fuel for shipping. However, one of the more promising options is to use hydrogen to produce ammonia, which is being examined as a potential fuel for internal combustion engines. Hydrogen is converted to ammonia using a method known as the Haber-Bosch process. In most cases, grey hydrogen is reacted with nitrogen to produce liquid ammonia. However, where green hydrogen is the feedstock, it is known as 'green ammonia' (a carbon-neutral process).

Green ammonia is concentrated and takes up less space than hydrogen, a significant advantage given volume restrictions in freight shipping. Converting hydrogen to green ammonia may also be a more cost-effective (and safer) method of transporting hydrogen over long distances. While technology to enable ammonia's integration into maritime freight is still being developed, ammonia already has a number of applications including in fertilisers, cleaning products and refrigeration.

Grid stabilisation

Hydrogen may be able to play a vital role in energy storage systems and the stabilisation of electricity grids, particularly when combined with renewable power. Due to the intermittent nature of renewable energy sources such as solar and wind, the flows of output produced can be variable and this can pose a challenge given fluctuating demand. Hydrogen is a potential source of baseload power to stabilise this intermittency with reliable, consistent output.

Excess electricity produced during peak supply cycles could be passed through an electrolyser to create hydrogen, which would act as an energy storage medium (for example, in underground caverns) or as a fuel for baseload supply. A benefit of green hydrogen produced in this way is that it could be piped into pipelines currently used for natural gas, subject to the necessary technical considerations.

2.4 Challenges

Overview

There are a wide range of very significant opportunities arising in the pursuit of a hydrogen economy. However, there are also a range of technical, regulatory and practical challenges that remain to be solved in order for the hydrogen economy to thrive.

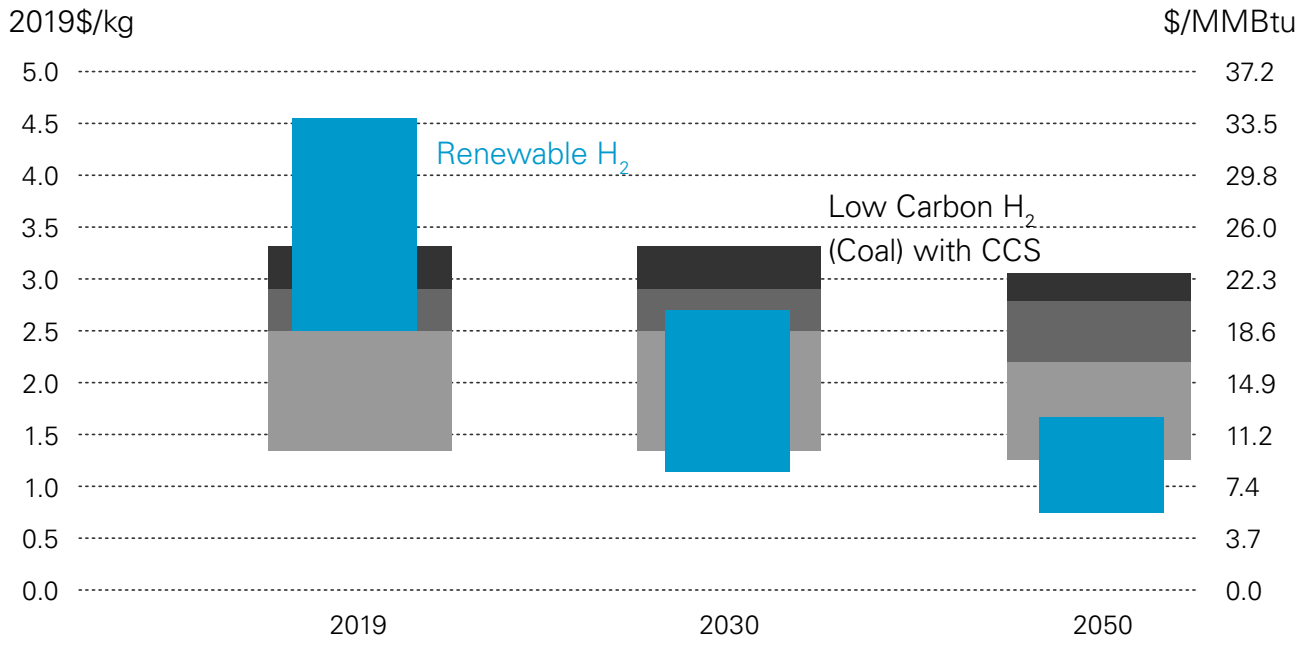
Commercial viability

A contributing reason the hydrogen economy is not a reality today is the cost of producing green hydrogen – high renewable energy prices and expensive electrolysers create challenging economics for large-scale production. However, falling renewables prices are a promising sign that green hydrogen production could be viable, provided the cost of electrolysers follows suit. The signs are encouraging: alkaline electrolysers produced in North America and Europe fell by 40% between 2014 and 2019, and Chinese-made electrolysers are already up to 80% cheaper than Western equivalents.

BNEF estimates that if costs continue to fall, green hydrogen could be produced for US$0.7 to US$1.60 per kilogram in most parts of the world by 2050. At this price, it would be competitive with natural gas on an energy-equivalent basis, and would be cheaper than blue hydrogen (produced from fossil fuels and combined with carbon capture and storage).

The Hydrogen Economy continued

Forecast global range of levelised cost of hydrogen production for large projects



Source: Bloomberg's New Energy Finance (BNEF) March 2020 'Hydrogen Economy Outlook'

Transportation and storage

Due to its low density, hydrogen takes up significant amounts of space. This presents difficulties for transport and storage. If blue hydrogen is to be a stepping stone on the path to green hydrogen, significant levels of investment will be required to service the additional requirements of carbon capture and storage.

BNEF estimates that in order to be competitive with natural gas (in terms of energy security), over 14,000 salt caverns would need to be built in order to store pressurised hydrogen, at a cost of US$637 billion. Liquefying the hydrogen is an option to increase density and therefore decrease storage costs, but this is also an expensive proposition.

The transportation of hydrogen poses similar issues and there are currently three primary means of movement: pipelines, trucks and ships. Piping the gas is the quickest and most cost-efficient means of transport, but large-scale exports of hydrogen are likely to require maritime freight (despite the cost of liquefying the gas). In a fully-functioning hydrogen economy, however, it is considered that the price of electricity in export hubs should be cheap enough to make this process economically feasible.

Cost of electrolysers

The cost of electrolysers is a major reason that green hydrogen remains expensive – bringing down the cost of this production equipment is crucial to increasing hydrogen's market competitiveness. The cost of Chinese-manufactured electrolysers is already 80% lower than Western equipment to compensate for volatile demand.

Market commentators have indicated that the one way to speed up the process of lowering electrolyser costs will likely be to ramp up manufacturing subsidies and production incentives.

Infrastructure upgrades

The storage and transportation challenges inherent in the hydrogen economy require significant investment in hydrogen infrastructure in coming decades. Required expenditure includes storage facilities, additional pipelines for hydrogen transmission, and the augmentation of existing gas distribution networks to ensure that natural gas infrastructure is equipped to handle hydrogen.

For hydrogen importers and countries intending to host fleets of fuel cell-powered hydrogen vehicles, the priority will be the construction of sufficient hydrogen stations to provide refuelling locations for these vehicles.

Fuel cell inefficiency

The nature of power input is one of the many differences between battery-powered and fuel cell vehicles. Where batteries can be charged at home, fuel cells require hydrogen refuelling facilities. While this may be an advantage for longer journeys (particularly in freight applications), these facilities remain rare and will require significant scaling-up.

In addition, the United Kingdom's Committee on Climate Change has estimated that a battery-powered vehicle using renewable energy sources converts 86% of the turbine's electricity output into direct power for the vehicle. The figure for a fuel cell-powered vehicle is estimated to be 41-44%.

These inefficiencies in respect of passenger vehicles, combined with the strength of the battery-powered vehicle market, means that hydrogen fuel cell manufacturers will need to innovate to remain competitive. A number of carmakers are pursuing the dual goals of battery – and fuel cell – powered vehicle penetration. Ensuring that fuel cells are equipped with the technology required to be used for power generation would also help mitigate the vehicle manufacturing risk.

Policy framework

The widespread use of hydrogen relies on its economic viability, including as measured in comparison to fossil fuels. In order to bring down the cost, governments can assist by providing subsidies, making investments and legislating to establish a clear regulatory framework for hydrogen's supply and use.

3/

Emerging Global Policy and Regulatory Initiatives

3/ Emerging Global Policy and Regulatory Initiatives

3.1 Introduction

This Chapter provides a snapshot of the emerging government policy and regulatory initiatives being implemented around the world to support the development of the hydrogen economy.

The analysis in this Chapter is organised into the following regions:

- Asia-Pacific;
- Europe & the United Kingdom;
- Central Asia;
- the United States & Canada;
- Latin America;
- the Middle East; and
- Africa.

What emerges clearly from our research is that the hydrogen economy is a truly global proposition. Different countries and regions have different strengths and challenges across the demand-side and the supply-side requirements of the hydrogen supply chain. Countries with a strong capacity and willingness to develop hydrogen-backed technology (for example, transport or turbines for power generation), may not have the geographical or other resources to mass produce hydrogen efficiently or cost effectively on the scale that would be necessary to fuel that technology if it was to become mainstream. It is apparent that significant opportunities exists for countries across the board, but often these opportunities are dependent upon co-ordinated interconnectivity with the efforts of other countries in pursuit of their own opportunities. Encouragingly, efforts at collaboration are emerging swiftly and powerfully around the globe.

For instance, the Australian and German governments are currently exploring the feasibility of a trans-continental hydrogen supply chain under a joint statement of intent signed in September 2020. The Japanese government has signed similar memorandums with New Zealand, Argentina, the European Commission and the United States, and Japan received its first shipment of Saudi-produced 'blue' ammonia in late 2020. The European Commission published a ground-breaking hydrogen strategy in July 2020, and has developed partnerships with nations in Asia and northern Africa to supply the hydrogen its ambitions will demand. In the Americas, projects in Argentina, Brazil and Chile are being proposed to meet North American and East Asian demand. The scale of such interconnectivity would be unprecedented in global energy markets.

Emerging global interconnectivity of hydrogen policy and regulatory initiatives

The following is a snapshot of notable global policy and regulatory activity in the hydrogen sector across the globe organised by region. This activity is fast paced and constantly changing. Therefore, this Chapter does not aspire to be a comprehensive or exhaustive account of all global policy and regulatory activity. Rather, it is a snapshot of notable developments emerging in key regions, based on publicly available information. This Chapter seeks to assist in enhancing a broad based understanding of the emerging global market for hydrogen – an ambition to 'see the whole board'.

3.2 Asia-Pacific

Overview

The Asia-Pacific region is particularly well-placed to play a key leadership role in the transition to a hydrogen economy. Key developments in the region include the following:

- **Australia**

  Australia has an abundance of the resources required for large scale hydrogen production, including plentiful natural and renewable resources and an established renewables industry.

  In recognition of the opportunity for Australia to become a major hydrogen producer, the Australian government is taking steps to develop a large-scale hydrogen industry, including preparing a 'National Hydrogen Strategy' with a goal of establishing leading commercial exports by 2030. This support is also reflected at a state level, with the Western Australian, Queensland, New South Wales, South Australian and Victorian Governments all having already made significant funding investments in hydrogen related projects in their respective states.

  As of the end of 2020, over 60 hydrogen production projects ranging from feasibility study to under-construction stage had been announced in Australia. Central to Australia's National Hydrogen Strategy is to create 'hydrogen hubs' comprising clusters of large-scale demand located at ports, cities and regionally. These hydrogen hubs are intended to make the development of infrastructure more cost-effective and pave the way to scale up production as the global demand for hydrogen grows with a view to Australia becoming a major global player in the market by 2030. These hubs will be supported by national initiatives to use hydrogen in transport, industry and gas distribution networks, and integration of hydrogen into the national electricity system in order to provide sufficient reliability for developers.

- **China**

  China is the largest hydrogen producer in the world, producing over 20 million tons of hydrogen annually, about one third of the world's total production. Most of China's hydrogen is currently used for industrial and chemical processes, but other applications are accelerating, including hydrogen-powered trams, aviation, ships, and heat and power. China will play a central role in the emerging hydrogen economy, and will be fundamental in the effort to improve the economic viability of technologies – as it has done for the broader renewable energy sector. In June 2019, the China Hydrogen Alliance, a government supported alliance formed by a consortium of energy and automotive companies, published a 'White Paper on China's Hydrogen and Fuel-cell Industry', mapping out the development strategy of the hydrogen industry. The White Paper projects that by 2050, hydrogen would cover 10% of China's energy needs, 10,000 hydrogen refuelling stations would be built, and hydrogen economy-related revenue is expected to increase to 12,000 billion yuan in 2050 (approximately US$1,740 billion).

  The last five years have seen increasing regulatory support for hydrogen industry in China at both national and local levels. In 2015, the State Council listed hydrogen as one of the key technologies in the Made in China 2025 Initiative, a national strategy to strengthen and upgrade China's manufacturing sector. In May 2016,

the CPC Central Committee and the State Council published an "Outline of the National Innovation-Driven Development Strategy", listing the development of hydrogen energy, fuel cells, and other new-generation energy technologies as one of the strategic tasks. In September 2019, the CPC Central Committee and the State Council issued the "Outline for Building a Powerful Transportation Country", requesting that the construction of hydrogen refuelling station facilities be expedited. In October 2020, The Chinese Society of Automotive Engineers (China SAE) published the "Energy-saving and New Energy Vehicle Technology Roadmap 2.0" under the guidance of the Ministry of Industry and Information Technology, pledging to transform China's automotive industry into a wholly electric industry by 2035.

□ Japan

Japan has also announced a commitment to decarbonise its economy, and was the first country to adopt a 'Basic Hydrogen Strategy' in 2017. Japan is also likely to be a net importer of hydrogen. Japan is a signatory to the Paris Agreement and views a hydrogen economy as a means of cutting its greenhouse gas emissions by the required 26% by 2030. In October 2020, Prime Minister Suga declared Japan's objective to reach carbon-neutrality by 2050. In furtherance of the declaration, the 'Green Growth Strategy towards 2050 Carbon Neutrality' was published, whereby hydrogen is identified as one of the key technologies to achieving the goal.

In January 2021, Japan approved the budget allocation of JPY 2 trillion to a 'green innovation fund' to be established with the Industrial Technology Development Organization of Japan (NEDO), a national research and development agency. The fund will be used to subsidise companies carrying out research and development of technology related to hydrogen, green electricity and next generation batteries and carbon recycling. The government plans to financially support these projects over a period of ten years. Japan is already backing a number of test projects, including production of green hydrogen by a solar powered electrolyser in Fukushima, co-firing of blue ammonia produced in Saudi Arabia for power generation and production, liquefaction and transportation of brown and blue hydrogen from Australia. The primary uses of hydrogen would be power generation, transportation, heating and industrial processes such as manufacturing. Several methods for transporting hydrogen from exporting countries to Japan are being explored, including liquefied hydrogen, ammonia, and other forms of hydrogen. Notwithstanding its clear commitment to the technology, Japan appears to be advocating a staged approach to clean hydrogen which includes brown and grey hydrogen in the initial trial steps to be followed by blue and green hydrogen upon becoming more economically feasible.

□ South Korea

South Korea has publicised its plans to decarbonise its economy, a significant commitment from a country whose economy was substantially built on carbon-intensive processes such as heavy machinery, shipbuilding and vehicle manufacturing. In 2019, the 'Hydrogen Economy Roadmap of Korea' was unveiled by the South Korean government, including a technology strategy which sets long term targets to 2040. In February 2020, the Korean National Assembly passed the *Hydrogen Law (Hydrogen Economy Promotion and Hydrogen Safety Management Law)*, laying the legal foundations for the government's hydrogen commitment and implementing safety standards for facilities.

South Korea has fewer renewable resources than its regional neighbours and an unfavourable geology for storage. For it to secure stable supply of hydrogen required to implement the Hydrogen Economy Roadmap, the natural strategy is to look for an overseas source of hydrogen. The South Korean government has therefore formed strategic partnerships with various countries including Saudi Arabia, Australia, Israel and Russia by leveraging its hydrogen technology capabilities in a bid to identify and develop a mutually beneficial hydrogen import and export partnership.

Emerging Global Policy and Regulatory Initiatives continued

Australia

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Hydrogen Strategy** In November 2019, the COAG Energy Council released a plan which aims to scale up hydrogen infrastructure in Australia with a set of nationally coordinated actions involving governments, industry, and the community. The focus of the strategy is international collaboration, national coordination, supporting priority industry projects and legislative reviews.	Australian Government COAG Energy Council Hydrogen Working Group
2.	**Western Australia Renewable Hydrogen Strategy** In July 2019, the Western Australian State Government released a plan which aims to leverage Western Australia's renewable energy resources, established energy production and export industry, and proximity to international markets to make Western Australia a significant producer and exporter of hydrogen.	Western Australian State Government
3.	**Victorian Hydrogen Investment Program** The Department of Environment, Land, Water and Planning of Victoria is exploring the interest and opportunity for renewable hydrogen projects with a view to establishing a hydrogen investment program. The program is in its early stages with the government publishing an initial Green Hydrogen Discussion Paper in November 2019.	Victorian State Government
4.	**South Australian Hydrogen Action Plan** Building on the release of the 'Hydrogen Roadmap for South Australia' in 2017, the South Australian State Government worked with industry to launch the South Australia Hydrogen Action Plan. The plan seeks to harness existing and future renewable energy resources to produce renewable hydrogen to export globally, and in particular to China, Singapore, South Korea and Japan.	South Australian State Government
5.	**Queensland Hydrogen Industry Strategy** Following the publication of the 'Advancing Queensland's Hydrogen Industry' discussion paper in September 2018, the Queensland State Government published a Hydrogen Industry Strategy in consultation with industry and researchers in May 2019. The plan has five focus areas which are intended to develop a sustainable hydrogen industry in Queensland. The Queensland plan seeks to harness existing and future renewable energy generation to create low cost green hydrogen, taking advantage of its close proximity to Asia.	Queensland State Government
6.	**'H2 Under 2' Goal** In 2020, the Australian government announced a 'H2 under 2' goal where hydrogen can be produced at under $2 per kilogram, a figure considered to be the point at which hydrogen becomes competitive with other energy alternatives.	Australian Government
B	**Specific grants, programs & incentives**	
7.	**Australia – Germany Supply Chain Feasibility Study** In September 2020, the Australian and German governments signed a Joint Declaration of Intent on a Supply Chain Feasibility Study of Hydrogen produced from Renewables. The Australian government is seeking an Australian research and industry consortium to partner with German industry on the study through an expression of interest process.	Australian Government Federal Republic of Germany

No.	Description	Key Players
8.	**Victoria – Japan Hydrogen Energy Supply Chain (HESC)** In November 2019, a pilot project was announced for the production and transport of hydrogen from Australia to Japan. The HESC proposal, supported by the Australian, Victorian and Japanese governments and several private partners, involves the production of brown (and possibly blue) hydrogen using brown coal deposits of brown coal in Victoria's Latrobe Valley, to be liquefied and shipped to Japan.	Victorian State Government Australian Government Japanese Government Project partners
9.	**ARENA Renewable Hydrogen Deployment Funding Round** In April 2020, the Australian Renewable Energy Agency (ARENA) announced up to $70 million in funding to support the acceleration of hydrogen in Australia. After an oversubscribed first stage, 7 companies were shortlisted in July 2020 for the next round. All applicants have well developed proposals involving deploying 10 MW or larger electrolysers for various end uses including transport, gas injection, renewable ammonia production, power, and industrial use.	ARENA Australian Government
10.	**Crystal Brook Hydrogen Superhub Grant** A developer has received a A$1 million grant from the South Australian government for a feasibility study on a hydrogen production facility at its Crystal Brook Energy Park. The proposed 50 MW Hydrogen Superhub would be the world's largest co-located wind, solar, battery and hydrogen production facility, with targeted production of 25,000 kg of hydrogen per day using 100% renewable energy.	South Australia State Government Commercial developer

South Korea

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Hydrogen Law (Hydrogen Economy Promotion and Hydrogen Safety Management Law)** In January 2020, the Korean National Assembly passed the Hydrogen Law (Hydrogen Economy Promotion and Hydrogen Safety Management Law), laying the legal foundations for the government's hydrogen commitment and implementing safety standards for facilities. This followed the release of the 'Hydrogen Economy Roadmap of Korea' in 2019, which sets long term targets to 2040.	South Korean Government
2.	**Hydrogen Economy Council** The South Korean government's strategies, policies and regulations related to the growth of the hydrogen economy are formulated by the Hydrogen Economy Council established under the Hydrogen Law. Chaired by the prime minister, the Hydrogen Economy Council consists of experts from eight related ministries including the Ministry of Trade, Industry and Energy, and the private sector including related industries and academia.	South Korean Government
B	**Policy framework and regulatory developments**	
3.	**Green Hydrogen Overseas Business Group** The Korean Ministry of Trade, Industry and Energy has announced it is considering six countries for a role as its overseas hydrogen production base, including Australia, Saudi Arabia and the United States, to import industrial-scale hydrogen by 2030.	South Korean Government (The Ministry of Trade, Industry and Energy)

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
4.	**SPC 'Korea Hydrogen Energy Network (Kohygen)'** The South Korean government will establish Kohygen, a special purpose company, by collaborating with regional governments and private entities. Starting from early 2021, Kohygen will install 10 gaseous hydrogen refuelling stations and more than 25 liquefied refuelling stations by 2023 for commercial vehicles such as buses and trucks. A total KRW 330 billion worth of funding will be injected.	South Korean Government Commercial partners
5.	**Hydrogen Regulation-Free Zone** Certain areas in Gangwon and Ulsan provinces of Korea have been designated as Special Regulation-Free Zone for hydrogen. A Special Regulation-Free Zone offers tax benefits and relaxed regulations to companies in relation to the research, testing and commercialisation of innovative technologies. Within this Special Regulation-Free Zone, companies will be allowed to demonstrate various new hydrogen technologies (for example, hydrogen-powered ships and hydrogen-powered construction equipment), which is not permitted in other areas due to regulatory reasons.	South Korean Government
6.	**Tax benefits for hydrogen manufacturers** The South Korean government will implement individual tariffs formula with respect to natural gas used for hydrogen production, and grant hydrogen manufacturers an exemption from import levy and safety management charges for a limited period of time. Under the 'individual tariffs' system, a state-run gas company, which has long provided imported LNG to local power utilities, will charge different prices to utilities through negotiations with each power utility. Along with the tax exemptions, this new tariff system will allow hydrogen manufacturers to secure natural gas at a lower price, which the government expects will lead to a cut in the natural gas price of as much as 43 per cent.	South Korean Government State utility
7.	**Introduction of the Hydrogen Energy Portfolio Standard (HPS)** The Hydrogen Economy Council has resolved to introduce the HPS by 2022, which involves creating a mandatory market supply of hydrogen power. The government plans to purchase environmentally-friendly and dispersal type fuel cell energy through auction.	South Korean Government
8.	**Hydrogen Model Cities** In December 2019, the South Korean government announced plans to transform three cities (Ulsan, Ansan and JeonjuWanju) into 'hydrogen model cities' by 2022. Under the plan, hydrogen would be sourced as the main fuel for heating and cooling, transportation, and electricity. The government has started integrating hydrogen into the cities' infrastructure, including the installation of pipelines for transporting hydrogen.	South Korean Government
9.	**Pohang fuel cell power generation cluster** A memorandum of understanding was signed in June 2020 between regulatory authorities, nuclear power stations and engineers to construct a hydrogen fuel cell power generation cluster in Pohang, Korea, by 2025 for the emerging fuel cell industry, at an estimated cost of US$200 million.	Local authorities Commercial partners
10.	**Change to the Natural Gas Supply Chain** The South Korean government has announced a plan to improve the natural gas supply system so that hydrogen manufacturers can stably and economically provide extracted hydrogen. Under the current natural gas supply system, only retail gas suppliers can supply natural gas for hydrogen production, however the government proposes to allow a state utility to directly supply natural gas to large-scale hydrogen manufacturing entities. It will also permit installation of high pressure pipelines by such facilities.	South Korean Government

No.	Description	Key Players
11.	**Hydrogen-Specialised Companies** The South Korean government will foster 1,000 specialised companies by 2040. Intensive support will be provided to companies engaged in five key areas – hydrogen mobility, fuel cells, liquid hydrogen, hydrogen refuelling stations, and water electrolysis. The government will also require local governments and government agencies to purchase products of these companies as a priority.	South Korean Government
12.	**Hydrogen Economy Fund** The South Korean government has formed a 'Hydrogen Economy Fund' worth KRW 34 billion to support early-stage hydrogen-related companies with a view to encouraging the private sector to participate in the hydrogen economy. The fund will be run as part of the government's KRW 505 billion New Energy Industry Fund launched in 2016.	South Korean Government (The Ministry of Trade, Industry and Energy)

Japan

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Japan's Basic Hydrogen Strategy** In 2017, Japan became the first nation to adopt a national hydrogen strategy. Under the plan, Japan aims to reach cost parity across hydrogen, LNG and petroleum to be used as fuel for transportation and feedstock for power generation.	Japanese Government (Ministerial Council on Renewable Energy, Hydrogen and Related Issues)
2.	**The 5th Strategic Energy Plan** This plan was formulated in July 2018 under the Basic Act on Energy Policy, and presents a basic direction of Japan's energy policy towards 2030 and further towards 2050. It emphasises the importance of energy mix and decarbonisation, anticipating the arrival of a 'hydrogen society'.	Japanese Government
3.	**Strategic Road Map for Hydrogen and Fuel Cells** In March 2019, the 'Strategic Road Map for Hydrogen and Fuel Cells' was announced by the Ministry of Economy, Trade and Industry of Japan. This document sets out specific action plans in order to achieve the goals envisaged in the 'Basic Hydrogen Strategy' discussed above. It aims for a full-scale implementation of hydrogen use in mobility starting in 2025 at a reduced cost, with around 800,000 fuel cell vehicles, 1,200 fuel cell buses and 900 hydrogen refuelling stations by 2030.	Japanese Government (METI)
4.	**Strategy for Developing Hydrogen and Fuel-Cell Technologies** This strategy was adopted in September 2019 to specify the types of technology that need to be developed in order to achieve the goals set out in the Strategic Road Map for Hydrogen and Fuel Cells discussed above. For instance, a fuel cell exceeding 65% power generation thermal efficiency is identified as a technology to be developed for large cost reduction.	Japanese Government (Council for a Strategy for Hydrogen and Fuel Cells)
5.	**Green Growth Strategy towards 2050 Carbon Neutrality** This strategy was published in December 2020 by the Ministry of Economy, Trade and Industry of Japan in furtherance of Prime Minister Suga's announcement of Japan's objective to reach carbon-neutrality by 2050. The paper features hydrogen prominently as one of the 14 key fields of focus in achieving this goal, and discusses issues and action plans in usage, transportation and production of hydrogen, among other topics.	Japanese Government (METI)

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
6.	**Tokyo Statement** In October 2018, the Tokyo Statement was released at the First Hydrogen Energy Ministerial Meeting held in Japan with over 300 stakeholders, including ministerial officials, top executives from related companies and representatives from around the world. The statement aims to facilitate the standardisation of regulations to support a global marketplace, information sharing, joint research and development and cost reduction in the hydrogen supply chain, among others.	Japanese Government Industrial Technology Development Organisation of Japan (**NEDO**)
7.	**New Zealand-Japan Memorandum of Cooperation on Hydrogen** In October 2018, at the First Hydrogen Energy Ministerial Meeting, New Zealand and Japan signed a memorandum of cooperation which envisages a cooperation between the two countries in developing renewable energy based hydrogen production technology, and a hydrogen strategic road map to be adopted in New Zealand to expand the demand of hydrogen in New Zealand.	Japanese Government New Zealand Government
8.	**JOGMEC and the State of Queensland: Memorandum of Understanding** JOGMEC and Queensland signed a memorandum of understanding in 2013 to encourage Japanese companies to invest in Queensland's natural resources including oil, natural gas, metal minerals and coal. In May 2019, JOGMEC and Queensland decided to add the exchange of information and opinions on hydrogen-related projects to the memorandum of understanding.	Japan Oil, Gas and Metals National Corporation (JOGMEC)
9.	**Joint Statement of future cooperation on hydrogen and fuel cell technologies** In June 2019, a Joint Statement was released to declare the acceleration of development of sustainable hydrogen and fuel cell technologies by Ministry of Economy, Trade and Industry of Japan (**METI**), European Commission Directorate-General for Energy (**ENER**) and Department of Energy of the United States (**DOE**), which the statement recognises as the world leaders in funding hydrogen and fuel cell programs.	METI ENER DOE
10.	**Argentina-Japan Memorandum of Cooperation on Hydrogen** In September 2019, at the Second Hydrogen Energy Ministerial Meeting, Argentina and Japan signed a memorandum of cooperation which envisages a cooperation between the two countries in developing renewable energy based hydrogen production technology, a strategic roadmap for hydrogen and measures for reducing mid- to long-term costs.	Japanese Government Argentine Government
11.	**Netherlands-Japan Memorandum of Cooperation on Hydrogen** In September 2019, at the Second Hydrogen Energy Ministerial Meeting, the Netherlands and Japan signed a memorandum of cooperation to encourage the governments, industrial participants and research institutes to cooperate in the fields of: efforts for hydrogen policies and utilisation of hydrogen, a strategic roadmap for hydrogen, creation of international hydrogen supply chains and technological development.	Japanese Government Government of Holland
12.	**Memorandum of Cooperation on Hydrogen Supply Chains with Rusatom Overseas** In September 2019, at the Second Hydrogen Energy Ministerial Meeting, the Ministry of Economy, Trade and Industry of Japan (**METI**) and Rusatom Overseas, a Russian company, signed a memorandum of cooperation for conducting a feasibility study on hydrogen supply chains.	Japanese Government Rusatom Overseas

No.	Description	Key Players
13.	**Victoria – Japan Hydrogen Energy Supply Chain (HESC)** In November 2019, a pilot project was announced for the production and transport of hydrogen from Australia to Japan. The HESC proposal, supported by the Australian, Victorian and Japanese governments and several private partners, involves the production of brown (and possibly blue) hydrogen using brown coal deposits of brown coal in Victoria's Latrobe Valley, to be liquefied and shipped to Japan.	Victorian State Government Australian Government Japanese Government Commercial partners
14.	**Australia-Japan Joint Statement on Cooperation on Hydrogen and Fuel Cells** In January 2020, Australia and Japan signed a joint statement of cooperation on hydrogen and fuel cells. The agreement followed the release of Australia's National Hydrogen Strategy in November 2019 and seeks to affirm its commitment to being an export hub for regional customers such as Japan.	Japanese Government Australian Government
15.	**Government Subsidies** There is a wide range of national and prefectural subsidies provided in Japan to incentivize the development and use of hydrogen technologies. METI has requested a budget of JPY 70.7 billion for the fiscal year 2021 to be allocated for subsidies in facilitating the realisation of hydrogen society. Subsidies include: □ Residential Fuel Cell System Installation Support Project: subsidises part of the purchase and construction costs of residential fuel cells. □ Business/Industrial Fuel Cell System Installation Support Project: subsidises part of the costs for installing industrial fuel cell systems. □ Clean Energy Vehicle Implementation Project: purchasers of clean energy vehicles, including fuel cell vehicles (FCVs), are eligible to receive subsidies. □ Fuel Cell Vehicle Hydrogen Supply Facilities Installation Support Project: subsidises part of the costs for installing hydrogen supply facilities for FCVs. □ Creation of New Demand for Fuel Cell Vehicles Support Project: subsidises costs spent on activities which create demand for FCVs. □ METI subsidies for R&D and demonstration projects for supply, transport and use of hydrogen.	Japanese Government
16.	**Green Innovation Fund** Separately, in January 2021, Japan approved the national budget allocation of JPY 2 trillion to a 'green innovation fund' to be established with the Industrial Technology Development Organization of Japan (NEDO), a national research and development agency. The fund will be used to subsidise companies carrying out research and development of technology related to hydrogen, green electricity, next generation batteries and carbon recycling. The government plans to financially support these projects over a period of ten years.	

China

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
17.	**Made in China 2025** In May 2015, the Chinese Government published 'Made in China 2025', a 10-year plan by the Chinese Government to comprehensively upgrade China's manufacturing industry. The plan highlights 10 priority sectors, including new-energy vehicles and equipment.	Chinese Government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
18.	**14th Five-Year Plan** As part of its latest five-year plan, released in November 2020, China announced a 15-year strategy for new energy vehicles which focuses on developing fuel cell technology for hydrogen-powered trucks and buses. China is already a world leader in government-sponsored hydrogen research and development expenditure, and the Beijing city government has announced plans to have 1,000 fuel cell buses in operation for the 2022 Winter Olympics. Two hydrogen refuelling stations have been opened in Shanghai since 2019, and the central government has declared a target of 1,000 stations by 2030.	Chinese Government
19.	**National Innovation Driven Development Strategy** In May 2016, the CPC Central Committee and the State Council issued a national strategy for innovation-driven development, identifying industries that China feels would most benefit from increased local innovation, including hydrogen energy and fuel cells industry.	Chinese Government
20.	**Guiding Opinion on Establishing a Sound, Long-term Clean Energy Consumption** In May 2019, China's National Energy Administration issued a draft Guiding Opinion on Establishing a Sound, Long-term Clean Energy Consumption. The policy includes "scientific targets" for renewable consumption and "strengthened analysis of renewable consumption capacity", promoting a list of innovative fields and technologies, including energy storage, multi-energy complementarity, and uptake of renewable electricity through port electrification, electric vehicle charging, hydrogen production, as well as heating and cooling.	Chinese Government
21.	**Draft Energy Law in 2020** In April 2020, China's National Energy Administration published a new draft Energy Law. The measure goes beyond the prior energy law by clearly stating that renewable energy has priority for development in China's energy system. The measure explicitly calls for development of a low-carbon energy system, for non-fossil energy to gradually replace fossil fuel energy sources, and for finding substitutes for natural gas and oil.	Chinese Government
B	**Specific grants, programs & incentives**	
22.	**Green hydrogen technology** A state-owned oil refiner announced in October 2020 that it was directing resources towards the development of green hydrogen technology in China, as the nation seeks to reach net zero carbon emissions by 2060.	State-owned oil refiner
23.	**Ministry Finance subsidy support to hydrogen vehicles** In March 2019, Chinese Ministry of Finance (**MOF**) announced it would remove subsidy support for electric vehicles, while keeping subsidy support for hydrogen vehicles. MOF especially emphasised that the funding saved from electric vehicles would instead be used on hydrogen refuelling infrastructure and services. By July 2019, over 20 cities announced initiatives to forge their hydrogen industry clusters.	Ministry of Finance
24.	**Energy-saving and New Energy Vehicle Technology Roadmap** On 27 October 2020, the Chinese Government released the 'Energy-saving and New Energy Vehicle Technology Roadmap 2.0', outlining concrete goals of transforming Chinese automotive industries into a wholly electric industry by 2035. The roadmap also emphasises the battery electric drive development strategy: by 2035, the market share of new energy vehicles will exceed 50%, and the number of fuel cell vehicles will reach 1 million.	Chinese Government China Society of Automotive Engineers

No.	Description	Key Players
25.	**White Paper on China's Hydrogen and Fuel Cell Industry** In June 2019, the China Hydrogen Alliance released a White Paper on China's Hydrogen and Fuel Cell Industry, regarded as a key publication in support of Chinese Government's decision making on hydrogen. Key targets recommended by the Alliance include increasing the percentage of hydrogen in China's primary energy consumption from 2.7% in 2019 to 10% in 2050, and the number of hydrogen refuelling stations to 10,000 by 2050.	China Hydrogen Alliance

3.3 Europe & the United Kingdom

Overview

European governments are now increasingly aware that they are facing global competition for hydrogen markets and are beginning to facilitate the necessary regulatory framework for establishing a hydrogen ecosystem in Europe. With the Renewable Energy Directive and the Emission Trading System, the European Union (EU) already has the basis for building up a supportive policy-framework for hydrogen.

In July 2020, the European Commission issued its 'Hydrogen Strategy for a Climate-Neutral Europe' (**EU Hydrogen Strategy**), identifying the use of hydrogen as essential for the decarbonisation of the energy system. The EU Hydrogen Strategy sets out a roadmap encompassing several phases of gradual development, with different speeds across regions and sectors:

- **first phase** – from 2020 up to 2024 – will focus on the installation of at least 6 GW of renewable hydrogen electrolysers in the EU, and the take-up of hydrogen use in new end-use applications in the industry and transport sector;
- **second phase** – from 2025 up to 2030 – installed production capacities of 40 GW shall make hydrogen an intrinsic part of an integrated energy system based on renewables; and
- **third phase** – from 2030 onwards – after renewable hydrogen technologies have reached maturity, the third phase shall see a significant increase in renewable electricity capacities in order to dedicate a significant share of electricity generation to the production of hydrogen to be used at large scale in the hard-to-decarbonise sectors.

The goals set out in the EU Hydrogen Strategy will require substantial investment in all sectors. Investments necessary for installing sufficient hydrogen production capacities alone are believed to total up to €470 billion, with another €340 billion required for the scale up of solar and wind electricity generation capacities. In order to support these investments, the European Clean Hydrogen Alliance has been established, bringing together key players of industry, national and local public authorities, civil society and other stakeholders. The European Clean Hydrogen Alliance established an investment agenda at the end of 2020 and provide a forum for coordinating action along the hydrogen value chain as well as across private and public stakeholders. The EU Hydrogen Strategy complements the Strategy for Energy System Integration. This Strategy also puts a focus on hydrogen as several of its key actions are directly related to hydrogen. In order to ensure the further deployment of hydrogen, several EU-funding programmes exist to support hydrogen projects.

In addition to the EU Hydrogen Strategy, EU legislation requires each Member State to draft a ten-year National Energy and Climate Plan (**NECP**) concerning, among other things:

- the reduction of greenhouse gasses; and
- the development of renewable energy by 2030.

Hydrogen is referred to directly in some of the NECPs, which include existing or intended hydrogen-specific measures and initiatives. Several NECPs contain expected or targeted hydrogen demand for 2030, targets for hydrogen production or specific hydrogen roadmaps or strategies that have been or will be elaborated at a national level. Only some NECPs comprise concrete dedicated measures to facilitate hydrogen deployment and its integration into energy systems. Several EU member states, as well as the UK, have already implemented, or are planning to implement, national strategies for the establishment of a hydrogen economy.

Emerging Global Policy and Regulatory Initiatives continued

The majority of EU member states have demonstrated a desire to decarbonise their energy systems as much as possible by switching from fossil energy (oil, natural gas and coal in particular) to renewable energy. In order to do so, many have introduced or plan to introduce strategies, programmes or grants concerning hydrogen. Several areas of connectivity and alignment can be identified:

- Germany, France, the Netherlands and Spain have each published a national strategy on hydrogen;
- Germany and France have both introduced a national hydrogen strategy with a similar tenor. Both countries are planning to become world leaders in hydrogen production. Germany is targeting 5 GW of electrolyser capacity by 2030, while France aims to build 6.5 GW of electrolyser capacity by 2030. Both strategies include contracts for difference. Following the plan laid out in its national hydrogen strategy, Germany is developing a pilot program for climate protection contracts based on the carbon contracts for difference approach, while France's hydrogen strategy includes tenders towards contracts for difference by 2022;
- the Netherlands and Spain set similar aims regarding hydrogen generation with Spain targeting 4 GW of electrolyser capacity by 2030 and the Netherlands aiming for 3-4 GW of electrolyser capacity by 2030;
- several European countries provide incentives to ramp up hydrogen production. In Germany energy used for the production of hydrogen will be exempt from the Renewable Energies Act levy (**EEG levy**), while in Spain a green tax has been introduced; and
- France, Germany, Spain and Sweden have specific programmes or financing instruments to further boost hydrogen production, while the Netherlands and Belgium focus more on private/public-private initiatives than on purely public incentives, grants or programs for the development of hydrogen-based technologies.

Key hydrogen activities across European countries including the following:

- **Germany**

  Germany published its National Hydrogen Strategy in June 2020 in order to foster its energy transition and to reduce the country's CO2-emissions. To ensure the success of the strategy, the German government has announced €9 billion of funding to promote hydrogen projects. No nationwide hydrogen infrastructure exists at present. However, the well-established gas infrastructure in Germany is also said to be suitable for the transportation of hydrogen, and there are also already small clusters of existing hydrogen infrastructure in commercial areas with connected production and consumption.

  The regulatory framework in Germany in some aspects hinders the deployment of hydrogen: in particular, Germany has comparably high energy costs partly caused by the EEG levy. Hence, the German legislator has become active in the space and further reform is anticipated. Pursuant to the new Renewable Energies Act (**EEG 2021**), which entered into force in January 2021, electricity used for hydrogen generation can be partially exempted from the EEG levy and, in case of generation of green hydrogen, fully exempted if further requirements are met. Also, amendments in the Energy Industry Act with regard to the regulation of the hydrogen networks are expected to be introduced in early 2021.

- **France**

  France has recently released its national strategy for the development of low-carbon hydrogen. The focus is on public grants and incentives on low-carbon hydrogen. Since 2018, France has allocated public resources to develop and support this sector. The national strategy unveiled in September 2020 aims to accelerate and increase those investments.

- **Netherlands**

  The Netherlands aims to distance the country from the use of fossil fuels in order to achieve a decarbonised energy system, partially by using hydrogen. The Netherlands is considered to possess the necessary elements to become Northwest Europe's hydrogen hub:

  a) a number of natural gas fields, of which the infrastructure can be modified to accommodate the production and supply of hydrogen;

  b) empty gas fields in the North Sea, where CO_2 can be stored, if needed;

  c) substantial offshore wind installations that can, eventually, produce green hydrogen;

  d) it is situated in a favourable location and has large ports; and

  e) extensive gas and electricity grids.

  The Dutch Government has already put emphasis on the creation and implementation of several strategies and programs fostering the hydrogen economy.

- **Sweden**

  The organisation 'Fossilfritt Sverige', a government initiative founded to aid Sweden's shift away from fossil fuels, is currently preparing a national hydrogen strategy to be presented to the government in 2021. Additionally, there are projects to develop hydrogen technologies that receive funding from governmental agencies, and the Swedish Energy Agency coordinates the building of infrastructure for alternative fuels including hydrogen.

- **Finland**

  Hydrogen is considered an integral part of Finland's national energy and climate strategy. Finland has set some of the world's most ambitious environmental targets, as it aims to be carbon neutral by 2035 and carbon negative by 2050. To achieve these goals, Finland is actively exploring its strengths and opportunities in the global market. Demand for hydrogen development in Finland exists especially in the transport, industry and building sectors. Building additional renewable electricity capacity dedicated to hydrogen production could be a feasible option to cover this demand.

- **Spain**

  Spain has established ambitious renewable energy objectives for 2030, the achievement of which will ensure the industrial and technological positioning of its economy at EU level, the production of coal-free hydrogen and the use of renewable energies. During 2020, the Spanish Government was focused on adopting measures to promote renewable energies, specifically renewable hydrogen.

- **Italy**

  Italy has a strategic geographic location, facilitating an aim to become the Mediterranean hub for the production, transportation and storage of green hydrogen. Italy's infrastructure and regulatory regime requires further development in support of hydrogen, including with respect to administrative requirements to establish hydrogen generation plants, the operation of electrolysers, and interconnection with existing grids. The Italian government plans to support hydrogen production and use through the implementation of a national regulatory framework. This will include the introduction of specific incentive schemes, as well as by streamlining the regulatory regime applicable to hydrogen plants and capacity of electrolysers, in order to promote the expansion of hydrogen-related infrastructure and at the same time stimulating demand.

- **United Kingdom**

  The UK recently announced that a targeted UK hydrogen strategy would be published in 2021, ahead of the next UN Climate Change Conference. Important to the UK's hydrogen strategy is the Department for Business, Energy & Industrial Strategy commissioned report on Business Models for Low Carbon Hydrogen Production. This underpins the UK government's overarching goal to mobilise private sector investment in the industry and reiterates that business models for low carbon hydrogen production should provide an incentive to invest, whilst limiting costs to consumers and taxpayers. The report details models such as regulated asset base (**RAB**) structures which would impose a floor on the return made by hydrogen producers.

  The UK's energy transition is bolstered by the fact that it can leverage its developed energy infrastructure, which includes 284,000 km of gas pipelines. Currently by law, only 0.1% of hydrogen gas is permitted in the gas network; this is despite there being widespread agreement that natural gas can be blended with hydrogen safely. However, a recent project has trialled blends of up to 20% hydrogen in the gas network, highlighting that this can be done safely in practice, encouraging regulatory reform to create a hydrogen-friendly regulatory environment.

  In July 2020, the Hydrogen Advisory Council was established to become the primary forum for ministerial engagement with the hydrogen sector. In addition, the House of Commons Science and Technology committee has an ongoing inquiry into the role of hydrogen in achieving net zero. As part of the UK government's commitment, in November 2020, the UK government published a ten-point plan for a 'green industrial revolution' that set out £240 million in new production facilities to generate 5 GW of low-carbon hydrogen by 2030. The government intends that this will generate a further £4 billion of private investment in hydrogen in that time. A White Paper published in December 2020 reiterates this pledge, and adds that £1 billion will invested into state-of-the-art carbon capture storage in four industrial clusters of the UK by 2030.

Emerging Global Policy and Regulatory Initiatives continued

- **Central & Eastern Europe**

  Several governments in Central & Eastern Europe are actively pursuing hydrogen strategies at a national and regional level. While many action plans remain high-level and are concerned with broader clean energy and climate goals (see, for example, the Bulgarian, Romanian, Ukrainian and Russian strategies below), there is an increasing number of hydrogen-specific programs being introduced in key regional jurisdictions (particularly the Czech Republic, Poland and Austria).

  There is a particular trend towards encouraging the use of hydrogen-powered vehicles in these states, including promoting the development and construction of hydrogen refuelling facilities. A number of projects have been announced (see section 4.2) and further developments are expected for this region, particularly given its geographical capacity for both demand and supply-side hydrogen projects. It is expected that the recent expansion of policy frameworks and a growing number of regulatory incentives can accelerate the development of these projects.

European Union (EU)

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**EU Hydrogen Strategy** In July 2020, the European Commission published their hydrogen strategy 'A hydrogen strategy for a climate-neutral Europe' (COM (2020) 301 final). The strategy aims to decarbonise the production of hydrogen and to help reach the long-term goal of a zero-carbon economy. Key actions are the development of an investment agenda, various actions to boost demand of hydrogen and scale up its production (such as creating tendering systems for carbon contracts for difference), designing a framework for hydrogen infrastructure and market rules, promoting research and innovation in hydrogen technologies and promoting new opportunities for cooperation on clean hydrogen with neighbouring countries and regions.	European Commission European Economic and Social Committee Committee of the Regions
2.	**Strategy for Energy System Transition** In July 2020, the European Commission presented a 'Strategy for Energy System Transition'. The purpose of the strategy is to identify actions to realise the transition to a more integrated energy system. Hydrogen-related key actions include the ensuring of cost-effective planning and deployment of offshore renewable electricity and thereby considering the potential for on-site or nearby hydrogen production, promoting the use of renewable hydrogen in hard-to-decarbonise sectors and promoting a level-playing field across all energy carriers (for example by revising the Energy Taxation Directive).	European Commission
B	**Specific grants, programs & incentives**	
3.	**InvestEU-programme** The InvestEU-programme will support the deployment of hydrogen through its original four policy windows and the new Strategic Investment Facility Window. Its aim is to encourage public and private investment by means of a guarantee that will back the investment projects of implementing partners. Hydrogen is mentioned as a key strategic sector of the new Strategic Investment Facility. The programme provides support via targeting specific projects or via diffused financing for a targeted sector.	European Commission Implementing partners

No.	Description	Key Players
4.	**Horizon Europe research and innovation programme** The programme is a financial instrument that succeeds the Horizon 2020 programme, which provides funding for research and innovation for hydrogen projects (among others). Among the key implementation tools of Horizon Europe are European partnerships which aim to avoid the duplication of investments and contribute to reducing the fragmentation of the research and innovation landscape in the EU by bringing private and public partners together. For example, the 'Clean Hydrogen Partnership' was proposed under Horizon Europe. Its main focus is renewable hydrogen production, transmission, distribution and storage, alongside selected fuel cell end-use technology. The Next Generation EU recovery package allocates at least €5 billion to Horizon Europe.	European Commission Hydrogen Europe
5.	**IPCEI on Hydrogen** The Strategic Forum for Important Projects of Common European Interest (**IPCEI**) on Hydrogen was launched in December 2020 when 22 Member States and Norway signed the 'Manifesto for the development of a European Hydrogen Technologies and Systems value chain'. IPCEI are possibilities to receive aid compatible with the internal market due to their importance for the EU. The IPCEI on Hydrogen includes a significant number of projects in all the areas important for hydrogen such as the generation of green hydrogen and its transportation. The objective of the IPCEI on Hydrogen is to support Europe's technological leadership, to allow European companies to take the lead on the emerging markets for hydrogen, and to build a European framework for the emergence of a hydrogen value chain.	European Commission Hydrogen Europe
6.	**Technical Guiding Templates for EU State Aid** The European Commission plans to publish a set of technical guiding templates on how hydrogen-related projects can be supported in line with the EU State Aid rules.	European Commission
7.	**Report of IPCEI** IPCEI's report 'Strengthening Strategic Value Chains for a future-ready EU industry' presents recommendations on actions for six selected strategic value chains with hydrogen technologies and systems being one of those. Recommendations include the promotion of well-coordinated or joint investments and actions across several Member States aimed at supporting a hydrogen supply chain.	Strategic Forum for Important Projects of Common European Interest (**IPCEI**)
8.	**Political declaration: 'The Hydrogen Initiative'** The Hydrogen Initiative is a political declaration of Energy Ministers of several EU-Member States. The signatories express their aim to promote the application of renewable hydrogen technology in the fields of sector integration and coupling, short and long-term storage, direct injection into the gas-grid, conversion to renewable methane and other fuels, industry as well as transport and mobility.	Energy Ministers from several Member States
9.	**2 x 40 GW Initiative** The 2 x 40 GW Initiative presents concrete steps to develop a 2 x 40 GW electrolyser market in the European Union and its neighbouring countries by 2030. The aim of the initiative is to create a world class leading electrolyser industry in Europe and to reduce CO2 emissions.	Hydrogen Europe

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
10.	**Oyster offshore pilot funded by EU** In January 2021 it was announced that a consortium including Ørsted, Siemens Gamesa, Element Energy and ITM Power had been granted €5 million in EU funding as part of the Fuel Cells and Hydrogen Joint Undertaking. The pilot project, named 'Oyster', will test the feasibility of offshore production of green hydrogen using a combined wind turbine, desalination and electrolyser system.	European Commission Consortium partners
11.	**REACT-EU** REACT-EU is an instrument that reinforces already existing funds for the period of 2020-2022 (the European Regional Development Fund (**ERDF**), the European Social Fund (**ESF**) and the Fund for European Aid to the Most Deprived (**FEAD**)). The largest potential for green energy and transport projects provides the ERDF as it includes a low-carbon-project. Hydrogen is eligible for funding.	European Commission
12.	**ETS Innovation Fund** The ETS Innovation Fund is funded by the EU-Emission Trading System and supports innovative low-carbon technology through launching calls for large and small-scale projects whose focus is among others on innovative low-carbon technologies and processes in energy-intensive industries, including products substituting carbon-intensive ones. Clean hydrogen is one of the potential projects to be supported.	European Commission Other partners
13.	**Plan to revise the State aid guideline for energy and environmental protection** The European Commission is planning to revise its Guidelines on State aid for environmental protection and energy. As also pointed out in the European Hydrogen Strategy of 2020, this is an opportunity to create a new framework to advance decarbonisation through the deployment of hydrogen (among others). The European Commission has published an Inception Impact Assessment, which outlines its initial ideas for the revision. The Inception Impact Assessment focuses on two main subjects: the review of compatibility criteria for environmental protection to promote the green transition and an assessment of State aid to energy intensive users.	European Commission
14.	**Just Transition Fund** The European Commission adopted a proposal for a regulation to create the Just Transition Fund in January 2020. The purpose of the fund is to help Member States in their transition towards climate neutrality. The funding will be accessible through calls for proposals based on approved territorial just transition plans which the Member States create. Hydrogen projects can benefit from the Just Transition Fund only if the Member States included these projects in their plans and the plans get approved. In this case, the projects can receive financial support in form of grants, guarantees, or loans.	European Commission
15.	**The Recovery and Resilience Facility** This facility aims to support reforms and investments undertaken by Member States. In order to benefit from the facility, Member States have to develop national Recovery and Resilience plans with a minimum of 37% of expenditure related to climate. If hydrogen technology forms part of the Recovery and Resilience plans and gets the approval of the European Commission, it can benefit from this facility.	European Commission European Investment Bank
16.	**Australia – Germany Supply Chain Feasibility Study** In September 2020, the Australian and German governments signed a Joint Declaration of Intent on a Supply Chain Feasibility Study of Hydrogen produced from Renewables. The Australian government is seeking an Australian research and industry consortium to partner with German industry on the study through an expression of interest process.	Australian Government Federal Republic of Germany

Germany

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**German Hydrogen Strategy** The German Hydrogen Strategy, published in June 2020, sets out a list of measures which aim to foster the generation, transport, nutilisation and re-utilisation of hydrogen. It aims at establishing hydrogen as a key element of the energy transition, creating the regulatory requirements for the deployment of hydrogen technologies, strengthening German corporations through a push for research and developments of such technologies, and ensuring the national supply of clean hydrogen. The German Hydrogen Strategy sets up a concrete plan of actions in order to secure the success of the strategy and targets 5 GW of electrolyser capacity by 2030.	German Government
2.	**Amendment of the Energy Industry Act (EnWG)** An amendment of the Energy Industry Act is planned to facilitate the hydrogen economy. In summer of 2020 the German Federal Network Agency conducted a market consultation on the question of how the current legal framework would have to change to enable a quick market ramp-up of hydrogen, in particular in regards to the regulation of hydrogen infrastructure and pipelines in the future. The suggestions made were reviewed by the German legislator and it is expected that amendments to the regulation of hydrogen are going to be introduced in the Energy Industry Act early in 2021.	German legislator
B	**Specific grants, programs & incentives**	
3.	**Amendment of the Renewable Energies Act** Under the Renewable Energies Act (**EEG**), energy consumers generally have to pay an EEG levy which forms part of the electricity price. In order to reduce the production costs of hydrogen, the National Hydrogen Strategy announced a review of whether electricity used to produce green hydrogen can be exempted from taxes, levies and charges such as the EEG levy. As a consequence, pursuant to the new Renewable Energies Act (**EEG 2021**), which entered into force on 1 January 2021, companies producing green hydrogen can be completely exempted from the obligation to pay the EEG levy for the electricity used, which will decrease costs for the hydrogen production significantly. Also, electricity-intensive companies producing grey hydrogen may also benefit from a reduction of the EEG levy.	German legislator
4.	**Technology Actions Strategy Hydrogen *(Technologieoffensive Wasserstoff)*** The aim of the initiative is to fund research projects on the generation, transport, storage or use of hydrogen.	German Federal Ministry for Economic Affairs and Energy
5.	**Energy Research Programme** This programme provides funding of up to €6 billion until 2022 for research and development as a basis for future applications in the fields of transport, hydrogen production, residential energy supply, sector coupling, industrial applications, special markets for fuel cells and horizontal issues.	German Government
6.	**Pilot program for climate protection contracts** A pilot program for climate protection contracts based on a carbon contracts for difference approach is currently being developed, following state aid consultations with the European Commission. The idea of the program is that contracts are to be concluded with companies for the development of climate-friendly projects and a fixed CO2-price is guaranteed to them for a certain period of time.	German Government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
7.	**Aid programme for the deployment of hydrogen** The German Government has announced the allocation of €9 billion in order to establish hydrogen as a marketable energy carrier. €7 billion is allocated for the promotion of hydrogen technologies in Germany while the other €2 billion is allocated for international partnerships regarding hydrogen.	German Government
8.	**Ideas competition 'Hydrogen Republic Germany'** In 2020, under the title 'Hydrogen Republic Germany', the German Federal Ministry of Education and Research sought ideas for industry-led large-scale projects with partners from science and industry. The three lead projects (H2Giga, H2Mare and TransHyDE) that won were announced in January 2021 and will be granted funding up to €700 million.	German Federal Ministry of Education and Research

France

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Strategy for the development of low-carbon hydrogen** On 8 September 2020, the French ministers for the Economy and Ecological transition released a plan to develop a French electrolysis sector to decarbonise industry, to develop heavy mobility using low carbon hydrogen and to support research, innovation and skills development. The national strategy plans to allocate €7 billion of funding through to 2030.	French Government Agency for ecological transition (**Ademe**)
2.	**Hydrogen Ordinance** Article 52 of the Law no. 2019-1147 of 8 November 2019 authorises the French Government to implement by ordinance regulations applicable to hydrogen. This ordinance should notably implement safety standards for facilities and support mechanism.	French Government
B	**Specific grants, programs & incentives**	
3.	**Call for proposals 'territorial hydrogen hub'** This program aims to deploy, by consortia of local authorities and industrial solution providers, large-scale territorial ecosystems bringing together different uses (industry and mobility), in order to promote the market ramping of hydrogen. This project will receive €275 million between 2020 and 2023.	Ademe
4.	**Call for proposals 'technological bricks and demonstrators'** This program aims to develop or improve components and systems related to hydrogen production and transport, and to its uses such as energy supply applications. It will also enable the support of demonstrator projects with strong value creation in France and, help the sector to develop new solutions and to structure the sector. This program has €350 million budget until 2023.	Ademe
5.	**Investment program for the future** This program aims at mobilising investment schemes to finance companies requiring support for the development of innovative technologies, industrialisation or launch of commercial firsts in the field of energy infrastructure.	FPCI Ecotechnologies (Bpi France) SPI Funds (Bpi France) Ademe Investissements
6.	**Call for proposals 'Hydrogen applications'** This priority research program will support upstream research and prepare the future generation of hydrogen technologies. It will be endowed with €65 million.	French National Research Agency (**ANR**)

No.	Description	Key Players
7.	**Call for tenders** This call for tenders will be organised within the framework of the support mechanism for the production of low-carbon hydrogen. Recipients will be awarded a contract for difference.	French Government

Netherlands

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Government Strategy on Hydrogen (National Policy)** This paper sets out the government's strategy on hydrogen as well as the corresponding policy agenda. It constitutes the prelude to the hydrogen program that is to be jointly outlined and implemented with stakeholders. This program will align with the ambitions of the National Climate Agreement on hydrogen. The policy agenda has four pillars: (i) legislation and regulation (for example use of the existing gas grid, safety, market regulation, guarantees of origin and certification), (ii) cost reduction and scaling-up green hydrogen, (iii) sustainability of final consumption and (iv) supporting and flanking policy (for example through international cooperation).	Netherlands Government
2.	**Climate Act and Long-term Growth Strategy for the Netherlands (National Policy) and Climate Plan and National Climate Agreement (National Policy)** In order to combat climate change, the Dutch government hopes to reduce the Netherlands' greenhouse gas emissions by 49% by 2030, compared to 1990 levels, and a 95% reduction by 2050. These goals are laid down in the Climate Act of 28 May 2019. Under the Climate Act, the government is required to draw up a Climate Plan setting out measures to ensure the targets stipulated in the Act are achieved. The National Climate Agreement, which was concluded in June 2019, is part of the Climate Plan. The National Climate Agreement is aimed at creating a joint public-private partnership endeavour with some of its objectives being the upscaling of hydrogen production, the cost reduction of hydrogen use and the innovations surrounding hydrogen in the coming years.	Netherlands Government Industrial stakeholders
B	**Specific grants, programs & incentives**	
3.	**SDE++ subsidy** SDE++ is an operating subsidy for climate-friendly technologies that compensates for the difference between the base cost of the technologies and their market price. Subsidies are available for technologies that reduce CO_2 emissions, including hydrogen-based projects. The opening budget of the SDE++ was €5 billion.	Netherlands Government (Ministry of Economic Affairs and Climate Policy)
4.	**DEI+ subsidy** The DEI+ scheme is meant for pilots and demonstration projects aimed at the reduction of CO_2 through to 2030. Subsidies are available for 25% (up to 45% for certain projects) of the eligible costs of technologies that reduce CO_2emissions, including hydrogen-based projects. The opening budget of the DEI+ is €86.1 million and the maximum amount of money a single project can receive is €15 million.	Netherlands Government (Ministry of Economic Affairs and Climate Policy)

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
5.	**Zero-emission (ZE) targets for all vehicles** From 2035 onwards, all new passenger vehicles must be able to drive with a carbon neutral footprint. In order to do so, the Netherlands has adopted a number of different incentives aimed at reducing the use of more polluting vehicles: □ zero-emission cars are exempt from paying the registration tax. For other kinds of cars, the system is progressive with five levels of CO_2 emissions. The tax ranges from €6 per gram of CO_2 (level 1) to €476 per gram of CO_2 (level 5); □ Fuel Cell Electric Vehicles (**FCEVs**) are also exempted from motor vehicle and road taxes; and □ fiscal costs for the private use of zero-emission lease or company cars, including **FCEVs**, are 4%, as opposed to 22% for petrol cars.	Netherlands Government
6.	**General tax exemption** The replacement of fossil fuels by hydrogen is encouraged by tax exemptions. For example, investments resulting in the replacement of fossil fuels by hydrogen are deductible from the profit before the latter is taxed (which can be up to 41.5%).	Netherlands Government
7.	**H2-Drive – Incentive package for hydrogen cars** A consortium of commercial stakeholders has announced an intention of deploying 90 additional hydrogen cars in the Arnhem Region with a 50% discount on all refuelling, hydrogen car introductory training, pick-up services and replacement transport. The promotion is aimed at people who live or work at a maximum of 30 kilometres away from the centre of Arnhem.	Commercial stakeholders

Sweden

No.	Description	Key Players
A	**Specific grants, programs & incentives**	
1.	***Industriklivet* program** This program aims to promote the development of transformational zero and negative emission technologies and to help reach the goal of zero greenhouse gas emissions. Funding is allocated to research, feasibility studies and investments to reduce process-related emissions in industry. Several hydrogen-related projects have already been supported, including fossil-free steel production (through use of hydrogen) and hydrogen production in refineries. The HYBRIT project has been co-financed by the program –an initiative by commercial parties to create the world's first fossil free steel making technology using hydrogen.	Swedish Energy Agency
2.	**Greener transport in the Nordic region with hydrogen initiative.** This initiative aims to explore and eventually provide zero emission transport solutions based on hydrogen. It is supported by the EU via co-financing by the Connecting Europe Facility (CEF).	Hydrogen Sweden Commercial stakeholders
3.	***Klimatpremien* program** This program aims to incentivise the introduction of green vehicles in Sweden by subsidising the purchase price of a variety of electric busses. The program includes fuel cell vehicles, which generate electricity using compressed hydrogen. The program is available to regional government authorities responsible for public transport and businesses and municipalities that are public transport providers or operators.	Swedish Energy Agency

No.	Description	Key Players
4.	**Project PUSH** The Swedish Foundation for Strategic Research (SSF) has created a new centre for research on production, use and storage of hydrogen, named Project PUSH. SSF has allotted SEK 50 million in funding to the centre and there are four universities involved in the project KTH, Lund University, Chalmers and Umeå University. Researchers from the universities work on using electrolysis to produce hydrogen from water and renewable electricity, converting hydrogen into fuel cells to generate electricity and the possibility to bind hydrogen to organic molecules to facilitate storage and distribution.	SSF

Finland

No.	Description	Key Players
A	**Specific grants, programs & incentives**	
1.	**National Hydrogen Roadmap for Finland** Business Finland (a Finnish Government owned organisation) published a national hydrogen roadmap for Finland in June 2020. The roadmap is expected to serve as the knowledge base for further work, such as shaping the hydrogen policy for Finland, and determining the role of hydrogen in the national energy and climate policy.	Business Finland
2.	**Green Electrification ecosystem** Green Electrification is an innovation ecosystem for the utilisation of hydrogen and carbon dioxide. The project is funded by Business Finland and has a goal of forming a cross-disciplinary network in Finland to help global business growth in the field of Power-to-X.	Green Electrification Business Finland
3.	**The Smart Energy Finland Program** The purpose of this program is to support the international expansion of growth-oriented companies that possess growth potential and feature renewable energy and smart energy solutions in their product portfolio. A total of €100 million will be granted to smart energy solution innovations under the program between 2017 – 2021.	Business Finland

Spain

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Hydrogen Roadmap: a commitment to renewable hydrogen** In October 2020, the Spanish government released a Roadmap that aims to identify the challenges and opportunities for the full development of renewable hydrogen in Spain, providing a series of measures to boost investment action. The Roadmap focuses on the production and use of renewable hydrogen, including a country strategy towards a coal-free economy, by boosting the hydrogen value chain through the creation of technology clusters and pilot projects at a regional level, promoting industrial innovation, supporting fair transition areas and making renewable energy available at competitive prices.	Spanish Government
2.	**National Integrated Energy and Climate Plan 2021-2030** In March 2019, a draft of the plan was submitted to the European Commission for evaluation. It defines the objectives for the reduction of greenhouse gas emissions, the generation of renewable energies and fuels (renewable hydrogen among others) and energy efficiency. It determines the lines of action and the path which, according to the models used, is the most appropriate and efficient, maximising opportunities and benefits for the economy, employment, health and the environment.	Spanish Government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
3.	**Long-term Strategy for a Modern, Competitive and Climate-neutral Spanish Economy 2050** In November 2020, the Spanish government released a strategy that paves the way for reaching the objective of climate-neutrality by 2050 by reducing greenhouse gas emissions by at least 90% in 2050 compared to the reference year 1990. This will require profound changes in the structure of the energy system (regarding the promotion of renewable hydrogen), including electricity storage and intelligent sectoral integration.	Spanish Government
4.	**Climate Change and Energy Transition Bill** In May 2020, a bill on climate change and the energy transition was submitted for assessment by the Spanish Parliament. It provides that the government will encourage, through the approval of specific plans, the market penetration of renewable gases, including biogas, bio methane and renewable hydrogen among others.	Council of Ministers of Spain
5.	**Spanish Strategy for Science, Technology and Innovation 2021 – 2027** In September 2020, the Spanish government released a strategy to promote national investigation, development and innovation. Among its strategic lines, it includes the application of renewable hydrogen in the industry as a resource for tackling climate change.	Spanish Government
B	**Specific grants, programs & incentives**	
6.	**Funds aimed at Green Hydrogen** In November 2020, the Spanish government announced that €1.5 billion of European funds will be provided to boost the development of green hydrogen over the next three years.	Spanish Government
7.	**Green Taxation** The Spanish government is considering to encouraging renewable hydrogen as opposed to hydrogen with untraceable origins. Within the framework of the Plan to Promote the Automotive Industry Value Chain, a measure has been promoted on the integral reform of vehicle taxation in coordination with the Territorial Authorities (Road Tax and Registration (Tax)), to introduce a greater environmental orientation in the determination of taxation.	Spanish Government
8.	**Financing Instruments for Renewable Hydrogen Projects** The Spanish government has issued financing plans to promote renewable energies, especially regarding renewable hydrogen: □ **CIEN Projects:** a financing mechanism of the Industrial and Technologic Development Centre launched in May 2019, in the form of partially reimbursable aid, aimed at large industrial research and experimental development projects, without restriction as to the sector or technology to be developed; □ **Science and Innovation Missions:** a financing mechanism launched in February 2020 to support, through subsidies, large strategic initiatives in innovation and development, carried out by a group of companies and with relevant participation of research bodies that aim to contribute to the development of five missions identified by their great relevance to the future challenges the Spanish economy will face; and □ **MOVES Plan:** an aid programme approved by the Spanish government in June 2020, in the form of a subsidy, which aims to contribute to a coal-free transport sector by the promoting of alternative energies.	Spanish Government

Italy

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Proposed national strategy on hydrogen** In November 2020, the Italian government launched a public consultation on the Italian national strategy on hydrogen. The strategy will allow the Italian government to achieve the goals set out in the Italian National Integrated Plan for Energy and Climate (*Piano Nazionale Integrato per l'Energia e il Clima – PNIEC*), favouring the transition towards a green, sustainable and technologically advanced economy. The proposed national strategy is based on a two-stage approach: □ a first phase of the national strategy with goals set for 2030 focused on the development of the generation and distribution infrastructure and expansion of hydrogen in the transportation sector (heavy vehicles and trains) and chemical and steel industry; and □ a second phase towards full expansion of the hydrogen technology and application to a broader range of industrial sectors, with the aim of achieving full decarbonisation by 2050.	Italian Government
B	**Specific grants, programs & incentives**	
2.	**Introduction of specific incentive scheme, modernisation of the regulatory regime, funds** The Italian Government plans to support hydrogen production both through the introduction of specific incentive schemes, as well as by streamlining the regulatory regime applicable to hydrogen plants and the capacity of electrolysers, in order to promote the expansion of infrastructure for hydrogen and stimulate demand (also through the creation of certificates guaranteeing the origin of hydrogen). There are resources available under EU funds (Next Generation EU and EU Innovation funds), as well as through the Sustainable Growth Fund *(Fondo crescita sostenibile (FRI)*), the funds available to support research and enterprises in general. Between 2020 and 2030, additional funds should be made available through the Research of the National Electric System funds (*Ricerca Sistema Elettrico Nazionale*), the Clean Tech Funds (*Fondo CleanTech*) and Development and Cohesion Fund (*Fondo Sviluppo e Coesione*).	Italian Government

United Kingdom

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**UK Government ten-point plan** In November 2020, as part of a broader £12 billion plan to guide the UK to net zero by 2050, the government published its ten-point plan which formed the road map for the UK's journey to net zero. Point two of the plan included a goal of producing 5 GW low carbon hydrogen production by 2030. A total of £500 million is dedicated to hydrogen related investment, and of this, the UK government has committed to a £240 million Net Zero Hydrogen Fund. Point eight of the plan includes a commitment to carbon capture, usage and storage (CCUS), with a commitment to invest up to £1 billion though a CCUS infrastructure fund, with a goal of capturing 10 MT of carbon dioxide per year by 2030.	UK government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**UK hydrogen strategy** Expected in advance of UN Climate Change Conference in 2021, this strategy is expected to firm up the size and scale of government investment, set out any regulatory adaptations, deliver results of consultation on business models and kick-start the UK's path towards a strong hydrogen economy.	UK government
3.	**Hydrogen Advisory Council** Specific hydrogen council created to inform the development of hydrogen as a strategic decarbonised energy carrier for the UK. It provides a form for the government to engage with industry through representatives for the hydrogen sector.	UK government Hydrogen Advisory Council
4.	**HyLaw Project (EU wide)** Project undertaken by 23 partners in 18 Member States, with a goal to increase the market uptake of hydrogen and fuel cell technologies, provide market developers a clear framework of the relevant regulations and highlight to policy makers the key legal barriers that need to be removed to facilitate a hydrogen solution. The UK National Policy Paper makes certain policy recommendations both at the UK level and EU level to facilitate roll out.	Greater London Authority UK Hydrogen And Fuel Cell Association
B	**Specific grants, programs & incentives**	
5.	**Hydrogen Supply Programme by UK Government** Comprised of two phases: phase one awarded funding for feasibility studies looking into accelerating the development of low carbon bulk hydrogen supply solutions. Phase two of the programme awarded £28.2 million of funding to five hydrogen projects under the Hydrogen Supply Programme to develop the selected hydrogen supply solutions.	Department for Business, Energy and Industrial Strategy
6.	**£100 million Low Carbon Hydrogen Production Fund** This fund is designed to support the roll out of low carbon hydrogen production capacity and encourage private sector investment. The Government intends to consult on the shape of the fund during 2020 with a view to launching the fund for bids in 2021.	Department for Business, Energy and Industrial Strategy
7.	**£240 million Net Zero Hydrogen Fund** Announced in the UK government 2020 Spending Review, this fund is allocated to the Department for Business Energy and Industrial Strategy to support industry to produce low-carbon hydrogen at scale. A further £81 million multi-year commitment has been allocated to hydrogen heating trials.	Department for Business, Energy and Industrial Strategy

Central & Eastern Europe

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Czech Republic´s National Hydrogen Strategy** The Czech Ministry of Industry and Trade is currently preparing the Czech National Hydrogen Strategy. The Strategy is to be based on three pillars: hydrogen production, hydrogen consumption and hydrogen technology.	Czech Ministry of Industry and Trade
2.	**Czech Republic´s National Energy and Climate Plan** In November 2019, the Czech government approved the new National Energy and Climate Plan. Under the plan, the Czech Republic aims to extend the use of hydrogen as fuel for transportation (the project of hydrogen mobility).	Czech Government

No.	Description	Key Players
3.	**Czech Republic´s National Energy Conception** In 2014, the Czech Ministry of Industry and Trade issued the National Energy Conception. This document includes a plan of development for the use of hydrogen as well as hydrogen research support.	Czech Ministry of Industry and Trade
4.	**Czech National Action Plan for Clean Mobility** This Plan was prepared in 2015 as required by the EU Directive No. 2014/94 and it has been subsequently updated. The updated version of the Plan, approved by the Czech government in April 2020, includes strategic goals for the use of hydrogen as fuel in road transport, including the development of hydrogen refuelling stations. The updated version reflects results of the 2017 study ('Use of Hydrogen Powered Vehicles in Transport in the Czech Republic') regarding the stimulator of the deployment of hydrogen mobility in the Czech Republic.	Czech Government Czech Ministry of Industry and Trade Czech Ministry of Transportation Czech Ministry of Environment
5.	**Slovak Republic´s National Hydrogen Strategy** Slovakia´s National Hydrogen Strategy is currently being prepared and is scheduled to be published in early 2021. The Strategy is likely to include Slovakia´s plans on hydrogen production with the use of excess electricity generated in nuclear power plants.	Slovak Government Slovak Ministry of Economy
6.	**Poland´s National Hydrogen Strategy** The Polish government is expected to publish a National Hydrogen Strategy in 2021. The Strategy is expected to include plans to have 2 GW of hydrogen electrolysis capacity and 2,000 hydrogen fuel-cell buses with 32 refuelling stations by 2030.	Polish Government
7.	**Ordinance of the Minister of Energy of Poland no. 2189/2019** In 2019, the Polish Minister of Energy announced the ordinance on detailed conditions for granting support for the purchase of new vehicles from the funds of the Low-Emission Transport Fund for natural persons not engaged in economic activity (including hydrogen-powered vehicles).	Polish Minister of Energy
8.	**Integrated National Energy and Climate Plan for Austria** In 2019, the Austrian government published the Integrated National Plan which, besides other topics, aims to increase the use of renewable hydrogen. One of Austria's priorities is to develop hydrogen-based fuel technology and hydrogen mobility (replacement of diesel fleets with zero-emission vehicles). The Plan includes a target of a renewable electricity-based hydrogen consumption of 1.1 TWh (4 PJ) in 2030.	Austrian Government
9.	**Austrian Government Programme** In 2020, the Austrian government set up the "Taking Responsibility for Austria" programme which, among other issues, includes the use of hydrogen and its possible contribution to decarbonisation of the industry and mobility.	Austrian Government
10.	**Austrian National Hydrogen Strategy** The Strategy is currently subject to public consultation and is expected to be published in 2021. The Strategy is expected to set out the goals for the deployment of hydrogen in order to reach Austria´s goal of reaching climate neutrality by 2040.	Austrian Government
11.	**Hungarian National Energy Strategy 2030** In 2012, the Hungarian Ministry of National Development issued the National Energy Strategy which aims to transit public transport to sustainable fuels such as hydrogen and to develop hydrogen infrastructure.	Hungarian Ministry of National Development

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
12.	**Hungary´s National Energy and Climate Plan** According to the Plan, Hungary intends to enable the integration of hydrogen in its mobility, industry, building, gas and power systems. Hungary considers using hydrogen for decarbonising its gas supply, producing electricity (in the long term), replacing fossil fuels in the transport sector and replacing partially fossil hydrogen by renewable hydrogen. The Plan includes a target of a renewable electricity-based hydrogen consumption of 51 ktoe in the heating and cooling sector by 2030.	Hungarian Government
13.	**Bulgaria´s National Energy and Climate Plan** The Plan mentions the prospective use of hydrogen. For instance, excess electricity generated from solar and wind power shall be used to produce green hydrogen. The Plan expects about 47 GWh of electricity to be used for such production by 2030.	Bulgarian Government
14.	**Romania´s National Energy and Climate Plan** In its 2020 Plan, the Romanian government sets out plans for the use of hydrogen as a source for electricity generation as well as its use in the industry on the basis of pilot projects.	Romanian Government
15.	**Ukraine´s Energy Strategy 2035** The Strategy, which was approved in August 2017, envisages the future replacement of combustion engines in cars by hydrogen engines.	Ukrainian Cabinet of Ministers
16.	**Russia´s Energy Strategy 2035** In the Strategy, the hydrogen energy sector is listed as the seventh most important component of Russia´s energy sector, following oil, gas, petrochemical, coal, electricity and nuclear sectors. The Strategy aims to enable Russia to become a global hydrogen leader.	Russian Government
17.	**Russia´s Action Plan on the Development of Hydrogen Energy 2024** The Plan sets out activities to build a hydrogen sector in Russia, such as state incentives, strategic measures, pilot projects, scientific development and changes to Russia´s regulatory framework. The Plan envisages the generation of hydrogen from renewable sources, natural gas as well as atomic energy. The Plan also seeks to develop new types of railway transport using hydrogen as fuel.	Estonian Government Estonian Parliament
18.	**Estonia´s Hydrogen Strategy** In 2020, the Estonian Parliament proposed to the Estonian government the development of a hydrogen strategy which shall set out plans and targets for the transition to the extensive use of hydrogen in energy, economy and transport.	Estonian Government Estonian Parliament
19.	**Latvia´s National Energy and Climate Plan** Latvia´s Plan considers the use of hydrogen as a future alternative fuel to replace petroleum products.	Latvian Government
20.	**Lithuanian Hydrogen Platform** In 2020, the Lithuanian Ministry of Energy and 19 other organisations (including ministries, business associations and energy companies) signed an agreement on the establishment of a hydrogen platform. This platform aims to develop hydrogen technologies through cooperation of all signed entities.	10 energy companies Lithuanian Ministry of Energy Lithuanian Ministry of Economy and Innovation

No.	Description	Key Players
21.	**Hydrogen Initiative** The Initiative, concluded in 2018 in Linz, Austria, underlines low carbon and sustainable transformation of energy sector moving towards an integrated approach. It aims to maximise the potential of sustainable hydrogen technology for decarbonisation of multiple sectors.	Several CEE Governments (Austria, Czech Republic, Hungary, Poland, Estonia, Lithuania, Latvia, Poland, Bulgaria, Romania) 50 companies and organisations
B	**Specific grants, programs & incentives**	
22.	**Operational Programme Transport** In 2020, the Czech Ministry of Transport issued a call for projects related to the development of hydrogen refuelling stations for hydrogen cars. The total amount of 102 million Czech crowns was dedicated to financially support these projects.	Czech Ministry of Transport
23.	**Grant Program for Hydrogen Re-Fuelling Stations and Hydrogen Cars** Slovak Act No. 71/2013 Coll., on the Provision of Subsidies within the Competence of the Ministry of Economy currently provides a framework for promotion of (i) the construction or reconstruction of hydrogen re-fuelling stations (up to 75 % of the eligible costs for companies, and up to 95 % of the eligible costs for municipalities); and (ii) the purchase of new electric vehicles with hydrogen fuel cells (up to 35 % of the total purchase price). In 2020, the Slovak Ministry of Economy announced its plans to introduce several hydrogen-oriented policies, including the grant program which is supposed to financially support the purchase of hydrogen cars.	Slovak Ministry of Economy
24.	**Ordinance of the Minister of Energy of Poland no. 2189/2019** In 2019, the Polish Minister of Energy announced the ordinance on detailed conditions for granting support for the purchase of new vehicles from the funds of the Low-Emission Transport Fund for natural persons not engaged in economic activity (including hydrogen-powered vehicles).	Polish Minister of Energy
25.	**Austria's Climate and Energy Fund** The Fund seeks to provide financial support to sustainable energy projects, including hydrogen projects. Several such projects in the area of hydrogen-related research and development have been financially supported by the Austrian government via the Fund.	Austrian Government
26.	**Romania´s Memorandum** The Romanian Ministries of Education and European Funds issued a Memorandum which sets out funding plans for the period of 2021-2027, including the funding of hydrogen-related research and development centres.	Romanian Ministry of Education and Research Romanian Ministry of European Funds

3.4 Central Asia

Overview

The policy and regulatory framework necessary for a hydrogen economy is in an early stage of development in Central Asia. Kazakhstan and Uzbekistan have adopted national concepts of transition into a green economy which are aimed at increasing the use of renewable energy sources and decarbonisation of energy sector.

These policies do not expressly focus on the development of a hydrogen economy, but it is expected that during further implementation, the governments will take specific steps targeted to support and development of a hydrogen economy in the region.

Kazakhstan

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	In 2013, the President of Kazakhstan adopted the 'Concept of Kazakhstan's Transition into Green Economy'. The concept lays down the vector towards modernisation of the existing energy and industry infrastructures through increasing the efficiency of renewable resources. The Concept does not specifically elaborate on hydrogen technologies and importance of facilitating hydrogen economy, however such measures may be taken in future.	Kazakhstan Government
B	**Specific grants, programs & incentives**	
2.	In 2018, the Kazakhstan government established the International Green Technologies and Investments Centre which is aimed at transformation of the energy sector and the development of renewable energy sources, as well as seeking investment opportunities for development of green business and mechanisms for attracting green financing. The Center was created with the objective to facilitate Kazakhstan's transition to a green economy by promoting technologies and best practices.	Kazakhstan Government
3.	The Ministry of Ecology, Geology and Natural Resources of Kazakhstan together with Deutsche Gesellschaft für Internationale Zusammenarbeit (**GIZ**) plan to adopt the Strategy of Low-Carbon Economic Development of Kazakhstan until 2050. The first working draft was prepared in February 2020 and is subject to further development.	Kazakhstan Government GIZ

Uzbekistan

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	In 2019, the President of Uzbekistan adopted the 'Strategy of Uzbekistan's Transition into Green Economy' which is to increase the energy efficiency of the economy and rational consumption of natural resources through technological modernisation and the development of financial mechanisms. The strategy does not expressly provide any framework for hydrogen technologies, however, the development of a hydrogen economy may result from the objectives set out by the said strategy.	Uzbekistan Government
B	**Specific grants, programs & incentives**	
2.	In August 2020, the Ministry of Innovation Development and the Ministry of Energy of Uzbekistan proposed to establish the Scientific and Practical Innovation Centre for Hydrogen Energy Technologies. The Center should combine the capabilities of scientific and higher educational institutions in the development of the sector, as well as create a platform for research.	Uzbekistan Government

3.5 United States and Canada

Overview

By comparison to other regions, formal government policy and regulatory initiatives in support of a hydrogen economy have been slower to emerge in North America. There is currently no formal legal and regulatory framework in place for hydrogen in North America, with most governmental action largely focused on the support of research and development of hydrogen technologies. The ambitions of industry players are a driving force in the hydrogen market in North America.

- **Canada**

  Canada has placed an increased focus on developing its hydrogen economy. As one of the world's largest hydrogen producers and due to recent zero-emissions initiatives, Canada has the capacity to become a major leader in the global hydrogen economy. Historically, Canada has lacked large-scale strategies to transition to clean energy and boost hydrogen production, but recent years have shown growth in these spaces.

  Although efforts were once localised at lower levels – led by companies and local government initiatives – large-scale initiatives and projects have begun to emerge from provincial governments and the Canadian government. Notably, the Canadian government has proposed legislation that commits the country to achieving net-zero emissions by 2050, which would impact the transportation sector and increase demand. Currently, many of the projects and initiatives underway involve transportation and the development of fuel cell technology.

- **United States**

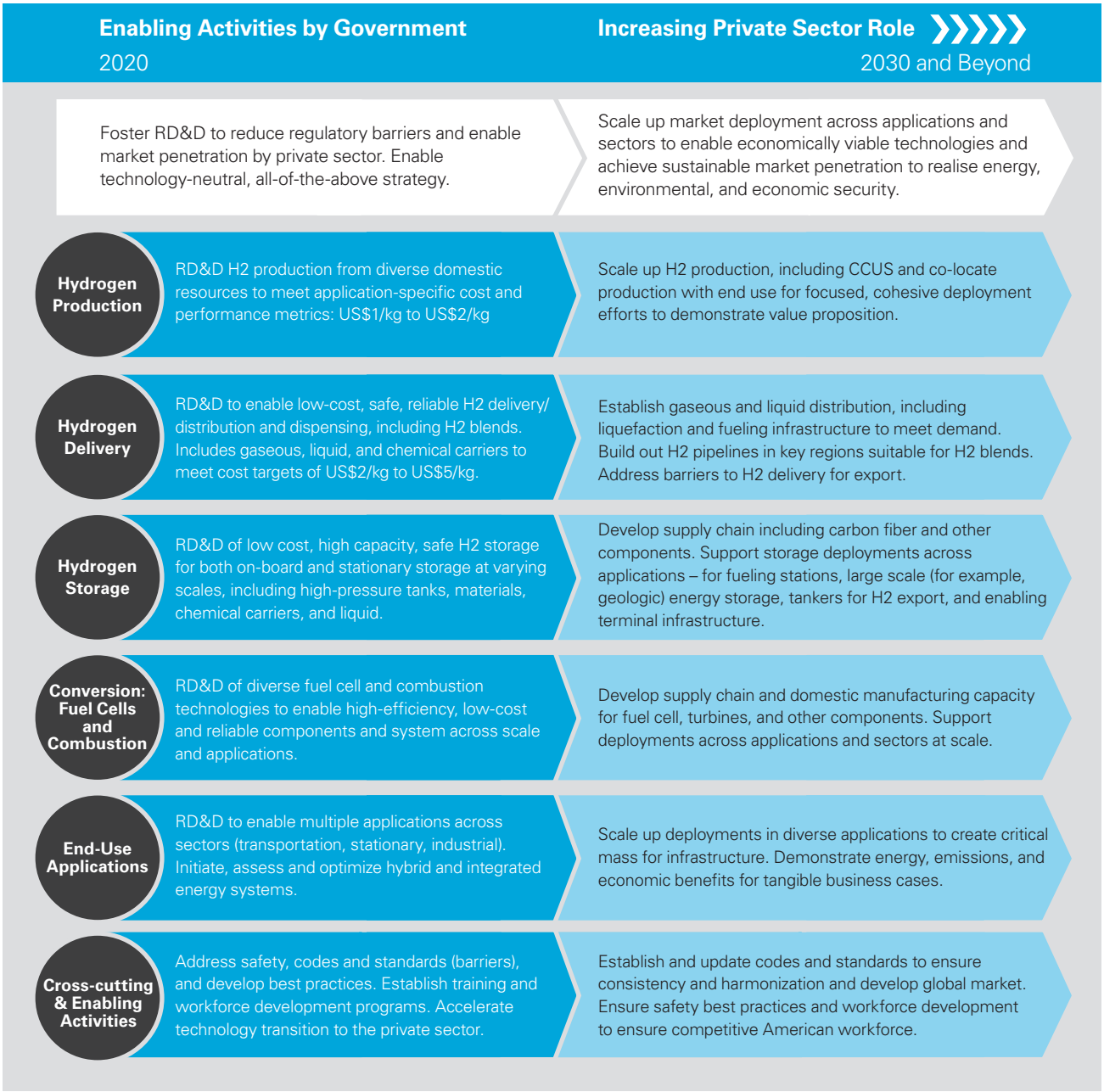
  In the United States, hydrogen falls under the existing general renewables development programs (hydrogen is considered an 'alternative fuel' by the Energy Policy Act (**EPAct of 1992**). However, government support for renewables development varies from state to state, with states like California leading in the implementation of renewable fuel regulations. The United States has also taken steps to expand the hydrogen market, for instance, the Department of Energy (**DOE**) released its 'Hydrogen Program Plan' in November 2020 to provide a strategic framework for the Department's hydrogen research, development, and demonstration activities.

  The DOE's plan is a coordinated effort to advance the affordable production, transport, storage, and use of hydrogen across different sectors of the economy, involving participation from the Offices of Energy Efficiency and Renewable Energy, Fossil Energy, Nuclear Energy, Electricity, Science, and the Advanced Research Projects Agency–Energy. Over the past 20 years, the DOE has invested more than US$4 billion in hydrogen and related areas, including hydrogen production from diverse domestic sources, hydrogen delivery and storage, and conversion technologies including fuel cells and turbines.

The DOE coordination employs a number of program management processes to ensure the effective use of taxpayer funds, including:

- developing targets and milestones for all R&D pathways in close consultation with experts in industry, end users and customers, and the scientific research community;
- a rigorous and competitive selection process, which ensures projects are selected based on technical feasibility, high-impact potential, innovation, and the likelihood of making progress toward DOE's milestones and targets;
- external review and evaluation processes, which include program reviews by the National Academies, reviews of DOE's RD&D progress under the partnership with US DRIVE; input and advice from the Hydrogen and Fuel Cell Technical Advisory Committee, other government agencies, congressionally requested reviews, and comprehensive project reviews by more than 200 technical experts at the Program's Annual Merit Review and Peer Evaluation Meeting; and
- down-selection and go/no-go decisions, which entail a systematic process for discontinuing certain research pathways, via 'go/no-go' decision points defined by performance-based milestones and quantitative metrics at the sub-program, task area, and project level. For example, the program has discontinued R&D of on-board vehicular fuel processing, sodium borohydride hydrolysis, and carbon nanotubes for on-board vehicular hydrogen storage.

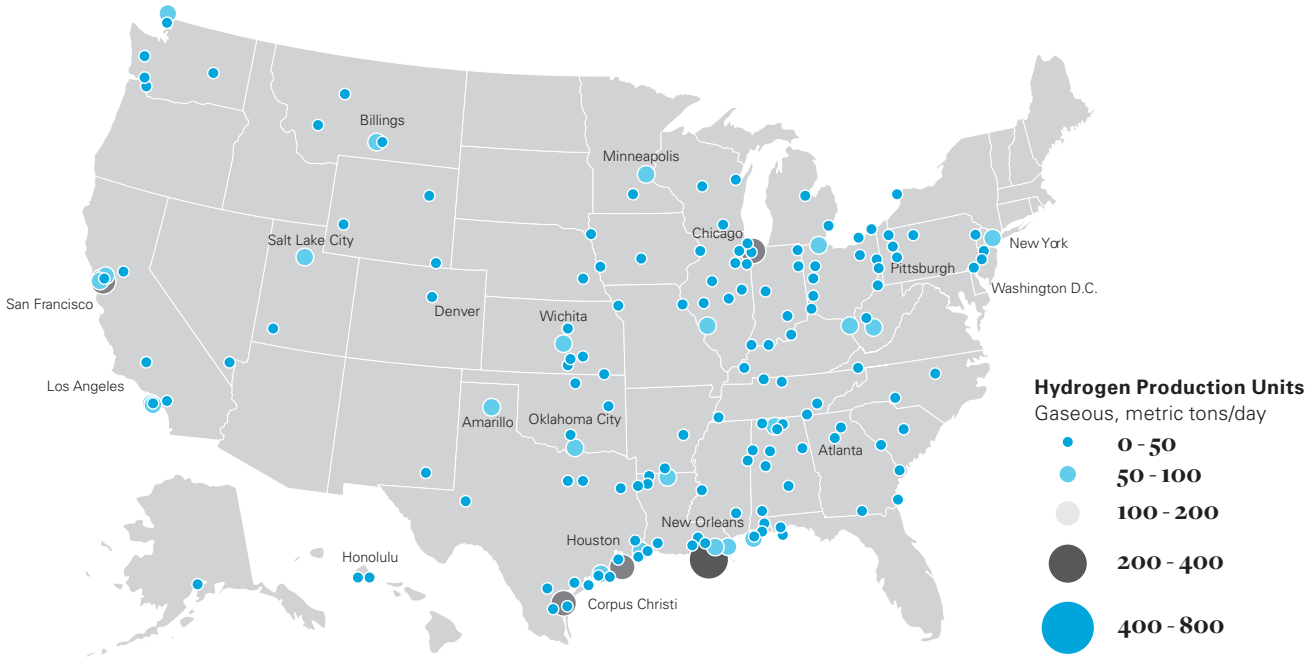
US DOE Hydrogen Strategy – emphasises government / private sector collaboration



Source: US Department of Energy

The United States has the diverse and abundant natural resources necessary to enable large-scale and affordable hydrogen production. For example, the widespread availability of shale gas throughout the United States, along with additional natural gas reserves, offer opportunities to produce hydrogen from natural gas in many regions. In addition to hydrogen production resources, the United States has over 1,600 miles of hydrogen pipelines and three caverns that can store thousands of tonnes of hydrogen. The US utilises gas-based steam-methane reforming (**SMR**) technology to produce 95% of its hydrogen – the US currently produces 10 million metric tons of hydrogen per year. The other 5% is comprised of 4% by partial oxidation of natural gas via coal gasification and 1% produced from electrolysis.

Hydrogen Production Units in the United States



Source: IHS Chemical Econimics Handbook Hydrogen Report, June 2015. NREL NATIONAL RENEWABLE ENERGY LABORATORY

United States

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**US Department of Energy Hydrogen Program Plan** The US Department of Energy (**DOE**) released a Hydrogen Program Plan in 2020 that summarises the current challenges and opportunities to grow the US hydrogen market and the DOE's hydrogen research and development targets. These targets include reducing electrolyser and fuel cell system costs while improving system durability and efficiency. The DOE projects the US market could quadruple by 2050 if sufficient research and development progress is made. One program highlighted in the DOE Hydrogen Program Plan is the DOE Loan Program Office (**LPO**), which currently has over US$20 billion in lending capacity for US energy projects that reduce greenhouse gas emissions. Developers of energy projects utilising new technologies and/or new monetisation structures should keep in mind LPO funding, which is often structured as limited recourse project financing.	US Department of Energy
2.	**US and Netherland Statement of Intent** The DOE's Office of Energy Efficiency and Renewable Energy (**EERE**) and a Dutch ministry has issued a statement of intent to collaborate on collecting, analysing, and sharing information on hydrogen production and infrastructure technologies. Through this effort, real-world data from hydrogen applications will be gathered to guide both organisations' future hydrogen research and development and demonstration activities. This new strategic cooperation between the US and the Netherlands on hydrogen will foster cooperation between Dutch and American practitioners in hydrogen research, industrial demonstrations to scale-up, regions and ports, innovative small and medium enterprises, and start-ups.	US Department of Energy's Office of Energy Efficiency and Renewable Energy Dutch Ministry of Economic Affairs and Climate Policy's Directorate General for Climate and Energy

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
3.	**Clean Energy Ministerial Hydrogen Initiative** The United States, Canada, Saudi Arabia, Japan and a range of other countries have partnered for the Clean Energy Ministerial Hydrogen Initiative, a collaborative effort to establish policies, programs and projects to develop and deploy hydrogen and fuel cell technologies.	United States and a range of other countries[1]
4.	**US Department of Energy Hydrogen and Fuel Cells Program Plan** The 2011 plan outlines the strategy, activities, and plans of the DOE Hydrogen and Fuel Cells Program. It describes the program's activities, the specific obstacles addressed, the strategies employed, key milestones, and future plans for each sub-program and the program as a whole.	US Department of Energy
5.	**Energy Independence and Security Act of 2007 (EISA)** The EISA includes provisions to move the United States toward greater energy independence and security, increase production of clean renewable fuels, protect consumers, increase product, building, and vehicle efficiency, promote research on and deploy greenhouse gas capture and storage options, and improve the energy performance of the federal government.	US Government
6.	**Energy Policy Act of 2005, Title VIII** The Energy Policy Act of 2005 calls for a wide-reaching research and development program on technologies related to the production, purification, distribution, storage, and use of hydrogen energy, fuel cells, and related infrastructure with the goal of demonstrating and commercialising the use of hydrogen for transportation, utility, industrial, commercial, and residential applications.	US Government
7.	**California Zero Emission Vehicle Mandate** The Governor of California issued an executive order in October 2020 that requires all new cars and passenger trucks sold in the state to be zero-emission vehicles by 2035. The original ZEV initiative began in California in the 1990s and has gone through three phases with the current target of all in-state sales of new cars and trucks be ZEV by 2035, and all medium and heavy-duty vehicles must be 100% ZEV compliant by 2045.	California State Government
8.	**California Low-Carbon Fuel Standard (LCFS)** Designed to lower the CO_2 intensity of California's transportation fuel pool and provide a growing range of low CO_2 and renewable alternatives in order to improve air quality and reduce the state's reliance on hydrocarbons. Heavy logistics activity causes transportation to account for more than 50% of the state's greenhouse gas emissions.	California State Government
9.	**California Clean Transportation Program (ARFVTP)** Leveraging public and private investments to invest US$100 million every year in order to support adoption of cleaner transportation powered by alternative and renewable fuels. Portfolio investments will tend to target transportation and fuel transportation projects within the state.	California State Government
B	**Policy framework and regulatory developments**	
10.	**Road Map to a US Hydrogen Economy.** The Fuel Cell and Hydrogen Energy Association (a coalition of major oil & gas, power, automotive, fuel cell, and hydrogen companies), has developed and released a roadmap listing nine required actions in the hydrogen sector: □ set dependable, technology-neutral decarbonisation goals; □ create public incentives to bridge barriers to the initial market launch;	Fuel Cell and Hydrogen Energy Association

1 Full list of member countries: Australia, Austria, Brazil, Canada, Chile, China, Costa Rica, European Commission, Finland, Germany, India, Italy, Japan, The Netherlands, New Zealand, Norway, Saudi Arabia, South Africa, South Korea, United Kingdom and United States.

No.	Description	Key Players
	□ support infrastructure development; □ expand the use of hydrogen across sectors and achieve economies of scale; □ include hydrogen-based options in government procurement; □ support research, development, demonstration, and deployment; □ harmonise technical codes and safety standards; □ support outreach and workforce development; and □ review energy sector regulations to ensure they account for hydrogen.	
11.	**Missouri S&T researcher earned US$4 million grant for energy-efficient steelmaking** The DOE has announced funding of US$4 million to the Missouri University of Science and Technology for grid-interactive steelmaking with hydrogen. The project would create a steel production system that combines a hydrogen-reduction reactor for ironmaking (**H2DR**) with electric furnace melting for steelmaking. This combination is then integrated into a flexible electrical grid with energy storage and hydrogen generation by balancing hydrogen and natural gas usage in the H2DR process.	US Department of Energy Missouri University of Science and Technology
12.	**H2@Scale initiative** The DOE will fund around US$64 million for 18 different projects that target hydrogen and fuel cell technologies research and development.	US Department of Energy
13.	**Clean Cities Coalition Network** The mission of Clean Cities Coalition Network is to foster the economic, environmental, and energy security of the United States by working locally to advance affordable, domestic transportation fuels and technologies. Nearly 100 volunteer coalitions carry out this mission by developing public/private partnerships to promote alternative and renewable fuels, idle-reduction measures, fuel economy improvements and emerging transportation technologies. The Clean Cities Coalition Network provides information about financial opportunities, coordinates technical assistance projects, updates and maintains databases and websites and publishes technical and informational materials.	US Department of Energy
14.	**Airport Zero Emission Vehicle (ZEV) and Infrastructure Incentives** The Zero Emissions Airport Vehicle and Infrastructure Pilot Program provides funding to airports for up to 50% of the cost to acquire ZEVs and install or modify supporting infrastructure for acquired vehicles. Grant funding must be used for airport-owned, on-road vehicles used exclusively for airport purposes. Vehicles and infrastructure must meet the Federal Aviation Administration's Airport Improvement Program requirements, including Buy American requirements. To be eligible, an airport must be for public use. The program will give priority to applicants located in nonattainment areas, as defined by the Clean Air Act, and projects that achieve the greatest air quality benefits, as measured by the amount of emissions reduced per dollar of funds spent under the program.	Federal Aviation Administration
15.	**Alternative Fuel Vehicle (AFV) and Fuelling Infrastructure Grants** The Motor Vehicle Registration Fee Program provides funding for projects that reduce air pollution from on- and off-road vehicles. Eligible projects include purchasing AFVs and developing alternative fuelling infrastructure.	California State Government

Canada

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Canada Introduces Bill to Reach Net-zero by 2050** The Canadian Net-Zero Emissions Accountability Act commits the federal government of Canada to achieve net-zero emissions in the country by 2050, with milestone targets set every five years between 2030-2050. This will increase the need for zero-emission vehicles, which will require a robust hydrogen-fuelling infrastructure.	Canadian Government
2.	**Quebec – Green Hydrogen and Bioenergy Strategy** The government of Quebec plans to unveil its green hydrogen and bioenergy strategy in 2021. The strategy is part of its 2030 Plan for a Green Economy (**PGE**), which aims to produce clean electricity and reduce greenhouse gas emissions by 37.5% below 1990 levels by 2030.	Quebec State Government
3.	**Clean Energy Ministerial Hydrogen Initiative** The United States, Canada, Saudi Arabia, Japan and a range of other countries have partnered for the Clean Energy Ministerial Hydrogen Initiative, a collaborative effort to establish policies, programs and projects to develop and deploy hydrogen and fuel cell technologies.	Canada and a range of other countries
B	**Specific grants, programs & incentives**	
4.	**Alberta - Emission Reductions Alberta's (ERA) BEST Challenge (Biotechnology, Electricity,** & Sustainable Transportation) Launched in July 2018, ERA's BEST Challenge is a program that provides funding opportunities for biotechnology, electricity, and sustainable transportation projects. Among the projects is an initiative to discover new uses for hydrogen.	Emissions Reductions Alberta
5.	**Coast-to-coast - Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative** National Resources Canada (**NRCan**) has provided funding to the Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative, which develops hydrogen refuelling station infrastructure across the country.	National Resources Canada

3.6 Latin America

Overview

Latin America has huge potential to play a key role in the emerging global hydrogen economy. In a break with its past, in recent times several countries in Latin America have announced dedicated efforts to combat climate change and reduce consumption of fossil fuels. In September 2019, at the initiative of Colombia, eight countries in Latin America set a collective target of 70% renewable energy use by 2030.

With abundant sources of renewable energy primarily from wind and solar sources, and easy access through the Pacific Rim to the western United States and East Asian markets, exporting hydrogen could become a major industry for Latin America if advances in technology allow for lower production costs and more efficient methods of transportation.

According to the International Renewable Energy Agency, Brazil, Chile and Mexico are already among the ten largest renewable energy markets in the world, and could utilise their renewable energy to produce green hydrogen.

From a legislative and policy perspective there has been flurry of activity since Chile announced its ambitious National Green Hydrogen Strategy in November 2020, with several countries in the region announcing their intentions to follow suit with their own national hydrogen plans or specific hydrogen legislation. The key will be for national governments to ensure a stable legal and regulatory environment to attract foreign investors interested in the sector to the region.

□ Argentina

The Argentine government paid early attention to the possibilities of hydrogen production based on renewables and non-renewables sources. In 2006, Law 26,123, the Hydrogen Promotion Law, was enacted to provide incentives for the sector, including the incorporation of the National Fund to Promote Hydrogen that is intended to be financed by the State through loans, disbursements and donations from persons as well as national and international corporations. Hydrogen projects are also intended to have tax benefits for the acquisition of goods and performance of works. However, the executive branch has not issued implementing regulations and the law is scheduled to expire in 2021.

Regulatory reform has been proposed that would extend Law 26,123 for 20 years with updates to promote the hydrogen industry in Argentina. This includes the promotion of research, development, production and use of hydrogen as fuel and as an energy vector, produced preferably from renewable sources. The bill also provides tax benefits to incentivise the production and use of hydrogen from both renewable and non-renewable sources.

In 2019, the governments of Argentina and Japan signed a memorandum of understanding for the production and export of hydrogen. In December 2020, the President of Argentina announced a new commitment to not exceed 358.8 mtCO2eq of greenhouse gas emissions by 2030, and to prepare a long-term strategy to become carbon neutral by 2050. Finally, in July 2020, H2AR, a consortium for the development of the hydrogen economy in Argentina, was launched. H2AR in comprised of 40 companies and lead by Y-Tec, a technology and research company part of the YPF group.

□ Brazil

The Brazilian government's National Energy Plan 2050 (**PNE2050**) includes a set of directives and long-term strategies for the country's power sector for the next 30 years, and recognises that as a result of the country's abundance of natural resources, Brazil has moved from a net importer of energy to a net exporter. PNE2050 treats hydrogen as a disruptive technology in which Brazil may play a key role, particularly in the green hydrogen industry due to the country's vast natural resources and strong clean energy potential. Initiatives regarding the relationship between reformed biofuel and fuel cells are currently being studied. In addition, natural hydrogen deposits have been located in the states of Ceará, Roraima, Tocantins and Minas Gerais.

Brazil's Ministry of Mines and Energy has recommended the creation of specific frameworks for the regulation of hydrogen production, transportation and storage. It also recognises hydrogen's role in enhancing grid stability in moments of high demand (through green hydrogen produced in moments of lower demand and high intermittent generation), and as a solution to decarbonise sectors that are not well suited to the use of electricity or biofuels. The Ministry recognises the potential of Brazil as a green hydrogen exporter. However, specific policy remains in planning stage. Current governmental initiatives focus on R&D initiatives and specific programs for hydrogen research, including hydrogen production and fuel cells.

The Brazilian / German Industry and Trade Association (**AHK**) has started a project with the Ministry of Mines and Energy and the German International Cooperation Agency (**GIZ**) to prepare studies on a Brazilian Green Hydrogen Roadmap. Brazil could become a hub to produce hydrogen and export it to Germany.

□ Chile

Chile is leading the way in Latin America by announcing a new National Green Hydrogen Plan (*Estrategia Nacional de Hidrógeno Verde*). Its main goals include 5 GW of electrolysis capacity built or under development by 2025 and the production of the world's cheapest green hydrogen by 2030 (at a cost of less than US$1.50/kg). Chile aspires to become the world's leading green hydrogen producer through electrolysis by the same year (with 25 GW installed capacity). The plan also proposes:

a) US$50 million in financing to develop green hydrogen projects;

b) the development of a regulatory framework to ensure the safety of hydrogen infrastructure and provide legal certainty to investors; and

c) the upgrading of existing natural gas pipelines to allow for the transportation of green hydrogen.

The Chilean government seeks US$2.5 billion in green hydrogen related exports by 2030, and puts green hydrogen at the centre of Chile's goal to achieve carbon neutrality by 2050. According to Chile's Ministry of Energy, up to 20% of the country's projected cumulative CO2 reduction by 2050 should be possible by increasing use of green hydrogen.

With this ambitious plan, Chile seeks to leverage its abundant renewable energy capacity and decreasing generation costs, which enables the relatively inexpensive production of green hydrogen by utilising electricity generated from Chile's vast solar and wind energy resources. Additionally, Chile's geographic location, with direct access to the West Coast of the United States and

Asia, as well as its relatively stable regulatory framework and expansive foreign trade agreements, make it well suited to become a green hydrogen exporter to developed countries who might otherwise have difficulty meeting their own carbon emission reduction targets. The International Energy Agency (IEA) estimates that Chile is capable of producing 160 million tons of green hydrogen per year and according to government estimates, Chile's renewable energy production (wind, solar and hydroelectric) could eventually reach 1,800 GW of installed capacity, which amounts to 70 times the internal demand. The combination of cheap and abundant renewable energy and expected decrease in electrolyser prices would make Chile's plan to become the world's cheapest green hydrogen producer by 2030 possible.

□ Colombia

The Colombian government plans to establish a roadmap for green hydrogen in 2021. This roadmap will allow the Colombian government to identify the country's potential and the regulatory framework required to permit and incentivise the production and use of green hydrogen. The Energy and Mines Planning Unit (**UPME**) and the Ministry of Science are spearheading a study in this regard, and the Colombian government recently announced a cooperation agreement with Chile.

In July 2020, Resolution No. 40177 was enacted by the Ministry of Mines and Energy and the Ministry of Environment and Sustainable Development, providing for the use of green hydrogen as a clean energy fuel that causes zero emissions when used for land transportation. This is important to the municipalities who have to adopt plans to promote sustainable mobility that prioritise public transportation with technologies that cause low or zero greenhouse gas emissions. In December 2020, the President of Colombia announced a new commitment to reduce Colombia's greenhouse emissions by 51% before 2030.

The political party of the President of Colombia has announced that they will present a bill to Congress in 2021 to promote the technological development, production and use of green hydrogen. The current draft of the bill provides:

a) that the national government shall adopt a framework to promote innovation, investigation, production, use and entrepreneurship in relation to the green hydrogen economy, containing at least the following: a package of incentives to further innovation; a program to promote education regarding green hydrogen and promote the international cooperation for production, use and export of green hydrogen; pilot plans to produce green hydrogen; a package of incentives for the local industry that uses green hydrogen as a source of energy or fuel; a package of incentives to promote foreign investment in the investigation, production and use of green hydrogen;

b) for the creation of the Green Hydrogen Fund that will be managed by the Ministry of Mines and Energy to support projects that have green hydrogen as main source of energy;

c) authorisation to the national government to use funds from the national budget and royalties to finance the participation of municipalities in projects that relate to the investigation, production and use of green hydrogen; and

d) the national government shall decree within two years a public policy that includes the objectives, investigation goals, production, commercialisation and use of green hydrogen for the years 2022, 2025, 2030 and 2050, as well as the specific action plan to achieve such goals.

□ Costa Rica

Costa Rica's national plan to decarbonise its economy provides for complete decarbonisation by 2050. The plan provides for the drafting by 2022 of a roadmap to consolidate a hydrogen cluster, design an inter-institutional plan to promote hydrogen in the transportation sector, and design pilot projects for hydrogen buses and heavy trucks. In May 2018, the President of Costa Rica decreed guideline No. 002-MINAE that orders the environment and energy sector institutions to prepare an action plan to promote the investigation, production and commercialisation of hydrogen as a fuel.

In November 2018, the inter-institutional action plan for hydrogen was published by a hydrogen commission organised by the national government. This plan focuses on the use of hydrogen in the transportation sector. The plan determines what changes (market price, regulatory or institutional, among others) must be adopted in order to incentivise businesses, citizens and investors to redirect their activities and achieve the goals as stated by the plan. Areas of focus that are identified in the plan include:

a) comprehensive reform for the new governmental institutions;

b) green tax reform;

c) funding strategy and investment attraction;

d) digitalisation and knowledge-based economy strategy; and

e) transformation of the public transport sector.

In October 2018, a cooperation agreement titled 'Towards Decarbonisation and Promoting the Hydrogen Economy in Costa Rica' was executed by the Inter-American Development Bank, CRUSA (a private non-profit organisation that supports sustainable development) and Ad Astra Rocket Company (as technical advisor). The general objective of this agreement is to support the country's progressive transition to net zero greenhouse gas emissions by 2050 through analysis of the reforms that are required to achieve such a goal. In October 2019, the Costa Rican Electricity Institute executed two cooperation agreements with Siemens and Ad Astra Rocket to research and identify business opportunities to promote hydrogen in the national market and for exports.

- **Ecuador**

Ecuador has significant renewable resources to produce green hydrogen. However, there is currently no roadmap or public policies decreed to promote it. In December 2020, the President of Ecuador announced that the government is preparing a national plan for climate change and Ecuador's so-called Decarbonization Plan 2050, which is expected to include plans for the hydrogen sector.

- **Mexico**

Mexico is well positioned from a geographical and renewable resources perspective to play a leading role in the development of the green hydrogen economy. However, while the Power Industry Law (*Ley de la Industria Eléctrica*) considers the generation of power through green hydrogen and fuel cells as 'clean energy', there is no formal or express legal framework or regulation of the sector. The current administration has not actively promoted 'green' energy technology.

The *Sociedad Mexicana del Hidrógeno*, a private industry group, has published a National Hydrogen Plan to identify key technologies, products, and markets for the development of hydrogen as a fuel and sustainable energy source in Mexico, through research, resource training, specialised human resources, the transfer of technology and production of goods and services.

- **Paraguay**

In May 2020, the Minister of Public Works and the Vice-minister of Mines and Energy announced that the Paraguayan government is preparing a national strategy for the use of hydrogen in line with its commitment to reduce by 20% the country's greenhouse gas emissions by 2030. This initiative is supported by the Inter-American Development Bank, with technical assistance from the Centre for Natural Resources, Energy and the Environment (**CRECE**), the Catalonia Institute for Energy Research (**IREC**), and the public oil company Paraguayan Petroleums (**PETROPAR**). This strategy will determine the use of hydrogen for long distance passenger and cargo transportation, in addition to a pilot project to generate hydrogen.

- **Perú**

In line with its commitment to reduce by 30% its greenhouse gas emissions before 2030 and Law N° 30754 (**the Climate Change Framework Law**), there is a currently proposed, unpublished bill that encourages investments in green hydrogen.

- **Uruguay**

Uruguay is usually hailed as an example of rapid decarbonisation, on the basis that the country generates around 98% of its electricity from renewable sources (wind, solar, photovoltaic and biomass). Uruguay also generates a significant surplus of energy (2TWh per year on average) for export to Brazil and Argentina. The Ministry of Industry, Energy and Mining and the State Utility UTE are currently coordinating the development of a hydrogen roadmap for Uruguay. The state oil company ANCAP has also begun working on hydrogen production for medium-distance passenger transport and heavy trucks in a project denominated Verne.

Argentina

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Hydrogen Promotion Law** Law 26,123 was enacted in 2006; however, no implementing regulations have been passed by the executive branch and the law will expire in 2021. There is a bill pending in the National Congress that proposes an extension of Law 26,123 for 20 years and an update to its terms to promote the hydrogen industry in Argentina.	National Congress
2.	**Memorandum of Understanding with Japan** A memorandum of understanding was signed in 2019 between the governments of Argentina and Japan to produce and export hydrogen.	Argentine Government Japanese Government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
3.	**H2AR consortium** On July 8, 2020, H2AR (*Consorcio para el Desarrollo de la Economía del Hidrógeno en Argentina*), a consortium for the development of the hydrogen economy in Argentina was launched. It is a consortium of 40 companies led by Y-Tec (a technology and research company part of the YPF group) and Conicet with the aim of generating specific roadmaps in various fields to identify challenges and drive pilot initiatives for the hydrogen economy. The consortium also seeks to contribute to the creation of a regulatory and business environment for the development of local technological and productive capacities.	H2AR

Brazil

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Natural Gas for Growth** A new regulatory framework called Natural Gas for Growth (*Gás para Crescer*) has been introduced which aims at liberalising natural gas markets which may create opportunities for the hydrogen industry.	Brazilian Government
2.	**National Energy Plan** The recently adopted National Energy Plan for 2050 (**PNE 2050**) establishes the long-term strategies for the Brazilian energy sector. PNE 2050 recognises hydrogen's importance and recommends the implementation of specific policies and regulatory frameworks.	Brazilian Ministry of Mines and Energy
B	**Specific grants, programs & incentives**	
3.	**Brazilian Green Hydrogen Roadmap** Launch of a sector mapping program to prepare studies on stakeholders for a Brazilian Green Hydrogen Roadmap and on the strategic potential of hydrogen exports from Brazil to Europe.	Brazilian / German Industry and Commerce Association (AHK) Germany's GIZ Brazilian Ministry of Mines and Energy

Chile

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Green Hydrogen Strategy** In November 2020, Chile's government launched the national green hydrogen plan (*Estrategia Nacional de Hidrógeno Verde*). Phase 1 of the plan (2020-2025) aims at developing an internal market for green hydrogen by focusing on (i) existing refineries, (ii) domestic ammonium use, (iii) mining trucks, (iv) trailer trucks for the transportation of goods, (v) long distance buses, and (vi) utilising gas transportation pipelines.	Chilean Ministry of Energy
B	**Specific grants, programs & incentives**	
2.	**Chile – Australia Associations Memorandum of Understanding** In October 2020, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*), H2 Chile, and the Australian Hydrogen Council signed a memorandum of understanding to promote the development of green hydrogen technology.	H2 Chile Australian Hydrogen Council

No.	Description	Key Players
3.	**Tax Policy Memorandum of Understanding** In October 2020, the Ministry of National Property, the Production Development Corporation (*Corporación de Fomento de la Producción de Chile – CORFO*) and the Ministry of Energy signed a memorandum of understanding to promote tax policy regarding land use for the production of green hydrogen.	Ministry of National Property Production Development Corporation Ministry of Energy
4.	**Chile – Argentina Associations Memorandum of Understanding** In November 2020, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*), H2 Chile, and the Spanish Hydrogen Association (Asociación Española del Hidrógeno), AeH2, signed a memorandum of understanding to collaborate on green hydrogen projects in Chile and Spain.	H2 Chile Spanish Hydrogen Association

Colombia

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Green Hydrogen Roadmap** The Colombian government plans to establish a roadmap for green hydrogen in 2021 to identify the possibilities in the country for the generation and use of hydrogen and to identify what regulations are needed for this purpose. The Colombian government, thorough the Energy and Mines Planning Unit (**UPME**) and the Ministry of Science, hired the Universidad de la Sabana, Cotecmar and Escuela Naval de Cadetes Almirante Padilla to undertake a research project to evaluate scenarios for energy transition for a hydrogen economy.	Colombian Government Ministry of Mines and Energy. UPME (National Energy and Mining Planning agency) CREG (National Energy and Gas Regulatory Agency)
2.	**Ministry Declaration of Green Hydrogen as Zero Emissions** In July 2020, Resolution No. 40177 was enacted by the Ministry of Mines and Energy and the Ministry of Environment and Sustainable Development, providing that green hydrogen is a clean energy fuel that causes zero emissions in land transportation use. This is important to the municipalities who have to adopt plans to promote sustainable mobility that prioritise public transportation with technologies that cause low or zero greenhouse gas emissions.	Ministry of Mines and Energy Ministry of Environment and Sustainable Development
3.	**Green Hydrogen Bill** In December 2020, the political party of the President of Colombia announced that in 2021 they will present a bill to Congress to promote the technological development, production and use of green hydrogen.	National Congress
B	**Specific grants, programs & incentives**	
4.	**Procolombia Memorandum of Understanding** In October 2019, Procolombia (an agency of the executive branch of the Colombian government in charge of promoting Colombian exports, tourism and foreign investment) and a commercial partner, signed a memorandum of understanding in order to create working groups to analyse opportunities in the energy transition, including green hydrogen.	Procolombia
5.	**IDB Assistance with National Strategy** In December 2020, the Inter-American Development Bank called for expressions of interest to hire a consultor to draft a road map and the national strategy for production and use of hydrogen for Colombia.	Inter-American Development Bank

Costa Rica

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Presidential Decree** In May 2018, the President of Costa Rica decreed Guideline No. 002-MINAE, ordering institutions that are part of the environment and energy sector to prepare an action plan to promote the investigation, production and commercialisation of hydrogen as a fuel.	Presidency of Costa Rica
2.	**Hydrogen Commission** A Hydrogen Commission was formed by the Ministry of Environment and Energy, the Ministry of Public Works and Transportation, Public Utilities Heredia (**ESPH**), Electricity Institute from Costa Rica (**ICE**), Management Board of the Energy Utilities of Cartago (**JASEC**) and Costa Rican Oil Refiner (**Recope**). This commission prepared an inter-institutional action plan for hydrogen in November 2018 which focuses on the use of hydrogen in the transportation sector.	Ministry of Environment and Energy and others
B	**Specific grants, programs & incentives**	
3.	**IDB Cooperation Agreement** In October 2018, a cooperation agreement titled 'Towards Decarbonization and Promoting the Hydrogen Economy in Costa Rica' was executed by the Inter-American Development Bank and CRUSA (a private non-profit organisation that support sustainable development), as technical advisor, to support the country's progressive transition to net zero greenhouse gas by 2050 through reforms to (i) incentivise the use of electric power, (ii) conserve and restore ecosystems with high rates of greenhouse gases, and (iii) strength management and monitoring of climate action in Costa Rica.	Inter-American Development Bank CRUSA (a private non-profit organisation that support sustainable development)
4.	**Alliance for Hydrogen** The Alliance for Hydrogen was formed to promote the hydrogen ecosystem as an alternative energy that contributes to the country's goal to decarbonise the economy. This alliance will seek technical advice to calculate the benefits and impact of the hydrogen economy for the country and to draft policy proposals to develop the hydrogen market.	Alliance for Hydrogen
5.	**Costa Rican Electricity Institute** In October 2019, the Costa Rican Electricity Institute (**ICE**) executed two cooperation agreements with commercial partners to research and identify business opportunities to promote hydrogen both in the national market and for exporting. The Costa Rican Electricity Institute announced that these agreements are executed to research the possibilities that this agency has to produce or use hydrogen as another renewable source of electricity and as part of this research the Institute aims to identify companies and businesses specialised in the production of hydrogen. This is part of the tasks assumed by Costa Rica under its national plan to decarbonise its economy.	The Costa Rican Electricity Institute (ICE)

Mexico

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Electricity Industry Law** The Electricity Industry Law (*Ley de la Industria Eléctrica*) considers the generation of power through green hydrogen and fuel cells as 'clean energy' and, therefore, based on the Sector Program issued by the Ministry of Energy in July 2020, debate is expected concerning the production and uses of green hydrogen.	Energy Regulatory Commission *(Comisión Reguladora de Energía – CRE)*

No.	Description	Key Players
2.	**Climate Change General Law** The Climate Change General Law (L*ey General de Cambio Climático*), enacted in 2012, promotes research, development and adaptation to Mexico of new technologies in renewable and clean energy, including hydrogen.	Ministry of Environmental and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales – SEMARNAT*)
B	**Specific grants, programs & incentives**	
3.	**SMH National Hydrogen Plan** The Mexican Hydrogen Association (*Sociedad Mexicana del Hidrógeno*) is an industry group comprised of researchers, sector business leaders and academics whose main objective is to coordinate efforts to promote the hydrogen industry in Mexico and become a project hub. It published a National Hydrogen Plan in 2016 to identify key technologies, products, and markets for the development of hydrogen as a fuel and sustainable energy source in Mexico, through research, resource training, specialised human resources, the transfer of technology and production of goods and services.	Mexican Hydrogen Association
4.	**Sectoral Program** On 7 July 2020, the Sectoral Program derived from the National Development Plan was published. This program acts as a principle to guide the 'rescue and promotion' of the energy sector including the exploration of the use of other energy sources such as hydrogen.	Mexican Hydrogen Association
5.	**Ministry of Energy and CONACYT** In 2016, the Mexican Energy Ministry (*Secretaría de Energía*) along with the Consejo Nacional de Ciencia y Tecnología (**CONACYT**) granted funds to develop a prototype for a zero-emission electric vehicle powered by hydrogen fuel cells. This project was developed by the National Institute of Electricity and Clean Energy along with the Centre for Research in Automotive Mechatronics of the Tecnológico de Monterrey, the Centre for Research and Technological Development, the Potosi Institute for Scientific and Technological Research, and the Autonomous University of San Luis Potosí. The prototype vehicle was developed for the utility market; however, its developers consider that only minor changes are required to extend its use to personal urban transport.	Mexican Energy Ministry CONACYT

Paraguay

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Strategy** In May 2020, the Ministry of Public Works and the Ministry of Energy and Mines announced that they are preparing a national strategy for the use of hydrogen. This initiative is supported by the Inter-American Development Bank, the technical assistance of the Centre for Natural Resources, Energy and the Environment (**CRECE**), Catalonia Institute for Energy Research (**IREC**) and the public oil company Paraguayan Petroleums (**PETROPAR**).	Ministry of Public Works Ministry of Energy and Mines

Uruguay

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Roadmap** The Ministry of Industry, Energy and Mining and the State Utility UTE are coordinating the development of a hydrogen roadmap for Uruguay.	Ministry of Industry, Energy and Mining UTE

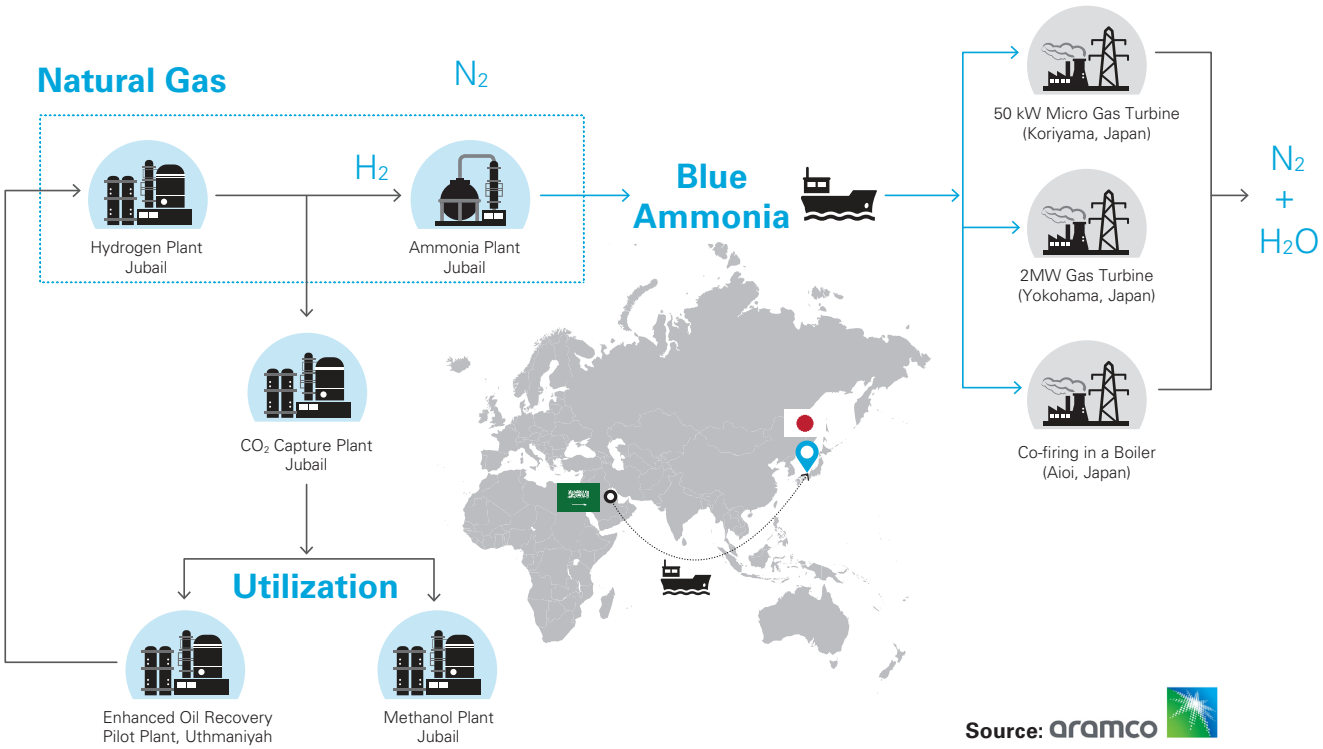
3.7 Middle East

Overview

The Middle East's current role of key energy exporter through oil and gas looks set to be supplemented by an expansion of hydrogen production and export capacity in order to link up with customer demand in the Asia-Pacific region. Such inter-regional links are based along the lines of existing carbon economy trading partners (see, for example, Saudi Arabia seeking to export hydrogen to Japan).

In line with the Australian approach, the Middle East region is awakening to the concept of using its vast geography (and central location) to produce and export blue and green hydrogen. Indeed, this year has seen the world's first blue hydrogen export (from Saudi Arabia to Japan). A diagram illustrating the links across such regions is included below.

Conceptual flow diagram of "Blue Ammonia" supply chain demonstration
(Duration: August 2020 – October 2020)



Alongside this success, the region's efforts in the hydrogen supply chain have picked up pace in 2020 with the region's first hydrogen transport standards announced (United Arab Emirates) and the world's largest green hydrogen facility announced (Saudi Arabia).

Regulatory initiatives outside of the support provided to renewable energy projects and those noted above are currently sparse but more development in this area is expected in the near future. By way of example,

DEWA (the Dubai Emirate's electricity authority) is currently preparing its own hydrogen roadmap alongside investing in hydrogen projects.

One strategic objective for the Middle East region will be to drive demand for the use of hydrogen in domestic economies in order to facilitate the greater export of hydrocarbons (thereby earning export revenue). An example of this can be seen in the United Arab Emirates' hydrogen-powered transport regulations.

Key jurisdictions of interest

No.	Description	Key Players	Status
A	**Policy framework and regulatory developments**		
1.	**Israel** In March 2016, the third Green Taxation Inter-ministerial committee released comprehensive policy recommendations to promote the use of oil substitutes through economic incentives, taking into account the environmental benefits of the fuels and vehicles.	Israel	
2.	**United Arab Emirates** The United Arab Emirates has introduced regulations and standards for the use of hydrogen-cell vehicles. This is alleged to be the first set of such regulations in the Middle East region.	United Arab Emirates	Regulations in place
B	**Specific grants, programs & incentives**		
3.	United Arab Emirates ADNOC has a range of operational and planned carbon capture, utilization and storage projects with a current plan to expand storage capacity to 5 million mt/ year of CO2 by 2030. The CCUS technology will be used in part to produce blue hydrogen.	Abu Dhabi National Oil Company (ADNOC)	Mix of operational and planned
4.	**United Arab Emirates: Abu Dhabi** ADNOC, Mubadala, and the industrial holding company ADQ signed a memorandum of understanding to establish the Abu Dhabi Hydrogen Alliance. The Alliance partners have agreed to collaborate to establish Abu Dhabi as a trusted leader of low-carbon green and blue hydrogen in emerging international markets. The partners will also aim to build a substantial green hydrogen economy in the UAE. ADNOC, Mubadala and ADQ are aiming to build on each's strengths to accelerate Abu Dhabi's hydrogen leadership. The signing of the memorandum comes quickly off the back of ADNOC's recent agreement with the Ministry of Economy, Trade, and Industry of Japan to explore cooperation on fuel ammonia and carbon recycling, harnessing technologies which will enable the hydrogen economy.	ADNOC, Mubadala Investment Company, ADQ (all Abu Dhabi).	Memorandum of Understanding signed
5.	**Israel** The Israeli Prime Minister's Office launched the "Fuel Choices and Smart Mobility Initiative" in 2011. It is a joint effort of ten government ministries, Energy, Transport, Economy, Environmental Protection, Science, Finance, Defense, Agriculture, Foreign Affairs, and the Prime Minister's Office. The initiative aims to reduce the share of oil in Israel's transportation sector by 60% by 2025 through implementation of alternative fuels. Through the Israel Science Foundation, the Initiative is promoting the Centre of Knowledge program, which is encouraging interdisciplinary research in the fields of hydrogen and synthetic fuels as well as photo-electrochemistry. The Israeli Ministry of Energy has funded various projects, among them in 2019 a planned hydrogen fuel station. A grant of NIS 4 million was allocated to the establishment of the first hydrogen fuel station in Israel. The companies that won them were Sonol and Metropolitan.	Israel	Momentum gaining

No.	Description	Key Players	Status
6.	**Morocco: Morocco/Germany Hydrogen Cooperation Agreement** This Agreement was signed in June 2020 by the Moroccan ambassador to Germany, and the German Federal Minister for Economic Cooperation and Development. Two projects have been announced within the framework of this economic cooperation agreement. Firstly, is the "Power to X" project for the production of green hydrogen proposed by the Moroccan Solar Energy Agency (MASEN); and secondly the establishment of a research platform on "Power to X", the transfer of knowledge and the strengthening of skills in partnership with the Moroccan Institute for Research in Solar Energy and New Energies (IRESEN).	Morocco/ Germany	Signed
7.	**Algeria:** National Energy Council. Algeria has announced the forthcoming formation of the National Energy Council. The strategic axis of the energy transition for Algeria will be the development of renewable energies, with the primacy of hydrogen between 2030 and 2040.	Algeria	

3.8 Africa

Overview

A number of countries in Africa have developed energy policies which consider hydrogen in a limited manner, including Algeria, Tanzania, Ghana, Nigeria and South Africa.

The Green Hydrogen Atlas-Africa project (the **GHAA Project**) was initiated in June 2020 by the German Federal Ministry of Education and Research in partnership with Ministers of Energy in the South African Development Community (**SADC**) and Economic Community of West African States (**ECOWAS**). It seeks to explore opportunities for green hydrogen development from the rich renewable energy sources on the continent with the intention of finding a sustainable energy source that meets the growing population and economy across the continent, as well as considering opportunities for exporting green hydrogen. The key objectives of the GHAA Project are:

a) analysis of available renewable energy and water resources as well as all other resources necessary for green hydrogen generation;

b) determine the green hydrogen potential within the West and Southern Africa regions based on the available assessed resources and identify the green hydrogen 'hot spots';

c) representation of green hydrogen potentials in an interactive 'H2Atlas'; and

d) propose sites and concepts for pilot projects based on the potential atlas.

It is contemplated that the GHAA Project will serve 'as a decision support tool for policy makers, investors, researchers and indeed all stakeholders in both Germany and Africa.' The H2Atlas will be informed by information obtained from each country based on the renewable energy resources, climate change scenarios and impacts, land and water resources and local energy demands and requirements. National teams from each of the SADC and ECOWAS countries will be responsible for collecting and compiling this information. It is hoped that the H2Atlas will provide a clear roadmap for the development of a green hydrogen-based economy. It is anticipated that the outcomes of these investigations will inform country-specific policies across SADC and ECOWAS.

The African Hydrogen Partnership (**AHP**) is working in partnership with governments, private sector companies and financial institutions to draft a series of high-level strategic documents to help policy makers and investors visualise an Africa-wide hydrogen strategy. The AHP recommends a strategy of establishing 'landing zones/ bridgeheads' where initial green hydrogen projects could be developed before expanding into other clusters. To finance this vision, the AHP is proposing a green bonds program for the Africa region and is working alongside stock exchanges in Africa and Europe to design a framework for investors and gauge appetite.

Although there is little in the way of policy as yet, there are significant opportunities for the development of hydrogen

as a source of energy for local consumption as well as export. It is suggested that South Africa's existing coal and natural gas pit to port infrastructure could be utilised to export hydrogen and the necessary components of fuel cell technology given the rich platinum reserves that exist in Southern Africa. The development of this technology could be used in the well-established car manufacturing business in South Africa as well as in locomotives of non-electrified railway networks across Africa and off-grid back-up power to renewable energy as a more sustainable alternative to batteries.

In this way the hydrogen economy may form a significant part of the South African economic recovery following COVID-19. In support of this, the South African government has undertaken to develop a National Hydrogen Society Roadmap aimed as using 'local resources to create knowledge and human resource capacity, enabling the development of high-value commercial activities in hydrogen fuel cell technologies'. In addition, the 'roadmap will set out the plan for creating an inclusive hydrogen society in South Africa so that an enabling compact between industry, labour, communities and government can be developed.'

Notwithstanding the lack of detailed policy, green hydrogen has been initiated in a number of countries by governments and in the private sector.

- **Morocco**

  Morocco signed a memorandum of understanding in 2020 with Germany to develop and build Africa's first industrial green hydrogen plant. This follows from Germany's hydrogen strategy which includes a commitment to investing US$2.38 billion in hydrogen projects abroad. The first project proposed is the 'Power-to-X' project for the production of green hydrogen (proposed by the Moroccan Solar Energy Agency).

- **Egypt**

  The Egyptian government has signed an agreement of intentions with Siemens AG for the start of discussions and studies to implement a pilot project for the production of green hydrogen in Egypt.

- **Uganda**

  In November 2018, the Belgian renewable energy company Tiger Power signed an agreement with the Ugandan government to power 3000 rural households and businesses in Kyenjojo by building a solar power plant in each village backed up by on-site hydrogen production and storage.

- **South Africa**

  In October 2020, the South African government announced that it will establish the Platinum Valley Project, serving as an industrial cluster and bringing various hydrogen applications in the country together to form an integrated hydrogen ecosystem. The initiative is part of the government's economic recovery plans. South Africa's version of a 'hydrogen valley' will identify concrete project opportunities for kick-starting hydrogen activities in promising hubs, with the aim of boosting economic growth and job creation, spurring the development of new industries, increasing the valorisation of the country's platinum reserves and reducing its carbon footprint.

North Africa

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Algeria** In 2019, the law governing hydrocarbon activities (**Law No.19-13**) was enacted. This legislation covers all matters pertaining to oil and gas activities within Algeria, including abandonment, flaring, and environmental issues. Depending on the approach taken by potential stakeholders, this may cover hydrogen production. The legislation also covers the regulatory roles of the National Agency for the Valorisation of Hydrocarbon Resources (**ALNAFT**). The main mission of ALNAFT is the potential evaluation of the hydrocarbon mining domain and the promotion of upstream investment.	Algerian Government National Agency for the Valorisation of Hydrocarbon Resources National Energy Council

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**Algeria National Energy Council** In 2020 the Algerian President announced the establishment of the 'National Energy Council'. Proposals for efficient energy transition being considered by the council include a focus on the primacy of hydrogen between 2030 to 2040.	Algerian Government National Energy Council
B	**Specific grants, programs & incentives**	
3.	**Morocco/Germany Hydrogen Cooperation Agreement** This Agreement was signed in June 2020 by the Moroccan ambassador to Germany, and the German Federal Minister for Economic Cooperation and Development. Two projects have been announced within the framework of this economic cooperation agreement. The first is the 'Power to X' project for the production of green hydrogen proposed by the Moroccan Solar Energy Agency (**MASEN**). The second is the establishment of a research platform on 'Power to X', the transfer of knowledge and the strengthening of skills in partnership with the Moroccan Institute for Research in Solar Energy and New Energies (**IRESEN**).	Moroccan Government German Government
4.	**Tunisia** In December 2020, the Minister of Industry, Energy and Mines and Parliamentary State Secretary to the Federal Minister for Economic Cooperation and Development (**BMZ**) signed a memorandum of understanding with the German government that aims to develop the green hydrogen market in Tunisia. Minister Salwa Sghaier stated: "the production of green hydrogen constitutes a new emerging niche in Europe and in particular in Germany for which Tunisia seeks to position itself with regard to its abundant renewable resources and this is the ultimate goal of our alliance. The Tunisian-German Hydrogen Alliance will support the achievement of this objective, through investment, regulation, the creation of markets as well as research and innovation".	Tunisian Government German Government

East Africa

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Tanzania** In 2015, the Tanzanian Government developed the National Energy Plan, which seeks to ensure the delivery of adequate, reliable and affordable, modern energy services to Tanzanians in a sustainable manner. The Ministry of Energy and Mineral is responsible for provision of overall leadership, oversight guidance and policy directions in the implementation of this Policy.	Tanzanian Ministry of Energy
B	**Specific grants, programs & incentives**	
2.	**Uganda** In November 2018, a Belgian renewable energy company signed an agreement with the Ugandan Government to power 3000 rural households and businesses in Kyenjojo by building a solar power plant in each village backed up by on-site hydrogen production and storage.	Ugandan Government Commercial parties

No.	Description	Key Players
3.	**Tanzania** In 2016, CAN-Tanzania, the World Future Council and Bread for the World embarked on an 18-month project in Tanzania to develop a strategy to implement 100 per cent renewable energy as part of the country's sustainable low carbon development initiatives and poverty reduction goals. The intention of the project was to, among other things, identify necessary legislation and policy reforms. As part of this effort, Tanzania may seek to introduce hydrogen and sustainable synthetic fuels as substitute for natural gas.	Tanzanian Ministry of Energy Tanzanian Government
4.	**Kenya** According to 'The Plan for 100% Renewable Energy Scenario in Kenya by 2050' prepared by Sustainable Environmental Development Watch, an important step that the country needs to take in order to achieve 100% renewable energy development is to change transport gradually to electricity, hydrogen and new fuels (electrofuels).	Kenyan Government
5.	**Mauritius** Mauritius's 'Long Term Energy Startegy 2009 – 2025' strategy places emphasis on (i) the development of renewable energy, (ii) reduction of our dependence on imported fossil fuel and (iii) the promotion of energy efficiency in line with the government's objective to promote sustainable development. Part of the strategy is to explore technologies such as hydrogen-based electricity, gasification and fuel cells on pilot basis subject to appropriate funding from donor agencies.	Mauritian Government

West Africa

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Ghana** The Renewable Energy Master Plan seeks to provide an investment-focused framework for the promotion and development of the country's rich renewable energy resources for sustainable economic growth, contribute to improved social life and reduce adverse climate change effects.	Ghanaian Government
2.	**Nigeria** In November 2005, Nigeria released its Renewable Energy Master Plan (**REMP**). REMP articulates Nigeria's vision and sets out a road map for increasing the role of renewable energy in achieving sustainable development. The plan recognises that, among other things, hydrogen is important in the long-term vision of providing secure, abundant, cost effective and clean sources of energy for Nigeria.	Nigerian Government

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
3.	**West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)** WASCAL is a large-scale, research-focused Climate Service Centre designed to help tackle this challenge and thereby enhance the resilience of human and environmental systems to climate change and increased variability. It does so by strengthening the research infrastructure and capacity in West Africa related to climate change and by pooling the expertise of ten West African countries (Benin, Burkina Faso, Cape Verde, Ivory Coast, Gambia, Ghana, Mali, Nigeria, Senegal and Togo) and Germany. WASCAL is implemented in a collaborative effort by West African and German partners and is funded by the German Federal Ministry of Education and Research (**BMBF**). The cooperation has given rise to several initiatives, such as the launch of the Go Green Go Africa Hydrogen Initiative by BMBF. The aim of the initiative is to support sustainable and economic development through a viable hydrogen economy with high potential to make Africa an exporter of green hydrogen, hence gaining even more relevance in international energy markets. In February 2020, the Federal Research Minister of BMBF and the Minister of Higher Education, Research and Innovation in Nigeria agreed to establish a hydrogen partnership and strategic measures to expand in West Africa.	The German Federal Ministry of Education and Research WASCAL
4.	**Workshop to Map Potential of Green Hydrogen in Africa** This project, developed in 2019, aims to determine locations in Africa where green hydrogen could play a key role both in energy supply for local areas and in exports to Germany. This interactive regional map will form the basis for pioneering demonstration projects involving industrial and scientific partners in Africa. The first workshop was held in November 2019 in Ghana.	WASCAL West African Governments

Southern Africa

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Development Plan (South Africa)** The National Development Plan, as well as the Integrated Resource Plan 2019, highlight the need for South Africa to diversify its energy sources and increase the use of renewable energy and gas to reduce the country's greenhouse gas emissions and address energy security. This has created a platform for emerging low-carbon energy technologies such as hydrogen fuel cells to be part of South Africa's future energy mix. The Department of Science and Technology has a number of programmes aimed at stimulating research and innovation in relation to hydrogen.	South African Government Department of Science and Technology
2.	**Carbon Tax Act (South Africa)** The South African President signed into law the Carbon Tax Act No 15 of 2019, which came into effect on 1 June 2019. As part of its contribution to the global effort on climate change, South Africa is introducing the Carbon Tax Act. Companies will pay a penalty of R120 per ton CO2-eq. The amount may be increased over time and the funds will be used to support green initiatives towards decarbonising the economy.	South African Department of Environmental Affairs

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
3.	**Hydrogen South Africa Strategy (HySA Strategy)** The HySA Strategy was approved by the South African Cabinet in 2007. The HySA Strategy is a long-term (15-year) programme aimed at developing South African intellectual property, knowledge, human resources, products, components and processes to support the South African participation in the nascent, but rapidly developing international platforms in Hydrogen and Fuel Cell Technologies, and has since made steady progress in developing hydrogen and fuel cell technologies focused on platinum group metal beneficiation and improved energy security.	Department of Science and Innovation Department of Defence Department of Public Works and Infrastructure
4.	**Platinum Valley Project (South Africa)** In October 2020, South African government announced it would establish the Platinum Valley Project, serving as an industrial cluster and bringing various hydrogen applications in the country together to form an integrated hydrogen ecosystem. South Africa's version of a 'hydrogen valley' will identify concrete project opportunities for kick-starting hydrogen activities in promising hubs, with the aim of boosting economic growth and job creation, spurring the development of new industries, increasing the valorisation of the country's platinum reserves, and reducing its carbon footprint.	Department of Science and Innovation Gauteng Industrial Development Zone Airports Company South Africa
5.	**International Partnership for Hydrogen and Fuel Cells in the Economy** South Africa is a member of the International Partnership for Hydrogen and Fuel Cells in the Economy (**IPHE**). The objective of the IPHE is to facilitate and accelerate the transition to clean and efficient energy and mobility systems using hydrogen and fuel cell technologies across applications and sectors. The IPHE's 17 members organize, evaluate, and coordinate multinational research, development, and deployment programs that will advance the introduction of fuel cells and hydrogen infrastructure at a global scale.	South African Government
6.	**National Hydrogen Energy & Fuel Cell R&D Strategy development** South Africa has a vision to carry out research and development, create knowledge and human resource capacity and develop high value commercial activities in utilising local resources for the production and use of hydrogen as an energy carrier. This will contribute to energy solutions, enhanced social benefits, business competitiveness and environmental protection. The research and development focus areas of the strategy are, among other things, hydrogen production and hydrogen storage.	South African Government

4/

Global Hydrogen Development Activity

4/ Global Hydrogen Development Activity

4.1 Introduction

The following is a snapshot of notable development activity in the hydrogen sector across the globe organised by region. We have further organised the activity by whether it relates to the Demand side (the use of hydrogen) or the supply side (the production of hydrogen) of the sector. Like the accompanying regulatory activity, new development activity around the world is fast paced and constantly changing. Therefore, this Chapter does not aspire to be a comprehensive or exhaustive account of all development activity. Rather, it is a snapshot of notable developments emerging in key regions, based on publicly available information. This Chapter seeks to assist in enhancing a broad based understanding of the emerging global market for hydrogen – an ambition to 'see the whole board'.

4.2 Hydrogen Development Activity by Region

Asia-Pacific

No.	Project	Country	Description
A	**Demand side**		
1.	**Port Kembla**	Australia	H2X Manufacturing has announced plans to manufacture hydrogen-powered heavy vehicles by 2022. Its focus is on powertrains that leverage kinetic energy in tandem with battery and hydrogen-fuel-cell power systems, and it seeks to reach production of 25,000 units by 2025.
2.	**Fuel cell joint venture**	Japan	In June 2020, Toyota announced a joint venture with Beijing SinoHytec, a Chinese fuel cell specialist, and four Chinese state-owned carmakers to develop hydrogen-powered fuel cell technology.
3.	**Floating data centre**	Singapore	In April 2020, Keppel signed an memorandum of understanding with Mitsubishi Heavy Industries to explore a concept for hydrogen-powered floating data centres in Singapore, including a hydrogen-powered 'tri-generation plant' (producing heat, power and cooling) using steam reformation.
4.	**Hydrogen mobility**	South Korea	Hyundai Motors has announced a commitment to hydrogen-powered fuel cell technology. Notably, it has launched a dedicated hydrogen fuel cell brand dubbed 'HTWO', with the goal of selling 700,000 units per year from 2030. The company had already started commercial production of cars, trucks and buses powered by the fuel cells well before the launch, and now plans to fully electrify its product line-up in major global markets by 2040. The company is also working to expand the application of the fuel cell system beyond passenger vehicles including shipping, forklifts and trams.
5.	**Model Cities**	South Korea	In December 2019, the South Korean government announced plans to transform three cities (Ulsan, Ansan and JeonjuWanju) into 'hydrogen model cities' by 2022. Under the plan, hydrogen would be sourced as the main fuel for heating and cooling, transportation, and electricity. The South Korean government has started integrating hydrogen into the cities' infrastructure, including the installation of pipelines for transporting hydrogen.
6.	**Pohang fuel cell power generation cluster**	South Korea	In December 2019, the South Korean government announced plans to transform three cities (Ulsan, Ansan and JeonjuWanju) into 'hydrogen model cities' by 2022. Under the plan, hydrogen would be sourced as the main fuel for heating and cooling, transportation, and electricity. The South Korean government has started integrating hydrogen into the cities' infrastructure, including the installation of pipelines for transporting hydrogen.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
7.	**Fuel cell shipping partnership**	South Korea	In June 2020, Samsung Heavy Industries announced a partnership with Bloom Energy to develop solid oxide fuel cell (SOFC) technology to power large ships. SOFCs generate power through an electrochemical reaction, using natural gas, biogas or hydrogen as fuel.
8.	**Fuel cell joint venture**	South Korea	In January 2020, SK E&C and Bloom Energy announced a joint venture, Bloom SK Fuel Cell, to locally produce SOFCs. The JV recently opened a plant in Gumi, Korea, and the plant's production capacity is to expand in phases from 50 MW to 400 MW by 2027.
9.	**Fuel cell and hydrogen powered tram**	China	In October 2017, CRRC Tangshan developed and put into commercial use the first fuel cell powered tram in Tangshan, Hebei province. In Nov 2019, another hydrogen-powered tram, built by CRRC Qingdao Sifang, was put into operation in Foshan, Guangdong province.
10.	**Hydrogen buses and electrolyser**	China	Zhangjiakou City, which will host part of the 2022 Beijing Winter Olympics, is rolling out 1,000 hydrogen trucks and buses to support the logistical effort of hosting the games. The joint venture between Shell China and the authorities in Zhangjiakou City will build a 20 MW electrolyser as well as refuelling stations.
11.	**Hydrogen refuelling stations**	China	In late 2019, Air Liquide partnered with Sinopec to open two hydrogen refuelling stations in Shanghai, with the ability to serve 200 hydrogen fuel cell buses operating in the area.
B	**Supply side**		
12.	**Asian Renewable Energy Hub**	Australia	A proposed 15 GW export hub in the Pilbara region of Western Australia, with green hydrogen production to be powered by wind turbines and solar panels. This project was designated a 'major project' by Australian government in October 2020, and has an estimated cost of over A$20 billion.
13.	**Murchison Renewable Hydrogen Project**	Australia	A proposed 5 GW facility north of Kalbarri, Western Australia. The project involves the construction of a combined solar and wind farm, desalination plant, electrolyser plant, spur pipeline and a coastal terminal storage and transport facility.
14.	**Arrowsmith Hydrogen Project**	Australia	A proposed green hydrogen plant in Dongara, 300km north of Perth. Targeted production of 25 tonnes of green hydrogen per day, to be exported together with output from several planned regional projects.
15.	**H2TAS Project**	Australia	Gas company Woodside has signed a MoU with the Tasmanian state government to develop a 10 MW electrolyser project in Bell Bay. A final investment decision is expected late 2021, with production targeted for the first half of 2023. In addition to the MoU, Woodside is investigating the blending of green hydrogen into Tasmania's main gas network through a non-binding commitment with the local gas company, Tas Gas.
16.	**Yara Green Ammonia pilot project**	Australia	A pilot project in Yara's plant in the Pilbara to produce green ammonia by using green hydrogen produced from renewable energy. Yara is collaborating with French energy company ENGIE on a feasibility study for a 66 MW plant and received in ARENA funding in February 2020.
17.	**Pacific Solar Hydrogen project**	Australia	Austrom Hydrogen has announced plans to build a 2.6GW green hydrogen production facility near Gladstone in Queensland, which would use solar panels and battery facilities to provide power for electrolysers. Production is targeted at 200,000 tonnes per year.

No.	Project	Country	Description
18.	**Crystal Brook Hydrogen Superhub**	Australia	A developer has received a South Australian government grant for a feasibility study on a hydrogen production facility at its Crystal Brook Energy Park. The proposed 50 MW Hydrogen Superhub would be the world's largest co-located wind, solar, battery and hydrogen production facility, with targeted production of 25,000 kg of hydrogen a day using 100% renewable energy.
19.	**Gladstone Hydrogen Production Plant**	Australia	A proposed hydrogen production facility near Gladstone, Queensland, which, once constructed, will produce 250-300 tons of hydrogen per year with a view to scaling up production over time. Sumitomo announced that it had signed a front-end engineering and design contract for the facility with JGC Holdings Corp in January 2021.
20.	**Fukushima Hydrogen Energy Research Field (FH2R)**	Japan	A 10 MW hydrogen production plant powered by renewable energy, with construction completed in February 2020.
21.	**Hydrogen Energy Supply Chain**	Japan	In November 2019, Japan announced a pilot for the production and transport of hydrogen from Australia to Japan. The proposal involves the production of brown (and possibly blue) hydrogen using brown coal deposits of brown coal in Victoria's Latrobe Valley, to be liquefied and shipped to Japan.
22.	**Hydrogen Energy Supply Chain Utilising the Organic Chemical Hydride Method**	Japan Brunei	The Advanced Hydrogen Energy Chain Association for Technology Development (**AHEAD**), an association of four private companies, was formed in July 2017 to conduct experimental research on and plan the practical application of hydrogen supply chains using the organic chemical hydride method. Through the demonstration project, the AHEAD has realised an international hydrogen supply chain of methylcyclohexane (**MCH**) production in Brunei, maritime MCH transport from Brunei to Japan and dehydrogenation of MCH in Japan.
23.	**FEED contract for Gladstone hydrogen plant**	Japan Australia	Sumitomo Corporation and JGC Holdings Corporation signed a Front End Engineering and Design (FEED) contract for a hydrogen related project planned by Sumitomo Corporation in Gladstone, Australia. The hydrogen plant would generate hydrogen from electrolysis of water using electricity from Solar PV as the main power source and produce 250-300 tonnes of hydrogen annually, with plans to scale up production.
24.	**Hydrogen supply chain**	Malaysia	In October 2020, it was announced that SEDC Energy, a subsidiary of state-owned Sarawak Economic Development Corporation, would partner with Japanese companies ENEOS and Sumitomo to conduct a feasibility study into a zero carbon hydrogen supply chain.
25.	**Hydrogen production facility**	Malaysia	National oil & gas giant Petronas has announced that it has signed a memorandum of understanding with Sarawak Energy, an electric utility company for a large-scale hydrogen production facility.
26.	**Hydrogen Energy System Pilot**	Singapore	In October 2019, state-owned energy utility SP Group announced that it had established a hydrogen energy system pilot at its Woodleigh lab, with the support of its Japanese partners, Marubeni Corporation and Tohoku University. The system uses solar energy to produce green hydrogen via electrolysis.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
27.	**Hydrogen Value Chain**	South Korea	In December 2020, SK Holdings announced plans to build facilities by 2023 that can produce 30,000 tonnes of liquid hydrogen each year. It will also produce 250,000 tonnes of blue hydrogen per year using natural gas imported by SK E&S starting from 2025. The company will oversee the entire process of the hydrogen value chain, ranging from production and distribution to supply.
28.	**Hydrogen production**	South Korea	POSCO has announced a goal to produce 5 million tonnes of hydrogen by 2050. The company aims to expand its by-product hydrogen capacity to 70,000 tonnes by 2025, blue hydrogen capacity to 500,000 tonnes in cooperation with global companies by 2030, and green hydrogen capacity to 2 million tonnes by 2040. POSCO has announced that it will also collaborate with Australian miner Fortescue Metals Group in the construction of a green hydrogen project in Tasmania, Australia, which may involve green hydrogen produced from the plant being imported into Korea.
29.	**Green Hydrogen Production Complex**	South Korea	A proposed water electrolysis facility capable of producing 290 tonnes of hydrogen per year and a charging station by using a wind turbine complex in Gangwon Province of Korea. The production complex will go into commercial operation in the second half of 2022 and will be run by Hanwha Solutions.
30.	**Hyosung-Linde Hydrogen Plant**	South Korea	Korean company Hyosung Heavy Industries has announced that it will partner with Linde to build a liquid hydrogen plant in Ulsan, Korea. Targeted production of 13,000 tonnes of liquid hydrogen per year.
31.	**Solar-powered hydrogen plant**	China	Ningxia Baofeng Energy Group, a private coal production and processing company, announced in April 2020 a start to construction on the world's largest solar-powered hydrogen plant in Ningxia Hui, northwest China. The plant, which will be producing hydrogen by 2021, will consist of two 100,000 m3/hr electrolysers powered by two 100 MW solar plants plus a 1,000 kg/day hydrogenation station, producing 160 million cubic meters of hydrogen annually.
32.	**Hydrogen production system**	China	Siemens Energy and Beijing Green Hydrogen Technology Development Co., Ltd, a subsidiary of China Power International Development Ltd, signed an agreement on providing a hydrogen production system for a hydrogen fuelling station in Yanqing District, Beijing. The green hydrogen production solution provided by Siemens Energy will help guarantee the hydrogen supply for the public transportation during and after the Beijing Winter Olympics 2022.

Europe & the United Kingdom

No.	Project	Country	Description
A	**Demand side**		
1.	**Pilot Carbon-Neutral Steel Plant**	Austria	Japan's Mitsubishi Heavy Industries is building the world's largest pilot carbon-neutral steel plant in Austria, which will use hydrogen instead of coal for steelmaking. Trial operation is slated to begin in 2021.
2.	**Hydrogen Refuelling Infrastructure Belgium**	Belgium	A large-scale, nation-wide project to set up hydrogen refuelling stations throughout Belgium. It is divided into three periods of five years, from 2015 to 2030, and promises a steady increase of such refuelling stations and general hydrogen infrastructure in the coming years.
3.	**HaYport**	Belgium	This project aims to equip Liège airport with the means to produce, distribute and use green hydrogen. The first step is to ensure that the airport's entire fleet of vehicles runs on green hydrogen before ultimately ensuring the same with respect to all other vehicles transiting through the airport and its vicinity.
4.	**Hydrogen Region Flanders-South Netherlands**	Belgium Netherlands	The 'Hydrogen Region Flanders-South Netherlands' is an 'Interreg' (inter-regional) project between the Regions of Flanders and South Netherlands to develop, by way of cross-border collaboration, all aspects of hydrogen technology. Under this project the first hydrogen stations using electrolysis in Belgium and the Netherlands were developed.
5.	**H2SHIPS pilot on the river Seine**	France	Launched in 2019, the European H2SHIPS project, whose partner is Hynamics, an EDF subsidiary, aims to demonstrate the economic viability of hydrogen fuelling and propulsion in maritime transport. The project includes the construction of a pilot recharging station and the development of a hydrogen ship. The second phase aims to operate hydrogen barges for the transport of waste on the Seine.
6.	**Fuel cell system**	France	Hydrogène de France and ABB Marine International, a company specialising in electric maritime transport, have signed a memorandum of understanding with the aim of developing a fuel cell system with a power greater than 1 MW for use in ships. The system will be used for shore-side powering of large ships and propulsion of smaller ships. The fuel cells will be produced in the Bordeaux plant of Hydrogène de France (**HDF Industry**).
7.	**High pressure hydrogen station**	France	Air Liquid has announced the construction of Europe's first high-pressure hydrogen station. This station will supply the first fleet of long-distance hydrogen trucks. The station will be built as part of the HyAMMED project, which brings together manufacturers, transporters and retail players such as Carrefour, Coca-Cola European Partners and Monoprix.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
8.	**tkH2Steel**	Germany	With its project 'tkH2Steel', thyssenkrupp Steel has announced its commitment to achieve climate neutral steel production by 2050. In order to achieve this goal it plans to use green hydrogen to reduce its carbon output as well as to develop technologies to utilise the remaining carbon produced in 'Carbon2Chem' procedures.
9.	**Fuel Cell Systems**	Germany	Bosch and UK company, Ceres Power, announced in December 2020 that they have made an agreement for the mass production of solid oxide fuel cell systems based on Ceres' proprietary fuel cell technology with an aim to achieve an initial annual production of around 200 MW from manufacturing facilities in Germany, following a successful prototype phase.
10.	**Hydrogen connection**	Germany France Luxembourg	In the project 'MosaHYc', GRTgaz SA and Creos Deutschland GmbH are collaborating to create a 100% pure hydrogen infrastructure, connecting the Saar (Germany), Lorraine (France) and the Luxembourg border. This 70 km-long infrastructure will be capable of transporting up to 20,000 m^3/h (60 MW) of pure hydrogen via retrofitted existing gas pipelines. In the longer term, the project paves the way for the subsequent conversion of available gas pipelines to pure hydrogen in other geographies and will accelerate the development of a real cross-border hydrogen market in Europe.
11.	**RH2INE-corridor**	Germany Netherlands	RH2INE seeks to realise market-ready hydrogen applications along one of the EU's oldest core network corridors, powered by the first sustainable and interoperable gas and electricity networks in the world. It is taking the first step towards a zero-emission transport corridor by developing the right conditions and infrastructure for the use of hydrogen for the inland transport chain for example inland shipping, freight transportation by road and rail for the last mile. It aims to stimulate a targeted structural demand for hydrogen in the mobility sector, aligned with a sustainable hydrogen supply network.
12.	**Fuel cell joint venture**	Germany Sweden	In November 2020, Volvo Group and Daimler Truck AG announced a joint venture for the development and series production of hydrogen-powered fuel cell systems with a focus on heavy trucks.
13.	**Hydrogen collaboration**	Italy	In 2019, Snam established a business unit dedicated specifically to hydrogen, and, in 2020 it launched hydrogen collaborations with RINA and Alstom, in the industrial and rail transport sectors, respectively. Snam and Rina set up a joint working group to study and develop tests on the compatibility with hydrogen of industrial burners and other equipment already in operation and to initiate experimentation, analysis and technological scouting in various areas concerning hydrogen: from production to storage and distribution.
14.	**Hybrid hydrogen turbine**	Italy	In 2020, Snam tested the world's first 'hybrid' hydrogen turbine designed for a natural gas transmission infrastructure. The turbine, manufactured by Baker Hughes in Italy and powered by up to 10% hydrogen, will be installed by 2021 at Snam's thrust plant in Istrana, in the province of Treviso. The company is now engaged in verifying the full compatibility of its infrastructures with increasing quantities of hydrogen blended with natural gas, as well as in supporting the development of the Italian supply chain to encourage the use of hydrogen in multiple sectors, from industry to transportation.

No.	Project	Country	Description
15.	**Hydrogen Fueled Large Cruise Ship**	Italy	Fincantieri S.p.A., which is one of the largest world shipbuilding manufacturers, started the construction of ZEUS – Zero Emission Ultimate Ship, an experimental ship fuelled exclusively by fuel cell for sea navigation, the first ever in its class.
16.	**Hydrogen refuelling stations and buses**	Netherlands	As of 2016, several Dutch Provinces have hydrogen-fuelled buses in commercial operation within their public transport system. An increase of the number of buses and refuelling stations is expected from 2021 onwards.
17.	**Magnum Project**	Netherlands	This project aims to convert one of the units of the Nuon Magnum power plant (a gas-fired combined-cycle power plant) to run on pure hydrogen by 2023.
18.	**SEAFUEL**	Spain	Since 2017, Enagás, along with a number of partners, participates in a project to demonstrate the viability of feeding local transport networks using fuels produced through renewable sources, like renewable hydrogen and seawater.
19.	**HIGGS (Hydrogen In Gas GridS)**	Spain	HIGGS project was launched during 2020. The objective of this project is to analyse the potential and the requirements upon the infrastructure, elements and management for the injection of hydrogen in the current transport networks.
20.	**H2PORTS (Hydrogen to Ports)**	Spain	Since 2019, the Valencia Port Authority, along with a number of private entities is carrying out feasibility studies for the development of a sustainable hydrogen supply chain in the port to reduce the environmental impact of its operations.
21.	**Sweden's zero-emission 'HYBRIT' steel**	Sweden	As part of a joint initiative dubbed 'HYBRIT,' LKAB, along with Vattenfall and SSAB plan to perform tests in several stages to explore the use of hydrogen produced via renewable and nuclear power.
22.	**Fuel cell systems**	Sweden	ABB Power Grids and PowerCell Sweden AB, a supplier of fuel cell solutions, have signed a memorandum of understanding with the aim of developing a 'plug-and-play' solution for stationary fuel cell systems. The aim of the cooperation is to leverage the companies' existing technologies to jointly develop a complete solution for the market.
23.	**HyDeploy**	UK	This project aims to prove that blending up to 20% volume of hydrogen with natural gas is a safe and greener alternative to the gas currently used. UK regulations currently have a 0.1% limit on hydrogen blend in the gas network. Phase 1 of the project involves running a blend of hydrogen and natural gas on part of the private gas network at Keele University campus with Phase 2 of the project involves a demonstration on a larger, public network with 670 homes and businesses receiving blended hydrogen in the North East and following that a demonstration in the North West.
24.	**StreetDeck Fuel Cell Electric Vehicle (FCEV)**	UK	Wrightbus manufactures buses that use a hydrogen fuel cell and battery pack to power the vehicles. They aim to roll out 3000 hydrogen buses in the UK by 2024. At present, several buses have been purchased for use in Birmingham, London, Aberdeen and Northern Ireland.
25.	**HydroFLEX**	UK	This project aims to set out a plan on how green hydrogen can power UK's transport needs. It developed the UK's first hydrogen-powered train, created in partnership between the University of Birmingham and Porterbrook, with financial support from UK government's Department of Transport. It was tested on 25 miles of mainline rail tracks in September 2020. Porterbrook announced its intention to develop the project to full commercialisation.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
26.	**H2Bus Consortium**	Latvia Denmark UK	H2Bus Consortium was formed in 2019 and is a trans-European project aiming to rollout hydrogen fuel cell electric buses. By 2023, these buses should be part of transport infrastructure in Latvia as well as in Denmark and the UK.
27.	**Hydra Tank Project**	Poland	Hydra Tank Project is a project of PGNiG S.A. focused on a hydrogen refuelling research station. The project is scheduled to be launched in Warsaw in 2021.
28.	**H2Nodes Project**	Latvia Estonia Netherlands	The goal of the H2Nodes Project is to plan and implement a chain of hydrogen refuelling stations and boost demand for fuel cell electric vehicles (**FCEVs**). The Project seeks to deploy hydrogen infrastructures. Within the framework of the Project, Riga has already received 10 hydrogen-driven trolleybuses.
29.	**Coradia iLint**	Austria	Alstom's Coradia iLint is said to be the world's first hydrogen fuel cell train. It has already completed its test operation on ÖBB's regional lines. Austria is the second country in Europe (after Germany) to approve this train as an alternative to diesel multiple units.
30.	**Pomeranian Hydrogen Valley**	Poland	The program was initiated by signing a declaration of cooperation by a wide range of stakeholders including the Municipality of Gdinya, Pomeranian Voivodeship, Association Metropolitan Area Gdańsk, Gdynia, Sopot and more. It aims to create conditions for full implementation of transport based on green hydrogen in the Pomerania region of Poland.
31.	**HySnow Project**	Austria	The goal of the HySnow Project is decarbonisation of winter tourism by hydrogen-powered fuel cell snowmobiles. The hydrogen is fuelled to drive a newly developed fuel cell system for the low temperature and high-performance targets, which will be integrated into two prototype snowmobile vehicles.
B	**Supply side**		
32.	**Hyport**	Belgium	A consortium of private and state-owned companies aims to have an operational plant in the port area of Oostende that produces green hydrogen.
33.	**Hyoffwind**	Belgium	A consortium of companies aims to build a power-to-gas installation in Zeebrugge to convert renewable electricity generated by offshore wind farms into green hydrogen through electrolysis.
34.	**Electrolyser plant project**	Finland	P2X Solutions Oy, a Finnish company specialising in producing hydrogen and refining it further into synthetic fuels, aims to construct a 20 MW electrolyser plant, which would run on electricity produced by renewable energy.
35.	**Hygreen Provence**	France	In 2019, Air Liquide, the Durance, Luberon, Verdon urban area (**DLVA**) and ENGIE signed a cooperation agreement to develop the 'HyGreen Provence' project, which aims at producing, storing and distributing green hydrogen. 'HyGreen Provence' enables the development and validation of technical and economic conditions for the production of 1,300 GWh of solar electricity, equivalent to the annual residential consumption of about 450,000 people, together with the production of renewable hydrogen on an industrial scale through water electrolysis.

No.	Project	Country	Description
36.	**'GET H2 Nukleus' project for a public transmission system**	Germany	This project, led by OGE and Amprion, seeks to establish the first public hydrogen infrastructure in Germany. The projects aims to build a 100 MW electrolyser plant connected by transmission systems stretching at around 130 km to industry consumers. The project plans to rededicate existing gas pipelines as well as to add pipelines for hydrogen transport only. OGE and Amprion plan to build another 100 MW electrolyser plant nearby, rededicate the OGE pipelines solely to hydrogen and connect them with Amprion's transmission system.
37.	**H2Giga**	Germany	The project aims at developing the serial production of electrolysers through further development of existing electrolysis technologies. Its target is the development of efficient production processes in a timely manner, which also take into account aspects such as recycling and flexible operation.
38.	**H2Mare**	Germany	The aim of the project is the development of possibilities for the production of hydrogen and hydrogen derivatives (methane, methanol, ammonia, fuel) directly at sea without grid connection through integrating an electrolyser directly into a wind turbine.
39.	**TransHyDE**	Germany	The project will develop and test possibilities for hydrogen transport over short, medium and long distances. TransHyDE consists of four demonstration projects which test one transport technology each: hydrogen transport in high-pressure containers; hydrogen-liquid transport; hydrogen transport in existing and new gas pipelines; and transport of hydrogen bound in ammonia. Apart from testing and developing these technologies, the project as well focuses on testing materials and working on new standards, new norms and new certificates.
40.	**Siemens Haru Oni**	Germany Chile	Siemens Energy AG is the first company to receive German national funding as part of its H2-Strategy for one of its projects. Siemens Energy, alongside several other companies, is developing and implementing the world's first integrated and commercial large-scale plant for the production of climate neutral e-fuel. Using the strong winds in south Chile, Siemens Energy plans to ship 750,000 litres of e-Methanol to Germany in 2022 and produce up to 550 million litres in 2026.
41.	**Energy storage and power generation (hybrid hydrogen turbine)**	Italy	In January 2019, Enel Green Power and the Municipality of Lipari entered into an agreement for the building of a new photovoltaic plant on the Island of Stromboli. The new plant will be equipped with an innovative energy storage system that will store the excess solar energy produced in the form of hydrogen and will convert it back into electricity during periods of maximum consumption. This storage system will avoid the risks related to non-programmable renewable energy sources and ensure the availability of electricity.
42.	**Power to Gas**	Italy	In April 2019, the National Agency for New Technologies, Energy and Sustainable Economic Development ('**ENEA**') and the Società Gasdotti Italia ('**SGI**'), an Italian company that offers the service of transportation of natural gas, signed a framework agreement to develop a 'Power to Gas' pilot project, consisting in one or more electrolysers directly connected to an electricity grid or to a renewable energy system converting the overproduced electricity into hydrogen.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
43.	**PosHYdon**	Netherlands	A consortium of companies seeks to use Neptune's Q13 oil platform in the North Sea as an offshore green hydrogen plant by producing hydrogen from seawater.
44.	**Djewels**	Netherlands	A consortium of companies is planning to build the biggest green hydrogen plant of Europe in Groningen.
45.	**Hystock Project**	Netherlands	Led by a state-owned company, this project is aimed at researching the production of hydrogen generated with solar energy through electrolysis in an attempt to stimulate the market with 100% green hydrogen. It includes a feasibility study concerning the storage of hydrogen in salt caverns in the Northern Netherlands.
46.	**Porthos Project**	Netherlands	Led by a consortium of state-owned companies, this project aims to reduce emissions by 2030, in line with the Dutch requirements. It shall do so by capturing the CO2 emitted within the Port of Rotterdam from the existing hydrogen production in order to produce large-scale blue hydrogen.
47.	**North Sea Wind Power Hubs**	Netherlands	A consortium of companies has started the further development of a 2016 project on the basis of which offshore wind parks are connected to multiple hubs in the North Sea from which the electricity generated is partially converted into hydrogen and connected to the shore via pipelines.
48.	**ElementEins**	Netherlands, Germany	A consortium of companies aims to develop an offshore power-to-gas pilot using wind energy. The installation is built near the North of Germany, where power generated by offshore wind turbines converges before being allocated. Whenever supply exceeds demand, the excess power can be converted into hydrogen and be temporarily stored.
49.	**Project 'H2morrow'**	Norway, Germany	In October 2019, OGE and Equinor together with their anchor customer thyssenkrupp Steel conducted a feasibility study for their proposed 1 GW blue hydrogen plant using steam reformation. For transport, existing pipelines are to be rededicated and used solely for hydrogen. The accumulating carbon dioxide is planned to be stored under the Norwegian north sea using carbon dioxide capture offshore storage (**CCOS**).
50.	**SUN2HY (Sun to Hydrogen)**	Spain	During 2019 and 2020, Repsol and Enagás have developed a pre-commercial full-scale demonstrator for the direct conversion of solar energy into hydrogen using photo electro chemical (**PEC**) cells.
51.	**Green hydrogen production**	Spain	In November 2020, Iberdrola announced its alliance with Fertiberia, which aims to place Spain at the forefront of green hydrogen in Europe and make it a technological benchmark in the production and use of this resource. To this end, both companies have launched an integral project that includes the construction of a plant and which contemplates the development of 800 MW of green hydrogen with an investment of 1.8 billion until 2027.
52.	**Green hydrogen production**	Spain	In December 2020, Iberdrola and a manufacturer of electrolysers, Nel Hydrogen Electrolyser, have combined their capacities to turn Spain into a technological and industrial benchmark in green hydrogen. The companies have signed a memorandum of understanding to develop and deploy large-scale electrolyser projects and promote the technology's supply chain in Spain. In addition, and in order to deliver this project, Iberdrola and Basque company Ingeteam have created a new venture under the name of Iberlyzer, set to become Spain's first integrator of large-scale electrolyser plants.

No.	Project	Country	Description
53.	**HyNet**	UK	A planned clean hydrogen production facility within North-West England industrial cluster, which is designed to serve as a model for clean hydrogen development. It aims to become the UK's first net-zero industrial zone and has plans to develop hydrogen pipeline and create the UK's first carbon capture usage and storage facility to produce clean hydrogen for use in industrial processes. At present the project has received approx. £13 million in government funding.
54.	**H2H Saltend**	UK	A project is being developed at Saltend Chemicals Park, where it will produce hydrogen from natural gas in combination with carbon capture and storage. When operational, it will enable industrial customers in the park to fully switch to hydrogen, and the power plant in the park to move to a 30% hydrogen to natural gas blend. Consequently, emissions from Saltend Chemicals Park are predicted to reduce by nearly 900,000 tonnes of CO2 per year.
55.	**Gigastack Project**	UK	This project involves offshore wind producing renewable electricity that then splits water into oxygen through ITM's electrolysers, after which the renewable hydrogen is used by Philips 66's Humber Refinery.
56.	**Dolphyn Project**	UK	An offshore floating hydrogen facility that produces hydrogen from wind power. The project has been awarded £3.1 million from the UK government to develop a 2 MW prototype system intended to be operational by summer 2024, with the intention to scale up to 10 MW following a successful initial prototype phase.
57.	**H2FUTURE**	Austria	H2FUTURE is a European flagship project that aims to develop ways to extend production and use of green hydrogen.
58.	**Green Hydrogen @ Blue Danube (IPCEI)**	Austria Germany Hungary	Green Hydrogen @ Blue Danube is a trans-European and large-scale hydrogen infrastructure project. The goal is to create a green hydrogen value chain – from production to transportation to purchase by industrial and mobility customers.
59.	**Demo4Grid**	Austria	Within the framework of the Demo4Grid project, Europe's largest single stack electrolyser plant for production of green hydrogen for industrial purposes will be built near Innsbruck.
60.	**InGrid**	Poland	InGrid is a project of PGNiG S.A. focused on the possibility of storing and transporting hydrogen using a natural gas network. As a part of this project, an installation will be built in one of PGNiG´s current locations, with production of green hydrogen (using electricity generated by solar panels) slated to begin in 2022.
61.	**MoU on hydrogen technology projects**	Slovakia	Slovnaft and InoBat signed a Memorandum of Understanding in 2019 in order to jointly develop and implement hydrogen projects in the CEE region, such as the sourcing and supply of hydrogen, development and testing of hydrogen-rich liquid fuel, distribution and sales of such fuel and setting up a production plant including fuel recycling facility. The hydrogen production plant should become operational at the beginning of 2023.

Global Hydrogen Development Activity continued

United States and Canada

No.	Project	Country	Description
A	**Demand side**		
1.	**Hydrogen Fuelling Stations**	British Columbia, Canada	The government of British Columbia has provided US$10 million in funding to the construction and operation of ten hydrogen fuelling stations in the province. The funding also supports Hydrogen BC, an entity of the Canadian Hydrogen and Fuel Cell Association (**CHFCA**), which supports Canadian governments, companies and academic institutions developing hydrogen and fuel cell products.
2.	**Danskammer Energy, Balico and EmberClear**	New York, US; Virginia, US; Ohio, US	Danskammer Energy, Balico and EmberClear have contracted Mitsubishi Power Americas Inc. to transition three power plants to run on green hydrogen produced and stored on-site. Collectively, the three plants will generate 3,284 MW of electricity. Danskammer's plant in New York will generate 600 MW, Balico's plant in Virginia will generate 1,600 MW and EmberClear's Ohio plant will be able to generate up to 1,084 MW.
3.	**Long Ridge Energy Terminal**	Ohio, US	Long Ridge Energy Terminal will transition a 485 MW combined cycle power plant that is under construction within its multimodal facility on the Ohio and West Virginia border with the capacity to run on a hydrogen blend when it begins operation in 2021, and eventually transition to 100% green hydrogen within a decade. The power plant will deploy a GE 7HA.02 combustion turbine, which, is estimated to burn between 15% to 20% hydrogen by volume in the gas stream initially, with the capability to transition to 100% hydrogen by 2030.
4.	**Hydrogen-gas turbine equipment**	US	MHPS announced it has been selected as the hydrogen-gas turbine equipment provider for Intermountain Power Agency's Intermountain Plant Project (**IPP**). The plant is expected to transition from a 1,800 MW coal-fired plant to an 840 MW gas-fired power plant by 2025 – the plant is expected to run on 30% green hydrogen by 2025 and 100% renewable hydrogen by 2045.
5.	**Intermountain Power Agency**	Utah, US	Intermountain Power Agency will convert its 1,800 MW coal-fired power plant in Delta, Utah into an 840 MW combined-cycle facility that will initially run on a mix of 30% hydrogen and 70% natural gas, and ultimately, on hydrogen alone. Mitsubishi Hitachi Power Systems Americas Inc. has been contracted to supply critical equipment for the project, including steam turbines, heat recovery steam generators, and auxiliary equipment.
B	**Supply side**		
6.	**Hydrogen Blending Project**	Alberta, Canada	In July 2020, the ATCO Group announced that it would embark on a hydrogen blending project in Fort Saskatchewan, Alberta. ATCO has also completed a similar project in Australia, where it currently generates and delivers hydrogen energy through the existing gas network. The project will use hydrogen derived from domestically-produced natural gas and blend it into the natural gas grid. It is set to begin in Q1 2021 and will be Canada's largest hydrogen blending project once complete.

No.	Project	Country	Description
7.	**SGH2 Energy Company**	California, US	SGH2 Energy Company will launch a green hydrogen production facility in Lancaster. The plant will feature SGH2's pioneering technology, which uses recycled mixed paper waste to produce 'greener than green' hydrogen that reduces carbon emissions by two to three times more than green hydrogen produced using electrolysis and renewable energy, and is five to seven times cheaper. SGH2 green hydrogen is cost competitive with grey hydrogen produced from fossil fuels like natural gas, which comprises the majority of hydrogen used in the United States. The SGH2 Lancaster plant will be able to produce up to 11,000 kilograms of green hydrogen per day, and 3.8 million kilograms per year – nearly three times more than any other green hydrogen facility, built or under construction, anywhere in the world. The facility will process 42,000 tons of recycled waste annually. The City of Lancaster will supply guaranteed feedstock of recyclables, and will save between US$50 to US$75 per ton in landfilling and landfill space costs.
8.	**NextEra Energy**	Florida, US	NextEra Energy has announced plans to build US$65 million pilot plant for Florida Power & Light. Through its Florida Power & Light utility, NextEra proposed a pilot in Florida that will use a 20 MW electrolyser to produce 100 % green hydrogen from solar power. The project could be online by 2023 if it receives approval from state regulators. The green hydrogen produced by Florida Power & Light's electrolysers would be used to replace a portion of the natural gas that's consumed by the turbines at FPL's existing 1.75-gigawatt Okeechobee gas-fired plant.
9.	**Praxair**	Louisiana, US	Praxiar has authorised the construction of a world scale hydrogen plant in Louisiana to supply product under a long-term contract with a major refinery in the area. The new plant will be integrated with Praxair's already extensive Louisiana production network via its Mississippi River Corridor hydrogen pipeline system. The steam methane reformer (**SMR**) will have a capacity in excess of 170 million standard cubic feet per day of high-purity hydrogen. The new plant, which is planned to start up in 2021, will be one of the largest hydrogen production units in the US, along with the SMR recently announced by Praxair in Texas.

Latin America

No.	Project	Country	Description
A	**Demand side**		
1.	**Hydrogen Fuel Cell Buses**	Brazil	This pilot project will assist the Brazilian Government and Sao Paulo's Metropolitan Urban Transportation Company in obtaining and operating eight fuel cell buses in order to provide feedback to technology developers as well as gain experience in the operation and management of buses powered by fuel cell drive trains.
2.	**Fuel cell trucks for the mining industry**	Chile	Anglo American Chile is developing a mining truck that will be fuelled by hydrogen together with Enel X, the e-mobility division of Enel.
3.	**Hydra project for hydrogen solutions for the mining industry**	Chile	Engie signed an agreement with Australian global mining technology developer Mining3 to co-develop hydrogen solutions for the mining industry. The first collaboration, called the Hydra project, is to develop a new powertrain and refuelling system for mining vehicles to run on hydrogen instead of diesel.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
4.	**Hydrogen ecosystem**	Costa Rica	In April 2019, Ad Astra Rocket announced two projects to strength the hydrogen ecosystem. The first project is an investment to expand its plant located in Liberia, Costa Rica to store hydrogen to state-of-the-art passenger car capability at pressures of 700 bar (10,000 psi). Presently, the facility only supports 350 bar (5,000 psi) refuelling, as required by urban buses, and other heavy-duty transport. This will be financed by the Toyota Motors Mobility Foundation (a global foundation established by Toyota Motors Corporation to support the development of a more mobile society). The second project seeks to increase sophistication of the Costa Rica's ecosystem to refuel both buses and passenger cars, including new operation protocols, control and monitoring software and complete system operation manuals. This project was financed by IDB Lab (the innovation laboratory of the Inter-American Development Bank Group). The CRUSA foundation is responsible for the administration of both projects.
5.	**Hydrogen Cars for sharing service in Las Catalinas**	Costa Rica	In May 2019 Ad Astra Aerospace, Purdy Motor and Toyota partnered with Las Catalinas, a beach town in Costa Rica, to bring hydrogen-powered Toyota Mirai to Las Catalinas. These cars will be used for the town's car sharing service throughout the region of Guanacaste. This is the first commercial use of hydrogen cars in Central America. The Mirai car has a range of 500 km on a single tank.
B	**Supply side**		
6.	**ENI and Enel to construct two 10 MW green hydrogen plants**	Chile	ENI and Enel are collaborating in the installation of two 10 MW electrolyser facilities which will produce green hydrogen from using renewable energy. Both plants will be located near two of ENI's refineries in Chile.
7.	**E-fuels Production in Cabo Negro**	Chile	A first-of-its-kind pilot project is being spearheaded by Enel Green Power Chile, a subsidiary of Enel Chile, Chilean power company AME, ENAP, Siemens Energy and Porsche, with financial support from the German economics ministry. The project consists of green hydrogen production through an electrolyser fuelled by wind energy combined with carbon capture from the atmosphere to produce green methanol and fuel for transport. The plant is expected to be commissioned in 2022, making it the first of its kind to produce green hydrogen in Chile as well as one of the largest in Latin America. The project is expected to produce around 550 million llitres of e-fuels by 2026. Porsche will be the primary offtaker.
8.	**Green hydrogen plant to produce ammonia for the explosives industry (HyEx)**	Chile	Engie and explosives company Enaex will produce green ammonia utilising green hydrogen produced from solar energy. The HyEx facility will be composed of a 2,000 MW solar farm powering a 1,600 MW hydrogen electrolysis plant which, in turn, will produce 124,000 tons of green hydrogen and 700,000 tons of green ammonia per year. The facility will be located in the Antofagasta mining region and full-scale operation is targeted for 2030.
9.	**Ecopetrol Decarbonization**	Colombia	Ecopetrol has hired Hinicio to evaluate alternatives to decarbonise its operations and identify business cases to integrate the production of green hydrogen in the company.

No.	Project	Country	Description
10.	**Power station that uses hydrogen for storage**	French Guiana	Project Centrale Électrique de l'Ouest Guyanais (**CEOG**) combines a 55 MW photovoltaic plant with a mass storage of energy in the form of hydrogen. This project implies the construction and 25-year operation of a power station with 120 MW renewable energy storage capacity. This project will supply half of the energy currently consumed by the people of Saint-Laurant-du-Maroni and Mana. It is expected to provide power to more than 10,000 households and will be connected to the local utility EDF Systèmes Energétiques Insulaires station. This project has a PPA for 25 years.
11.	**Air Liquide México**	Mexico	In 2017, Air Liquide, a company dedicated to the production and distribution of gases such as nitrogen, hydrogen, and oxygen, announced its acquisition of the hydrogen production business unit of Pemex Transformación Industrial, S.A. de C.V., a subsidiary of PEMEX, for US$59 million (around €50 million). Under the terms of the agreement, Air Liquide will supply hydrogen to PEMEX's Miguel Hidalgo refinery, based in Tula de Allende, Hidalgo State, for 20 years.
12.	**PEMEX and Linde**	Mexico	In 2017, PEMEX established an alliance with Linde, a global industrial gas and engineering group. The purpose of the alliance was to obtain a long-term supply of hydrogen for the Francisco I. Madero refinery in Ciudad Madero, Tamaulipas State. Linde will invest approximately US$40 million into the operation of the hydrogen plant and PEMEX will provide the entire operating structure. It is estimated that the plant will have a capacity to produce around 42 million ft3 per day.
13.	**Hydrogen production**	Mexico	Two potential projects whose main purpose is to generate green hydrogen: one generating both energy and hydrogen; and the other only generating hydrogen from organic waste. The projects are planned to be developed in the State of Puebla because the energy produced could then be readily transported, with the relevant adjustments to the pipeline networks, to the Municipality of Tula, State of Hidalgo or the Municipality of Veracruz, State of Veracruz.
14.	**Hydrogen production**	Paraguay	In 2020, Seven Seas Energy Limited announced the construction of a hydrogen production plant based on electrolysis. The estimated amount of investment is US$1.5 million. The second phase estimates an investment of US$20 million for the expansion of the plant to produce hydrogen for the transportation and household sectors.
15.	**Hydrogen production**	Trinidad & Tobago	In August 2020, NewGen Energy and Trinidad Nitrogen Company signed a memorandum of understanding for the potential supply of green hydrogen to the Tringen Ammonia Plant. This memorandum of understanding is to carry out a feasibility study for the use of green hydrogen in the production of ammonia from the Trinidad Nitrogen Company facilities and to determine the major agreements that would be needed for the sale of hydrogen by NewGen to Tringen.
16.	**Project Verne**	Uruguay	ANCAP, the state oil company, plans to build a pilot plant in Montevideo with the capacity to produce at least 900 kg of hydrogen per day through water electrolysis. Additionally, the plan includes using the hydrogen of the pilot plant to power five long-distance buses and five heavy trucks.

Global Hydrogen Development Activity continued

Middle East

No.	Project	Country	Description
A	**Demand side**		
1.	**Transport**	Israel	Italian infrastructure company Snam has recently entered into a memorandum of understanding with Dan (the main Israeli national public transport company) in order to evaluate sustainable mobility projects based on renewable gas (biomethane and hydrogen) and electricity, as well as possible joint initiatives for the development of Hydrogen. Snam has also signed a collaboration and research agreement with H2Pro (as mentioned above) which has developed an innovative technology to produce 30% more green hydrogen from water splitting compared to traditional electrolysis.
2.	**Hydrogen/gas station under development**	Israel	A grant of NIS 4 million was allocated to the establishment of the first hydrogen fuel station in Israel. The companies that won were Sonol and Metropolitan.
3.	**Power Plant Cooling applications**	Lebanon	McPhy installed hydrogen production equipment for power plant cooling applications. This was to replace deliveries of hydrogen cylinders. McPhy's equipment produces hydrogen for injection into the power plant's alternator cooling circuit.
B	**Supply side**		
4.	**Hydrogen Production Facility Unit**	Egypt	This project supports the Egyptian Government's energy transition strategy and will reinforce the economic growth of rural areas while minimising environmental emissions as well as reducing the government export bill. The project includes new units including a Diesel Hydrocracking Unit as well as a Hydrogen Production Facility Unit.
5.	**Hydrogen production technology start ups**	Israel	H2Pro is an Israeli company developing a novel, efficient and low-cost green hydrogen production technology. H2Pro recently received investment from New Fortress Energy. New Fortress Energy's renewable hydrogen-focused division 'Zero' will work in conjunction with H2Pro. Zero was created with a mission to invest in and deploy promising hydrogen technologies to displace fossil fuels and eliminate carbon emissions. Another Israeli company involved in the developing Hydrogen sector is GenCell, which has developed a way of generating and using hydrogen from Ammonia. GenCell has now developed a way of using hydrogen by storing it in Ammonia for off-grid and back-up power. The hydrogen from the Ammonia is used when back-up power is required.
6.	**NEOM / AirProducts**	Saudi Arabia	NEOM and AirProducts have announced a US$5 billion project to use renewable energy to develop up to 15,000 barrels of oil equivalent of green hydrogen per day. The project will be located in the new NEOM city in Saudi Arabia and will also be owned and developed in conjunction with ACWA Power.
7.	**Al-Jubail Blue Hydrogen Export**	Saudi Arabia	Saudi Aramco recently exported the world's first shipment of blue ammonia in the form of 40 tonnes exported on a tanker. The result is of particular interest given the export was achieved through a collaboration between Saudi Aramco and Institute of Energy Economics, Japan.
8.	**DEWA solar park**	United Arab Emirates	The Mohammed bin Rashid Al Maktoum Solar Park will be used to generate green hydrogen as a demonstration plant. Authorities state that 'the hydrogen produced at the facility will be stored and deployed for re-electrification, transportation and other uses'.

No.	Project	Country	Description
9.	**Carbon Capture, Utilisation and Storage**	United Arab Emirates	ADNOC has a range of operational and planned carbon capture, utilisation and storage projects with a current plan to expand storage capacity to 5 million mt/year of CO2 by 2030. The CCUS technology will be used in part to produce blue hydrogen.

Africa

No.	Project	Country	Description
A	**Demand side**		
1.	**Anglo American Platinum hydrogen mine trucks**	South Africa	More than 400 mine-haul trucks are planned to be rebuilt to use hydrogen fuel, with a pilot project starting in 2021 at Anglo American Platinum Limited's Mogalakwena platinum open pit mine in the north-western part of South Africa in Mokopane, Limpopo. A 3.5 MW electrolyser will produce hydrogen on site, while the trucks will also be fitted with a platinum catalyst.
2.	**Impala Platinum investment into Anglo American Platinum**	South Africa	Impala Platinum plans to invest in Anglo American Platinum's AP Ventures fund. AP Ventures' investment strategy is focused on companies developing technologies which are capable of sustainably solving global challenges, such as renewable energy integration and resource scarcity. A key area of focus is the decarbonisation of transport, mining and heavy industry. AP Ventures has an existing portfolio of investments with a focus on the hydrogen value chain and fuel-cell electric mobility.
3.	**1 Military Hospital**	South Africa	In 2020 the Department of Science and Innovation (**DSI**) unveiled seven hydrogen fuel cell systems which are being used as the primary power source for the field hospital established at 1 Military Hospital in Pretoria as part of the government's response to COVID-19.
B	**Supply side**		
4.	**Hydroma Inc. hydrogen-based electricity production**	Mali and other African countries	Hydroma Inc. has launched industrial production of hydrogen-based electricity in Mali. Natural hydrogen wells operated by Hydroma Inc. will be used to produce clean electricity on a large scale to meet the energy needs of Mali and other countries on the African continent. In 2015, Hydroma discovered hydrogen whilst drilling to pump water in Mali. Analysis indicated the gas had a concentration of 98% pure hydrogen (the purest naturally occurring hydrogen ever to have been discovered).
5.	**H2 Power-Africa project**	Southern Africa and West Africa	The project is funded by the Germany Federal Ministry of Education and Research (**BMBF**), and will place Southern Africa and West Africa on the road to contributing meaningfully to global sustainable development goals. The objective of the project is to explore the potential of green hydrogen production from the significant renewable energy sources within the sub-regions. The aim is to support sustainable and economic development through a viable hydrogen economy with a potential to make Africa an exporter of green hydrogen.
6.	**Green hydrogen plant**	Morocco	Morocco has forged close ties with Germany, signing a memorandum of understanding in July to develop its Power to X industry and build Africa's first industrial green hydrogen plant (100 MW). Iresen (Morocco's research institute created in 2011 by the Ministry of Energy, Mining, Water and Environment) has stated that locally made green hydrogen could be used in the short term as an industrial feedstock and for export – as liquid fuels, hydrogen and ammonia.

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Global challenges require global resources and local knowledge

White & Case is a truly global law firm, uniquely positioned to support our clients in achieving their highest global ambitions. As a pioneering international law firm, our cross-border experience and diverse team of local, US and English-qualified lawyers consistently deliver results for our clients.

In both established and emerging markets, our lawyers are integral, long-standing members of the community, giving our clients insights into the local business environment alongside our global perspective. We work with many of the world's most respected and well-established businesses and banks, as well as start-up visionaries, governments and state-owned entities.

Whether it's raising capital to fund needed investment, solving the challenges of cross-border investments, meeting environmental and regulatory requirements or addressing disputes and governmental inquiries, our clients come to us for the in-depth knowledge and experience of industry experts.

Our hydrogen practice

Our hydrogen practice leverages from White & Case's position as a global market leader in the acquisition, development and financing of large scale energy & infrastructure projects, together with our market leading practice in the LNG and renewable energy sectors. We are independently recognized as a leading global firm in this sector – having been ranked Band 1 for Project & Energy by Chambers for 15 consecutive years. We pride ourselves in successfully delivering 'first of' transactions in emerging markets and sectors around the world.

Our team's hydrogen sector experience spans hydrogen production hubs, industrial gas and ammonia plants, government funding arrangements and regulatory frameworks for electrolysers, and the development of hydrogen refuelling stations. White & Case actively tracks the emerging hydrogen economy around the world, including the developing policy and regulatory incentives.

Given the similarities between the value chains and infrastructure requirements of the hydrogen and LNG sectors, our firm's strength in hydrogen is supported by our global leading LNG practice. White & Case is the most experienced law firm in the global LNG industry, dating back to the origins of the industry in the 1980s and continuing to the present day. We have the broader perspective of LNG sector experts, allowing us to find a path forward on challenging projects. Renewable project development is also key to the emerging hydrogen economy, and our team is global market leader in the renewables sector.

In short, our unrivalled expertise in key sectors means that we know what it takes to get the deal done.

Brendan Quinn
Partner, Global Head of Power

T +61 3 8486 8035
E brendan.quinn@whitecase.com

Global Band 1: Projects & Energy
(15 consecutive years)
Chambers Global 2020

"White and Case is very strong in the energy area. The team is very knowledgeable and provides excellent advice."

Legal 500, 2020

"The team is responsive and problem solving oriented."

Legal 500, 2020

"The team is outstanding. Key strengths are knowledge, tenacity, enthusiasm and being a pleasure to deal with."

Chambers Global 2018

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Authors of the White & Case Global Hydrogen Guide

Asia-Pacific

Fergus Smith
Partner, Singapore

T +65 6347 1323
E fergus.smith@whitecase.com

Alex Woody
Partner, Tokyo

T +81 3 6384 3227
E awoody@whitecase.com

Dongho Lee
Partner, Seoul

T +82 2 6138 8811
E dongho.lee@whitecase.com

Adeline Pang
Partner, Melbourne

T +61 3 8486 8035
E adeline.pang@whitecase.com

Mark Montag
Local Partner, Sydney

T +61 2 8249 2631
E mark.montag@whitecase.com

Europe & the United Kingdom

Thomas Burmeister
Partner, Duesseldorf

T +49 211 49195 372
E thomas.burmeister@whitecase.com

Carina Radford
Partner, London

T +44 20 7532 2365
E cradford@whitecase.com

Sandra Rafferty
Partner, London

T +44 20 7532 1254
E sandra.rafferty@whitecase.com

Vit Stehlik
Partner, Prague

T +420 255 771 221
E vstehlik@whitecase.com

Tommaso Tosi
Partner, Milan

T +39 02 00688 430
E tommaso.tosi@whitecase.com

United States & Canada

Ray Azar
Partner, New York

T +1 212 819 8581
E raymond.razar@whitecase.com

Ryan Hopkins
Partner, Houston

T +1 713 496 9705
E ryan.hopkins@whitecase.com

Steven Otillar
Partner, Houston

T +1 713 496 9717
E sotillar@whitecase.com

Latin America

Jeannine Acevedo
Partner, Miami

T +1 305 995 5294
E jacevedo@whitecase.com

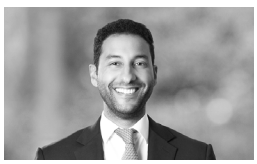
Francisco de Rosenzweig
Partner, Mexico City

T +52 55 5540 9654
E frosenzweig@whitecase.com

Middle East

Antoine Cousin
Partner, Abu Dhabi

T +971 2 611 3457
E antoine.cousin@whitecase.com



Yasser Riad
Partner, Abu Dhabi

T +971 2 611 3420
E yasser.riad@whitecase.com

Africa

Matt Burnell
Local Partner, South Africa

T +27 11 341 4072
E matthew.burnell@whitecase.com

Central Asia

Pavel Kornilov
Partner, Nur-Sultan

T +7 717 223 5416
E pavel.kornilov@whitecase.com

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Coordinating editors

Henry Carlson and Petra Kistner

Contributing team members

Rodrigo Belle Gubbins, Patrick Burrows, Natasha Cacela, Yoon Choi, Naomi De Leon Muratalla, Laura del Olmo, Mario Forero, Michael Gabriel, Pedro Hendel, Verona Huang, Marat Ibragimov, Paul Monzon, Aigerim Raikhanova, Nicole Rodriguez-Fierro, Ned Simpson, Marina Tatsumi, Lauren Vallender, Meron Werkneh, David Wilhelm, Megan Wilson and Yushu Xie.

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