WHITE & CASE

Global Hydrogen Guide: Emerging Policy & Regulatory Initiatives

Edition 2: April 2022

Contents

1/
Introduction
page 1

2/
The Hydrogen Economy
page 3

2.1	Introduction	3
2.2	Hydrogen production	3
2.3	Hydrogen's uses	4
2.4	Challenges	6
2.5	Guarantee of Origin schemes / 'colour' classification requirements	8
2.6	Spotlight: European regulatory reforms	8

3/
Emerging Global Policy and Regulatory Initiatives
page 11

3.1	Introduction	11
3.2	Asia-Pacific	12
	Overview	12
	Australia	14
	China	16
	Japan	19
	Singapore	23
	South Korea	25
3.3	Europe & the United Kingdom	27
	Overview	27
	European Union (EU)	30
	Germany	35
	France	38
	Netherlands	39
	Belgium	41
	Sweden	42
	Finland	44
	Spain	44
	Italy	46
	United Kingdom	48
	Central & Eastern Europe	49
3.4	Central Asia	54
	Overview	54
	Kazakhstan	54
	Uzbekistan	55
	Turkmenistan	55
3.5	United States and Canada	56
	Overview	56
	United States	59
	Canada	63
3.6	Latin America	64
	Overview	64
	Argentina	68
	Brazil	69
	Chile	71
	Colombia	72
	Costa Rica	73
	Mexico	75
	Paraguay	77
	Peru	77
	Uruguay	78
3.7	Middle East	78
	Overview	78
	Key jurisdictions of interest	79
3.8	Africa	82
	Overview	82
	North Africa	84
	East Africa	86
	West Africa	87
	Southern Africa	89

4/
Global Hydrogen Development Activity
page 93

4.1	Introduction	93
4.2	Hydrogen development activity by region	93
	Asia-Pacific	93
	Europe & the United Kingdom	99
	Central Asia	111
	United States and Canada	112
	Latin America	114
	Middle East	120
	Africa	122

5/
White & Case
page 125

Global challenges require global resources and local knowledge	125
Our hydrogen practice	125

1/
Introduction

1/ Introduction

White & Case's Global Hydrogen Guide provides an overview of the fast emerging hydrogen policy and regulatory initiatives being pursued around the world, as well as a snapshot of global hydrogen development activity. Edition 2 of our guide provides an updated snapshot of developments emerging during 2021 and early 2022 – a period which saw the hydrogen sector continue to emerge prominently as part of the broader global energy transition discussion.

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".

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 therefore a potential substitute for fossil fuels. It 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 electricity production, steelmaking and heavy transport.

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

As Edition 2 of this guide demonstrates, there is a continuing 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 truly, and necessarily, a global ambition.

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 summary 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 global hydrogen development activity around the world.

White & Case is at the heart of the emerging global hydrogen economy, advising our clients on many of the world's most prominent projects. 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 needed to lead 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 Edition 2 of this guide demonstrates, there continues to be very significant policy and regulatory activity from governments around the world, stepping up to lead the hydrogen transition.

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.

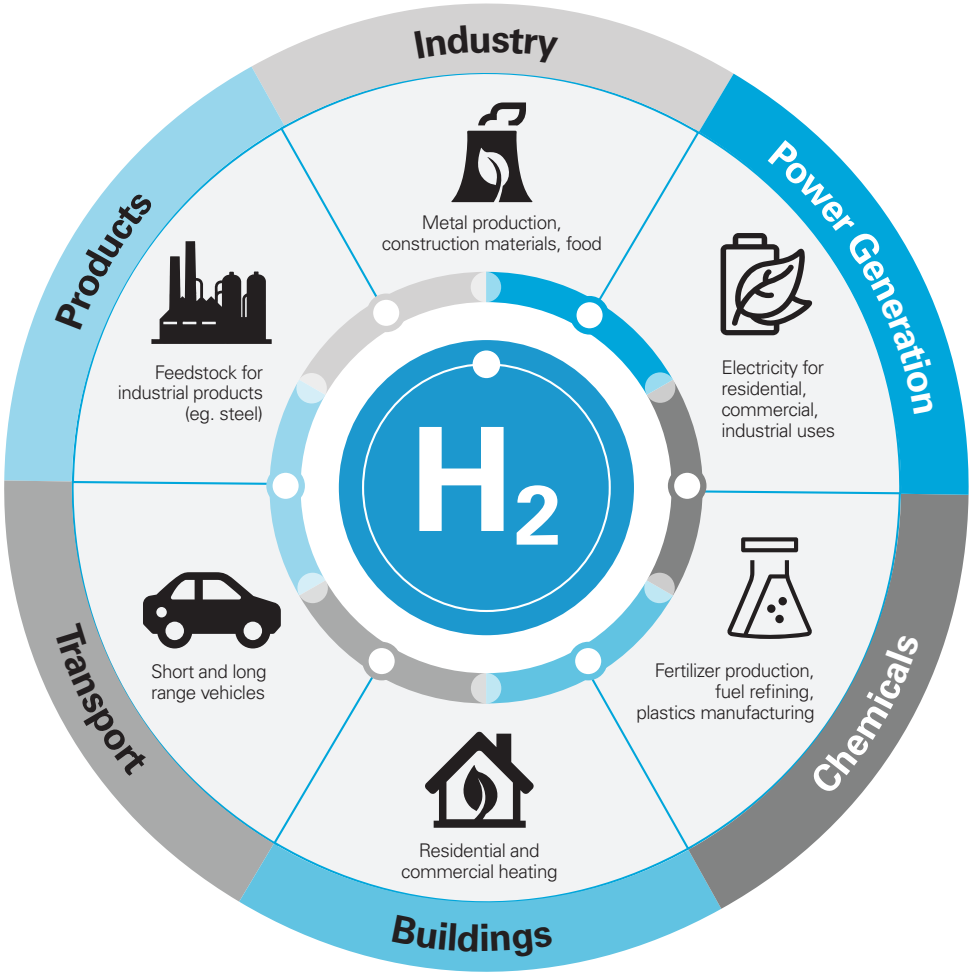
Green hydrogen

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.



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 (H_2O).

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 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).

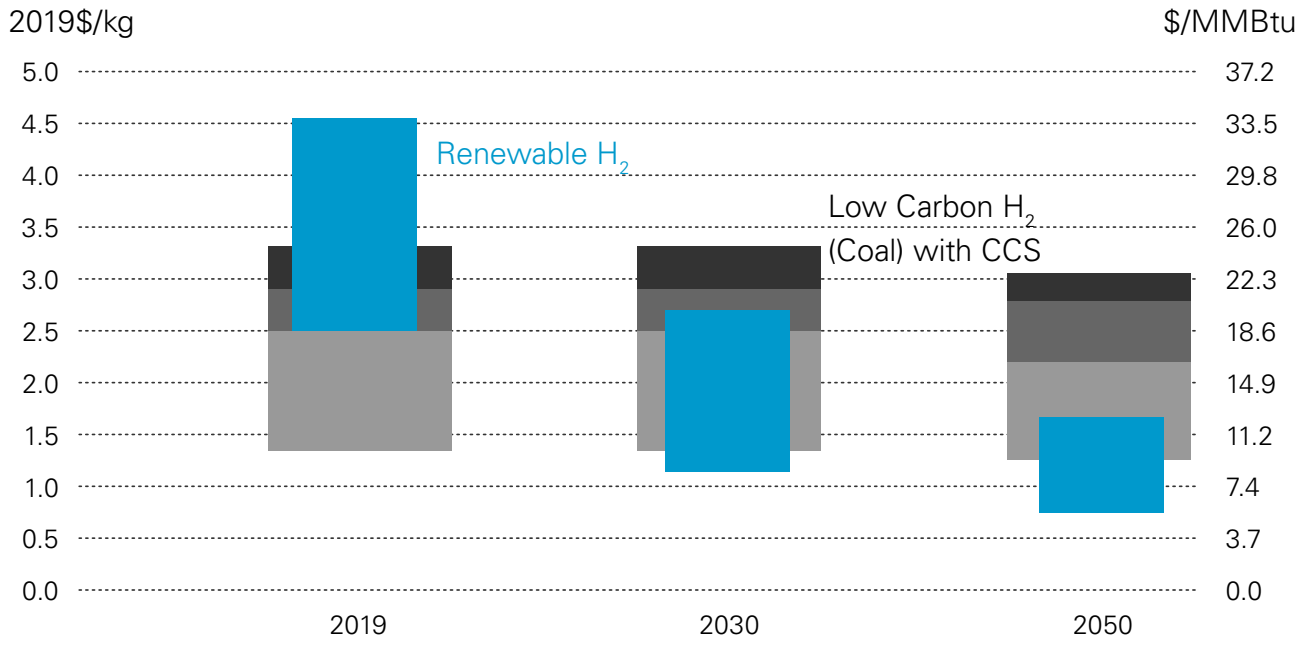
Green ammonia is concentrated and takes up less space than hydrogen, a significant advantage given volume restrictions in freight shipping. Converting hydrogen to green ammonia may also be a more cost-effective (and safer) method of transporting hydrogen over long distances. While technology to enable 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.

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



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

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).

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 approximately 80% lower than Western equipment, although costs are being driven down.

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. Measures being enacted by governments appear positive: BNEF estimates that electrolyser sales will quadruple in 2022, driven by the Chinese, European and US markets.

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 are 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 regulatory framework for hydrogen's supply and use.

2.5 Guarantee of Origin schemes / 'colour' classification requirements

In recent years, there has been a recognition of the need for hydrogen 'guarantee of origin' (**H2GO**) certification schemes to verify the source of low-carbon hydrogen and 'certify' its carbon intensity. The establishment of H2GO regimes, particularly in jurisdictions primed to become hydrogen exporters, is considered an important catalyst toward achieving a hydrogen economy.

H2GO schemes typically seek to track and measure each step in the hydrogen production process to ascertain its carbon footprint, which would allow purchasers of hydrogen to have transparency on the specific emissions associated with the supply chain. This would be means of distinguishing, for example, grey hydrogen from green, blue and other types of hydrogen.

Ideally, H2GO schemes would tie into existing and prospective carbon trading frameworks in order to unlock a key financial incentive for transitioning to low-carbon hydrogen. Because the market for hydrogen is likely to be cross-jurisdictional, it is important that certification methodologies are consistent or at lease compatible with one another. Governments are currently examining such considerations in designing H2GO frameworks, and the outcomes will be crucial for hydrogen customers and exporters.

In Edition 2 of this guide, we have included a new section in Chapter 3 outlining the state of play in each jurisdiction with respect to H2GO schemes.

2.6 Spotlight: European regulatory reforms

Making a competitive hydrogen market a reality is one major goal and necessity of the European Union. Also, the replacement of fossil gases is essential for the European Union to achieve the goal of climate neutrality by 2050. Therefore, the European Commission aims at placing the European Union's gas market at the center of its modernisation efforts. Modernisation of this area is seen as inevitable, as the implementation of the European Union's climate targets depends to a large extent on decarbonisation of the gas sector and a significant increase in the production and use of green hydrogen.

In December 2021, the European Commission proposed the recast of the Regulation (EC) 715/2009 and Directive 2009/73/EC, which – as of today – only address the (natural) gas market. The European Commission suggests to replace this regulation with a "Regulation on the internal markets for renewable and natural gases and for hydrogen" and a "Proposal for directive focusing on common rules for the internal markets in renewable and natural gases and in hydrogen".

The main goal of these proposals is the integration of renewable and low-carbon gases such as renewable hydrogen, so that these can gradually replace fossil gases. The proposals leave the existing provisions for the gas market, in particular the gas network regulation, largely untouched. The European Commission assumes a transition period for the new hydrogen market of eight years starting in 2022, by which time it wants to have completed the

hydrogen market ramp-up. In the long term, however, an alignment between the hydrogen and the natural gas market is envisaged, in particular when it comes to the network integration of hydrogen.

In this respect, the European Commission aims at applying the unbundling requirements from the electricity and gas market liberalisation to hydrogen. As a consequence – and as a general rule – companies active in the generation and sale of hydrogen will not be allowed to also own and operate a hydrogen network (known as ownership unbundling). Only if strict further requirements are met, ownership and operation of a hydrogen network will be allowed within the same company group producing hydrogen.

Under the proposals, hydrogen networks will also be subject to a non-discriminatory network access and connection regime by way of negotiated network access. In regard to the blending of hydrogen into the natural gas networks, the proposals foresee that the transmission system operators will have to accept gas flows with a hydrogen content of up to 5% by volume.

In order to promote the cooperation between hydrogen network operators, an association of hydrogen network operators will be established to provide special support for the development of the hydrogen network infrastructure (called the European Network of Network Operators for Hydrogen (**ENNO**)), which will be comparable to the existing associations of gas network operators in the natural gas market. It follows that the European Union will focus its hydrogen ramp-up on renewable and low-carbon hydrogen.

As at the date of this guide, the above proposal remains to be approved by the European Parliament and the Council, and the proposals could therefore be subject to further changes. The proposals are expected to be approved by end of 2022 or beginning of 2023.

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. Edition 2 of our guide provides an updated snapshot of developments emerging during 2021/2022 – a period which saw the hydrogen sector continue to emerge prominently as part of the broader global energy transition discussion.

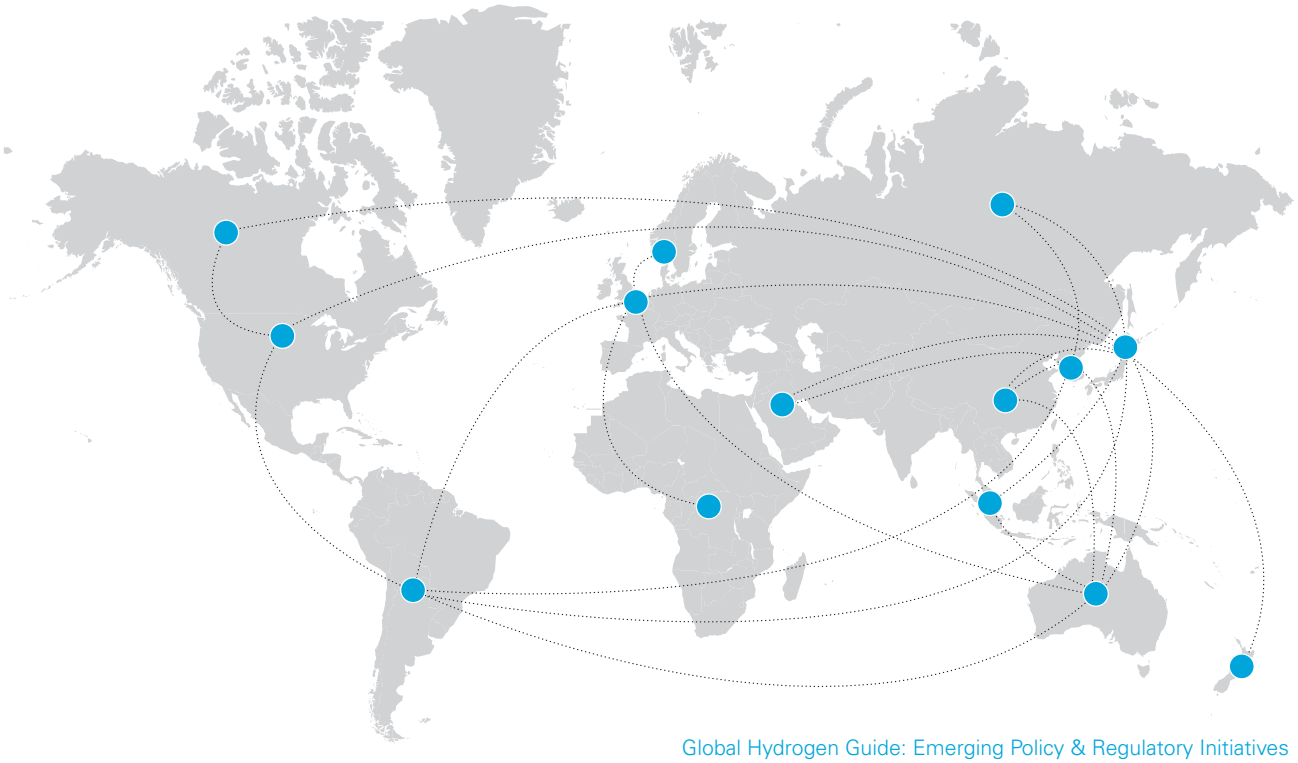
The analysis in this Chapter is organised into the following regions:

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

As Edition 2 of this guide demonstrates, there is a continuing groundswell of activity in pursuit of a hydrogen economy by both the public and private sectors around the globe. What continues to emerge clearly from our research in Edition 2 of this guide, 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 space 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 huge 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.

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'.

Emerging global interconnectivity of hydrogen policy and regulatory initiatives



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:

- **South Korea**

  The South Korean government released the "First Basic Action Plan for Hydrogen Economy" on November 26, 2021. The Action Plan is the country's first legally binding plan established in accordance with the Hydrogen Economy Promotion and Hydrogen Safety Management Act, which came into force on 5 February 2021.

  South Korea aims to make hydrogen the country's largest single energy source by 2050. Under the Action Plan, South Korea will source 100% of its hydrogen fuel energy from "clean hydrogen energy", namely green and blue hydrogen. At present, all hydrogen produced in South Korea is grey hydrogen produced from fossil fuels. Due to limited renewable resources and land space available for large-scale clean hydrogen energy generation, South Korea believes that it can only reach net-zero emissions by importing significant quantities of clean hydrogen. South Korea will increase investments in overseas clean hydrogen projects to secure hydrogen supply channels leveraging its financial and technical capabilities.

- **Japan**

  Japan 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.

  Japan will be a key player in the global hydrogen economy, with Japanese companies emerging as key players in the development of large scale hydrogen production facilities around the world, supported by proactive Japanese government regulatory initiatives.

- **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 although other applications are accelerating, including hydrogen-powered trams, aviation, ships, and heat and power. China will inevitably 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.

  The last five years have seen increasing regulatory support for hydrogen industry in China at both national and local levels. China has announced its intention to reduce carbon dioxide emissions and will encourage clean power solutions (hydrogen power included) through government policy and regulation. The State Council has 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 February 2021, the State Council published a guiding opinion calling for an increase in the proportion of renewable energy and infrastructure construction related to hydrogen. In October 2021, the State Council issued a notice to take hydrogen energy as a measure to reach carbon peaking by 2030, to encourage the related research and to improve the system of laws and regulations.

  In September 2021, the China Hydrogen Alliance, a government supported alliance formed by a consortium of energy and automotive companies, published the "White Paper 2020 on China's Hydrogen and Fuel Cell Industry" which anticipates that, under a scenario of carbon neutralisation in 2060, hydrogen will cover 20% of energy consumption, and renewable hydrogen production will be 100 million tons per year.

  In June 2019, the China Hydrogen Alliance published a "White Paper on China's Hydrogen and Fuel-cell Industry" which maps out the development strategy of the hydrogen industry. The white paper projects that by 2050, hydrogen will cover 10% of China's energy needs, 10,000 hydrogen refuelling stations will be built, and hydrogen economy-related revenue is expected to increase to 12,000 billion yuan in 2050 (approximately USD 1,740 billion).

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. On 19 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.

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 by 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 New South Wales, Western Australian, Queensland, 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 2021, almost 100 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.

Singapore

Singapore launched its Green Plan 2030 in February 2021, which sets out the country's agenda on sustainable development for the next 10 years across five key pillars. Under the pillar of Green Economy, which aims to seek green growth opportunities for new jobs and industry transformation, one of Singapore's priorities is to study the potential of low-carbon hydrogen and other emerging technology pathways for decarbonisation.

The plan unveils that hydrogen is envisioned to be a key part of Singapore's decarbonisation and sustainable future. Since the launch of the plan, Singapore has issued research, development and demonstration grants to a variety of industry-university partnership projects, particularly on exploring potential hydrogen generation opportunities and the importation of hydrogen into Singapore. There has also been increasing industry partnerships to develop technologies and conduct feasibility studies and trials in using hydrogen as a sustainable fuel in the maritime and aviation industries. Key regulatory developments have granted additional powers the Energy Market Authority signalling that the Singaporean government is prepared to invest in new low-carbon technologies to ensure long-term energy security and system stability, as well as to meet Singapore's commitments and ambitions in climate action.

Funds raised by carbon tax revenue will also be applied to Singapore's decarbonisation strategy and climate action. The Singaporean government has earmarked funds under the Research, Innovation and Enterprise 2025 plan for the research, development and demonstration of sustainable urban solutions, as well as emerging low-carbon technologies that can drive deeper decarbonisation.

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.	**New South Wales Hydrogen Strategy** In October 2021, the New South Wales State government released its hydrogen strategy. The strategy aims to place the state as a world leader in the hydrogen industry, and to rapidly increase the scale and competitiveness of green hydrogen. The government has committed A$3 billion in support for the industry, including providing a 90% exemption to network charges for electrolysers.	New South Wales State government
3.	**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
4.	**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
5.	**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
6.	**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
7.	**'H2 Under 2' Goal** In 2020, the Australian government announced a 'H2 under 2' goal where hydrogen can be produced at under A$2 per kilogram, a figure considered to be the point at which hydrogen becomes competitive with other energy alternatives.	Australian government
8.	**Tasmanian Renewable Hydrogen Action Plan** In September 2021, the Tasmanian State government released an action plan to establish hydrogen production in Tasmania. The government has announced funding for collaboration with the Tasmanian government on specific projects.	Tasmanian State government

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
9.	**Australia-Germany Partnership Incentives** In June 2021, it was announced that a Declaration of Intent between the Australian government and the German government on the Australia-Germany Hydrogen Accord was signed by the two countries. In November 2021, a joint Hydrogen Innovation and Technology Incubator named 'HyGATE' was announced, with funding initiatives to open in the first quarter of 2022.	Australian government Federal Republic of Germany
10.	**Australia-South Korea Low Emissions Technology Cooperation** In October 2021, Australia and the Republic of Korea formed the 'Australia-Republic of Korea Low and Zero Emissions Technology Partnership' to drive increased adoption of these technologies. The partnership will involve collaboration on clean hydrogen supply, hydrogen power generation and carbon capture. The partnership forms part of Australia's commitment to build new international technology partnerships to drive investment and job creation in Australia.	Australian government Republic of Korea
11.	**Western Australian Renewable Hydrogen Fund** The Western Australia State government has designed a renewable hydrogen fund to support growth of the industry in the state. First introduced in 2019, the fund has awarded grants to one capital works project and three feasibility studies.	Western Australia State government
12.	**Queensland Renewable Energy and Hydrogen Jobs Fund** The Queensland State government has established a jobs fund, committing A$2 billion to support infrastructure, including partnerships with the private sector.	Queensland State government
13.	**Australian government Clean Hydrogen Industrial Hub Program** In September 2021, the Australian government announced that two further locations will be included in the Hub Program. The program, which has now identified seven priority regional sites, is aimed at achieving the goal of hydrogen production under A$2 a kilogram. The Hub Program has been identified as a priority under the National Hydrogen Strategy. As of September 2021, the Australian government has committed A$464 million in grants for the program.	Australian government
14.	**Western Australian Renewable Hydrogen Grants** The Western Australian government has announced a grant program to support the growth of the renewable hydrogen industry. The program will provide financial support for projects that include the operation and procurement of hydrogen transport and refuelling stations.	Western Australia State government
15.	**New South Wales Hydrogen Hub Program** The New South Wales State government has announced a A$70 million hub initiative to support the establishment and growth of hydrogen industries in the state. The government has set a target to increase electrolyser capacity to 700 megawatts by 2030. The initiative supports commercial scale green hydrogen projects in order to reduce investment risk.	New South Wales State government
16.	**Western Australia Hydrogen Hubs** The Western Australian government will invest up to A$117.5 million to attract Federal funding for the Pilbara Hydrogen Hub and the Mid West Clean Hydrogen Hub. The state lodged applications through the Commonwealth government's Clean Hydrogen Industrial Hubs program in order to secure Commonwealth funding to develop the hubs.	Western Australia State government Australian government
17.	**Tasmanian government agreement with Belgium on Hydrogen Exports** The Tasmanian government signed a Memorandum of Understanding (**MoU**) with the region of Flanders in Northern Belgium on February 3, 2022. The scope of the MoU extends beyond importing and exporting green hydrogen to include the use of hydrogen in aquaculture operations and offshore energy systems.	Tasmanian government Kingdom of Belgium

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
18.	In June 2021, the Department of Industry, Science, Energy and Resources released a discussion paper regarding a Hydrogen Guarantee of Origin Scheme for Australia. At this stage, the discussion paper covers three main production pathways: electrolysis with electricity, coal gasification with carbon capture storage, and steam methane reforming of natural gas with carbon capture and storage. The initial scheme will verify and track hydrogen production technology/pathways, including the primary fuel source, carbon emissions with production, and product location. These points would be identified on the certificate issued.	Australian government

China

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s** On November 10, 2021, China and the United States released a declaration at COP26 announcing an intention to cooperate on policies to encourage decarbonisation and electrification of end-use sectors and key areas such as green design and renewable resource utilisation. In order to reduce CO_2 emissions, the two countries declared their intention to cooperate on distributed generation policies that encourage integration of solar, storage, and other clean power solutions closer to electricity users.	Chinese government
2.	**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 put over 800 hydrogen 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
3.	**White Paper on China's Energy Development in the New Era** In December 2020, the State Council Information Office issued a white paper, proposing that the development of green hydrogen production, storage, transportation and utilisation of hydrogen industry chain technology and equipment should be accelerated, and hydrogen fuel cell technology should be promoted.	Chinese government
4.	**Standardization of New Energy Vehicles in 2020** In April 2020, China's Ministry of Industry and Information Technology issued 'Key Points for Standardization of New Energy Vehicles in 2020', which calls for the development of key standards in fuel cell and related fields, the optimisation of the standard system and the leading role of standards in technological innovation and industrial upgrading.	Chinese government
5.	**New Energy Vehicle Industry Development Plan (2021-2035)** In October 2020, the General Office of the State Council published 'New Energy Vehicle Industry Development Plan (2021-2035)', which mentions that by 2025 the sales of new energy vehicles shall reach 20% of all the sales of new vehicles, and that fuel cell vehicles shall realise a commercial application. The plan also states the importance in promoting the hydrogen fuel supply system, improving the economic efficiency in the production, storage and transportation of hydrogen and the construction of hydrogen refuelling infrastructure.	Chinese government

No.	Description	Key Players
6.	**Guiding opinion on Accelerating the Establishment and Improvement of a Green and Low-Carbon Circular Development Economic System** In February 2021, the State Council published a guiding opinion highlighting that the proportion of renewable energy utilisation should be increased by developing various new energy including hydrogen energy according to local conditions. At the same time, infrastructure construction such as new energy vehicle charging and replacement station and hydrogen station is to be strengthened.	Chinese government
7.	**Guiding Opinions on Energy Work for 2021** In April 2021, the National Energy Administration released the guiding opinion to improve the energy technology innovation system, develop hydrogen energy innovation platforms, explore hydrogen energy technology development and application, and deepen the technology cooperation between hydrogen energy and other energy resources.	Chinese government
8.	**Notice on the Action Plan for Carbon Peaking by 2030** In October 2021, the State Council issued the 'Notice on Printing and Distributing the Action Plan for Carbon Peaking by 2030', which highlights measures to reach carbon peaking by 2030. These measures call for a development of new energy, by actively expanding the utilisation of hydrogen energy in the industrial field (hydrogen metallurgy) and transportation field, promoting hydrogen refuelling station and infrastructure construction in an orderly manner, carrying out scientific research and cooperation in the fields of hydrogen energy and the capture, utilisation and storage of carbon dioxide, and improving the system of laws and regulations on the production, storage, transmission and usage standards of hydrogen.	Chinese government
9.	**14th Five-Year Development Plan for Comprehensive Transportation Services** In November 2021, the Ministry of Transport issued the '14th Five-Year Development Plan for Comprehensive Transportation Services' to actively promote the application of new energy vehicles/ships in the transportation field, and accelerate the construction of infrastructure such as hydrogen refuelling stations. In national ecological civilisation pilot areas and key areas for air pollution prevention, the proportion of new energy vehicles among new vehicles every year shall not be less than 80% in public transportation, taxi industry, and logistics distribution.	Chinese government
10.	**Made in China 2025** In 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
11.	**National Innovation Driven Development Strategy** In 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
12.	**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

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
13.	**Opinion on establishing a system of laws and policies of green production and consumption** In March 2020, China's National Development and Reform Commission together with Ministry of Justice issued an opinion on establishing a system of laws and policies of green production and consumption. The opinion states that standards and supporting policies for developing hydrogen energy and marine energy shall be researched and formulated.	Chinese government
14.	**Draft Energy Law in 2020** In April 2020, China's National Energy Administration published a new draft Energy Law. The measure goes beyond 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**	
15.	**White Paper 2020 on China's Hydrogen and Fuel Cell Industry** In September 2021, China Hydrogen Alliance released the 'China Hydrogen and Fuel Cell Industry Development Report 2020 - Low Carbon Clean Hydrogen Supply System under Carbon Neutralization Strategy'. The report focuses on the low carbon clean hydrogen supply system and studies the path for green development of hydrogen from both demand side and supply side. Key targets recommended by the Alliance include that: (1) under the scenario of carbon peak in 2030, hydrogen will account for about 6% of the energy consumption and the output of hydrogen production from renewable energy, about 5 million tons; (2) in the case of carbon neutralisation in 2060, hydrogen will cover 20% of the energy consumption and the renewable hydrogen production, about 100 million tons per year.	China Hydrogen Alliance
16.	**100 Initiatives on Renewable Hydrogen** In September 2021, China Hydrogen Alliance released the '100 Initiatives on Renewable Hydrogen', outlining the goal to reach 100 GW renewable hydrogen production by 2030. It also emphasises other targets: accelerating the development of renewable hydrogen; building a unified renewable hydrogen market; adhering to the safe development of hydrogen industry; improving the construction of new power system with new energy; and promoting the decarbonisation in industry, transportation and other fields.	China Hydrogen Alliance
17.	**Notice on the Demonstration Application of Fuel Cell Vehicles** In September 2020, the Ministry of Finance and other four ministries announced an adjustment to the subsidy policy for the purchase of fuel cell vehicles to the demonstration application of fuel cell vehicles. During the demonstration period, which is set as four years, the urban agglomeration shortlisted for the demonstration will be rewarded according to the completion of its objectives. The incentive funds are utilised by local governments and enterprises for the industrialisation of core technologies of fuel cell vehicles, talent introduction, and the demonstration application of new vehicle models and new technologies, etc.	Chinese government
18.	**Notice on Further Improving the Financial Subsidy for the Promotion and Application of New-energy Vehicles** In December 2020, the Ministry of Finance and other three ministries released the 'Notice on Further Improving the Financial Subsidy for the Promotion and Application of New-energy Vehicles', which announces that, after the transition period, subsidies will not be given to new-energy vehicles, but to the charging /hydrogen refuelling infrastructure and other relevant operation services.	Chinese government

No.	Description	Key Players
19.	**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
20.	**Ministry Finance subsidy support to hydrogen vehicles** In March 2019, Chinese Ministry of Finance (**MOF**) announced to scrap subsidy for the electric vehicles, while keeping subsidy support to hydrogen vehicles. MOF especially emphasised on using the funding saved from electric vehicles on hydrogen refuelling infrastructure and services instead. By July 2019, over 20 cities announced initiatives to forge their hydrogen industry clusters.	Ministry of Finance
21.	**Energy-saving and New Energy Vehicle Technology Roadmap** In 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
22.	**White Paper on China's Hydrogen and Fuel Cell Industry** In June 2019, China Hydrogen Alliance released a White Paper on China's Hydrogen and Fuel Cell Industry, which is widely 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
C	**Guarantee of Origin / 'colour' classification requirements**	
23.	**Classification Requirements** In December 2020, the China Hydrogen Alliance issued the report 'Standard and Evaluation for Low-Carbon Hydrogen, Clean Hydrogen and Renewable Hydrogen'. The standard uses the life cycle assessment method in establishing a quantitative standard and evaluation system for low-carbon hydrogen, clean hydrogen and renewable hydrogen: □ **Low-Carbon Hydrogen** – where carbon dioxide emissions per kilogram of hydrogen produced are no more than 14.51 kilograms (14.51kg CO_2e/kgH_2); □ **Clean Hydrogen and Renewable Hydrogen** – when carbon dioxide emissions per kilogram of hydrogen produced are no more than 4.9 kilograms (4.9kg CO_2e/kgH_2); and □ **Renewable Hydrogen** – requires that the energy consumed by hydrogen production should be renewable energy (hydropower, wind energy, solar energy, etc.).	China Hydrogen Alliance China Industry-University-Research Institute Collaboration Association

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)

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**The 6th Strategic Energy Plan** This plan was released in October 2021 under the Basic Act on Energy Policy and replaces the 5th Strategic Energy Plan of July 2018. It presents a basic direction of Japan's energy policy towards 2030 and further towards 2050. It recognises that hydrogen will play an essential role in achieving carbon neutrality as well as emphasising the enhancement of efforts towards realising a 'hydrogen society'. The plan sets out a target of 36-38% renewable energy power generation in fiscal 2030 (up from the 22-24% target under the previous plan) and aims for hydrogen / ammonia to make up 1 percent of Japan's power generation mix in fiscal 2030.	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. 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 Ministry of Economy, Trade and Industry of Japan (**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 (and updated in June 2021) by the METI 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
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**) Queensland State government

No.	Description	Key Players
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 the 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 Netherlands government
12.	**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 government Australian government Japanese government Commercial partners
13.	**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`
14.	**Government Subsidies** □ Residential Fuel Cell System Installation Support Project: subsidises part of the purchase and construction costs of a residential fuel cells. □ Business/Industrial Fuel Cell System Installation Support Project: subsidises part of the costs for installing an industrial fuel cell system. □ 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.	Japanese government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
15.	**Green Innovation Fund** In January 2021, Japan approved the national budget allocation of JPY 2 trillion to a 'green innovation fund' to be established with the 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.	Japanese government NEDO
16.	**ADNOC–METI Memorandum of Cooperation** In January 2021 METI and Abu Dhabi National Oil Company (**ADNOC**) signed a memorandum of cooperation to accelerate development in the fields of fuel ammonia and carbon recycling.	Japanese government (METI) ADNOC
17.	**UAE–Japan Memorandum of Cooperation on Hydrogen** In April 2021, METI and the Ministry of Energy and Infrastructure of the UAE, and signed a memorandum of cooperation on hydrogen, which envisages cooperation on matters such as exchanging information on hydrogen policy, constructing supply chains (including hydrogen production and transportation to Japan) and exchanging information toward developing regulations and standards.	Japanese government (METI) UAE government (Ministry of Energy and Infrastructure)
18.	**Gazprom–METI Memorandum of Cooperation** In September 2021, METI and Gazprom signed a memorandum of cooperation in relation to hydrogen, ammonia, carbon capture and storage, carbon capture utilisation and carbon recycling.	Japanese government (METI) Gazprom
19.	**Rosneft-METI Memorandum of Cooperation** In September 2021, METI and Rosneft signed a memorandum of cooperation which envisages cooperation on projects relating to hydrogen, ammonia, carbon capture and storage, carbon capture utilisation and carbon recycling.	Japanese government (METI) Rosneft
20.	**Province of Alberta-JOGMEC Memorandum of Cooperation** In October 2021, JOGMEC and the Province of Alberta, Canada signed a memorandum of cooperation which envisages strengthening their existing scope of cooperation to also include carbon capture and storage, hydrogen and fuel ammonia production.	JOGMEC Government of the Province of Alberta, Canada
21.	**Financing Programme: "Pilot project for comprehensive support throughout the whole hydrogen supply chain abroad"** In 2021 a financing program was introduced as part of the Ministry of the Environment of Japan's Joint Credit Mechanism (**JCM**) Financing Scheme for the transition to a decarbonised society in developing countries. Calls for proposals for this financing program are issued by the Ministry of the Environment and if a project is selected, the Japanese government will subsidise part of the project. The project must be one that will produce hydrogen derived from renewable energy in third party countries and the resulting green hydrogen must then be transported to and supplied for use in JCM partner countries.	Japanese government (Ministry of Environment) Global Environment Centre Foundation (**GEC**)

No.	Description	Key Players
22.	**R&D and Social Implementation Plan for Hydrogen-related Projects** In May 2021, METI implemented a plan to subsidise projects relating to hydrogen using the Green Innovation Fund. There are two categories of applicable projects: □ large-scale hydrogen supply chain establishment projects – this relates to implementing demonstrations of hydrogen power generation at a power plant (co-combustion with other fuels and single-fuel combustion using hydrogen only) as well as enlarging transportation facilities and other resources including hydrogen carriers; and □ hydrogen production through water electrolysis using power from renewables projects – this relates to the establishment of a domestic hydrogen production base utilising excess renewable energy and other resources and gaining a share in leading overseas markets. The aim is to further reduce the cost of water electrolysers to one-sixth of their current cost. In May 2021, NEDO issued a call for proposals and three projects were selected in September 2021.	Japanese government (METI) NEDO
C	**Guarantee of Origin / 'colour' classification requirements**	
23.	Japan uses certificates which identify the origin of electricity, such as the Green Energy Certificate (*green denryoku shōmeisho*) and the Non-Fossil Value Certificate (*hikaseki shōmeisho*), but the use of such certificates for hydrogen is still under discussion. At a regional level, the local prefectural government of Aichi Prefecture introduced a Low-Carbon Hydrogen Certification Scheme in March 2021 for producers of low-carbon hydrogen within the prefecture.	Regional government of Japan (Aichi Prefecture)

Singapore

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Singapore Green Plan 2030** In February 2021, Singapore published a decarbonisation and sustainability strategy for the following 10 years. The plan has 5 key pillars: City in Nature, Sustainable Living, Energy Reset, Green Economy and Resilient Future. Under the Green Economy pillar, Singapore is committed to studying the potential of low-carbon hydrogen and other emerging technology pathways for decarbonisation. In 2030, Singapore aims to be a leading centre for green finance and services, a carbon services hub and the leading regional centre for developing new sustainable solutions, to facilitate Asia's transition to a low-carbon and sustainable future.	Singapore government
2.	**Singapore-Australia partnership – hydrogen in maritime sector** In June 2021, Australia and Singapore established a A$30 million partnership to accelerate the deployment of low emissions fuels and technologies such as clean hydrogen in maritime and port operations. The partnership builds on the existing Australia-Singapore memorandum of understanding on low emissions technologies and solutions, and recognises Singapore's role as a major global shipping hub and Australia's growing use of clean hydrogen and clean ammonia. Each country will commit up to A$10 million over five years to fund industry-led pilot and demonstration projects, with at least A$10 million of additional investment expected to be leveraged from industry. The initiative will trial the use of clean hydrogen, clean ammonia and other hydrogen derivatives in shipping and port operations and explore the potential for hydrogen demand from the maritime sector.	Singapore government Australian government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
3.	**Progressive increase in Carbon Tax and Offset Initiatives** Singapore implemented a carbon tax at S$5/$tCO_2e$ from 1 January 2019 to 2023, but the carbon tax is set to increase significantly to S$25/$tCO_2e$ in 2024 and 2025, and S$45/$tCO_2e$ in 2026 and 2027, with a view to reaching S$50-80/$tCO_2e$ by 2030. It has also been announced that companies will also be able to surrender high quality international carbon credits to offset up to 5% of their taxable emissions from 2024. These measures will support the adoption of low-carbon technology in the power sector. Revenue from the carbon tax has already been earmarked for decarbonisation efforts, including further deployment of low-carbon technologies. This will be necessary to continue to support hydrogen blended fuels, and ensure they are commercially viable.	Western Australian State government
B	**Specific grants, programs & incentives**	
4.	**Study of Hydrogen Imports and Downstream Applications for Singapore** This study was concluded in June 2021 as part of Singapore's preliminary investigation into low-carbon technologies. The study highlighted pathways for low-carbon hydrogen that could be relevant for Singapore, including diversifying Singapore's fuel mix across a number of applications, such as electricity generation and transport (e.g. in goods vehicles and ships). The study also identified key barriers to deployment including the lack of a global and diverse supply chain for low-carbon hydrogen, the high costs associated with producing and importing low-carbon hydrogen and a lack of infrastructure to support this.	National Climate Change Secretariat (**NCCS**) Singapore Economic Development Board (**EDB**) Energy Market Authority (**EMA**)
5.	**Low-Carbon Energy Research Funding Initiative: Ammonia Cracking** In October 2021, the Singaporean government announced the award of S$55 million for multiple research and development projects on hydrogen and CCUS. This project is one of the awarded projects, and aims to develop more efficient processes to release H_2 from ammonia, by examining the development of robust and efficient ammonia cracking technologies suitable for use in Singapore. Releasing hydrogen from ammonia is an energy intensive process, so it is envisioned that an improved and more efficient process will reduce the energy penalty of transporting hydrogen by using ammonia as a carrier, thereby reducing the cost of hydrogen adoption in Singapore.	National University of Singapore Surbana Jurong Infrastructure Pte Ltd
6.	**Low-Carbon Energy Research Funding Initiative: Miniature hydrogen leakage and purity sensors for downstream hydrogen use** Another of the awarded projects, this initiative aims to develop two types of hydrogen sensors, a purity sensor and a leakage sensor, with small form factor, high selectivity minimal interferences and immunity to poisoning for downstream use. Standards will also be created for hydrogen sensors evaluation and quality. This will improve the safety of hydrogen use, and allow deployment of sensors economically to enable trading and safety and increase confidence towards adoption of hydrogen for downstream uses.	Institute of Microelectronics Agency for Science, Technology and Research Hydrogen and Fuel Cell Association of Singapore
7.	**Low-Carbon Energy Research Funding Initiative: Methane Pyrolysis for hydrogen and Carbon Nanotube Production** This project, also sponsored by the Singapore government, aims to develop an improved process for methane pyrolysis, i.e. catalytic cracking and separating natural gas/methane into hydrogen gas and solid carbon. Methane pyrolysis is a potential pathway to producing low-carbon hydrogen in Singapore.	National University of Singapore and others

No.	Description	Key Players
8.	**Low-Carbon Energy Research Funding Initiative: Liquid Organic Hydrogen Carriers (LOHCs) Technology for Singapore** Another of the awarded projects, this project aims to develop new catalysts and systems to reduce the costs of extracting hydrogen from methylcyclohexane (**MCH**) as an LOHC technology and to design a minimum-cost hydrogen supply chain network for Singapore. A comprehensive financial model to access the cost of the hydrogen supply chain in Singapore will also be developed by collaborating with the project's industry partners.	Nanyang Technological University Chiyoda Corporation Mitsubishi Corporation PSA Corporation Limited Sembcorp Industries Ltd City Gas Pte Ltd Jurong Port Pte Ltd Singapore LNG Corporation
9.	**Singapore Sustainable Air Hub Blueprint** In November 2021, the Civil Aviation Authority of Singapore (**CAAS**) signed a memorandum of understanding with Airbus to launch a two-year technical feasibility study of an airport hydrogen hub and the infrastructure requirements to support future hydrogen-powered aircraft operations. The study, due to start in early 2022, will cover areas such as the production, storage and distribution of hydrogen, aircraft ground services, logistical equipment and refuelling systems. This is part of developing the Singapore Sustainable Air Hub Blueprint by early 2023. CAAS conducted a study of the operational and commercial viability of sustainable aviation fuels at Changi Airport with Industry partners. A pilot will be conducted at Changi Airport in 3Q 2022. Singapore also convened an International Advisory Panel on the Sustainable Air Hub Blueprint in February 2022.	CAAS Airbus
10.	**Sydrogen Energy (JV)** In April 2021, Singaporean sovereign wealth fund Temasek entered into an agreement to form a US$140 million joint venture with Nanofilm Technologies (a Singapore stock exchange (**SGX**)-listed nanotechnologies manufacturer). The joint venture, known as Sydrogen Energy, is being established with the aim of leveraging Nanofilm's core technologies to develop new components and solutions to overcome existing limitations in enabling the use of hydrogen as an energy source.	Temasek Nanofilm Technologies

South Korea

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**First Basic Action Plan for Hydrogen Economy** On 26 November 2021, the South Korean government announced the First Basic Action Plan for Hydrogen Economy in accordance with the Hydrogen Economy Promotion and Hydrogen Safety Management Act, which came into force on 5 February 2021. Under the Action Plan, the government will source 100% of its hydrogen fuel energy from either green or blue hydrogen and boost the country's clean hydrogen self-sufficiency ratio to 60% by 2050.	South Korean government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**Hydrogen and Ammonia Based Power Generation Roadmap** In November 2021, the South Korean government announced that it will commercialise hydrogen and ammonia co-firing power generation by 2030 to replace coal and liquefied LNG power generation. The hydrogen-ammonia co-firing power generation is a new technology that generates electricity by burning hydrogen and ammonia in existing coal and LNG generators. South Korea will release a comprehensive roadmap with regard to hydrogen and ammonia based power generation during the first quarter of 2022.	South Korean government
B	**Specific grants, programs & incentives**	
3.	**Green Hydrogen Overseas Business Group and Korea H2 Business Summit** The Korean Ministry of Trade, Industry and Energy and 42 companies and institutions formed the "Green Hydrogen Overseas Business Group" in June 2020 to develop overseas clean hydrogen supply channels. In September 2021, fifteen major Korean conglomerates launched a business council called the "Korea H2 Business Summit" to coordinate their efforts in achieving the hydrogen economy, and this council is expected to help facilitate and expedite the Green Hydrogen Overseas Business Group's plans for clean hydrogen importation.	Ministry of Trade, Industry and Energy 15 Korean conglomerates
4.	**SPC 'Korea Hydrogen Energy Network (Kohygen)'** Kohygen, a special purpose company established by the South Korean government and eight other regional governments and private entities, has started constructing hydrogen refuelling stations for commercial vehicles. A total KRW 330 billion worth of funding will be injected.	South Korean government Commercial partners
5.	**Tax Benefits for Research and Development (R&D) of Hydrogen Technologies** The South Korean government has offered tax preferential treatment for the R&D of key hydrogen technologies related to hydrogen mobility, fuel cells and liquid hydrogen, and promised that it will extend tax benefits to companies engaged in the R&D of core technologies at every stage of the hydrogen value chain.	South Korean government
6.	**Introduction of the Clean Hydrogen Energy Portfolio Standard (CHPS)** As of December 2021, an amendment to the Hydrogen Economy Promotion and Hydrogen Safety Management Act seeking to introduce a mandatory clean hydrogen energy portfolio standards is currently pending in the National Assembly. Under the current system, hydrogen fuelled power generation, like other renewable energy resources, is supported by the Renewable Portfolio Standards. The proposed CHPS will create a separate mandatory supply market dedicated to hydrogen power to account for its unique characteristics, such as variable input fuel prices.	South Korean government
7.	**Hydrogen-Specialised Companies and Hydrogen Economy Fund** Pursuant to the Hydrogen Economy Promotion and Hydrogen Safety Management Act, the South Korean government will foster 1,000 hydrogen-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 subsidise or provide loans to hydrogen specialised companies for, amongst others, the development of hydrogen related projects and cooperative efforts with foreign entities. Expert consulting services have also been provided to help hydrogen specialised companies commercialise their technologies and establish sales channels. The South Korean government has formed a 'Hydrogen Economy Fund' worth KRW 34 billion to support early-stage hydrogen specialised companies with a view to encouraging the private sector to participate in the hydrogen economy. The fund will be a part of the government's KRW 505 billion New Energy Industry Fund launched in 2016.	South Korean government

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
18.	A hydrogen bill currently pending in the National Assembly proposes that "clean hydrogen" (defined as green hydrogen and blue hydrogen) be certified by a clean hydrogen certification institution established for the purpose of carrying out the certification of clean hydrogen, and clean hydrogen production facilities so certified will be subject to regular inspection. Once certified, a clean hydrogen manufacturer would issue purchasers a "Clean Hydrogen Sale Certificate". The manufacturer's certified status may be revoked or suspended should they fail to comply with the certification standards. The hydrogen bill also proposes to introduce an origin verification system which will be designed through consultation with hydrogen producing countries so that it is recognised across the globe.	South Korean government

3.3 Europe & the United Kingdom

Overview

In 2021, the European Commission sought to deliver on its 'Hydrogen Strategy for a Climate-Neutral Europe' (**EU Hydrogen Strategy**), which was introduced in 2020 and identified hydrogen as essential anchor for the decarbonisation of the energy system.

The EU seeks to develop a supportive legal environment for hydrogen, although the legal framework necessary to implement the hydrogen market ramp-up is still under development in the EU. For example, the European Commission announced in mid-2021 that it would revise the Renewable Energy Directive II (**RED II**), although the necessary Delegated Act RED II to be issued by the European Commission to specify certain hydrogen requirements is not yet published.

In December 2021, the European Commission published a proposal to revise the European Gas Regulation and the Gas Directive, which is the corner stone for regulating the natural gas network in Europe. The proposal seeks to ensure that the legal framework supports the integration of hydrogen into the gas network. These proposals highlight that the European Commission will continue to focus on renewable and low-carbon hydrogen in order to foster the decarbonisation of the European economies. However, further work is required to determine how renewable and low carbon hydrogen are going to be defined in detail.

The goals set out in the EU Hydrogen Strategy also require substantial investment in all sectors. In order to ensure the further deployment of the hydrogen economy, several EU-funding programmes exist to support hydrogen projects. These developments on a European level, are also mirrored in the Member States. Several EU member states, as well as the UK, have also introduced national strategies for the establishment of a hydrogen economy and key hydrogen activities across European countries can be summarised as follows:

- **Germany**

  Since Germany published its National Hydrogen Strategy in June 2020, the German government and legislator have been actively fostering the market ramp up of hydrogen in Germany. In order to enable its energy transition and to reduce the country's CO_2-emissions, Germany in particular focusses on the generation, transport, storage or use of renewable (green) hydrogen. In 2021, Germany also selected a number of large-scale hydrogen projects to receive government funding as part of the IPCEI-funding.

  The regulatory framework in Germany has also been further developed in order to address some aspects which hindered the deployment of hydrogen. In particular, due to the comparably high energy costs in Germany, partly caused by the German renewables surcharge, the German legislator has exempted electricity used for green hydrogen generation from the obligation to pay this surcharge. Delivering on the implementation of the National Hydrogen Strategy, Germany also introduced a new hydrogen network regulation by an amendment of the Energy Industry Act (**EnWG**). The changes introduced in the new EnWG include rules for conversion of natural gas pipelines to hydrogen pipelines.

- **France**

  In 2020, France 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 aims to accelerate and increase those investments, thanks notably to a EUR 7 billion budget. French President Emmanuel Macron stated in October 2021 that an additional EUR 2 billion would be invested by the French State to fund the sector.

A new legal framework for hydrogen has been established by Ordinance n° 2021-167 in February 2021, creating articles L. 811-1 et seq. of the French energy code. These articles organise the production, transmission, distribution, storage and sale of hydrogen. This framework establishes different categories of hydrogen (renewable, low-carbon and fossil), a support scheme and the certification process for renewable hydrogen.

- **Netherlands**

The Netherlands aims to reduce 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 Netherlands government has already put emphasis on the creation and implementation of several strategies and programs fostering the hydrogen economy (including the Government Strategy on Hydrogen, the Climate Act and Long-term Growth Strategy, the Climate Plan and the National Climate Agreement). The current Gas Act (setting out the rules applicable to the transmission and supply of gas) and Electricity Act (providing the rules applicable to the production, transportation and supply of electricity), are expected to be combined into the Energy Act. As opposed to the Gas Act and the Electricity Act, which do not contain any provisions specifically applicable to the production, transportation and supply of hydrogen, the Energy Act should contain such provisions. It will therefore constitute the first step to a more specific and comprehensive regulatory framework for hydrogen in the Netherlands.

- **Belgium**

Belgium unveiled its federal hydrogen vision and strategy plan In October 2021. The plan mainly aims to ensure that Belgium becomes a centre for the import and transit of renewable green hydrogen by 2030 and to help reach its energy and climate objectives of greenhouse gas reduction by 2030 and carbon neutrality by 2050. The plan focuses on developing low-carbon and green hydrogen technologies (with the former being a transitional measure to aid with the large-scale development of the latter) in the industrial, transport and power sectors. Similarly to the Netherlands, Belgium has a strategic and central position that will aid in the development of the hydrogen market. Belgium has important ports in the North Sea, possesses important industrial hubs and is a neighbour to France, Germany and the Netherlands, all of which are developing their own hydrogen networks.

- **Sweden**

The organisation '*Fossilfritt Sverige*', a government initiative founded to aid Sweden's shift away from fossil fuels, has in November 2021 presented a national hydrogen strategy to the government. The government is reviewing the proposed strategy. 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

2021, the Spanish government was focused on adopting measures to promote renewable energies, specifically renewable hydrogen.

Italy

Italy has a strategic geographic location, facilitating its aim to become the Mediterranean hub for the production, transportation and storage of green hydrogen. Italy's infrastructure and regulatory regime require 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 has set ambitious goals in the National Recovery and Resilience Plan (Piano Nazionale di Ripresa e Resilienza) to support hydrogen production and use through the implementation of a national regulatory and industrial framework. This includes the introduction of specific incentives and streamlining of the regulatory regime applicable to hydrogen plants and the capacity of electrolysers to simultaneously promote the expansion of hydrogen-related infrastructure and stimulate demand.

United Kingdom

In August 2021, the UK published its much awaited UK Hydrogen Strategy which confirmed the government's commitment to hydrogen as a medium to decarbonise several sectors of the economy (including transport, power generation and heating) to support the UK in meeting its net zero target by 2050. Included in this, the UK government reiterated its 5 GW low carbon hydrogen production target by 2030, and set out the basic tenets of its proposed hydrogen business model aimed at incentivising low carbon hydrogen production, with the intention to finalise the model in 2022, and to award the first contracts in Q1 of 2023. The strategy emphasises that government action alone is not enough to successfully scale up the hydrogen economy and stresses that collaboration with industry and innovation is imperative in creating a viable and enduring hydrogen economy. In April 2022, the Government published its British Energy Security Strategy which updated some of the targets set out in the UK Hydrogen Strategy. This included a commitment to double its ambitions for hydrogen production capacity to 10 MW by 2030, with at least half coming from electrolytic hydrogen, an ambition to run annual allocation rounds for Government support for electrolytic hydrogen production and to develop a hydrogen transport and storage business model by 2025.

The strategy sets out a number of policies that the UK government is considering on the demand-side to bolster the UK hydrogen market. These include a combination of existing policies together with new suggested policies, including:

- **Carbon pricing**: strengthening the demand for and investment in low carbon technologies (such as hydrogen) through expansion of the UK Emissions Trading Scheme (**ETS**) and Carbon Price Support so that carbon becomes an increasing cost for industry;
- **Low Carbon Hydrogen Standard**: undertaking a consultation for developing a UK low carbon hydrogen standard so that end users have confidence that hydrogen is a low carbon alternative to existing fuels, and more broadly, to ensure that UK hydrogen projects are consistent with the UK's net zero ambitions. The government published its response to this consultation in April 2022 (together with its guidance document regarding the methodology of calculating the emissions associated with hydrogen production). Respondents included a variety of stakeholders in the hydrogen sector and energy industry. and the document sets out a summary of respondents' responses to the consultation together with the government's proposed policy design and next steps for implementing a low carbon hydrogen standard. Importantly, the consultation confirms that producers seeking support through government schemes and policies that apply the standard (such as the Net Zero Hydrogen Fund and Hydrogen Business Model) will have to prove compliance with the standard at the point of application for government support and throughout the life of their contract or funding agreement; and
- **Sector-specific policies**: supporting the use of low carbon hydrogen using existing sector policies such as the Renewable Transport Fuel Obligation in transport, the Capacity Market in the power sector and the Industrial Energy Transformation Fund in industry.

The Government's response to the Low Carbon Hydrogen Business Model consultation (including an indicative heads of terms) confirmed that the business model for low carbon hydrogen will be based on the UK's Contract for Difference contractual support model that has been successful in rolling out and expanding renewable energy generation in the UK. This model aims to mitigate price risk and encourage production of hydrogen by setting a 'strike price' where if the hydrogen reference price is below the agreed 'strike price', producers' revenues are

topped up to the 'strike price'. To the extent the reference price for hydrogen is above the 'strike price', producers will be required to repay the excess above the 'strike price'. At this stage, there are still relatively few details regarding how a hydrogen reference price will be calculated and the government has confirmed that it will continue to develop the business model with an aim to finalise the model in 2022. Given the absence of a hydrogen price benchmark, the UK government has confirmed that it will proceed by developing a detailed design of the proposed hydrogen reference price based on an achieved sales price, with a floor at the natural gas price and move to the development of a 'contractual mechanism' to enable price discovery.

The UK has some ways to go to scale up its hydrogen programmes that are very much in their infancy, however, the publication of its hydrogen strategy together with the publication of the its responses to the first of its commissioned consultations provide an encouraging roadmap for the expansion of blue and eventually green hydrogen.

- **Central & Eastern Europe**

  Several governments in Central and 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, 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 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 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** The EU Hydrogen Strategy (Hydrogen Strategy for a Climate-Neutral Europe), adopted in July 2020, aims to accelerate the development of clean 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. The last year has been marked by EU implementation efforts, with a focus on creating a legal framework for a hydrogen infrastructure. Albeit the legislative process is not finished the proposal for a Hydrogen and Decarbonised Gas Package can be named here.	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

No.	Description	Key Players
3.	**Proposal for a Regulation on guidelines for trans-European energy infrastructure and repealing Regulation (EU) No 347/2013** In December 2020, the European Commission initiated a revision of the Regulation 347/2013 on guidelines for trans-European energy infrastructure (**TEN-E Regulation**) in order to adapt the rules for the definition and selection of projects of common interest. As the European Commission expects the role of hydrogen to grow significantly by 2050, the revised TEN-E Regulation will reflect the changing landscape with an increased role for renewable and low carbon gases by creating a new category of infrastructure for smart gas grids; supporting investments at distribution and/or transmission level to integrate green gases (typically biogas and biomethane but also hydrogen) in the network. To support the decarbonisation needs of the hard-to-abate sectors, TEN-E Regulation will also include dedicated new and repurposed hydrogen networks with cross border relevance.	European Commission
4.	**EU Taxonomy Regulation** The EU Taxonomy Regulation (EU) 2020/852 is a classification system set up to establish a list of environmentally sustainable economic activities by defining six environmental objectives and the overarching conditions that an economic activity has to meet in order to qualify as environmental sustainable. In June 2021, the European Commission published the EU Taxonomy Climate Delegated Act in which the first two environmental objectives (contribution to climate protection and adaptation to climate change) were further developed. The production of hydrogen, of hydrogen-based fuels and the manufacturing of machines used for the hydrogen production have been determined to be a sustainable economic activity for climate protection. At its core, the taxonomy compliance of hydrogen production and related activities depends on not exceeding greenhouse gas emissions threshold. Only if these activities meet the life-cycle GHG emission saving requirement of 73.4% (resulting in life-cycle GHG emissions of less than $3tCO_2e/tH_2$) do they comply with the EU taxonomy requirements.	European Commission
5.	**European Commission delegated Regulation supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by setting out appropriate rules for the production of renewable hydrogen from electricity (unpublished)** The draft of this Delegated Act (based on Article 27 para. 3 RED II), serves to implement the Renewable Energy Directive (RED II). It establishes a methodology setting out detailed rules which have to be fulfilled in order to produce hydrogen accountable as renewable under the RED II. In this respect, renewable hydrogen requires in particular the exclusive use of renewable energy sources. Different rules for electricity sourced from directly connected installations and electricity taken from the grid are applicable. The adoption of the delegated act is currently pending and the draft is currently unpublished.	European Commission
6.	**Proposal for an amendment of Directive (EU) 2018/2001 of the European Parliament and of the Council** As part of the 'Clean Energy for all Europeans' initiative, the EU legislator approved the RED II in 2018. Like its predecessor act, RED II sets targets for the consumption of renewable energy in different sectors. Through RED II, the overall EU target for renewable energy sources consumption by 2030 has been raised to 32%, with a sub-target for transport of 14%. The expansion of the green hydrogen production is of great importance in this context. Green hydrogen is in itself not defined in RED II (but has to be defined by the still yet to be published delegated Act based on Article 27 para. 3 RED II). In July 2021, a proposal for an amended RED II was published, even though the RED II has not been fully implemented by member states and the European Commission. The amendment, if implemented, could lead to an expansion of the RED II renewable hydrogen requirements to other sectors than the transportation sector.	European Commission

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
7.	**Proposals for the recast of the European Gas Market Directive 2009/73 and Regulation 715/2009** In December 2021, the European Commission proposed a recast of the 2009 Gas Market Directive and as well as of the Gas Market Regulation to facilitate the network integration of hydrogen. The proposals aim to enable a transition from natural gas and to allow for renewable and low-carbon gases, such as renewable hydrogen, to play their needed role towards the goal of EU climate neutrality in 2050. Key actions are the establishment of common rules for related to the organisation and functioning of the hydrogen market, the introduction of regulated third party access as the default option in the gas market, approval of blending of gases with a hydrogen content of up to 5% by volume within the networks, supply and storage of hydrogen as well as the regulation of hydrogen networks.	European Commission
B	**Specific grants, programs & incentives**	
8.	**InvestEU-programme** The InvestEU-programme is one of the pillars of the overarching Just Transition Mechanism (**JTM**). 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
9.	**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). It will run until 2027. 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 EUR 5 billion to Horizon Europe.	European Commission Hydrogen Europe
10.	**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

No.	Description	Key Players
11.	**European Clean Hydrogen Alliance** The European Clean Hydrogen Alliance supports the large-scale deployment of clean hydrogen technologies by 2030. It aims to promote investments and stimulate the roll-out of clean hydrogen production and use. Set up in July 2020, the European Clean Hydrogen Alliance is part of EU efforts to ensure industrial leadership and accelerate the decarbonisation of industry in line with its climate change objectives. In April 2021 the European Commission launched the project collection for European Clean Hydrogen Alliance investment pipeline. The objective is to scale up the deployment of clean hydrogen in Europe. The Strategy sets the objective to install 6 GW of renewable hydrogen electrolysers and produce up to 1m tonnes of renewable hydrogen by 2024, and 40 GW of renewable hydrogen electrolysers and 10m tonnes renewable hydrogen by 2030.	European Clean Hydrogen Alliance, European Commission
12.	**Technical Guiding Templates for EU State Aid** In December 2020, the European Commission published a set of technical guiding templates on how hydrogen-related projects can be supported in line with the EU State Aid rules. As part of the "European flagships" of the European Commission's Annual Sustainable Growth Strategy 2021 two technical guiding templates which are directly concerned with hydrogen infrastructure and production have been published.	European Commission
13.	**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.	IPCEI
14.	**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
15.	**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 CO_2 emissions.	Hydrogen Europe
16.	**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 EUR 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
17.	**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

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
18.	**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
19.	**Revised State aid guideline for energy and environmental protection** As pointed out in the European Hydrogen Strategy of 2020, adapted guidelines for the state aid rules create an opportunity to further advance decarbonisation through the deployment of hydrogen (among others). In December 2021, the European Commission adopted its revised Guidelines on State aid for environmental protection and energy. The new guidelines extend the scope of the guidelines by including new areas such as clean mobility and decarbonisation. Aid for the production of renewable hydrogen is also included in the new Guidelines under the conditions of RED II and its delegated acts.	European Commission
20.	**Just Transition Fund** The Just Transition Fund (**JTF**) is one of the pillars of the overarching Just Transition Mechanism (**JTM**). 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
21.	**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. In this context, the European Commission published a set of technical guiding templates on how hydrogen-related projects can be supported in line with the EU State Aid rules. The first recovery plans of the member states have been approved by the European Commission in mid-2021.	European Commission European Investment Bank
22.	**CertifHy** The CertifHy project is a private initiative led by multiple stakeholders aiming to develop a European-wide definition of green and low-carbon hydrogen and aiming to establish a common guarantee of origin scheme for hydrogen in compliance with the RED-II. The project encompasses the entire life cycle from auditing hydrogen production plants, certification of green or low carbon hydrogen production batches, issuing, trading as well the application of the guarantees of origin. The project has already undergone Phase 1 and Phase 2 which involved primarily the preparation of a widely acceptable definition of green hydrogen and the design of the proposed European-wide guarantee of origin scheme. In October 2020, Phase 3 was launched and is expected to continue to run until the end of 2023. The main objective of Phase 3 is to implement the guarantee of origin scheme building up on the normative outcomes of previous phases.	Private initiative by multiple stakeholders

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
23.	**Guarantee of Origin** Guarantee of Origin were first introduced in the context of renewable electricity. Through RED II, Guarantee of Origin has also been introduced in the context of gases, e.g. hydrogen. The member states are now obliged to implement a respective guarantee of origin system. The extension of the guarantees of origin regime aims at providing a consistent means of proving to final customers the origin of renewable gas such as hydrogen.	European Commission
24.	**European Commission's Database of Renewable and Low Carbon Fuels, including Hydrogen** The European Commission is planning to introduce a Europe-wide certification scheme for the carbon footprint of low-carbon fuels and low-carbon hydrogen. The scheme is being developed as part of the planned revision of RED II and has also been taken up in the proposed recast of the European Gas Market Directive in December 2021. The European Commission has therein set itself a deadline until the end of 2024 to define the methodology for assessing greenhouse gas savings from low-carbon fuels. The methodology should, among other things, ensure that the avoided emissions credit is not given for carbon dioxide that has already been captured under other legislation.	European Commission
25.	**Hydrogen 'Colour' Classification Scheme** The European Commission has suggested definitions for renewable as well as for low-carbon hydrogen in its proposal for a European Gas Market Directive, which is not yet approved. This can be seen as a basis for a European hydrogen colour system, once the respective proposal was approved by the European legislator. The European Commission defines renewable hydrogen (or green hydrogen) by reference to Article 2 point 36 and Article 29a of the proposal for an amendment of RED II as liquid and gaseous fuels that derive its energy content from renewable sources other than biomass; and achieves a 70% GHG emission reduction compared to fossil fuels. Low-carbon hydrogen, known as blue hydrogen, is defined in Article 2 point 10 of the proposed European Gas Market Directive as hydrogen with an energy content that is derived from non-renewable sources, and that meets a GHG emission reduction threshold of 70% compared to fossil-based hydrogen.	European Commission

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, utilisation 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 plan of actions in order to secure the success of the strategy and targets 5 GW of electrolyser capacity by 2030. The strategy was implemented in 2021 through a series of measures: namely the amendments of the Energy Industry Act 2021 (**EnWG** 2021) and the Renewable Energies Act (**EEG** 2021), which address a number of questions concerning hydrogen. A number of funding schemes to intensify the hydrogen production and research have also been introduced.	German Government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**Amendment of the Energy Industry Act** In July 2021, the EnWG 2021 has entered into force. It contains a new regulatory regime for pure hydrogen networks which will be held separately from gas networks, when it comes to their regulation. It introduces a voluntary opt-in regulation for pure hydrogen networks. The use of the opt-in has consequences with regards to among others the rules concerning the unbundling, according to which hydrogen network operators are not allowed to simultaneously also produce, store or distribute hydrogen and concerning network tariffs. Additionally, the EnGW 2021 introduces rules for conversion of natural gas pipelines to hydrogen pipelines and non-discriminatory third party access.	German legislator
3.	**Amendment of the Renewable Energies Act and the establishment of Green Hydrogen Ordinance EEG 2021** Under the Renewable Energies Act, energy consumers in Germany generally have to pay a renewable surcharge which forms part of the electricity price. In order to reduce the production costs of hydrogen, electricity used to produce green hydrogen can be exempted from the EEG levy. As a consequence, pursuant to the new EEG 2021 and its complementing Green Hydrogen Ordinance (**EEV** 2021), which both entered into force in 2021, companies producing green hydrogen can be 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 benefit from a reduction of the EEG levy. According to section 12i EEV 2021, green hydrogen is hydrogen that has been produced electrochemically in the first 5,000 hours of full use of a calendar year in a facility by the exclusive consumption of electricity that demonstrably originates from facilities for the generation of electricity from renewable energies.	German legislator
4.	**Amendment of the Federal Emission Control Act** In July 2021 an amendment of the Federal Emission Control Act (**BImSchG**) entered into force. It aimed at implementing the RED II by increasing the greenhouse gas reduction quotas (*Treibhausgasminderungsquote*) to 25% by 2030. The BImSchG offers different fulfilment options (*Erfüllungsoptionen*), one of them being the use of liquid or gaseous renewable fuels of non-biological origin, such as hydrogen if further requirements are met.	German legislator
B	**Specific grants, programs & incentives**	
5.	**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
6.	**Energy Research Programme** This programme provides funding of up to EUR 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
7.	**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 EUR 700 million.	German Federal Ministry of Education and Research

No.	Description	Key Players
8.	**Climate Protection Emergency Program 2022** The Climate Protection Emergency Program 2022 includes a pledge for around EUR 8 billion in order to reduce greenhouse gas emissions and introduces programs to stimulate greenhouse gas free and low greenhouse gas industrial processes. Measures in the energy sector include: the development of national structures for the additional production of hydrogen from offshore wind power generation is to be initiated and the H2Global program which aims at stimulating the international hydrogen market by purchasing green hydrogen abroad with long-term contracts and reselling it in Germany via annual auctions. In December 2021, the European Commission approved the H2Global scheme under EU State aid rules.	German Government
9.	**Announcement of the funding guideline for international hydrogen projects** In September 2021, the German government published a new funding guideline which aims at promoting international cooperation in the field of green hydrogen and the derivatives produced from it, as well as storage, transport and integrated application technologies. It is also intends to effectively support the market ramp-up of green hydrogen and its derivatives, accelerate the creation of an international market for these products, and contribute to achieving climate protection goals and strengthening the economy. Fundable projects are divided into module 1 projects and module 2 projects. Module 1 projects aim to develop sustainable production options for green hydrogen and its derivatives. Under the funding guidelines hydrogen is considered green if it is produced from water by electrolysis on the basis of renewable energies. Module 2 projects comprise accompanying research projects as well as preparatory or accompanying scientific analyses and studies.	German Federal Ministry for Economic Affairs and Energy, Federal Ministry of Education and Research
10.	**German IPCEI's** In May 2021, the German Federal Ministry of Economic Affairs and the German Federal Ministry of Transport selected 62 large-scale hydrogen projects to receive government funding as part of the IPCEI-funding. The German government pledged EUR 8 billion in state subsidies, the aim is for the projects to be approved by the European Commission under state aid law before the end of 2021.	German Federal Ministry for Economic Affairs and Energy, German Federal Ministry of Transport
11.	**Australia – Germany Hydrogen Accord** In June 2021, the Australian and German governments announced a Declaration of Intent between the Australian government and the Germany government on the Australia-Germany Hydrogen Accord. In this context, the Case for an Australian Hydrogen Export Market to Germany: State of Play report analysed the costs of producing hydrogen and hydrogen-based energy carriers (such as ammonia) using renewable energy, and shipping options for export to Germany. The report showed that Australia will be competitive as a hydrogen exporter, even when compared to countries located closer to Germany. Both countries agreed to partner up in establishing a German-Australian Hydrogen Innovation and Technology Incubator (**HyGATE**), facilitating the cooperation in the Australian hydrogen hubs and exploring options to facilitate the trade of hydrogen.	Australian government Federal Republic of Germany

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
12.	**Rules of Origin** In Germany, rules of origin exist in relation to electricity from renewable energies (section 79 EEG 2021). Section 79 EEG serves to implement the corresponding rules of RED II. The German government opted to empower the Federal Environment Agency (Umweltbundesamt) to issue guarantees of origin for electricity from renewable energy mixes, provided that no financial support has been received elsewhere in the EEG. So far, there are no guarantees of origin for green hydrogen established in German law. Indirectly, hydrogen production in Germany is also linked to certificates of origin: the requirements for green hydrogen include the use of electricity from renewable energy, section 12i EEV 2021. In the event that electricity is taken from the grid, the invalidation of certificates of origin is required.	Federal Environment Agency

France

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Strategy for the development of low-carbon hydrogen** In 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 EUR 7 billion of funding through to 2030.	French Government Agency for ecological transition (**Ademe**)
2.	**Hydrogen Ordinance** In February 2021, the French government adopted the Ordinance No. 2021-167 on hydrogen codified in Article L.811-1 et seq. of the French Energy Code. This ordinance is the first specific framework applicable to production, transmission, distribution, storage and sale of hydrogen. This new legal framework has been adopted to encourage the development of hydrogen in France and the achievement of the objectives listed in the National Strategy for the development of low-carbon adopted in 2020.	French Government
3.	**France 2030 Investment Plan** President Emmanuel Macron stated, on 12 October 2021, that the France 2030 investment plan planned to allocate EUR 2 billion of funding, in completion of the National Strategy for the development of low-carbon hydrogen.	French Government
B	**Specific grants, programs & incentives**	
4.	**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 EUR 275 million between 2020 and 2023.	Ademe
5.	**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 EUR 350 million budget until 2023.	Ademe

No.	Description	Key Players
6.	**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
7.	**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 EUR 65 million.	French National Research Agency (**ANR**)
8.	**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
9.	**Call for expression of interest 'Hydrogen IPCEI'** French General Direction for Businesses organised a call for expression of interest to illustrate its will of putting a hydrogen IPCEI in place. Nevertheless, such a project can only be put in place after a revision of the TEN-E Regulation, expected in mid-2022.	French Government
10.	**Purchasing obligations for green vehicles** Laws n°2015-992 of 17 August 2015 ; n°2021-1104 of 22 August 2021 and Ordinance n°2021-1490 of November 17 2021 establish purchasing obligations of green vehicles for public entities and companies replacing old vehicles. The green vehicle category includes hydrogen powered vehicles.	French Government
11.	**Call for tenders Contracts for Difference (CFD)** The French government has stated it will to launch, in 2022, the first calls for tenders for the first decarbonised hydrogen CFD's (this includes low carbon and renewable hydrogen).	French Government
C	**Guarantee of Origin / 'colour' classification requirements**	
12.	The national regulatory framework does not use a colour code for hydrogen. It refers to renewable, low-carbon and fossil hydrogen. For instance, in order to be classified as "renewable energy" hydrogen must be produced either by electrolysis using electricity from renewable energy sources or by any other technology using exclusively one or more renewable energy sources and not conflicting with other uses allowing their direct valorisation. In all cases, its production process shall emit, per kilogram of hydrogen produced, a quantity of carbon dioxide equivalents less than or equal to a threshold which has not yet been set.	French Government

Netherlands

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Government Strategy on Hydrogen (National Policy)** The national policy 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 (e.g. 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 (e.g. through international cooperation).	Netherlands Government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
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
3.	**Pentalateral Energy Forum** In this joint political declaration, dated June 2020, the Ministers of Energy of the Pentalateral Energy Forum, namely Austria, France, Germany, Switzerland and the Benelux affirm their commitment to strengthen their cooperation on the production of green hydrogen with the aim of contributing to the full decarbonisation of the energy system.	France, Austria, Netherlands, Switzerland and Benelux governments
4.	**The Energy Act** There is currently no specific regulatory framework applicable to hydrogen in the Netherlands. The Gas Act (setting out the rules applicable to the transmission and supply of gas) and the Electricity Act (providing the rules applicable to the production, transportation and supply of electricity) do not contain any specific provisions regarding hydrogen. The Dutch legislator is working on an Energy Act, which is intended to both combine and replace the existing Gas and Electricity Acts.	Netherlands Legislator
B	**Specific grants, programs & incentives**	
5.	**SDE++ subsidy** Stimulation of Sustainable Energy Transition (**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++ 2021 was EUR 5 billion. It was confirmed that the budget of the SDE++ 2022 (which opens in June 2022) will be increased from EUR 5 billion to a maximum of EUR 11 billion. It is not yet known by how much the base budget of EUR 5 billion will actually be increased. The functioning of the SDE++ programme in 2022 remains similar to the functioning of the SDE++ 2021 programme.	Netherlands government (Ministry of Economic Affairs and Climate Policy)
6.	**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 a certain percentage of the eligible costs of technologies that reduce CO_2 emissions, including hydrogen-based projects. The subsidised percentage of each project will depend on the type of project (e.g. an environmental project or other CO_2-reducing measures will benefit from a subsidy rate of 40%, while project developing energy efficiency will benefit from a subsidy rate of 30%) and the size of the company (i.e. small and medium-sized enterprises will benefit from an additional 10% and 20% subsidy, respectively). The opening budget of the DEI+ 2020 scheme was EUR 86.1 million and the maximum amount of money a single project can receive is EUR 15 million. It was possible to apply for the DEI+ 2020 scheme from 15 January 2020 to 7 January 2021. The opening budget of the DEI+ 2021 scheme is EUR 126.6 million and the maximum amount of money a single project can receive is EUR 15 million.	Netherlands government (Ministry of Economic Affairs and Climate Policy)

No.	Description	Key Players
7.	**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 EUR 6 per gram of CO_2 (level 1) to EUR 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
8.	**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
9.	**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
C	**Guarantee of Origin / 'colour' classification requirements**	
10.	**Guarantee of Origin** In its Government Strategy on Hydrogen, dated 6 April 2020, the Netherlands government stated that in order to facilitate a market for zero-carbon hydrogen, a reliable system of Guarantee of Origin and certification will be required. The development of a Guarantee of Origin system is required under RED-II. As agreements will have to be reached regarding definitions, the Netherlands will coordinate and cooperate with other European countries in the development of the Guarantee of Origin system, the final aim being to implement RED-II as coherently as possible. Vertogas, at present already responsible for the Guarantee of Origin system for green gas, has been designated to develop the Guarantee of Origin system.	Netherlands government, Vertogas

Belgium

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Federal Hydrogen Vision and Strategy** Belgium unveiled its federal hydrogen vision and strategy plan in October 2021. The plan aims to ensure that Belgium becomes a centre for the import and transit of renewable green hydrogen by 2030 and to help reach its energy and climate objectives of greenhouse gas reduction by 2030 and carbon neutrality by 2050. The plan focuses on developing low-carbon and green hydrogen technologies (with the former being a transitional measure to aid with the large-scale development of the latter) in the industrial, transport and power sectors. It is based on four pillars. The first is to ensure that Belgium becomes an important transit and import hub for green hydrogen in Europe. The second is to make Belgium a global leader in hydrogen technologies. The third is to create a strong hydrogen market, a "hydrogen backbone", much like what is being proposed in the Netherlands. Finally, the fourth pillar is to ensure both intranational (between the governments and stakeholders of the regions of Brussels, Flanders and Wallonia) and international cooperation in order to achieve the first three pillars.	Belgium federal and regional governments

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**Pentalateral Energy Forum** In this joint political declaration dated June 2020, the Ministers of Energy of the Pentalateral Energy Forum, namely Austria, France, Germany, Switzerland and the Benelux affirm their commitment to strengthen their cooperation on the production of green hydrogen with the aim of contributing to the full decarbonisation of the energy system.	France, Austria, Netherlands, Switzerland and Benelux governments
B	**Specific grants, programs & incentives**	
3.	**Federal Energy Transition Fund** The Energy Transition Fund aims to encourage and support research, development and innovation in the field of energy within the competences of the federal government. It presents three axes, one of which is the "renewable energy sources in the Belgian exclusive economic zone of the North Sea and biofuels". The energy transition fund budget for 2021 was EUR 25 million, to be divided among these three axes. It was possible to apply for the fund until 21 January 2021. The budget for 2022 will be EUR 25 million, which can be awarded as a subsidy to projects that meet all the relevant conditions and relate to research and development, investment in research infrastructure and/or innovation by small or medium-sized enterprises. Applications closed in January 2022. The amount of support that each project will receive depends on the company size and on the project's objective (e.g. fundamental research may be 100% covered by the fund, while only 25% of the costs of experimental development will be covered by the fund).	Belgium federal government
4.	**Belgium Recovery Plan** In the wake of the Covid-19 pandemic, Belgium issued a EUR 5.9 billion recovery plan that was greenlit by the European Commission on 23 June 2021. Amongst other things, the plan supports the decarbonisation of the energy sector by promoting the use of hydrogen as an energy source, by way of an investment of EUR 540 million and an accompanying reform aimed at making it happen.	Belgium federal government
C	**Guarantee of Origin / 'colour' classification requirements**	
5.	**Federal Hydrogen Vision and Strategy** The Belgian Federal Hydrogen Vision and Strategy unveiled on 29 October 2021 refers to the need for a cross-jurisdictional certification system for renewable fuels, which would include renewable hydrogen and its derivatives. Since Belgium's plan is mainly to become a hub for import and transit of renewable hydrogen, it must be able to verify whether the latter is, in fact, "green".	Belgium federal government

Sweden

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Government Strategy on Hydrogen (National Policy)** The government had instructed Fossil Free Sweden (*Fossilfritt Sverige*) to present a national hydrogen strategy. The proposed strategy was presented on 25 November 2021 and, amongst other matters, discusses issues such as the development of frameworks and regulations and financial incentives.	Swedish government

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
2.	***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 production technology using hydrogen. Industriklivet has further in 2021 allotted support to e.g. the steel-company Ovako in Hofors municipality of SEK 70 million for the investment in a facility for production of hydrogen to replace liquefied petroleum gas for the heating of steel.	Swedish Energy Agency
3.	**Greener transport in the Nordic region with hydrogen initiative** The 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**). The Nordic Hydrogen Corridor initiative is project managed by Hydrogen Sweden (*Vätgas Sverige*). In 2022, the project will deliver 8 new hydrogen fuel stations, a number of hydrogen vehicles and a larger facility for renewable hydrogen production.	Hydrogen Sweden Commercial stakeholders
4.	***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. The applicant may receive a maximum of 20% of the green vehicle's purchase price and the support is only (at present) expected to be available until 2023.	Swedish Energy Agency
5.	**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.	Swedish Foundation for Strategic Research
6.	***Klimatklivet*** *Klimatklivet* is an investment support program for local and regional measures that provide reduction in greenhouse gas emissions. Klimatklivet is managed by the Swedish Environmental Protection Agency (*Naturvårdsverket*). Support can e.g. be given to measures in transport, charging infrastructure, energy and industry, agriculture, real estate and recycling. *Klimatklivet* has granted Strandmöllen AB investment support of SEK 50 million for the construction of a facility for hydrogen production in Ljungby municipality. The company will produce renewable hydrogen, so-called green hydrogen, through electrolysis of water. The Dutch company OrangeGas has received investment support of SEK 20+ million from *Klimatklivet* to establish hydrogen gas refueling stations in Sweden. The company Maserfrakt received support of SEK 7.7 million from *Klimatklivet* to build a hydrogen gas facility. Svea Vind Offshore will collaborate with Maserfrakt on the hydrogen deliveries. In 2022 new requirements are expected in regards to applications for support within *Klimatklivet* for public charging-stations and hydrogen fueling stations.	Swedish Environmental Protection Agency

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
7.	No specific developments to report.	

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. Hydrogen is expected to be covered in a new national energy and climate strategy.	Business Finland; Ministry of Employment and Economy
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 EUR 100 million will be granted to smart energy solution innovations under the program between 2017-2021.	Business Finland
B	**Guarantee of Origin / 'colour' classification requirements**	
4.	No specific developments to report.	

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 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 2021, after the European Commission approved the draft, the final version of the National Integrated Energy and Climate Plan 2021-2030 was adopted. 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

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. During 2021, state and regional plans have been projected and their development monitored. These first developments will be reviewed in 2023.	Spanish Government
B	**Specific grants, programs & incentives**	
6.	**Funds aimed at Green Hydrogen** In November 2020, the Spanish government announced that EUR 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 encouraging renewable hydrogen as opposed to hydrogen with untraceable origins. Within the framework of the Plan to Promote the Automotive Industry Value Chain, a reform of vehicle taxation, in coordination with the Territorial Authorities (Road Tax and Registration (Tax)), introduces 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 Center 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

No.	Description	Key Players
9.	**Govern Balear Power to Green Hydrogen Mallorca** The Autonomic government of the Balearic Islands together with various companies have carried out the execution of the Power to Green Hydrogen Mallorca Project that will allow from 2021 to build a green hydrogen production plant to supply non-polluting energy to sustainable mobility vehicles, both public (through EMT buses) and private fleets; as well as to hotel plants in the bays of Alcúdia and Pollença, and to the industrial estate of Inca.	Autonomic government of Islas Baleares
C	**Guarantee of Origin / 'colour' classification requirements**	
10.	In September 2021, the Ministry for Ecological Transition and the Demographic Challenge (**MITECO**) released a draft royal decree for informational purposes that will create a system of guarantees of origin for renewable gases, such as green hydrogen, biogas or biomethane, which will allow marketers and consumers to differentiate them from fossil origin gas. The draft regulation also includes the sustainability criteria contained in the EU regulations for solid biomass and biogas, biofuels and bioliquids for transport, electricity, heating and cooling, as well as the biofuel penetration targets from 2023.	MITECO

Italy

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**National Integrated Plan for Energy and Climate** 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
2.	**National Recovery and Resilience Plan** The Next Generation EU programme allocated EUR 191.5 billion in grants and loans to Italy. Within this framework, in April 2021, the Italian government presented to the European Commission the National Recovery and Resilience Plan (*Piano Nazionale di Ripresa e Resilienza* – **PNRR**), which proposes to utilise around 60% of the funds for the transition to a green economy. In particular, the development of flagship projects for the use of hydrogen in hard-to-abate industrial sectors and in heavy transports have been included amongst the goals of the PNRR. To achieve this, the PNRR will finance the development of 1 GW of electrolysation power, promote the creation of the so-called "hydrogen valleys" in decommissioned industrial sites and support R&D. Overall, it is estimated that 5 GW of electrolysation power will be installed in Italy by 2030. The PNRR also plans to create a legal environment to regulate the use and transport of hydrogen, as well as by simplifying the bureaucracy burdening the authorisation procedures for small sized green-hydrogen production plants. Greater details on the approach to promote and implement the production and transport of hydrogen will be outlined in the forthcoming Hydrogen Strategy (*Strategia Idrogeno*).	Italian Government

No.	Description	Key Players
3.	**Hydrogen Strategy Preliminary Guidelines** The Hydrogen Strategy Preliminary Guidelines outline the Italian government's goals and ambitions, to be pursued in the Hydrogen Strategy. In the long term (up to 2050), the Italian government's strategy is to support decarbonisation. In the short term (up to 2030) the strategy is to make the implementation of hydrogen based solutions progressively more competitive to allow the development of a system capable of exploiting the full potential of hydrogen technologies in the long term. Pursuant to these Guidelines, the legal framework regulating the transports sector will evolve with the aim of pursuing decarbonisation and setting new emission standards for Original Equipment Manufacturers. Moreover, the guidelines contemplate a global investment of up to EUR 10 billion between 2020 and 2030, of which (i) around EUR 5-7 billion for the production of hydrogen; (ii) around EUR 2-3 billion in infrastructures and machinery for the distribution and use of hydrogen; and (iii) around EUR 1 billion in R&D. The expected effects of this stimulus would be that of a positive increase of around EUR 27 billion on the Italian GDP, with the creation of more than 200,000 temporary workplaces and 10,000 permanent workplaces. The sources for these investments will be collected through the Sustainable Growth Fund (*Fondo Crescita Sostenibile*), the August Law Decree (*DL Agosto*) and the Mission Innovation fund. Furthermore, the pursuit of these goals shall also be financed through the National Electric System Research Programme (Ricerca Sistema Elettrico Nazionale), the Clean Tech Fund (*Fondo Clean Tech*) and the Cohesion Fund (*Fondo Coesione*).	Italian Government
B	**Specific grants, programs & incentives**	
4.	**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 are 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*). In detail, the PNRR will finance 1 GW of electrolysation by reconverting decommissioned industrial areas, with a production of around 1 to 5 MW per site. Hydrogen thus produced will be delivered to local industries through existing pipelines (compounded with methane) or by means of road transport. Moreover, the plan contemplates the establishment of 49 hydrogen fuel stations for both road and rail transport in strategic areas. Hydrogen will be used to substitute diesel trains in those areas where electrification of train lines is inefficient (see in particular the Val Camonica and Salento projects). In this context, to supply fuel to hydrogen trains, the PNRR contemplates to promote the research and development of high pressure electrolysers and high capacity storage systems. Furthermore, the PNRR plans to promote the implementation of fiscal incentives and green taxes to boost the production and use of green hydrogen.	Italian Government

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
10.	The PNNR contemplates the creation of a guarantee of origin classification to allow consumers to identify hydrogen produced through electrolysis. This certification will be issued by the Italian Regulatory Authority for Energy, Networks and Environment (**ARERA**) and by *Gestore dei Servizi Energetici GSE S.p.A.* (**GSE**).	ARERA and GSE

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 (which has been confirmed in the UK's hydrogen strategy published in August 2021). 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 (see below). 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
2.	**UK hydrogen strategy** The UK's hydrogen strategy reaffirms the UK government's commitment to producing 5 GW of low carbon hydrogen by 2030 and provides a roadmap for the supporting policies and activities that will be required by both governmental and private actors to achieve this. The UK government updated this strategy in April 2022, including a commitment to double its planned hydrogen production capacity to 10 MW by 2030.	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)** This 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.	**£1 billion Net Zero Innovation Portfolio** This fund is designed to support the development of green technologies for the UK to meet its climate change targets. Hydrogen has been identified as one of the ten key priority areas that will be supported by the fund.	Department for Business, Energy and Industrial Strategy
6.	**Low Carbon Hydrogen Supply 2 Programme by UK government** Supported by the Net Zero Innovation Portfolio, the Low Carbon Hydrogen Supply 2 Programme looks to build upon the initial Low Carbon Hydrogen Supply Programme and has a total budget of £60 million that can be awarded to projects involved in hydrogen supply, production, storage and transport that could enable low carbon hydrogen to be supplied in sufficient volumes and at competitive pricing.	Department for Business, Energy and Industrial Strategy

No.	Description	Key Players
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 and will be launched in early 2022. A further £81 million multi-year commitment has been allocated to hydrogen heating trials. The fund is currently in its consultation phase and is seeking views on how to maximise its benefits whilst ensuring value for money.	Department for Business, Energy and Industrial Strategy
C	**Guarantee of Origin / 'colour' classification requirements**	
8.	**UK Low Carbon Hydrogen Standard** As part of the UK's hydrogen strategy, the government is considering and is publishing a consultation on the development of a UK low carbon hydrogen standard to give confidence to end users that hydrogen purchased is a low carbon alternative to counterfactual fuels.	UK government

Central & Eastern Europe

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Czech Republic´s National Hydrogen Strategy** In July 2021, the Czech government approved the National Hydrogen Strategy, prepared by the Ministry of Industry and Trade. The National Hydrogen Strategy is based on four pillars: low-carbon hydrogen production, low-carbon hydrogen utilisation, hydrogen transport and storage and hydrogen technologies. Further, the strategy aims to achieve balance between consumption and production and thus keep hydrogen imports from third countries to minimum.	Czech Ministry of Industry and Trade
2.	**Czech Republic´s National Energy and Climate Plan** In January 2020, the Czech government approved the new National Energy and Climate Plan. Under the plan, the Czech Republic aims to extend use of hydrogen as fuel for transportation (the project of hydrogen mobility).	Czech Government
3.	**Czech Republic´s National Energy Conception** In 2014, the Czech Ministry of Industry and Trade issued the National Energy Conception. This document includes, among other information, a plan of development for the use of hydrogen as well as hydrogen research support. The draft of an update of the National Energy Conception should be submitted by the Czech Ministry of Industry and Trade for approval by the end of 2023.	Czech Ministry of Industry and Trade
4.	**Czech National Action Plan for Clean Mobility** The Plan was prepared in 2015 as required by the EU Directive 2014/94 and 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 simulating 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 was approved in June 2021. The Strategy includes, among other things, Slovakia's plans on creating the legislative framework and financial conditions for hydrogen production with the use of excess electricity generated in nuclear power plants.	Slovak government Slovak Ministry of Economy

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
6.	**Poland´s National Hydrogen Strategy** In November 2021, the 'Polish National Hydrogen Strategy' was adopted. The strategy includes plans to have 2 GW of hydrogen electrolysis capacity and 800-1,000 Polish-manufactured hydrogen fuel-cell buses with 32 refuelling stations on streets by 2030. It further aims to develop at least 5 hydrogen valleys 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 Energy and Climate Plan' which, among 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 consultations and is expected to be published in 2022. The strategy should 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.	**Austrian Renewable Energy Expansion Act** In July 2021, the Austrian Parliament enacted the Renewable Energy Expansion Act. One part of the act is investment grants in the amount of EUR 80 million per year for the development of technologies for renewable gases, including hydrogen.	Austrian government
12.	**Hungarian National Energy Strategy 2030** In 2012, the Hungarian Ministry of National Development issued the 'National Energy Strategy' which aims to transition public transport to sustainable fuels such as hydrogen and to develop hydrogen infrastructure.	Hungarian Government
13.	**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

No.	Description	Key Players
14.	**Hungary´s National Hydrogen Strategy** In June 2021, Hungary officially published its National Hydrogen Strategy, which in long term focuses on green hydrogen as well as hydrogen based on electricity generated using renewable resources (primarily solar energy). Primary objectives are production of large volumes of low-carbon and carbon-free hydrogen, decarbonisation of industrial consumption (partly with hydrogen), green transport and electricity and gas support infrastructure.	Hungarian Government
15.	**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
16.	**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
17.	**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
18.	**Latvia´s National Energy and Climate Plan** Latvia's Plan, among other things, considers the use of hydrogen as a future alternative fuel to replace petroleum products.	Latvian Government
19.	**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
20.	**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 Central Eastern Europe (**CEE**) governments (Austria, Czech Republic, Hungary, Poland, Estonia, Lithuania, Latvia, Poland, Bulgaria, Romania) 50 companies and organisations

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
21.	**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. In September 2021, the Czech government approved the Operational Transport Program for 2021-2027.	Czech Ministry of Transport
22.	**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). Moreover, it appears that the promotion program will be further extended. 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. However, specific details and conditions of the program are yet to be set out.	Slovak Ministry of Economy
23.	**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
24.	**Mobility of the Future (*Mobilität der Zukunft*)** The funding program Mobility of the Future aims to support research projects that are expected to contribute to developing mobility system of the future, using among others hydrogen. The program includes four thematic areas: (i) innovation in passenger transportation; (ii) reorganisation of freight transport; (iii) developing alternative mobility technologies; and (iv) joint development of road infrastructure.	Austrian Research Promotion Agency (**FFG**)
25.	**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

No.	Description	Key Players
26.	**Estonia's Recovery and Resilience Plan** In June 2021, the Estonian government approved Estonian recovery and resilience plan. Under the plan, approximately one billion EUR will be allocated to investments into the environment and development of digital opportunities, as well as hydrogen technologies. The funding plans to support the green transition of undertakings through a dedicated green fund, the uptake and improvement of innovative and resource-efficient green technologies, the upcycling of bio-resources, the uptake of integrated hydrogen technologies and the development of skills supporting the green transition.	Estonian government
C	**Guarantee of Origin / 'colour' classification requirements**	
27.	**Draft Amendment of the Slovakian Act on Renewable Energy Sources** A register of renewable gases is proposed to be established for the purpose of recording the production of renewable gases and issuance of guarantees of origin for renewable gas. The draft amendment is currently projected to come into force on 1 July 2022. As part of the implementation of the RED II, the Slovak Ministry of Economy prepared an amendment to the Act on Renewable Energy Sources No. 309/2009. The amendment defines the term "renewable gas" which would also cover the so-called green hydrogen (i.e. hydrogen produced by using renewable energy sources). The amendment further envisages the existence of guarantees of origin for renewable gases which will be issued to the producers upon request by SPP – *distribúcia*, the Slovakian distribution system operator. Based on the draft amendment, the register of renewable gases will be established for the purpose of recording the production of renewable gases and issuance of guarantees of origin for renewable gas. The draft amendment is currently projected to come into force on 1 July 2022.	Slovak Ministry of Economy

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. The Uzbekistan President adopted a Decree on Measures for the Development of Renewable and Hydrogen Energy and the Turkmenistan President initiated the Strategy for the Development of Low-Carbon Energy and an international roadmap for hydrogen development. Several hydrogen development projects have been initiated in Kazakhstan, Uzbekistan and Turkmenistan. It is expected that in future years, governments in the region will take additional 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
2.	In September 2021, the President of Kazakhstan instructed the government during his annual address to the nation of Kazakhstan to prepare proposals for the introduction of hydrogen energy in Kazakhstan.	Kazakhstan Government
B	**Specific grants, programs & incentives**	
3.	In 2018, the Kazakhstan government established the International Green Technologies and Investments Center 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
4.	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
5.	JSC NC KazMunayGas, state-owned oil and gas company, has developed a Low-Carbon Development Program which includes both current opportunities to reduce its carbon footprint and additional activities for decarbonisation including development of renewable energy and hydrogen production.	JSC NC KazMunayGas
C	**Guarantee of Origin / 'colour' classification requirements**	
6.	No specific developments to report.	

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 Center 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.	In April 2021, the President of Uzbekistan signed a Decree On Measures for the Development of Renewable and Hydrogen Energy in the Republic of Uzbekistan under which the following is envisaged: □ establishment of the National Research Institute of Renewable Energy Sources under the Ministry of Energy on the basis of International Institute of Solar Energy of the Academy of Sciences; □ establishment of Research Center for Hydrogen Energy and the Laboratory for Testing and Certification of Renewable and Hydrogen Energy Technologies; and □ establishment of Interdepartmental Commission on Development of Renewable and Hydrogen Energy which is instructed to, among other things, ensure the preparation of the National Strategy for the Development of Renewable and Hydrogen Energy.	Uzbekistan Government
4.	The Ministry of Energy of Uzbekistan and the World Bank in 2022 plan to assess the technical potential of Uzbekistan for the production of hydrogen. Based on the results of the study, a road map for the development of "blue" and "green" hydrogen in the country will be developed.	Uzbekistan government The World Bank
C	**Guarantee of Origin / 'colour' classification requirements**	
5.	No specific developments to report.	

Turkmenistan

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	In May 2021, President of Turkmenistan instructed the leadership of the country's fuel and energy complex to increase the pace of work in the field of renewable energy sources and hydrogen energy. At a high-level Global Roundtable on Extractive Industries as an Engine of Sustainable Development, the President of Turkmenistan took the initiative to start developing a Strategy for the Development of Low-Carbon Energy and an international roadmap for hydrogen development within the UN.	Turkmenistan government
B	**Specific grants, programs & incentives**	
2.	No specific developments to report.	N/A
C	**Guarantee of Origin / 'colour' classification requirements**	
3.	No specific developments to report.	N/A

3.5 United States and Canada

Overview

With the introduction of the Infrastructure Investment and Jobs Act in 2021, the United States has now increased its attention on the hydrogen sector. However, 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 remain the 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.

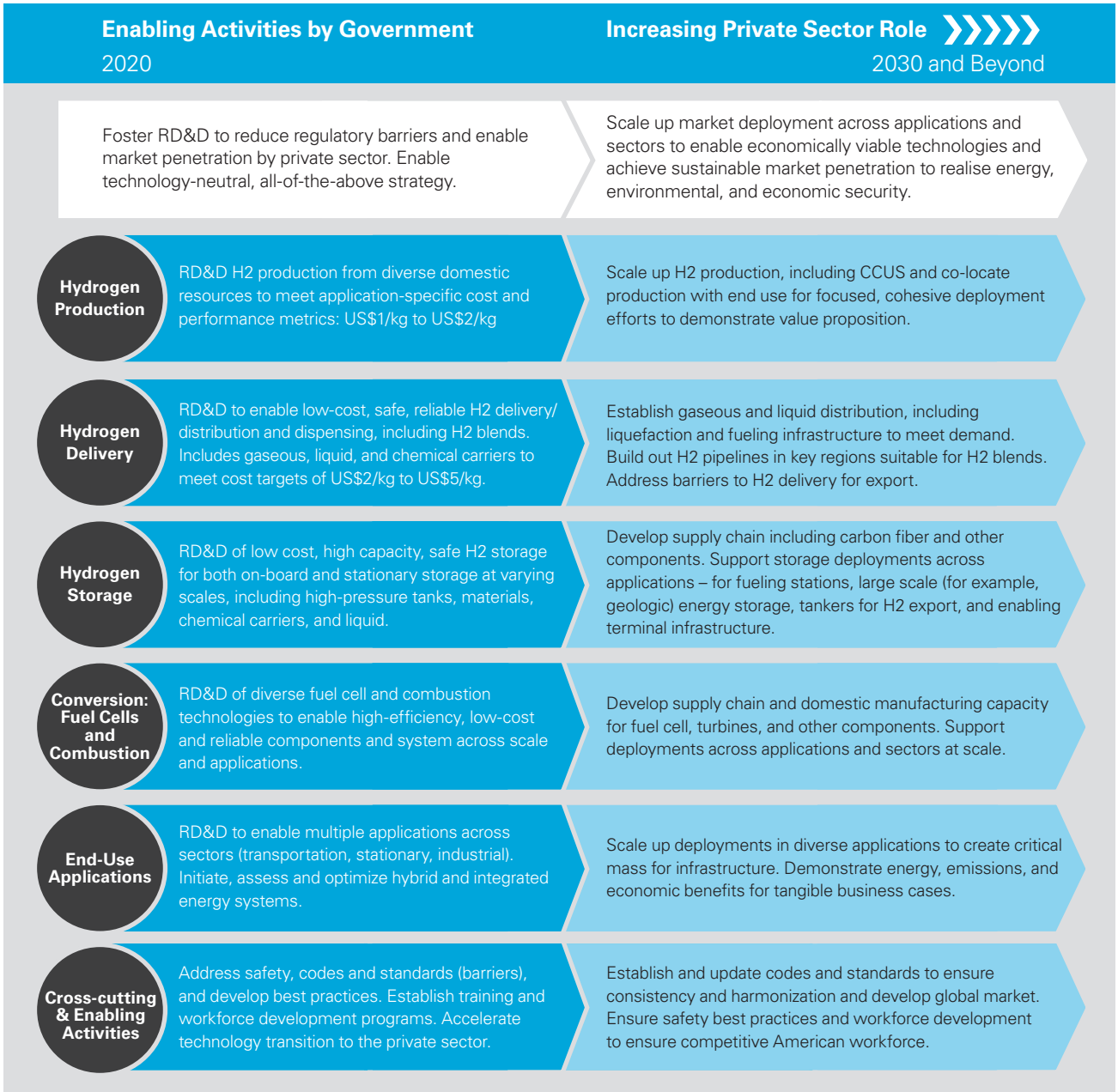
Although efforts were once localised at lower levels, led by companies and local government initiatives, large-scale initiatives and projects have begun to emerge from provincial governments and the Canadian government. Notably, the Canadian government has proposed legislation that commits the country 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 2021, the Infrastructure Investment and Jobs Act of 2021 (**IIJA**) allocated approximately US$9.5 billion to fund such research, development, and demonstration activities and implemented an initial regulatory framework by establishing minimum standards for "clean hydrogen," creating the Joint Office of Energy and Transportation (an office intended to, among other things, facilitate the development of hydrogen fuelling infrastructure), and directing the Department of Energy (**DOE**) to establish standards by which to measure carbon intensity in the context of hydrogen production. 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 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.

US DOE Hydrogen Strategy – emphasises government / private sector collaboration



Source: US Department of Energy

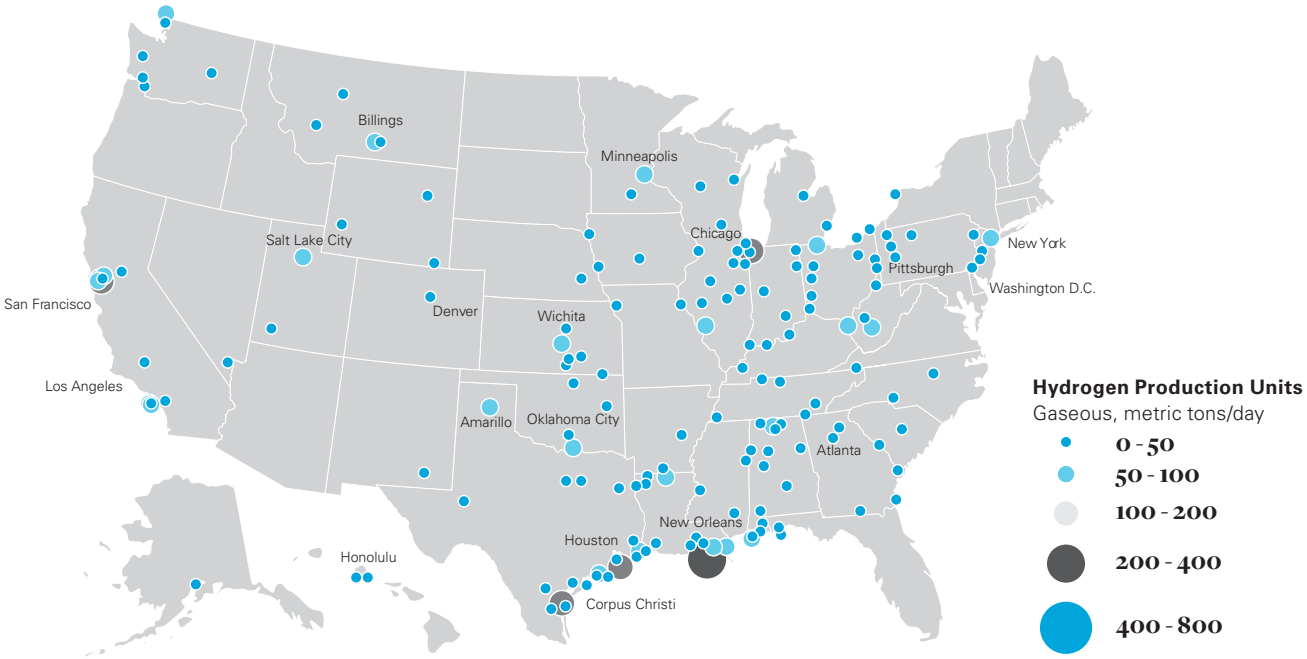
Emerging Global Policy and Regulatory Initiatives continued

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 U.S. 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.

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 Infrastructure Investment and Jobs Act of 2021** In 2021, under the IIJA, the United States has committed approximately US$9.5 billion in investments in clean hydrogen programs. Among other initiatives, the IIJA amends the Energy Policy Act of 2005 to provide a statutory definition for the term "clean hydrogen," establish a clearing house for clean hydrogen program information at the National Energy Technology Laboratory, provide regional clean hydrogen hubs, and authorise appropriations to carry out the DOE Hydrogen Program Plan. A significant portion of the IIJA's funding will go to the DOE to fund the advancement of clean energy technologies and the acceleration of the development of clean hydrogen technology and to the Department of Transportation (**DOT**) to establish grant programs to support the development of hydrogen fuelling infrastructure. The IIJA also requires that the DOE and DOT establish a Joint Office of Energy and Transportation to coordinate technical assistance relating to the development and maintenance of electric vehicle supply equipment (**ESVE**) and hydrogen fuelling infrastructure.	US government
2.	**US DOE Hydrogen Program Plan** The US 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 DOE
3.	**DOE Energy Earthshot Initiative** The DOE's Energy Earthshot Initiative aims to accelerate the development of affordable clean energy solutions. The first of these initiatives, Hydrogen Shot, seeks to reduce the cost of clean hydrogen by 80% to US$1 per kilogram in 1 decade (or, from about US$5 per kilogram to US$1 by 2030). The Hydrogen Shot establishes a framework for the development of clean hydrogen in the proposed American Jobs Plan. As part of that initiative, the DOE issued a Request for Information (**RFI**) on potential U.S. locations that could support near-term, large-scale, clean hydrogen demonstration projects and launched a new tool called "H2 Matchmaker" to facilitate the formation of clean hydrogen hubs by connecting producers, consumers, and operators. The first Hydrogen Shot Summit took place in August / September 2021.	US DOE

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
4.	**IIJA Hydrogen Investments and Incentives** Under the IIJA, there is approximately $9.5 billion to fund: □ at least 4 regional clean hydrogen hubs across the United States intended to demonstrate clean hydrogen production, processing, delivery, storage, and end-use; □ the advancement of clean hydrogen production and manufacturing technologies; □ the advancement of technologies that produce clean hydrogen using electrolysers; □ the development by the DOE, in consultation with the Environmental Protection Agency (**EPA**) and industry stakeholders, of an initial standard for the carbon intensity of clean hydrogen production; □ community alternative fuel infrastructure grants to develop hydrogen fuelling infrastructure; and □ alternative fuel corridor (**AFC**) grants to deploy publicly accessible hydrogen fuelling infrastructure along DOT Federal Highway Administration AFCs.	US DOE US EPA US DOT
5.	**US Department of Energy Awards $1 Billion Loan for Hydrogen Expansion Project** The DOE has granted turquoise hydrogen company Monolith a $1.04 billion loan under its Title XVII Innovative Energy Loan Guarantee Program to expand its hydrogen production operations. The Title XVII loan program allows the DOE to grant loans for projects that employ new or significantly improved technologies to avoid, reduce, or sequester emissions of greenhouse gases. The loan will be used to accelerate Monolith's development of pyrolysis technology to convert natural gas into hydrogen using renewably-sourced electricity.	US DOE Monolith
6.	**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 DOE's Office of EERE Dutch Ministry of Economic Affairs and Climate Policy's Directorate General for Climate and Energy
7.	**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]
8.	**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 DOE
9.	**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

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
10.	**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
11.	**California Zero Emission Vehicle (ZEV) 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
12.	**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
13.	**California Clean Transportation Program (ARFVTP)** Leveraging public and private investments to invest $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**	
14.	**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; □ 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.	Fuel Cell and Hydrogen Energy Association
15.	**Missouri S&T researcher earned US$4 million grant for energy-efficient steelmaking** The DOE has announced funding of $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 DOE Missouri University of Science and Technology

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
16.	**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 DOE
17.	**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 DOE
18.	**Airport 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
19.	**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
C	**Guarantee of Origin / 'colour' classification requirements**	
20.	**Qualification under the IIJA** Qualification for several of the incentives and grant opportunities under the IIJA requires that the activity involve "clean hydrogen," defined as "hydrogen produced with a carbon intensity equal to or less than 2 kilograms of carbon dioxide-equivalent produced at the site of production per kilogram of hydrogen produced." The IIJA directs the DOE, in consultation with the EPA and other industry stakeholders, to establish a standard to measure carbon intensity in the context of hydrogen production within six months after enactment of the law.	US DOE US EPA

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.	**Canada's Hydrogen Strategy: 2020-2050** The Canadian federal government released its Hydrogen Strategy in December 2020, which outlines Canada's plan to increase hydrogen production and achieve its goal of net-zero emissions by 2050.	Canadian Government
3.	**MoU between the government of Canada and the government of the Netherlands on Cooperation in the Field of Hydrogen Energy** The governments of Canada and the Netherlands signed an MoU to enhance bilateral cooperation and knowledge sharing to support the development of clean hydrogen, promote investment in clean hydrogen projects, and strengthen collaboration in multilateral hydrogen forums.	Canadian government Dutch government
4.	**Quebec – Green Hydrogen and Bioenergy Strategy** The government of Quebec plans to unveil its green hydrogen and bioenergy strategy in 2022. 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
5.	**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**	
6.	**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
7.	**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.	NRCan
C	**Guarantee of Origin / 'colour' classification requirements**	
8.	No specific developments to report.	Canadian government

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. With abundant sources of renewable energy primarily from wind and solar sources, and easy access to European 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 others 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, including Brazil and Colombia, following suit with their own national hydrogen plans or specific hydrogen legislation.

On November 5, 2021, at the 2021 United Nations Climate Change Conference (**COP26**), a framework agreement titled 'LAC Green Hydrogen Action' was entered into among the Ministry of Environment and Energy of Costa Rica, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*), the Costa Rican Hydrogen Association (*Asociación Costarricense de Hidrógeno*), the Peruvian Hydrogen Association (*Asociación Peruana de Hidrógeno*), the Colombian Hydrogen Association (*Asociación Colombiana de Hidrógeno*), and the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*), with the objective of promoting the development of a green hydrogen economy in Latin America and the Caribbean. The agreement calls for the furthering of national policies and regulations regarding the production of green hydrogen, identifying opportunities and financing requirements for projects, and the development of certification schemes to ensure compliance with international standards for climate-related disclosures.

Key to the development of the hydrogen sector in Latin America will be for national governments to ensure a stable legal and regulatory environment to attract foreign investors.

.

□ 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 was intended to be financed by the State through loans, disbursements and donations as well as tax benefits for goods and services. However, the executive branch did not issue implementing regulations and it appears that the law expired.

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 $mtCO_2eq$ of greenhouse gas emissions by 2030, and to prepare a long-term strategy to become carbon neutral by 2050. In July 2020, H2AR, a consortium for the development of the hydrogen economy in Argentina, was launched. H2AR in comprised of 40 companies and and is led by Y-Tec, a technology and research company part of the YPF group.

A new legislative reform was proposed in August 2021 to abrogate Law 26,123 and enact a new regulatory framework drafted with the participation of the private sector. The new regulatory proposal establishes a promotion regime exclusively for the development of green hydrogen and includes a special tax scheme for 20 years which contemplates a reduced income tax of 15% –instead of the regular 35% rate–, no export and import taxes and tax payments deductions for electromechanical equipment.

In September 2021, the National Social and Economic Counsel, which is an entity under the authority of the Argentinean government, issued a document titled 'Towards a National Strategy Hydrogen 2030'. This document evidences the interest of the Argentine government in promoting hydrogen production and summarises the potential for its development in the country.

As of the end of November 2021, the National Secretary of Strategic Affairs assured that the Executive Power is working on a new regulatory framework for the promotion of hydrogen, which will join the cooperative endeavours of public and private sector for the renewal of the energy matrix.

In addition, an electromobility regulatory bill has been presented to Congress which aims to replace combustion engines in cars by more sustainable alternatives, such as hydrogen, by 2041.

□ Brazil

There has recently been fast-paced development of the regulatory framework necessary for the operation of hydrogen projects in Brazil. The Brazilian government's National Energy Plan 2050 (**PNE2050**), issued in December 2020 by Ministry of Mines and Energy, included hydrogen as a disruptive technology in which Brazil could play a key role, particularly in the green hydrogen industry, as a result of the country's vast natural resources and clean energy potential. In February 2021, the Brazilian Energy Planning Agency provided a roadmap containing data and guidelines to support the Brazilian Hydrogen Strategy. At the request of the National Energy Council and following the guidelines created by the Brazilian Energy Planning Agency, the Brazilian Ministry of Mines and Energy launched the National Hydrogen Program (**PNH2**), together with the Ministries of Science and Technology and Regional Development.

PNH2 was the result of inputs from various national and international stakeholders and defined a set of tasks to be addressed by the Brazilian government regarding its three objectives of public policy planning, technological development and market promotion. Therefore, a new regulation addressing several concerns of the hydrogen industry is expected during 2022.

The new regulation is expected to also include certification schemes, which is one of the main topics to be developed under the new regulatory initiatives by the PNH2. Such certification schemes are particularly important to fulfil export requirements and supply clean hydrogen to European countries, which are expected to play a major role in the Brazilian industry. Furthermore, the Brazilian Power Trading Chamber (**CCEE**), the association responsible for overseeing and liquidating all electricity sales and well recognised among the power industry players, recently declared that it is planning to create certifications for green hydrogen. This certification would be issued by analysing the energy sources used and the production processes. CCEE currently already receives the data for monitoring large power consumer's energy sources, since all energy purchases are mandatorily registered with CCEE, and possesses know-how on certification processes given its partnership with biofuel sector associations for the '*Selo Energia Verde*' certification scheme.

There are various (mostly green) hydrogen projects already in development in Brazil, particularly in the renewables-resource rich north-eastern states. The Brazilian northeast ports are natural export hubs to Western Europe, with one of the main players being the Port of Pecém, in Ceará, which has already entered into several memorandums of understanding regarding hydrogen projects.

□ Chile

Chile is leading the way in Latin America after announcing its National Green Hydrogen Plan (*Estrategia Nacional de Hidrógeno Verde*) in November 2020. 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. 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, with the initial tender to award up to US$30 million being launched in April 2021;

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 products.

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 CO_2 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 Asian markets, 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.

Since the launch of the National Green Hydrogen Plan, a number of companies have announced plans to develop projects in the country. The combination of cheap and abundant renewable energy and expected decrease in electrolyser prices would make Chile's plan to become one of the world's cheapest green hydrogen producers by 2030 possible.

□ Colombia

One of the main policy focuses for the government of Colombia has been to speed up the country's decarbonisation process and transition to nonconventional renewable energy sources (**FNCERs** for its Spanish acronym). In December 2020, the President of Colombia announced a new commitment to reduce Colombia's greenhouse emissions by 51% by 2030. The government has recognised that low-carbon hydrogen will be crucial for obtaining such policy goals.

At the end of the 2020 legislative year, a bill was introduced to Congress for the promotion of the technological development, production and use of green hydrogen. The bill provided:

a) that the national government shall within six months of the effectiveness of the law, 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 package of aids for investors and entrepreneurs in the green hydrogen value chain, 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; and 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.

On July 10, 2021, the Congress of Colombia enacted Law 2099 of 2021 (the **Energy Transition Law**), which recognises blue hydrogen and green hydrogen as FNCERs, thus making such projects/technologies eligible for the tax incentives available to all FNCERs. The Energy Transition Law authorises the *Fondo de Energia No Convencionales y Gestion Eficiente de la Energia* to finance and/or execute any projects along the low-carbon hydrogen value chain. Additionally, 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 for municipalities that are required to adopt plans to promote sustainable mobility that prioritise public transportation with technologies that cause low or zero greenhouse gas emissions.

On September 30, 2021, the Colombian government published its roadmap for green hydrogen, which identifies the country's competitive advantage in the blue and green hydrogen value chains and outlines the regulatory framework that will be required to permit and incentivise the development, production and use of low-carbon hydrogen. Additionally, in November 2021, the Colombian government entered into a cooperation agreement with Chile.

□ Costa Rica

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 October 2018, a cooperation agreement titled 'Towards Decarbonization 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.

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 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 December 2021, the President of Costa Rica signed Decree No. 43366-MINAE, which formalises the policy for the use of surplus resources in the National Electric System for the development of a green hydrogen economy. Decree No. 43366-MINAE establishes guidelines for the development of a regulatory framework by the Public Services Regulatory Authority (**ARESEP**) which would enable distribution companies to utilise energy surpluses of the National Electric System for the production of green hydrogen. Despite the fact that over 99% of Costa Rica's electrical energy is generated with renewable sources, electricity constitutes a mere 26% of the energy consumed in the country, while the transportation sector represents 64.5% of the total electrical energy consumption. Transportation is still heavily dependent on fossil fuels, generating 60% of the total greenhouse gas emissions in Costa Rica, and the development of hydrogen technologies is considered essential to decarbonise the transportation industry and ensure Costa Rica's compliance with its ambitious climate change goals.

The government of Costa Rica is also finalising its National Green Hydrogen Plan, which it intends to launch in 2022. In addition, there is a bill on the promotion and implementation of a green hydrogen economy, regulating tax benefits to promote the import of technology used in the production of green hydrogen, which is currently under consideration by the Legislative Assembly.

□ Ecuador

On September 28, 2021, the government of Ecuador formally launched its National Decarbonization Plan (*Plan Nacional de Transición hacia la Descarbonización*), which will result in a roadmap for the reduction of greenhouse gases to further the transition of Ecuador towards a carbon-free economy. Although no concrete policies have been proposed or implemented to date, it is expected that specific policies for the hydrogen sector will be included as part of the National Decarbonization Plan.

□ 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 and 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.

Likewise, the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*), another private industry group, has recently been created with more than 35 associated companies, with the purpose of promoting the hydrogen industry in Mexico by articulating strategies and actions in an organised and efficient manner, involving all public and private actors in the promotion and development of the hydrogen industry.

□ Panama

The National Secretary of Energy of Panama announced in early 2021 the government's vision to transform the country into a low-carbon hydrogen logistics and distribution centre, in light of its strategic location as a global hub for maritime transport, with the transport sector becoming an important offtaker of hydrogen-based fuels. The government recognises that the decarbonisation of maritime shipping will require new fuelling infrastructure and related supply chains. Phase one of the development of a Green Hydrogen Roadmap was launched in January 2022.

Emerging Global Policy and Regulatory Initiatives continued

□ Paraguay

In line with Paraguay's commitment to reduce by 20% the country's greenhouse gas emissions by 2030, the Vice Ministry of Mines and Energy issued Paraguay's green hydrogen framework proposal titled 'Towards the Green Hydrogen Route in Paraguay' in the summer of 2021. The proposal was developed jointly with the National Electricity Administration, Petroleos Paraguayos, the Ministry of Industry and Commerce, the Vice Ministry of Transportation, the Ministry of Environment and Sustainable Development, the Itaipu Technological Park, the Inter-American Development Bank, CRECE Paraguay and the Energy Research Institute of Catalonia.

The proposal provides a framework for the development of strategic guidelines and regulatory frameworks, as well as technical and institutional capabilities, in order to establish the basis for the promotion and development of the green hydrogen economy in Paraguay. The proposal contemplates the installation of three pilot projects to assess and demonstrate the technical feasibility of green hydrogen production in the country.

In September of 2021, the International Renewable Energy Agency, working with the Vice Ministry of Mines and Energy of the Ministry of Public Works and Communications of Paraguay, released the 'Renewable Readiness Assessment: Paraguay'. The report examines Paraguay's policy and regulatory framework for renewable energy, as well as its energy institutions and their governance, to identify key short and medium-term recommendations aimed at accelerating Paraguay's transition towards renewable energy technologies.

□ Perú

In line with Peru's commitment to reduce its greenhouse gas emissions by 30%-40% before 2030, as stated in its revised National Determined Contribution to the Paris Agreement for the period of 2021-2030, H2 Perú, the Peruvian hydrogen association, was created in early 2021, with the main goal of promoting the development of the green hydrogen industry in Peru by exploring opportunities in the country, proposing strategies and roadmaps and developing key strategic partnerships. H2 Perú has already developed 26 partnerships, including with Siemens Energy, Engie, Anglo American and Goldfields.

□ Uruguay

Uruguay is usually hailed as an example of rapid decarbonisation, given that the country generates around 97% of its electricity from wind, solar, photovoltaic and biomass renewable sources. Uruguay also generates a significant surplus of energy (2TWh per year on average) for export to Brazil and Argentina in part because of its very favourable wind resource conditions. On April 8, 2021, the Ministry of Industry, Energy and Mining and the state utility UTE launched its 'H2U' program for private investment in green hydrogen with government support. The program contemplates several projects at both the pilot and commercial scales for production of hydrogen and related products for sale in the local and export markets.

The government expects to offer income tax exemption for the supply of green hydrogen to heavy vehicle transport and shipping, as well as fertilisers and ammonia production. In addition, state company ANCAP has set up a technical data room and is presently inviting companies interested in undertaking feasibility studies for hydrogen production based on offshore wind power generation and related infrastructure.

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 it appears that the law expired. A new bill is pending in the National Congress that proposes to abrogate Law 26,123 and enact a new regulatory framework to promote the hydrogen industry in Argentina.	National Congress
2.	**Electromobility Bill** An electromobility bill has been presented to Congress to replace by 2041 the production of combustion engines in cars by more sustainable alternatives, such as hydrogen.	National Congress

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
C	**Guarantee of Origin / 'colour' classification requirements**	
4.	No specific developments to report.	

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
3.	**National Hydrogen Program** In August 2021, guidelines were presented addressing, among other topics: (i) the inclusion of hydrogen as a priority when it comes to investments for research; (ii) the diversity of economic applications of hydrogen; and (iii) the diversity of Brazilian energy sources and the technologies associated with hydrogen already developed or under development in the country. The Brazilian Ministry of Mines and Energy made a conscious effort to reconcile the planning of public politics with the technological and market development, having met with more than 40 stakeholders, including private and public institutions, both local and international, to develop such guidelines. In addition, the German government seeks to collaborate on the development of a regulatory framework for the production of green hydrogen in Brazil, in line with the National Hydrogen Program. The long-term relationship of both countries, boosted by the German companies established in Brazil, is expected to foster the growth of the hydrogen market.	National Energy Policy Council Brazilian Ministry of Mines and Energy Energy Research Company
4.	**Public Consultation 11/2020** ANEEL opened Public Consultation (*Tomada de Subsídios*) no. 11/2021 in order to receive proposals for regulatory models aimed at the insertion of distributed energy resources in the Brazilian grid. The main focus is on energy storage, electric vehicles and demand response, as well as microgrids and virtual power plants. Under energy storage solutions, hydrogen batteries emerge as a possible solution already foreseen by Brazilian regulators.	National Electric Energy Agency

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
5.	**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**) GIZ Brazilian Ministry of Mines and Energy
6.	**Future Fuels Program** Future Fuel Program or '*Combustível do Futuro*' aims to further expand the use of sustainable fuels with low carbon intensity, by, for example, reviewing the blue hydrogen regulatory framework. This program would seek to base itself on Brazil's successful experiences with ethanol and biodiesel, for which the RenovaBio program required the acquisition of green certificates by fuel distribution companies.	Brazilian Ministry of Mines and Energy
7.	**Hydrogen Hub at Porto de Pecém** The government of the State of Ceará, where the Porto de Pecém is located, intends to create a green hydrogen hub in the region, with tax incentives, export infrastructure and abundant renewable energy generation. The State of Ceará has partnered with the local industries federation and the federal university, established a partnership with Rotterdam Port in Europe for exports, and has been active in entering into memorandums of understanding with key players in the private sector to promote business in the region.	State of Ceará Complexo do Pecém – CIPP S/A (mixed economy company that oversees the special economic zone surrounding the Pecém port) Ceará Federation of Industries Federal University of Ceará
8.	**Call for Projects and Financing by GIZ and AHK** The AHK and the GIZ have recently announced that a three-round call for projects will be opened in March 2022, in order to finance projects related to low-carbon hydrogen. This project is related to ongoing efforts by the German government to foster the development of green hydrogen in Brazil, under the H2 Brasil program.	AHK GIZ
C	**Guarantee of Origin / 'colour' classification requirements**	
9.	**CCEE's Certification Efforts** The CCEE has announced that it intends to develop a certification scheme for hydrogen production, capitalising on its systemic view of the energy market in Brazil. Because every power trade has to be registered at CCEE, CCEE is capable of analysing which energy sources were utilised in a given hydrogen production plant. CCEE has already participated in different certification projects, including (a) certification for biomass fuelled thermal power plants together with UNICA, and (b) certification for renewable energy in general, together with Instituto Totum.	CCEE

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.	H_2 Chile Australian Hydrogen Council
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 CORFO Ministry of Energy
4.	**Chile – Spain Associations Memorandum of Understanding** In November 2020, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*), H_2 Chile, and the Spanish Hydrogen Association (*Asociación Española del Hidrógeno*), AeH_2, signed a memorandum of understanding to collaborate on green hydrogen projects in Chile and Spain.	H_2 Chile Spanish Hydrogen Association
5.	**Chile – Singapore Memorandum of Understanding** In February 2021, Chile and Singapore signed a memorandum of understanding for the collaboration on projects and initiatives to advance the deployment of hydrogen as an alternative energy source.	Chilean Ministry of Energy Ministry for Trade and Industry of Singapore
6.	**Chile – Port of Rotterdam Memorandum of Understanding** In March 2021, Chile and the Port of Rotterdam Authority signed a memorandum of understanding to further the collaboration between Chile and the Netherlands in the international supply and demand for green hydrogen. The Port of Rotterdam is Europe's largest port and point of entry of 13% of the energy used in Europe.	Chilean Ministry of Energy Port of Rotterdam Authority
7.	**Chile Launches First Green Hydrogen Tender** In April 2021, CORFO announced the initial tender under Chile's National Green Hydrogen Strategy to award up to USD 30 million for the co-financing of one or more green hydrogen projects. The projects must have an installed capacity of at least 10 MW and enter into operation by the end of 2025.	CORFO
8.	**Chile – Germany Memorandum of Understanding** In June 2021, Chile and Germany signed a memorandum of understanding to strengthen cooperation on green hydrogen production and announced the creation of a working group within the framework of the German-Chilean Energy Partnership to identify viable projects.	Chilean Ministry of Energy German Ministry of Economics and Energy

No.	Description	Key Players
9.	**Chile – Ports of Antwerp and Zeebrugge Memorandum of Understanding** In November 2021, the Port of Antwerp, the Port of Zeebrugge and the Chilean Ministry of Energy signed a memorandum of understanding to collaborate in the export of green hydrogen from Chile to Western Europe.	Chilean Ministry of Energy Port of Antwerp Port of Zeebrugge
10.	**LAC Green Hydrogen Action** In November 2021, at the COP26, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*) entered into the LAC Green Hydrogen Action framework agreement with the Ministry of Environment and Energy of Costa Rica, the Costa Rican Hydrogen Association (*Asociación Costarricense de Hidrógeno*), the Peruvian Hydrogen Association (*Asociación Peruana de Hidrógeno*), the Colombian Hydrogen Association (*Asociación Colombiana de Hidrógeno*), and the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*), with the aim of promoting the development of a green hydrogen economy in Latin America and the Caribbean. The main lines of action are the furthering of national policies and regulations regarding the production of green hydrogen, identifying opportunities and financing requirements for projects, and the development of certification schemes to ensure compliance with international standards for climate-related disclosures.	H_2 Chile Spanish Hydrogen Association
C	**Guarantee of Origin / 'colour' classification requirements**	
11.	**World Bank Finances Certification Benchmarking Study** In May 2021, consulting firms Hinicio and Ludwig Bölkow Systemtechnik issued their definitive Advisory Report on Development of a Green Hydrogen Certification Scheme in Chile. The report was funded by the World Bank and contains detailed recommendations on how Chile can implement a hydrogen certification scheme that is compatible with national and international carbon markets, though no specific legislation has been adopted to date.	Chilean Ministry of Energy Hinicio Ludwig Bölkow Systemtechnik

Colombia

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**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
2.	**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
3.	**Energy Transition Law** In July 2021 the Congress of Colombia enacted Law 2099 of 2021 for the purpose of strengthening the energy transition to renewable sources of energy. The law recognises low carbon hydrogen as renewable sources of energy, extends tax incentives available to renewable projects to low carbon hydrogen projects and authorises the *Fondo de Energia No Convencionales y Gestion Eficiente de la Energia* to finance and/or execute any projects along the low-carbon hydrogen value chain.	National Congress

No.	Description	Key Players
4.	**Green Hydrogen Roadmap** On September 30, 2021, the Colombian government published its roadmap for green hydrogen in which it identifies Colombia's competitive advantages in the low carbon hydrogen value chain and outlines regulations and other legal frameworks required to promote the development, production and use of blue and green hydrogen. The roadmap was drafted with the advice and guidance of the Inter-American Development Bank.	Colombian government Ministry of Mines and Energy National Energy and Mining Planning Agency (**UPME**) National Energy and Gas Regulatory Agency (**CREG**)
B	**Specific grants, programs & incentives**	
5.	**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
6.	**LAC Green Hydrogen Action** In November 2021, at the COP26, the Colombian Hydrogen Association (*Asociación Colombiana de Hidrógeno*) entered into the LAC Green Hydrogen Action framework agreement with the Ministry of Environment and Energy of Costa Rica, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*) the Costa Rican Hydrogen Association (*Asociación Costarricense de Hidrógeno*), the Peruvian Hydrogen Association (*Asociación Peruana de Hidrógeno*), and the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*), with the aim of promoting the development of a green hydrogen economy in Latin America and the Caribbean. The main lines of action are the furthering of national policies and regulations regarding the production of green hydrogen, identifying opportunities and financing requirements for projects, and the development of certification schemes to ensure compliance with international standards for climate-related disclosures.	Inter-American Development Bank
C	**Guarantee of Origin / 'colour' classification requirements**	
7.	No specific developments to report.	

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**), Costa Rican Electricity Institute (**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

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
3.	**Policy for the use of surplus resources in the National Electric System** In December 2021, the President of Costa Rica signed Decree No. 43366-MINAE, which formalises the policy for the use of surplus resources in the National Electric System for the development of a green hydrogen economy. Decree No. 43366-MINAE establishes guidelines for the development of a regulatory framework by the Public Services Regulatory Authority (**ARESEP**) which would enable distribution companies to utilise energy surpluses of the National Electric System for the production of green hydrogen.	Presidency of Costa Rica Ministry of Environment and Energy
4.	**National Green Hydrogen Plan** The government of Costa Rica is finalising its National Green Hydrogen Plan, which it intends to launch in early 2022, with funding from the Japan government and assistance from the Inter-American Development Bank. The National Green Hydrogen Plan will establish the strategic lines for the development of a green hydrogen market and attraction of private investment to generate international export opportunities.	Ministry of Environment and Energy
5.	**Law on the Promotion and Implementation of a Green Hydrogen Economy** A bill on the promotion and implementation of a green hydrogen economy, regulating tax benefits to promote the import of technology used in the production of green hydrogen, is currently under consideration by the legislature of Costa Rica.	Legislative Assembly
B	**Specific grants, programs & incentives**	
6.	**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
7.	**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
8.	**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.	ICE

No.	Description	Key Players
9.	**LAC Green Hydrogen Action** In November 2021, at the COP26, the Ministry of Environment and Energy of Costa Rica and the Costa Rican Hydrogen Association (*Asociación Costarricense de Hidrógeno*) entered into the LAC Green Hydrogen Action framework agreement with the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*), the Peruvian Hydrogen Association (*Asociación Peruana de Hidrógeno*), the Colombian Hydrogen Association (*Asociación Colombiana de Hidrógeno*), and the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*), with the aim of promoting the development of a green hydrogen economy in Latin America and the Caribbean. The main lines of action are the furthering of national policies and regulations regarding the production of green hydrogen, identifying opportunities and financing requirements for projects, and the development of certification schemes to ensure compliance with international standards for climate-related disclosures.	Ministry of Environment and Energy Hydrogen Associations of Chile, Costa Rica, Peru, Colombia and Mexico
10.	**Partnership between Costa Rica and the International Renewable Energy Agency** In December 2021, the government of Costa Rica and the International Renewable Energy Agency signed an agreement to work together to strengthen the country's decarbonisation plans and boost renewable energy project financing.	Presidency of Costa Rica International Renewable Energy Agency
11.	**Memorandum of Understanding** In February 2022, the ICE and Australian company Kadelco signed a memorandum of understanding to identify electricity supply conditions for the production of green hydrogen in Costa Rica, including mechanisms for the exchange of technical information on quality, carbon content, availability, and seasonality of electricity supply, as well as joint cooperation to facilitate the development of a green hydrogen production plant in Costa Rica.	ICE Kadelco
C	**Guarantee of Origin / 'colour' classification requirements**	
12.	No specific developments to report.	

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**)*
2.	**Climate Change General Law** The Climate Change General Law (*Ley 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***)
3.	**Energy Transition Law** The Energy Transition Law (*Ley de Transición Energética*), enacted on 2015, determines that the minimum efficiency for the use of hydrogen to be considered a Clean Energy shall not be less than 70% of the lower calorific value of the fuels used in the production of such hydrogen.	CRE

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
B	**Specific grants, programs & incentives**	
4.	**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
5.	**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
6.	**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
7.	**Mexican Hydrogen Association** In 2021 the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*) was founded with more than 35 associated companies with the purpose of promoting the hydrogen industry in Mexico by articulating strategies and actions in an organised and efficient manner, involving all public and private actors in the promotion and development of the hydrogen industry. Recently, the Mexican Hydrogen Association and Hannover Fairs Mexico signed a cooperation agreement in order to boost Mexico's green hydrogen industry by promoting the benefits of renewables energies.	Mexican Hydrogen Association
8.	**LAC Green Hydrogen Action** In November 2021, at the COP26, the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*) entered into the LAC Green Hydrogen Action framework agreement with the Ministry of Environment and Energy of Costa Rica, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*), the Costa Rican Hydrogen Association (*Asociación Costarricense de Hidrógeno*), the Peruvian Hydrogen Association (*Asociación Peruana de Hidrógeno*), and the Colombian Hydrogen Association (*Asociación Colombiana de Hidrógeno*), with the aim of promoting the development of a green hydrogen economy in Latin America and the Caribbean. The main lines of action are the furthering of national policies and regulations regarding the production of green hydrogen, identifying opportunities and financing requirements for projects, and the development of certification schemes to ensure compliance with international standards for climate-related disclosures.	Ministry of Environment and Energy of Costa Rica and the Hydrogen Associations of Chile, Costa Rica, Peru, Colombia and Mexico

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
9.	The Mexican regulatory framework offers the possibility for the production and use of hydrogen, so that hydrogen is supposed to be eligible for Clean Energy Certificates, however, there is no formal definition of this gas as an energy molecule. In this regard, we have neither found any adoption plans or incentives for hydrogen technologies nor certifications schemes to measure and track the emission associated with hydrogen production.	CRE Mexican Energy Ministry

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
B	**Guarantee of Origin / 'colour' classification requirements**	
2.	No specific developments to report.	

Peru

No.	Description	Key Players
A	**Specific grants, programs & incentives**	
1.	**SMH National Hydrogen Plan** In early 2021, H2 Perú, the Peruvian hydrogen association, was created, with the main goal of promoting the development of the green hydrogen industry in Peru by exploring opportunities in the country, proposing strategies and roadmaps and developing key strategic partnerships.	Peruvian Hydrogen Association
2.	**LAC Green Hydrogen Action** In November 2021, at the COP26, the Peruvian Hydrogen Association (*Asociación Peruana de Hidrógeno*) entered into the LAC Green Hydrogen Action framework agreement with the Ministry of Environment and Energy of Costa Rica, the Chilean Hydrogen Association (*Asociación Chilena de Hidrógeno*), the Costa Rican Hydrogen Association (*Asociación Costarricense de Hidrógeno*), the Colombian Hydrogen Association (*Asociación Colombiana de Hidrógeno*), and the Mexican Hydrogen Association (*Asociación Mexicana de Hidrógeno*), with the aim of promoting the development of a green hydrogen economy in Latin America and the Caribbean. The main lines of action are the furthering of national policies and regulations regarding the production of green hydrogen, identifying opportunities and financing requirements for projects, and the development of certification schemes to ensure compliance with international standards for climate-related disclosures.	Ministry of Environment and Energy of Costa Rica and the Hydrogen Associations of Chile, Costa Rica, Peru, Colombia and Mexico
B	**Guarantee of Origin / 'colour' classification requirements**	
2.	No specific developments to report.	

Uruguay

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**H2U Project** In April 2021, the Ministry of Industry, Energy and Mining and the State Utility UTE launched a green hydrogen program ('H2U') with the participation of private and public parties. The main purposes and guidelines for the program were published in an online data room where companies could upload green hydrogen projects. Virtual meetings were coordinated from May to April 2021 between the Ministry and the participants to discuss the proposed projects. The government is now working on the next stage of the project and bidding terms are expected to be published based on the projects received. Investors would be awarded tax benefits for the development of green hydrogen projects for the production of fertilisers or green ammonia and fuel for heavy vehicle and ship transportation. Awarded bidders could get 100% exemption from income tax to be discounted in a period between four to 10 years.	Ministry of Industry, Energy and Mining UTE
B	**Specific grants, programs & incentives**	
2.	**Memorandum of Understanding** Around March 2022, *Administración Nacional de Combustibles, Alcohol y Portland* (**ANCAP**) and International Finance Corporation (**IFC**) signed a memorandum of understanding to facilitate collaboration in the development of the green hydrogen industry in Uruguay, including from offshore wind (Uruguay's H2U Offshore Program) and other green hydrogen projects (the H2U Program), and may include the development of market, technical, environmental and social, and legal studies, knowledge sharing of experiences in other countries, review of legal terms for possible engagements, and review of business models.	ANCAP IFC
C	**Guarantee of Origin / 'colour' classification requirements**	
3.	No specific developments to report.	

3.7 Middle East

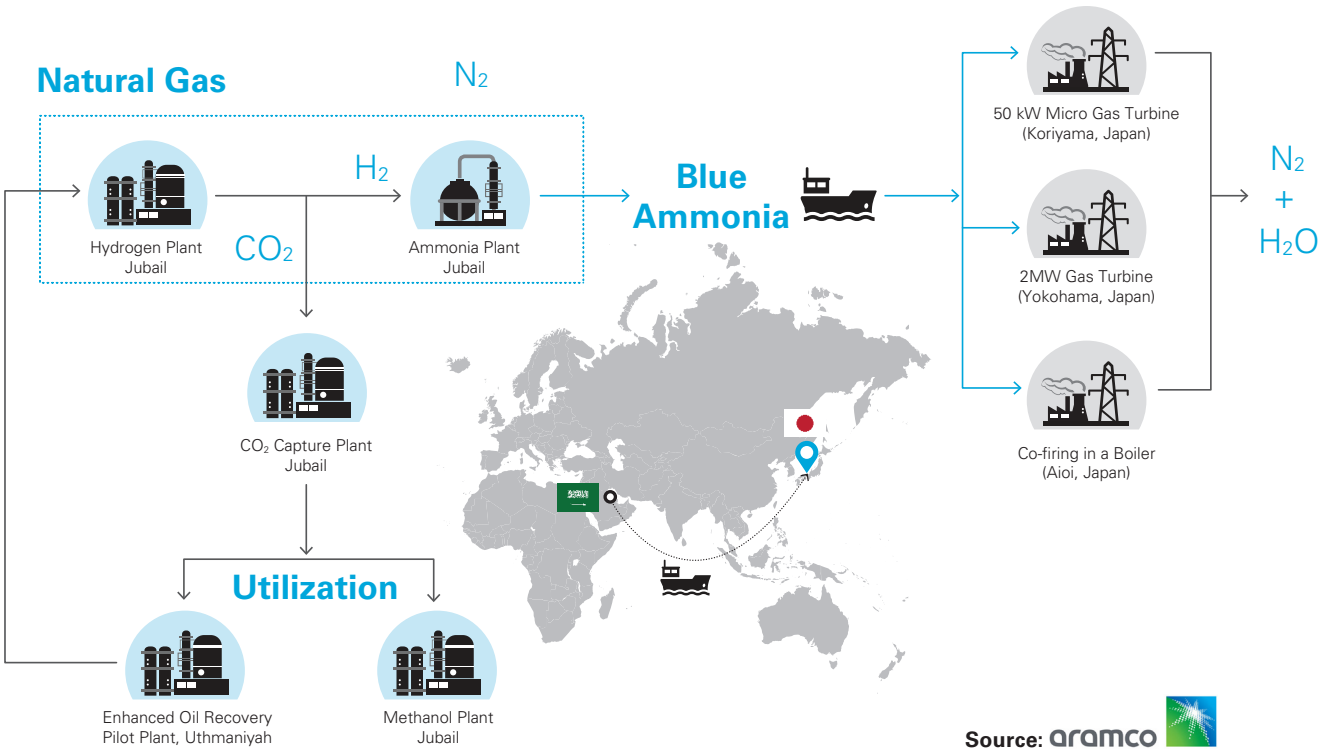
Overview

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).

There were significant developments in the Middle East in 2021. After the COP26, the United Arab Emirates revealed its new Hydrogen Leadership roadmap which aims to support domestic carbonisation and also establish the country's status as a key global export hub of hydrogen. In addition, Saudi Arabia has announced its ambitions to become the biggest global supplier of hydrogen. Both countries have entered into and continue to enter into partnerships for hydrogen offtake, and in the United Arab Emirates' case, the Emirate of Abu Dhabi has recently partnered with Engie to develop a green hydrogen production plant.

The Middle East is awakening to the concept of using its vast geography (and central location) to produce and export blue and green hydrogen. Indeed, the Middle East 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.

Blue Ammonia Supply Chain Demonstration



Alongside this success, the region's efforts in the hydrogen supply chain picked up pace in recent years, 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, the Dubai Emirate's electricity authority (**DEWA**) is currently preparing its own hydrogen roadmap alongside investing in hydrogen projects.

One strategic objective for the Middle East 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 system.

Key jurisdictions of interest

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Israel Green Taxation Inter-ministerial Committee Policy Recommendations** 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

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**United Arab Emirates – Hydrogen-cell Vehicles** 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
B	**Specific grants, programs & incentives**	
3.	**United Arab Emirates: Abu Dhabi Hydrogen Hub** Engie and Masdar have established a strategic alliance focused on the development of projects related to green hydrogen. The companies confirmed that the agreement would "explore" the co-development of a UAE-based green hydrogen hub, and that investment in this initiative would amount to around USD 5 billion. The companies are looking to develop projects with an electrolyser capacity of 2 GW.	ADNOC Engie Masdar
4.	**United Arab Emirates – Green Energy Joint Ventures** A global green energy joint venture between Abu Dhabi National Oil Company (**ANDOC**) and Abu Dhabi National Energy Company (**TAQA**) was recently established with the intention of generating a capacity of at least 30 GW of renewable energy by 2030, which intends to further establish the United Arab Emirates' role in green hydrogen. The partnership between the two entities will focus on domestic and international renewable energy and waste-to-energy projects as well as the production, processing and storage of green hydrogen and ancillary activities.	ADNOC TAQA
5.	**United Arab Emirates – Hydrogen Alliance** ADQ and Alpha Dhabi Holding (both Abu Dhabi based investment companies) sign a hydrogen alliance with OCI, headquartered in the Netherlands. As part of the deal, a 15% stake is offered in the OCI Methanol Group for US$375 million, which will be registered at Abu Dhabi Global Market Square. The alliance will focus on clean methanol as a "fuel for the future" with hydrogen as the primary feedstock.	ADQ Alpha Dhabi Holding OCI
6.	**United Arab Emirates/ United Kingdom Research Paper** A new research paper has been launched, sponsored by HSBC, which will seek to uncover mutual opportunities to accelerate the development of the respective clean hydrogen markets of the United Arab Emirates and the UK.	United Arab Emirates United Kingdom HSBC
7.	**Saudi Arabia – France Partnership** Saudi Aramco has signed a number of key agreements with leading French companies in order to boost its hydrogen transport business and explore opportunities in carbon technology. In particular, Saudi Aramco has entered into a memorandum of understanding with Gaussin, a key player in clean transport solutions, for the exploration and potential development of a hydrogen-powered vehicle business. As part of this agreement, Saudi Aramco and Gaussin will aim to establish a modern manufacturing facility for on-road and off-road hydrogen-powered vehicles in Saudi Arabia.	Saudi Aramco Gaussin

No.	Description	Key Players
8.	**United Arab Emirates – CCUS** 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 CO_2 by 2030. The CCUS technology will be used in part to produce blue hydrogen. As part of the United Arab Emirates' participation in COP26 which took place in November 2021, the United Arab Emirates has launched a roadmap for hydrogen production to support climate neutrality and development, where the United Arab Emirates is intending to become a leader in the field of hydrogen and to achieve climate neutrality in 2050.	ADNOC
9.	**Abu Dhabi Hydrogen Alliance** 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 United Arab Emirates. 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)
10.	**Israel – Hydrogen Fuel Stations** 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
11.	**Algeria: National Energy Council** In June 2020, the government created the Ministry of Energy Transition and Renewable Energies. One focus of the renewable energy development plan is to substitute natural gas consumption with blue and green hydrogen. The country's energy mix model aims to generate 25 GW of power from green and blue hydrogen by 2050. Algeria hopes to sell hydrogen instead of natural gas to Spain and Italy starting 2030.	Algeria
12.	**Egypt 2035 Energy Strategy** The Minister of Electricity and Renewable Energy has announced that green hydrogen will be introduced in Egypt's 2035 Energy Strategy. In August 2021, the Egyptian Electricity Holding Company and Siemens Energy entered into a memorandum of understanding on the development of green hydrogen industry. The agreement envisages implementing a green hydrogen generation project from renewable energy with a capacity of 100 megawatts.	United Arab Emirates United Kingdom

No.	Description	Key Players
C	**Guarantee of Origin / 'colour' classification requirements**	
13.	**United Arab Emirates** The ministries of Energy & Infrastructure, and Climate Change & Environment, together with the Dubai Future Foundation, released a publication on hydrogen in 2021 which identified the following 'colour' classifications of hydrogen: □ *Grey Hydrogen*: produced from fossil fuels, typically natural gas or coal, which are reformed to release the hydrogen from their hydrocarbon molecules, a process that results in CO_2 being released into the atmosphere. □ *Blue Hydrogen*: Grey hydrogen becomes blue hydrogen when the CO_2 emissions are captured and sequestered via CCUS technology, minimising the impact on the environment. □ *Turquoise Hydrogen*: produced by a process known as methane pyrolysis, which relies on heat produced with electricity rather than through the combustion of fossil fuels. The method also produces hydrogen and carbon as outputs, but the carbon is produced in solid form, avoiding emissions to the atmosphere. □ *Green Hydrogen*: typically produced via electrolysis of water in which the electricity required to drive the process comes from renewable energy sources such as wind and solar. □ *Yellow Hydrogen:* refers to hydrogen extracted from water using electrolysis, similar to green hydrogen. The only difference is that the electricity source used is nuclear energy instead of renewables.	United Arab Emirates

3.8 Africa

Overview

A number of countries on the continent 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 (**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 results of the H2Atlas for West Africa have been published since the project began, and show that there is significant potential for the production of green hydrogen throughout the region. In particular, countries such as Mali, Niger, Nigeria and Senegal show promise.

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 initial appetite. AHP foresees the development of power-to-gas renewable energy hubs in Africa that will provide critical energy for the industrial, transportation, commercial, and social sectors.

The International Renewable Energy Agency (**IRENA**) and the EU have organised a series of workshops to promote a dialogue over the challenges and policy measures needed to develop green hydrogen in the Middle East and North Africa (**MENA**) region. The workshops form part of the Strategic Partnership for the Implementation of the Paris Agreement (**SPIPA**), which is aimed at facilitating exchanges on climate policy options and good practice between the EU and non-European major economies. The workshops are centred on technology, standards and certification, financing and the creation of a market and are aimed at facilitating future trade between the EU and MENA regions. In addition, the Dii Desert Energy Vision is a joint hydrogen strategy between Europe and North Africa that is centred on building a European energy system based on 50% renewable energy and 50% green hydrogen by the year 2050. The strategy of the Dii Desert Energy Vision is to connect the international industry active in the MENA region with authorities and institutions, to add to the energy value chain, and thereby promote tangible and profitable projects that benefit local and international stakeholders.

Although there is little in the way of policy, 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 economy recovery following Covid-19. In support of this, the South African government has developed 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.' In September 2021, South Africa's Cabinet approved the extension of the National Hydrogen Society Roadmap, which builds on what has been achieved in the last few years to prepare the country to move from research and development to manufacturing and commercialisation. The roadmap is intended to position South Africa as a destination with sustainable hydrogen economic capability, as well as expand export markets on hydrogen technologies. The roadmap also focuses on contributing to the renewable energy sector and reducing emissions in the heavy-duty transport sector.

Notwithstanding the lack of 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 USD 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). However in May 2021, Morocco halted the agreement following diplomatic tensions between the nations, with Germany looking at different strategies to get the project back on track.

  In addition to the above, Morocco has signed a strategic partnership in June 2021 with IRENA, with the aim to become a major green hydrogen producer and exporter. The two parties will actively pursue green hydrogen studies and explore policy instruments to engage the private sector at a national level in the green hydrogen economy.

- **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, as a first step towards expanding in this field to the possibility of exporting.

- **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.

  A report entitled 'South Africa's Hydrogen Valley' was published in October 2021, and confirms that hydrogen fuels cells are a national priority as an alternative energy source. The report is the culmination of an extensive feasibility study undertaken to determine hydrogen's potential as an alternative energy source in South Africa. The hydrogen valley will be located in the Bushveld complex and larger region around Johannesburg, Mogalakwena and Durban. Three catalytic green hydrogen hubs have been identified, which will host pilot projects to launch the hydrogen economy in the Hydrogen Valley. The report identifies three catalytic green hydrogen hubs. The Johannesburg hub will have spokes extending to Rustenberg and Pretoria, the Durban hub will encompass Durban and Richards Bay, and the third hub will encompass Mogalakwena and Limpopo. It is anticipated that the hydrogen demand in these hubs could reach up to 185 kt H_2 by 2030, or 40% (low case) to 80% (high case) of demand of the national hydrogen roadmap. In addition, 9 pilot projects have been identified to kick-start the Hydrogen Valley in the mobility (mining trucks, buses), industrial (ammonia/chemicals) and buildings (fuel cell power) sectors.

- **Namibia**

  The Namibian government announced that it has selected HYPHEN Hydrogen Energy as the preferred bidder for a USD 9.4 billion green hydrogen project to be developed near the coastal town of Luderitz in southern Namibia. The vertically integrated project will produce 300,000 t/year of green hydrogen and green ammonia for export into regional and global markets from 2026 onwards. The first phase of the project will involve the building of 2 GW of renewable electricity generation capacity. This phase will also involve the development of electrolyser capacity to produce green hydrogen for conversion into green ammonia, and will make use of desalinated water. Once complete, the facility will have renewable generation capacity of 5 GW and electrolyser capacity of 3 GW. Surplus electricity will be fed into the Namibian energy grid and potentially into the southern African regional power pool.

North Africa

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Algeria – Hydrocarbon Laws** In 2019, 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 missions of ALNAFT is the potential evaluation of the Hydrocarbon mining domain and promotion of upstream investment.	Algerian Government ALNAFT National Energy Council

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
3.	**Tunisia** Tunisia has, in response to energy security issues and vulnerability to fluctuating international energy prices, embarked on an energy transition journey to give effect to its sustainable social and economic development strategy. The strategy is focused on two primary objectives, namely energy efficiency and increasing renewable energy in the electricity production mix to 30% by the year 2030. A Renewable Readiness Assessment carried out by IRENA in 2021 notes that in order for Tunisia to reach its targets, it will need to 'use renewables to produce hydrogen or hydrogen-rich chemicals to serve as feedstock, process agents or fuels.' This will form a part of the energy transition journey for Tunisia in the near future.	Tunisia government IRENA
4.	**Morocco** The 2009 National Energy Strategy set a goal for Morocco to reach a total of 42% installed energy capacity to come from renewable energy by 2020. In 2015, at COP21, the government announced an additional planned increase in renewables capacity to reach 52% of total installed energy capacity by 2030. While the National Energy Strategy is focused on wind and solar, Morocco formed a collaboration with IRENA in 2021 to advance the nation's renewable hydrogen economy. The parties will conduct green hydrogen studies and explore policy instruments under the strategic agreement between the Moroccan Ministry of Energy, Mines and Environment and IRENA. As part of IRENA's Collaborative Framework on Green Hydrogen, Morocco will focus on developing technology, infrastructure and certification for a global green hydrogen economy.	Moroccan government Moroccan Ministry of Energy, Mines and Environment IRENA
B	**Specific grants, programs & incentives**	
5.	**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**). The German government will support Morocco in constructing a hydrogen production plant and with the subsequent production of green hydrogen. However, water shortages mean that not enough is available for hydrogen production. The Moroccan government is looking to extract the required freshwater from desalination plants. These plants will need to be powered by green electricity, meaning that the already-extensive solar power network will need to be expanded. In May 2021, Morocco halted the agreement following diplomatic tensions between the nations, with Germany looking at different strategies to get the project back on track. In addition to the above, Morocco has signed a strategic partnership in June 2021 with IRENA, with the aim to become a major green hydrogen producer and exporter. The two parties will actively pursue green hydrogen studies and explore policy instruments to engage the private sector at a national level in the green hydrogen economy.	Moroccan government German government IRENA

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
6.	**Tunisia – Germany Energy Partnership and Hydrogen Alliance** In December 2020, the Minister of Industry, Energy and Mines and Parliamentary State Secretary to the Federal Minister for Economic Cooperation and Development, signed a memorandum of understanding with the German government that aims to develop the green hydrogen market in Tunisia. This resulted in the establishment of the German-Tunisian Energy Partnership. Thanks to its geographical location, Tunisia has significant potential for renewables. The aim is to build up a sustainable, secure and affordable energy supply system in Tunisia. The partnership's activities focus on creating effective and efficient energy market conditions. 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
C	**Guarantee of Origin / 'colour' classification requirements**	
7.	Guarantees of origin have been identified by IRENA as a key pillar of hydrogen policy making, and it is anticipated that such guarantees will form part of North Africa's policy and legislation once developed.	Law-making authorities in each jurisdiction

East Africa

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Tanzania National Energy Plan** 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, 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. Tiger Power is a member of Alliance for Rural Electrification (**ARE**) which seeks to ensure that by 2030 everyone in the world and in particular all rural people in low-and medium income countries should have access to affordable, secure and clean energy and energy services.	Ugandan Government Commercial parties
3.	**Tanzania** In 2016, Climate Action Network-Tanzania (**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% 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 a substitute for natural gas.	Tanzanian Ministry of Energy Tanzanian Government CAN-Tanzania

No.	Description	Key Players
4.	**Kenya – The Plan for 100% Renewable Energy Scenario in Kenya by 2050** According to 'The Plan for 100% Renewable Energy Scenario in Kenya by 2050' prepared by Sustainable Environmental Development Watch, one of the most important steps 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 – Long Term Energy Strategy 2009-2025** Mauritius's 'Long Term Energy Strategy 2009-2025' was developed. The 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
6.	**Uganda – HYENA** The Hydrogen Energy in Africa (**HYENA**) Network has launched a campaign to obtain funding from the UK government for green hydrogen for Ugandan permaculture. Recognising that many countries with an abundance of solar energy struggle with natural resources and import large quantities of energy from neighbouring countries, the HYENA Network states that the solution is to use low-cost, high-efficiency electrolysers to convert excess renewable energy into hydrogen gas that can then be stored distributed and used to meet all energy needs. By setting up micro grids running on hydrogen, solar energy on building roofs can be fed into the network where the excess energy is converted into hydrogen. The hydrogen is passed through a green hydrogen smart grid network to the storage and then to the cooking facilities, to allow for green carbon-neutral cooking.	Ugandan government UK government
7.	**Djibouti and Ethiopia** In July 2021, Hong Kong based energy company GCL Group announced that Ethiopian natural gas will power the ammonia which it will use to generate blue hydrogen. The gas, secured under Belt & Road agreements dating back to 2013, will be piped to Djibouti where it will feed 4 million tons per year of ammonia feedstock for hydrogen, to power steel smelting, refining and power generation in China. Blue hydrogen, which requires the use of carbon capture and storage to mitigate the fossil fuel emissions of natural gas use, would be the result, said GCL, adding that the Ethiopian proven natural gas reserves run to 190.7 billion cubic meters, with a first-phase annual output of 3.5 billion cubic meters, which can be used for 40 consecutive years.	Djibouti government Ethiopia government Chinese government
C	**Guarantee of Origin / 'colour' classification requirements**	
8.	Guarantees of origin have been identified by IRENA as a key pillar of hydrogen policy making, and it is anticipated that such guarantees will form part of East Africa's policy and legislation once developed.	Law-making authorities in each jurisdiction

West Africa

No.	Description	Key Players
A	**Policy framework and regulatory developments**	
1.	**Ghana Renewable Energy Master Plan** 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

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
2.	**Nigeria Renewable Energy Master Plan** 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
B	**Specific grants, programs & incentives**	
3.	**West African Science Service Centre on Climate Change and Adapted Land Use** West African Science Service Centre on Climate Change and Adapted Land Use (**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. 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 German Federal Ministry of Education and Research 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
5.	**Senegal – Technip Energies** Technip Energies is advancing the Senegal's oil and gas sector and the energy transition. Technip Energies is a leader in LNG, ethylene and hydrogen production and is growing its blue and green hydrogen capacity. While still in the early phases, Senegal aims to partner with entities like Technip to move away from oil and gas, while stimulating environmental preservation and socio-economic development in Senegal.	Senegal government Technip Energies
6.	**Mali – Hydroma Inc.** Hydroma Inc. uses natural hydrogen wells to produce clean energy on a large scale to meet Mali's energy needs. However, the company intends to move in the green hydrogen sphere and use less naturally occurring hydrogen, instead producing hydrogen through the electrolysis of water. To achieve this, Hydroma Inc. is constructing solar plants in Mali and Senegal.	Hydroma Inc. Mali government

No.	Description	Key Players
7.	**Ivory Coast** Ivoire Hydrogène has seen notable developments in 2021 in expanding its hydrogen offering and is set to build on this in 2022 and beyond, with the ultimate aim of bolstering the Ivory Coast's global presence in the green hydrogen market. Ivoire Hydrogène aims to facilitate the expansion of hydrogen in Africa, offering services for entities requiring hydrogen-based solutions in West Africa. The company is in talks with collaborators for neighbouring countries and aims to turn Africa into a continent where green hydrogen is available for all.	Ivoire Hydrogène
8.	**Mauritania – Project Nour** The Mauritania government has signed a Memorandum of Understanding to progress Project Nour, a green hydrogen development that will produce up to 10 GW of electricity. Project Nour has been given exclusivity over an offshore and onshore area of around 14,400 square kilometres, to carry out pre-feasibility and feasibility studies with the goal of generating electricity from wind and solar resources to be used in electrolysis. Mauritania possesses world-class wind and solar resources and Project Nour could potentially allow the nation to produce the cheapest green hydrogen in Africa, allowing it to export green hydrogen and derivative products to large European markets.	Ivoire Hydrogène
9.	**H2 Atlas-Africa Project (2020-2022)** The German research ministry is funding the joint H2 Atlas-Africa Project from 2020 to 2022. A feasibility study will aim to determine potential suitable locations for green hydrogen production in West Africa, where after production, transport and processing tests will be carried out. The project will include the 15 Economic Community of West African States. Initial results have shown that approximately 75% of West Africa's land area is suitable for wind turbines, and that by using wind and solar energy, West Africa could produce around 165,000 terawatt hours of green hydrogen per annum, at comparatively cheap prices.	German Research Ministry West African governments
C	**Guarantee of Origin / 'colour' classification requirements**	
10.	There are no legislative or regulatory requirements regarding Guarantee of Origin and / or colour classification requirements for hydrogen in West Africa. However, ongoing project planning and discussions are focused on green hydrogen to accelerate multi-sector development in West Africa, and Africa as a whole. Guarantees of origin have been identified by IRENA as a key pillar of hydrogen policy making, and it is anticipated that such guarantees will form part of West Africa's policy and legislation once developed.	Law-making authorities in each jurisdiction

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

Emerging Global Policy and Regulatory Initiatives continued

No.	Description	Key Players
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/tCO_2e. 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
3.	**Climate Change Bill (South Africa)** The Minister of Forestry, Fisheries and the Environment published her notice of intention to introduce the National Climate Change Bill in the National Assembly. The Bill seeks to enable the development of an effective climate change response and a long-term, just transition to a climate resilient and low carbon economy and society in the context of sustainable development. The Bill, once passed as law, will support the objectives in the National Development Plan and the Carbon Tax Act.	South African government South African Department of Environmental Affairs
B	**Specific grants, programs & incentives**	
4.	**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
5.	**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. 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. A report entitled 'South Africa's Hydrogen Valley' was published in October 2021 by the Department of Science and Innovation in conjunction with Engie, Anglo American, Bambili Energy and Sanedi, and confirms that hydrogen fuels cells are a national priority as an alternative energy source. The report is the culmination of an extensive feasibility study undertaken to determine hydrogen's potential as an alternative energy source in South Africa. The hydrogen valley will be located in the Bushveld complex and larger region around Johannesburg, Mogalakwena and Durban. Three catalytic green hydrogen hubs have been identified, which will host pilot projects to launch the hydrogen economy in the Hydrogen Valley. The report recognises that Hydrogen Valleys can be leveraged to kickstart the hydrogen economy, and envisages the creation of an integrated hydrogen ecosystem that is an important part of the Economic Reconstruction and Recovery Plan. The report identifies three catalytic green hydrogen hubs. The Johannesburg hub will have spokes extending to Rustenberg and Pretoria, the Durban hub will encompass Durban and Richards Bay, and the third hub will encompass Mogalakwena and Limpopo. It is anticipated that the hydrogen demand in these hubs could reach up to 185 kt H_2 by 2030, or 40% (low case) to 80% (high case) of demand of the national hydrogen roadmap. In addition, 9 pilot projects have been identified to kick-start the Hydrogen Valley in the mobility (mining trucks, buses), industrial (ammonia/chemicals) and buildings (fuel cell power) sectors.	South African government Department of Science and Innovation Gauteng Industrial Development Zone Airports Company South Africa Energy companies Mining companies

No.	Description	Key Players
6.	**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 organise, 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
7.	**National Hydrogen Energy & Fuel Cell R&D Strategy development** South Africa has the 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 Africa already has capability in blue and brown hydrogen, although climate change activism has directed the focus to green hydrogen. South Africa's strategy has therefore shifted to a focus on green hydrogen production.	South African Government
8.	**National Hydrogen Society Roadmap** In September 2021, South Africa's Cabinet approved the extension of the National Hydrogen Society Roadmap, which builds on what has been achieved in the last few years to prepare the country to move from research and development to manufacturing and commercialisation. The roadmap is intended to position South Africa as a destination with sustainable hydrogen economic capability, as well as expand export markets on hydrogen technologies. The roadmap also focuses on contributing to the renewable energy sector and reducing emissions in the heavy-duty transport sector.	South African Government
C	**Guarantee of Origin / 'colour' classification requirements**	
9.	The South African Hydrogen Valley Final Report notes that the three catalytic hubs identified will be green hydrogen hubs. They key focus in South Africa, insofar as hydrogen related projects are concerned, is the creation of green hydrogen. Guarantees of origin have been identified by IRENA as a key pillar of hydrogen policy making, and it is anticipated that such guarantees will form part of Southern Africa's policy and legislation once developed.	Law-making authorities in each jurisdiction

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, based on publicly available information. 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.

4.2 Hydrogen Development Activity by Region

Asia-Pacific

No.	Project	Country	Description
A	**Demand side**		
1.	**H2X Gippsland**	Australia	H2X Manufacturing has announced a deal with Gippsland Circular Economy Precinct to manufacture hydrogen-focused products, including hydrogen fuel cells, electrolysers, and hydrogen-powered vehicles, by mid-2022.
2.	**Tallawarra B Project**	Australia	EnergyAustralia's Tallawarra B project will provide over 300 MW of dispatchable capacity for NSW customers. It will be ready in the summer of 2023-24 and will make Australia the first country in the world to employ a hybrid gas-hydrogen turbine for grid electricity. The project is also intended to offset EnergyAustralia's residual emissions.
3.	**Fuel cell truck transportation**	Japan	Toyota Motor Corporation, Hino Motors, Ltd., Asahi Group Holdings, Ltd., Seino Transportation Co., Ltd., Yamato Transport Co., Ltd. and NEXT Logistics Japan, Ltd. will use hydrogen fuel cell powered trucks developed by Toyota Motor Corporation and Hino Motors, Ltd. to commence demonstration transportation for courier deliveries on various routes from around April 2022.
4.	**Fuel cell railway**	Japan	East Japan Railway Company, Hitachi, Ltd. and Toyota Motor Corporation are working together on the development of Japan's first train to run on hydrogen fuel cells and storage batteries.
5.	**Japan H2 Mobility (JHyM)**	Japan	JHyM, established in 2018, is aimed at the full-fledged development of hydrogen stations for FCVs in Japan. It currently consist of 27 Japanese entities including major automotive companies, infrastructure companies, utility companies and financial institutions. As of November 2021, it had opened 156 hydrogen stations nationwide.
6.	**Hydrogen Utilisation Demonstration Project at LNG thermal plant**	Japan	In August 2021, JERA announced that it will conduct a demonstration project related to hydrogen utilisation at an LNG thermal power plant in Japan under NEDO's Green Innovation Fund program. The project will switch a portion of the LNG fuel used to generate electricity at JERA's large-scale LNG thermal power plant in Japan to hydrogen, and the resulting operational and environmental characteristics will be evaluated over a period of approximately 5 years.
7.	**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.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
8.	**Floating Living Lab**	Singapore	In April 2020, Keppel signed a 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.
9.	**Hydrogen Refuelling Stations**	South Korea	The South Korean government has announced plans to build more than 2,000 hydrogen refuelling stations nationwide by 2025, with at least one refuelling station in each of 226 cities, counties and districts.
10.	**Fuel cell joint venture**	South Korea	In October 2021, SK E&S and Plug Power formed a joint venture with a plan to build a "gigafactory" for fuel cells and electrolyser systems in a key metropolitan area in South Korea by 2024, as well as supply domestic and overseas markets in Asia.
11.	**Fuel Cell Plants**	South Korea	In October 2021, Hyundai Mobis announced that it will invest about KRW 1.3 trillion (US$1.1 billion) in the construction of two plants for fuel cell systems in the Korean cities of Incheon and Ulsan.
12.	**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 November 2019, another hydrogen-powered tram, built by CRRC Qingdao Sifang, was put into operation in Foshan, Guangdong province. In October 2021, the first China-developed hydrogen fuel cell hybrid locomotive—from core power to main components—has started trial runs on a 627 km railway line for coal transport in Inner Mongolia Autonomous Region.
13.	**Hydrogen buses/ trucks and electrolyser**	China	Zhangjiakou City 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. In August 2021, 100 hydrogen trucks have been put in to operation for the building materials transportation in Baoding, Hebei.
14.	**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. By the first half of 2021, China has built 146 hydrogen refuelling stations, of which 136 have been put into operation and 10 are to be operated. In November 2021, the first highway hydrogen refuelling station was officially completed and put into operation in Zibo, Shandong Province. The hydrogen refuelling station is jointly constructed by Shandong High-speed Service Development Group and Sinopec Shandong Petroleum Branch, with the refuelling capacity of 500 kg/12 hours.
15.	**Plateau hydrogen Fuel cell engine**	China	In January 2021, the first batch of plateau hydrogen fuel cell engines, developed by Dongfang Electric (Chengdu) fuel cell technology Co., Ltd., were officially delivered for operation.
B	**Supply side**		
16.	**Western Green Energy Hub**	Australia	CWP Global and Intercontinental Energy have proposed to build the world's biggest renewable energy hub, in the south east of Western Australia. The project would stretch over 15,000 square kilometres and produce up to 3.5 million tonnes of green hydrogen or 20 million tonnes of green ammonia annually.

No.	Project	Country	Description
17.	**Clean Energy Innovation Park**	Australia	ATCO's Clean Energy Innovation Park plans to establish Australia's first commercial scale green hydrogen supply chain. It will include a 10 MW electrolyser powered by a wind farm, which will be capable of producing up to 4.3 tonnes of hydrogen per day.
18.	**HyEnergy Zero Carbon Hydrogen Project**	Australia	The proponents are performing a feasibility study of a potential renewable energy hydrogen project in Western Australia, which they aim to complete in 2021. The project would total 8 GW of renewable energy capacity and is the first green hydrogen project to be listed on the Australian Stock Exchange.
19.	**Gibson Island Project**	Australia	Fortescue Future Industries and fertiliser supplier Incitec Pivot have announced a proposal to build a 50,000 tonne per year green hydrogen and ammonia facility in Gibson Island, Queensland.
20.	**Asian Renewable Energy Hub**	Australia	A proposed 26 GW solar and wind farm in the Pilbara region of Western Australia, which will be capable of producing approximately 1.8 million tons of green hydrogen and up to 10 million tons of green ammonia per year. This project was designated a 'major project' by the Australian government in October 2020, and has an estimated cost of approximately A$50 billion.
21.	**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. It plans to export hydrogen to Asian markets, notably Japan and Korea.
22.	**Arrowsmith Hydrogen Project**	Australia	A proposed green hydrogen plant in Dongara, 300 km north of Perth. Targeted production of 25 tonnes of green hydrogen per day, to be exported together with output from several planned regional projects.
23.	**H2TAS Project**	Australia	Woodside has signed a MoU with the Tasmanian state government to develop a project of up to 300 MW with targeted production of 200,000 tonnes of ammonia per annum in Bell Bay. Woodside secured land for the project in late 2021, and a final investment decision is targeted for 2023 with construction expected to take about two years. 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.
24.	**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. This will serve both local and export markets.
25.	**Pacific Solar Hydrogen project**	Australia	Austrom Hydrogen has announced plans to build a 2.6 GW 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.
26.	**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.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
27.	**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.
28.	**SunHQ Hydrogen Hub**	Australia	Ark Energy H2 Pty Ltd has been given a grant by the Australian government to support the deployment of a 1 MW electrolyser, which will be powered by a solar farm, with storage and refuelling to fuel five new 140 tonne fuel cell electric trucks. The trucks are expected to become the largest road-going fuel cell electric trucks globally at the time of their deployment.
29.	**Hokkaido Green Hydrogen Plant**	Japan	Japan's largest hydrogen plant powered by offshore wind energy which will be located in Ishikari, Hokkaido. Operations are scheduled to begin as early as fiscal 2023 and production will be 550 tonnes of hydrogen per year. Plans are to sell the hydrogen in Hokkaido and ship it to other parts of Japan.
30.	**Fukushima Hydrogen Energy Research Field (FH2R)**	Japan	A 10 MW hydrogen production plant powered by renewable energy, which opened in Fukushima in March 2020.
31.	**Fujiyoshida Hydrogen Power Plant**	Japan	Japan's first commercial hydrogen combustion power plant located in Yamanashi prefecture. Operations are expected to begin in March 2022.
32.	**Hydrogen Energy Supply Chain**	Japan	In November 2019, Japan announced a pilot project 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.
33.	**Large-scale Hydrogen Supply Chain Establishment Project**	Japan	A project by ENEOS Corporation, Iwatani Corporation and Japan Hydrogen Energy, Ltd., a subsidiary of Kawasaki Heavy Industries, Ltd. aims to reduce the cost of hydrogen supply to a similar level as that of fossil fuels, by enlarging the transportation facilities and other resources such as hydrogen carriers and implementing demonstrations of hydrogen power generation at a power plant.
34.	**Yamanashi Hydrogen Energy Society (H2-YES)**	Japan	The Yamanashi Hydrogen Energy Society (**H2-YES**) consortium proposes to develop technology for energy conversion and usage in large-scale Power-to-Gas (**P2G**) systems that use solar power and a water-splitting technology called solid polymer type, to produce green hydrogen. The P2G initiative currently produces hydrogen on a small scale which is supplied to supermarkets in Yamanashi prefecture for use in fuel cells for power supply. A new demonstration project, based on this technology, for larger scale production of green hydrogen is also being developed by H2-YES in Yamanashi prefecture and was chosen as one of the Green Innovation Fund projects by the Japanese government.
35.	**Hydrogen Energy Supply Chain Utilizing 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.

No.	Project	Country	Description
36.	**Central Queensland Green Hydrogen Project**	Japan Australia	In September 2021, a consortium of four Japanese companies (Iwatani Corporation, Kawasaki Heavy Industries Ltd., Kansai Electric Power Co Inc. and Marubeni Corporation) and two Australian companies (Stanwell Corporation and APT Management Services Pty Ltd,) announced that they will study the feasibility of building a green liquefied hydrogen supply chain to export hydrogen from Australia to Japan and which that could produce 100 tonnes of hydrogen a day by 2026 (and 800 tonnes a day by 2031). The proposed hydrogen production base project would be located in Aldoga, Queensland, with the hydrogen liquefaction and loading base to be located at the Port of Gladstone.
37.	**South Australia Green Hydrogen Project**	Japan Australia	Marubeni Corporation's planned green hydrogen production project in South Australia will manufacture hydrogen produced with renewable energy and transport and supply such hydrogen for use in countries such as Pacific Island countries. It was announced in November 2021 that Japan's Ministry of the Environment (**MOEJ**) will subsidise part of the project after it was selected by the MOEJ as a pilot project under a program to accelerate the introduction of hydrogen to the Indo-Pacific region and reduce greenhouse gas emissions in developing countries.
38.	**H2TAS Hydrogen Plant (Export)**	Japan Australia	In May 2021, Marubeni signed a heads of agreement with Woodside and IHI Corporation to investigate the production and export to Japan from the Bell Bay area in Tasmania of green hydrogen produced from renewable hydro power. The project's initial phase is expected to have electrolysis-based capacity of up to 300 MW and a target production of 200,000 tonnes per annum of ammonia, with the potential for up to 1.7 GW of electrolysis capacity for hydrogen and ammonia production.
39.	**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.
40.	**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.
41.	**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.
42.	**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.
43.	**Hydrogen Liquefaction Plant**	South Korea	SK E&S has announced its intention to build the world's largest hydrogen liquefaction plant with an annual capacity of 30,000 tons within SK Incheon Petrochemical Complex by 2023.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
44.	**Blue Hydrogen Plant**	South Korea	SK E&S signed a Memorandum of Understanding with Korea Midland Power (**KOMIPO**), the city of Boryeong, and Chungnam Province to build a blue hydrogen plant near the Boryeong LNG Terminal with an annual capacity of 250,000 tons in the province by 2025.
45.	**Turquoise Hydrogen**	South Korea	In October 2021, SK Inc signed a MoU with Monolith, an American green energy company specialised in the production of turquoise hydrogen.
46.	**Hydrogen FPSO**	South Korea	A consortium of state and private sector bodies led by Korea Maritime & Ocean University is seeking to develop an offshore green hydrogen plant based on a floating production, storage and offloading (**FPSO**) unit. The consortium aims to develop a 1MW pilot plant by 2022, and a gigawatt-class plant by 2030.
47.	**Blue Ammonia**	South Korea	GS Energy Corp. has signed a contract with ADNOC to import blue ammonia from the UAE from 2025, intending to use the fuel to generate electricity or crack into blue hydrogen.
48.	**Solar-powered hydrogen plant**	China	In December 2019, China's first solar-powered hydrogen production project landed in Lanzhou, Gansu Province. The project can effectively improve the utilisation rate of solar-powered hydrogen and use the rich solar energy to produce liquid fuel of hydrogen power.
49.	**Hydrogen production system**	China	Siemens Energy and Beijing Green Hydrogen Technology Development Co., Ltd, a subsidiary of China Power International Development Ltd, has signed an agreement on providing a hydrogen production system for a hydrogen fuelling station in Yanqing District, Beijing.
50.	**Green hydrogen project**	China	On November 30, 2021, Sinopec Group launched China's first 10,000-ton level photovoltaic green hydrogen project, Sinopec Xinjiang Kuqa Green Hydrogen Demonstration Project. When completed, it will produce 20,000 tons of green hydrogen per year.
51.	**Hydrogen liquefaction system**	China	On September 9, 2021, China Aerospace Science and Technology Corporation developed the first hydrogen liquefaction system based on a helium expansion refrigeration cycle. The anticipated liquid hydrogen output of this system is 1.7 tons / day, and the actual full-load output will be 2.3 tons / day.
52.	**Hydrogen supply centre**	China	On September 28, 2021, Sinopec Shanghai hydrogen supply centre was officially completed. Its daily hydrogen supply is 2,500 kg, including 2,000 kg daily filling capacity and 500 kg daily refuelling capacity. In late September, Sinopec Tianjin hydrogen fuel cell project was successfully put into operation. This project is regarded as the largest hydrogen supply project in North China, with an annual hydrogen production capacity of 2,250 tons, which can meet the hydrogen demand of all refuelling stations in Tianjin.
53.	**H2Perth Hydrogen Facility**	Australia Singapore Japan	On October 25 2021, Woodside Energy Ltd announced its proposed H2Perth Hydrogen facility in Kwinana, Western Australia, a large-scale hydrogen and ammonia export hub. In December 2021, Woodside Energy Ltd announced a partnership with Keppel Data Centres Holding Pte Ltd, City Energy Pte Ltd. (as Trustee of City Energy Trust), Osaka Gas Singapore Pte Ltd. and City-OG Gas Energy Services Pte Ltd. To conduct a feasibility study of a long-term, stable supply chain of sustainable liquid hydrogen from Western Australia to Singapore and potentially Japan.

No.	Project	Country	Description
54.	**Hydrogen supply chain**	Singapore	Mitsubishi Corporation, Chiyoda Corporation and Sembcorp Utilities have signed a strategic collaboration Memorandum of Understanding to explore the feasibility and implementation of a commercial-scale supply chain to deliver decarbonised hydrogen into Singapore, utilising Chiyoda's proven hydrogen storage and transportation technology "SPERA Hydrogen™".

Europe & the United Kingdom

No.	Project	Country	Description
A	**Demand side**		
1.	**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.
2.	**Pilot Carbon-Neutral Steel Plant (HYFOR - Hydrogen-based fine-ore reduction)**	Austria	Mitsubishi Heavy Industries has been building the world's largest pilot carbon-neutral steel plant in Austria, which will use hydrogen instead of coal for steelmaking. First test operations were successfully executed in April and May 2021. The HYFOR pilot plant shall be operated for at least 2 years in multiple campaigns to test various ore types and to evaluate the optimal process parameters for the next scale up step.
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.	**HyTrucks**	Belgium	A group of Belgian companies joined forces in the HyTrucks consortium to deploy 300 hydrogen-powered trucks in the area around the port of Antwerp and major logistics hubs in Belgium for both national and international transport by 2025.
5.	**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.
6.	**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.
7.	**Fuel cell system**	France	Hydrogène de France and ABB Marine International 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.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
8.	**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.
9.	**Renewable Hydrogen Production Facility**	France	Lhyfe has launched its first renewable hydrogen production site in France, hoping to increase its production capacities to an industrial scale in a near-future. The company simultaneously aims at putting a local hydrogen distribution system in place in order to locally dispatch locally produced hydrogen.
10.	**Hy24 JV – Ardian/ FiveT**	France	On 1 October 2021, Adian and FiveT Hydrogen launched Hy24, a joint-venture aiming to create the world's largest hedge-fund (EUR 1.5 billion) dedicated to low-carbon infrastructures.
11.	**Régiolis H2 Trains**	France	French SNCF has ordered, on behalf of four Régions, 14 hybrid locomotives powered by hydrogen and electricity to Alstom.
12.	**Hyia JV – Renault / Plugpower**	France	Renault and Plugpower have launched a joint-venture, which seeks to produce light utility vehicles to individuals, and to develop infrastructures for refuelling for their clients.
13.	**Aircraft**	France	Airbus and Plugpower have partnered to develop hydrogen-fuelled planes and hydrogen compatible infrastructures in airports. Moreover, Airbus, Air Liquide and ADP Group (Paris Airports) have signed a partnership regarding the adaptation of airport infrastructures for the Hydrogen Shift.
14.	**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.
15.	**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.
16.	**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.
17.	**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 e.g. 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.

No.	Project	Country	Description
18.	**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.
19.	**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.
20.	**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.
21.	**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.
22.	**H2iseO (Val Camonica)**	Italy	In 2020 FNM S.p.A. and Trenord S.p.A. announced the implementation of the use of hydrogen trains on the Brescia-Iseo-Edolo line, which will entail the construction of hydrogen supply and refuelling methods along the line by building a plant for the production, storage and distribution of blue hydrogen. This plant will be accompanied by an electrolysation plant for the production of green hydrogen. The new technology is expected to substitute the existing diesel trains by 2023.
23.	**Life3H (Civitavecchia Port)**	Italy	A consortium of private companies and public entities, co-financed by the EU's Life programme, aims at using the hydrogen surplus of certain confining industrial areas to power a hydrogen fuelled bus fleet in the Civitavecchia area.
24.	**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.
25.	**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.
26.	**Green Deal H2 Neighbourhoods**	Netherlands	This initiative is aimed at demonstrating the feasibility of hydrogen use in dedicated networks of a few hundred dwellings under development, namely Hoogeveen and Stad aan't Haringvliet. In Hoogeveen, 100 new buildings will be built and 427 existing households will be converted to run on hydrogen for heating. In Stad aan't Haringvliet, 600 existing buildings will be disconnected from natural gas by 2025, which will help identify the barriers and operational needs to scale up hydrogen use in such buildings.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
27.	**WaterstofWijk Wagenborgen**	Netherlands	This pilot will connect 1970s buildings with 40 residents in Wagenborgen to a hydrogen network. Hybrid heat pumps will be installed in each house, running as much as possible on electricity and switching to hydrogen during cold periods only.
28.	**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.
29.	**HIGGS (Hydrogen In Gas GridS)**	Spain	HIGGS project, launched in 2020 and planned to be developed until 2022, has the objective to analyse the potential and the requirements upon the infrastructure, elements and management for the injection of hydrogen in the current transport networks.
30.	**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.
31.	**Hydrogen in the tourism sector**	Spain	In October 2021, Iberostar Group, Acciona Energía and Enagás entered into an agreement whereby the hotel group (an international benchmark in responsible tourism), became the first consumer of renewable hydrogen in the tourism sector in Spain. The initiative, a pioneer in the tourism industry, will allow energy supply through green hydrogen to all hotels owned by Iberostar Group in Mallorca, reducing by 2-5% the consumption of natural gas in its premises.
32.	**'HYBRIT' steel**	Sweden	In August 2021 the world's first delivery of hydrogen produced steel took place within the HYBRIT project. The delivery was made to the Volvo Group. The HYBRIT project has received further grants in order to further scale up the technological tests.
33.	**Fuel cell systems**	Sweden	Hitachi ABB Power Grids and PowerCell Sweden AB, a supplier of fuel cell solutions, have previously 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. The companies have since signed an agreement regarding an in-depth collaboration around fuel cell based stationary power solutions. In January 2021, PowerCell Sweden AB received an order for a MS-100 fuel cell system for stationary power. The system will be developed by PowerCell Sweden AB and Hitachi ABB Power Grids and is the companies' first joint project.
34.	**Green Steel and Green Hydrogen**	Sweden	H2 Green Steel to build a large-scale fossil-free steel plant in northern Sweden. Furthermore, the company recently announced a EUR 2.3 billion Green hydrogen venture with Spanish Iberdrola for the production of a similar plant in the Iberian Peninsula.
35.	**Hydrogen refuelling stations**	Sweden	The municipality of Trelleborg, Trelleborg Energi AB and the Danish hydrogen gas company Everfuel have signed a cooperation agreement regarding a hydrogen refuelling station. The agreement covers the first of eight potential stations in Sweden within the Nordic Hydrogen Corridor project (**NHC**), which is co-financed by the European Union's program Connecting Europe Facility program (**CEF**).

No.	Project	Country	Description
36.	**Nouryon**	Sweden	Nouryon AB is planning to replace the fossil hydrogen gas with fossil-free hydrogen for its hydrogen peroxide production.
37.	**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 was successfully completed and involved running a blend of hydrogen and natural gas on part of the private gas network at Keele University campus. Phase 2 of the project is ongoing and involves a demonstration on a larger, public network with 670 homes and businesses receiving blended hydrogen in the North East. If successfully completed, the project will be rolled out with a demonstration in the North West.
38.	**StreetDeck 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.
39.	**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. HydroFLEX was showcased at COP26 and work is being undertaken to develop a hydroFLEX train into a commercial passenger train.
40.	**H2Bus Consortium**	Latvia Denmark	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.
41.	**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.
42.	**New Fuel Lab**	Poland	PGNiG S.A. aims to establish a New Fuel Lab within the group´s Central Measurement and Research Laboratory. The laboratory will study hydrogen and its mixtures as fuel.
43.	**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 FCEVs. The Project seeks to deploy hydrogen infrastructures. Within the framework of the Project, Riga has already received 10 hydrogen-driven trolleybuses.
44.	**Coradia iLint**	Austria	Alstom's Coradia iLint is 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.
45.	**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 Pomeranian region of Poland.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
46.	**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. The snowmobiles are being used in Hinterstoder Ski area as of February 2021. The ski area has its own refuelling station.
47.	**UP generators**	Estonia	UP generators are the world´s first portable hydrogen fuel cell based smart generators. The generators allow its user to connect the fuel cell unit in combination with an external battery with solar panels and wind turbines to produce and store excessive energy for future usage.
48.	**Procurement of hydrogen-powered city buses**	Slovakia	In December 2021, the provider of city public transport in Bratislava announced procurement of 40 hydrogen-powered city buses from the Polish company SOLARIS Bus & Coach sp. Zoo.
B	**Supply side**		
49.	**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.
50.	**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.
51.	**North-C-Methanol**	Belgium	North-C-Methanol is the first implementation of the North-CCU-Hub Roadmap, a more general project aimed at developing and demonstrating new circular value chains in which carbon emissions can be used as a raw material. It consists of an electrolyser plant with a power of 63 MW, splitting water into green hydrogen and oxygen by using renewable energy originating from off-shore wind. The oxygen will be used locally by the steel industry, while the green hydrogen will be combined with captured CO_2 originating from industrial point sources in a catalytic methanol synthesis plant. The project is currently in phase 1, "feasibility studies", and is expected to start-up in 2024 (phase 2).
52.	**MoU between Belgium and Chile**	Belgium, Chile	During the COP26, Belgium and Chile signed a MoU for the import of green hydrogen from Chile to Belgium. On the one hand, in Belgium, the upcoming merger between the port of Antwerp and the port of Zeebrugge will give the new port a leading position as an important centre for green hydrogen. On the other hand, Chile has a large solar and off-shore wind potential and is expected to be able to export large volumes of renewable hydrogen in the future.
53.	**MOU between Belgium and Namibia**	Belgium, Namibia	During the COP26, Belgium and Namibia signed a MoU for the import of green hydrogen from Namibia to Belgium. As partners, Belgian and Namibian companies will cooperate to develop hydrogen refuelling stations, industrial hydrogen applications and a medium-sized solar power plant in Namibia, which will produce around one million tonnes of green hydrogen annually, half of which will be intended for export.
54.	**Waste to hydrogen project**	Bulgaria	In November 2021, the Hydrogen Utopia International signed a letter of intent with the city of Simitli (Bulgaria) to develop a waste to hydrogen plant to help phase out fossil fuels usage in Bulgaria. The project should be based on scalable technology which can utilise raw materials of high calorific value and convert them into synthesis gas, from which further products such as hydrogen can be obtained.

No.	Project	Country	Description
55.	**Hydrogen Eagle**	Czech Republic Slovakia Poland	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.
56.	**Greening of Gas**	Czech Republic	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.
57.	**H2Base**	Czech Republic	The Czech company DEVINN has developed a mobile hydrogen generator. The aim of the H2Base generator is to supply electricity to places with no electrical infrastructure. The solution is based on fuel cell technology.
58.	**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. The company has in December 2021 announced a EUR 13-18 million equity funding round.
59.	**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.
60.	**'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.
61.	**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.
62.	**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.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
63.	**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 also focuses on testing materials and working on new standards, new norms and new certificates.
64.	**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.
65.	**Aquamarine**	Hungary	The goal of the MFGT´s Aquamarine project is to commence the study of utilising hydrogen in the smallest storage. An electrolysis system and the corresponding hydrogen gas preparatory technology will be implemented as part of the project. The hydrogen, mixed with natural gas, will be used for replacing MFGT´s own natural gas consumption.
66.	**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.
67.	**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 of one or more electrolysers directly connected to an electricity grid or to a renewable energy system converting the overproduced electricity into hydrogen.
68.	**Hydrogen Park (Porto Marghera)**	Italy	Hydrogen Park is a consortium planning to invest EUR 21 million for the implementation of 12 projects with the aim of transforming the venetian area into a hydrogen distribution hub, increasing both the production and storage capacity of green hydrogen.
69.	**Agnes**	Italy	ENI S.p.A. has proposed to establish the first offshore hydrogen valley in the Romagna region by reconverting decommissioned gas extraction platforms. Among other projects, Agnes involves the creation of an electrolysation plant capable of producing 4,000 tons of green hydrogen per year.
70.	**Hydrogen research centre of Casaccia**	Italy	The ENEA has proposed a EUR 14 million investment to create a research centre employing 1,000 researchers to develop new technologies involving the entire supply chain of hydrogen.

No.	Project	Country	Description
71.	**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.
72.	**Djewels**	Netherlands	A consortium of companies is planning to build the biggest green hydrogen plant of Europe in Groningen. The project is still in the business analysis and development phase.
73.	**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. The green hydrogen plant has been operational since 2019 and produces around 400 kilograms of hydrogen daily.
74.	**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 CO_2 emitted within the Port of Rotterdam from the existing hydrogen production in order to produce large-scale blue hydrogen. The CO_2 will then be transported to empty gas fields in the North Sea seabed for storage. On 8 June 2021, the Dutch Ministry of Economic Affairs and Climate Policy confirmed, in a letter to Parliament, that the Dutch government will be setting aside EUR 2.1 billion in grant money that may be used for this project. The awarded grants come from the SDE++ scheme, which was set up to support projects that help reduce the Netherlands' carbon footprint. The project is expected to be operational by 2024.
75.	**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. The consortium envisages having the first energy hub operational by 2030.
76.	**Hydrogen Backbone**	Netherlands	Gasunie (the Dutch government company responsible for the transport of Dutch natural gas), aims to develop a national network that will link op the carbon-free hydrogen supply and demand. The objective of the plan is first to use pre-existing pipelines and build a few new pipelines to connect the hydrogen supply and demand of five industrial hubs in the Netherlands (Noord, IJmond, Rijnmond, Limburg and Zeeland). Once this national network has been completed (or, in some cases, while it is being completed), the project further aims to establish connections between the Netherlands and its neighbouring countries Belgium and Germany.
77.	**Hydrogen Delta Network NL**	Netherlands	An agreement concluded between Gasunie and the North Sea Port Authority to develop the regional hydrogen infrastructure. The infrastructure will be first aimed at ensuring the link between supply and demand for hydrogen in the southern delta region of the Netherlands before being connected to Gasunie's "hydrogen backbone", to the HyStock facility and to the Belgian and German hydrogen transport infrastructures. The project also aims at developing large-scale electrolysis and stimulating hydrogen import and export.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
78.	**H2Gate**	Netherlands	A consortium of companies and the port of Amsterdam have joined forces to investigate the technical and commercial feasibility of importing and storing large volumes of green hydrogen in the Amsterdam port on an industrial scale. During the second part of 2021, the parties worked on blueprints for import, storage, distribution and trading of green hydrogen, consisting of facilities with a total throughput capacity of 1 million tonnes of hydrogen per year.
79.	**Sines Hydrogen Production Plant**	Netherlands, Portugal	Portugal and the Netherlands intend to build a 1 GW green hydrogen production plant in the port of Sines by 2023. The green hydrogen would be produced via electrolysis, and the electricity for the electrolysis would be generated by a solar park in proximity.
80.	**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.
81.	**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.
82.	**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 cells.
83.	**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 EUR 1.8 billion until 2027.
84.	**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.
85.	**Green hydrogen production**	Spain	In April 2021, BP, Iberdrola and Enagas entered into an agreement to study the feasibility of building, at BP's plant in Castellón, the first phase of the largest green hydrogen production facility in the region of Valencia. The purpose of this agreement is to evaluate the installation of a 20 MW electrolyser for the production of green hydrogen on land owned by BP in the El Serrallo industrial estate. The electrolyser would run on renewable energy produced by a 40 MW photovoltaic plant, among other sources.

No.	Project	Country	Description
86.	**Green hydrogen production**	Spain	Exolum will invest approximately EUR 2 million in the construction of the first green hydrogen production plant in the Community of Madrid on land adjacent to its San Fernando de Henares - Torrejón de Ardoz facilities. The plant is expected to be fully operational in the second half of 2022 and will initially produce around 60 tons of green hydrogen per year, so that any company or user interested in introducing this energy vector in their activity will have access to it.
87.	**Green hydrogen production**	Spain	In October 2021, Repsol and EDP (through its subsidiary EDP Renewables (**EDPR**)), will work together to evaluate new investment opportunities in renewable hydrogen projects in the Iberian Peninsula. The Memorandum of Understanding marks the start of the discussions between the two parties to implement renewable energy projects on the Iberian Peninsula.
88.	**HyVus**	Spain	In November 2021, Vectalia, Fotowatio Renewable Ventures (**FRV**), part of Abdul Latif Jameel Energy, Iberdrola and Aguas de Alicante entered into the HyVus project consortium that pursues the application of renewable hydrogen as a vector for the decarbonisation of large-scale heavy vehicle mobility, through an initiative ranging from clean energy generation, self-production and hydrogen supply, to fleet transformation.
89.	**Green hydrogen production**	Spain	In November 2021, Solaria and Enagás entered into an agreement to study the potential development of a green hydrogen plant. This project, which contemplates the potential dedication of up to 200 MWp of solar photovoltaic energy for the production of green hydrogen, highlights the excellent synergies between the different renewable energy sources and the production of green hydrogen with the aim of advancing in the process of decarbonisation and energy transition.
90.	**H2BASQUE**	Spain	In November 2021, Tubacex Innovación, Cidetec, CIC Energigune, the University of the Basque Country/Euskal Herriko Unibertsitatea, Tekniker, Petronor Innovación and the Energy Cluster launched the project to develop technologies for the generation of green hydrogen in the Basque Country, together with a Basque consortium formed by. Its objective is to develop and improve technologies and solutions for the production of green hydrogen in the Basque Country, to obtain this type of hydrogen more competitively, encouraging the use of renewable energies and large-scale manufacturing to reduce costs, and thus improving the productive capacity of Basque companies and their industrial competitiveness.
91.	**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 approximately £13 million in government funding.
92.	**East Coast Cluster**	UK	The East Coast Cluster is a project that plans to decarbonise industrial emissions around the Humber and Teesside, with its ambitious target to transport and securely store nearly 50% of all UK industrial cluster CO_2 emissions (27 million tonnes) a year by 2030. The project was given government backing in October 2021 with the intention for the project to be in commercial operation by 2025.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
93.	**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 CO_2 per year.
94.	**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.
95.	**Dolphyn Project**	UK	An offshore floating hydrogen facility that produces hydrogen from wind power. The project was awarded £3.1 million from the UK government to develop a 2 MW prototype system and its development is being accelerated up to two years earlier than initially planned. The project is now scaling up to commercial production with the aim of producing 10 MW of hydrogen.
96.	**Project Mayflower**	UK	Project Mayflower is a project being run out of the Port of Immingham and is sponsored by Toyota Tsusho UK, Uniper, Siemens Energy UK&I and Associated British Ports, who have launched a feasibility study on the potential for green hydrogen production, transport, storage and use as a replacement fuel source for diesel and heavy fuel oil. The project aims to start the production of 20 MW of green hydrogen at the Port of Immingham by 2025 as a replacement for fossil fuels in the maritime sector. Financial investment decisions are expected in 2023.
97.	**Ukraine Hydrogen Valley**	Ukraine	The aim of the project is to develop a hybrid park of wind and solar power plants in the water area of the Kakhovsky reservoir with subsequent conversion of the energy into green hydrogen (green ammonia). The Ukraine Hydrogen Valley project plans to use the existing infrastructure and network of gas pipelines for sale of generated hydrogen.
98.	**H2FUTURE**	Austria	H2FUTURE is a European flagship project that aims to develop ways to extend production and use of green hydrogen.
99.	**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.
100.	**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.
101.	**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.
102.	**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.

No.	Project	Country	Description
103.	**Black Horse Project**	Slovakia Czech Republic Hungary Poland	The goal of the Black Horse Project is to launch 10,000 fuel cell trucks. The project should represent the whole value chain, all the way from green hydrogen production to the trucks that would consume the green hydrogen. The Project is now waiting for the approval by the European Commission
104.	**GET H2**	Slovakia	TeHO Topoľčany aims to build a plant that will produce green hydrogen by electrolysis of water. The project is currently waiting for the approval by the Slovak Ministry of the Environment.
105.	**BFC Energy Stations**	Slovakia	BFC Energy aims to build 40 hydrogen filling stations in Slovakia which should become a part of the Benzinol Slovakia concern. Hydrogen is to be produced by electrolysis by the four BFC Energy plants located in Modrý Kameň, Pezinok, Malacky and Trenčín. The company projects to initiate production and sale of hydrogen in 2023/2024.
106.	**H2Pioneer**	Austria	H2Pioneer project is focused on the production of green hydrogen and targets green hydrogen applications for an industry segment with moderate hydrogen capacity needs and superior quality requirements. The focus of the project is the application of hydrogen at a semiconductor production site. Another key goal is the development of a modular thermodynamic simulation tool for the optimisation of hydrogen cycles for industrial processes.
107.	**Nordic Hydrogen Corridor**	Sweden	The Gothenburg Port Authority and the Norwegian company Statkraft are planning to establish a facility for production and handling of hydrogen gas in the port of Gothenburg. The facility shall produce up to two tonnes of hydrogen per day and the planned production start is mid- 2023. The project is part of the EU co-financed project Nordic Hydrogen Corridor (**NHC**).

Central Asia

No.	Project	Country	Description
	Supply side		
1.	**Construction of hydrogen filling stations**	Kazakhstan	In October 2021, JSC NC KazMunayGas, Atyrau Oil Refinery LLP and Air Liquide Munai Tech Gases LLP signed a Memorandum of Understanding aimed at the development of hydrogen initiatives in the country to achieve carbon neutrality.
2.	**Framework Agreement on 30 GW green hydrogen developments**	Kazakhstan	In October 2021, Republic of Kazakhstan represented by the Ministry of Foreign Affairs and Svevind signed a roadmap for 30 GW green hydrogen developments in Kazakhstan. In November 2021, Kazakhstan government and Svevind signed the Framework Agreement on the Basic Principles of Project Implementation, outlining the principles of the implementation of Svevind´s green hydrogen projects in the Mangystau region, Western Kazakhstan, to deliver green hydrogen from 2030. Svevind´s green hydrogen projects will support the action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
3.	**Framework Agreement on hydrogen development**	Uzbekistan	The Ministry of Energy of Uzbekistan and ACWA Power (Saudi Arabia) signed a framework agreement for the development of hydrogen energy. It implies the first steps of Uzbekistan in achieving the goal to combat climate change and reduce greenhouse gas emissions through scientific research in the field of hydrogen and renewable energy.
4.	**Construction of hydrogen production unit**	Turkmenistan	The Turkmenbashi complex of oil refineries plans to build a hydrogen production unit. In October 2021, the company announced an international tender for the development of relevant tender proposals.

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 $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 to 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.

No.	Project	Country	Description
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.
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 GW 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.
10.	**Alberta Zero-Emissions Truck Electrification Collaboration (AZTEC)**	Alberta, Canada	In June 2021, the Canadian government through the Alberta Motor Transport Association (**AMTA**) in collaboration with other partners (**AZTEC**) is building a hydrogen fuelling station to test real word conditions for heavy-duty freight transportation while AZTEC will design, manufacture, and operate a long-range fuel cell electric trucks for hauling between Calgary and Edmonton.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
11.	**H2OK**	Oklahoma, US	Woodside Energy is progressing the development of Phase 1 of its green hydrogen project in Oklahoma, which will be a 290 MW facility producing approximately 90 tons/day of liquid hydrogen using electrolysis. The facility has the space to further expand to 550 MW producing 180 tons/day in the future. The facility is scheduled to begin production in 2025 and provide fuel for the heavy transport sector.
12.	**Hydro-Quebec**	Quebec, Canada	Hydro-Quebec intends to construct a 90 MW electrolyser facility using Thyssendrupp technology at a cost of $200 million. The project will generate approximately 11,100 metric tonnes of hydrogen and 88,000 metric tonnes of oxygen annually to be supplied to the Recyclage Carbone Varennes (**RCV**) plant project, which transforms non-recyclable waste into biofuels.
13.	**PNW Hydrogen LLC**	Arizona, US	PNW Hydrogen LLC with support from the US Department of Energy will construct a power-to-power hydrogen project using power from the Palo Verde Nuclear Generating Station to produce and store hydrogen, which will then be used to produce approximately 200 MW of electricity during high demand periods. The stored hydrogen may also be used to produce other chemicals and liquid fuels.

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.
4.	**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 litres of e-fuels by 2026. Porsche will be the primary offtaker.

No.	Project	Country	Description
5.	**Fuel cell forklifts for warehouses**	Chile	Engie and Walmart have announced a pioneering project to produce green hydrogen to power 259 forklifts used in Walmart's warehouse located in Quilicura. Both companies will invest US$15 million to replace the battery-powered forklifts with hydrogen-powered fuel cells. Walmart intends to adopt this technology in all its warehouses in Chile and operate solely with hydrogen by 2025. The time required to fuel the forklifts with hydrogen will be reduced to two minutes from the 20 minutes which is currently required using batteries.
6.	**First green hydrogen fuelling station for zero-emission vehicles**	**Chile**	Anglo American marked a key milestone for the development of green hydrogen in Chile with the start-up of the country's first green hydrogen plant for zero-carbon vehicles. The project consists of a hydrogen electrolyser with a production capacity of 2 kg/day, which is dispensed to a zero-emission drive forklift, and also includes a stationary fuel cell. The green hydrogen is produced from reused water from Anglo American's mining operations and is powered by two on-site photovoltaic plants.
7.	**Hydrogen ecosystem**	**Costa Rica**	In April 2019, Ad Astra Rocket announced two projects to strengthen the hydrogen ecosystem. The first project is an investment financed by the Toyota Motors Mobility Foundation to expand a plant located in Liberia, Costa Rica to store hydrogen for 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. The second project seeks to increase sophistication of 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.
8.	**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.
9.	**Hydrogen fuelled cargo sailboats**	**Costa Rica**	In May 2021, Ad Astra Rocket and Sailcargo launched the 'Hydrogen for the Seas' initiative, with the goal of using green hydrogen to power Sailcargo's zero-emission sailboats used for transportation (with a cargo capacity of up to 250 tons per sailboat).
B	**Supply side**		
10.	**Hychico Hydrogen Plant**	Argentina	In Chubut, Hychico Hydrogen Plant has operated since January 2009, using electricity generated on its own operated wind park, with an installed capacity of 6.3 MW and a capacity factor of 48.3%. Hydrogen is then blended with natural gas to feed a 1.4 MW internal engine power generator.
11.	**IEASA Project**	Argentina	The State-owned company IEASA reached an agreement in October 2021 with Fraunhofer Institute to jointly develop a green hydrogen project based on 200 MW wind park in the Province of Buenos Aires. According to IEASA, the minimum investment will be equal to US$200 million. The total cost of the project is yet to be determined.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
12.	**Fortescue Project**	Argentina	In November 2021, Fortescue Future Industries announced the investment of US$8.4 billion in a green hydrogen project which, according to Río Negro province public authorities, will be based in Sierra Grande. A first stage US$1.2 billion pilot project with production of 35,000 tons of green hydrogen is planned for 2022-2024, after which a further US$7.2 billion investment is foreseen, aiming for a total output of 215,000 tons of green hydrogen, enough to power 1.6 million homes.
13.	**H2 Green Power / Ceará state**	Brazil	Ceará state in Brazil signed an MOU with H2 Green Power in March 2022 for the potential development of a green hydrogen production plan at Pecém port, and includes the development of a green hydrogen production chain project, with the possibility of an ammonia and utilities storage pool to be developed at the port.
14.	**Porto de Pecém**	Brazil	The Porto de Pecém has entered into several memorandums of understanding regarding large-scale projects for production of green hydrogen, with key players such as White Martins (a Brazilian company of the Linde group), Enegix (Australian energy company), Fortescue (Australian mining company) Engie and Qair (French energy companies) and the Transhydrogen Alliance (a dutch consortium).
15.	**Porto do Açu**	Brazil	Fortescue Future Industries and Porto do Açu Operações (a joint venture between Prumo Logística and Port of Antwerp International that operates the Porto do Açu) have entered into a memorandum of understanding to analyse the viability of hydrogen plants in the Porto de Açu, with a foreseen 300 MW of installed capacity.
16.	**Porto de Suape**	Brazil	Neoenergia group and the State of Pernambuco have entered into a memorandum of understanding to develop pilot projects for hydrogen production in the Porto de Suape. Similarly, the State of Pernambuco and the Qair Group have begun technical and economic feasibility studies for the implementation of a 2,240 MW green hydrogen production plant at the Porto de Suape.
17.	**Eletrobras/Siemens**	Brazil	Brazilian stated owned company Eletrobras has entered into a memorandum of understanding with Siemens Group to jointly study the cycle of production and consumption of hydrogen by means of a pilot project.
18.	**Rio Grande do Norte government and Copenhagen Infrastructure Partners**	Brazil	The government of the State of Rio Grande do Norte has entered into a memorandum of understanding with Danish investment fund Copenhagen Infrastructure Partners regarding an offshore wind generation and green hydrogen production project.
19.	**H2 Brasil**	Brazil	During an event organised by the Brazil-Germany Chamber (**AHK**), the German Agency for International Cooperation announced an investment of EUR 34 million for the development of green hydrogen production projects in Brazil. The initiative foresees the availability of resources over the next two years for the construction of a pilot electrolysis plant with a capacity of 5 MW. Recently, representatives of the Rio de Janeiro chapter of AHK announced that they were planning to launch a call for projects until April 2022 to finance innovation projects related to low carbon hydrogen.

No.	Project	Country	Description
20.	**Shell offshore wind projects**	Brazil	Shell Plc has announced plans to develop 17 GW of offshore wind in Brazil in order to supply green hydrogen projects. Permits have been sought for six projects along Brazil's coast, and the company hopes to sell the electricity generated as an input for green hydrogen projects.
21.	**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. To minimise transportation costs, both plants will be located near two of ENI's refineries in Chile, which will use the green hydrogen to remove sulphur from crude oil.
22.	**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.
23.	**Gasvalpo H2GN Project**	Chile	Gasvalpo, though its Energas brand, has announced a project to produce and inject green hydrogen into Chile's natural gas distribution networks. The project will be monitored by the University of La Serena and is expected to replace up to 20% of the natural gas currently supplied with green hydrogen. The first beneficiaries will be nearly 2,000 families in Coquimbo and La Serena.
24.	**Quintero Bay Green Hydrogen Project**	Chile	A consortium formed by GNL Quintero, Enagas and Acciona Energía, will develop an electrolysis plant in the region of Valparaíso for the generation of green hydrogen from water and renewable electricity, with an estimated investment of US$30 million. The project will be located at the GNL Quintero regasification terminal and will have a nominal capacity of 10 MW, contemplating an initial production of around 500 t/year, which will be gradually increased according to the demand generated in the area.
25.	**HNH Energy Project**	Chile	The HNH Energy project, led by Austrian developers AustriaEnergy and Ökowind EE, involves the installation of a plant for the commercial production of green ammonia. The plant, to be located in the Magallanes region, will be powered by 2 GW of onshore wind energy and include a 1.4 GW electrolyser, allowing for the production of up to 1Mt/year of green ammonia.
26.	**Port of San Antonio hydrogen plant**	Chile	The Port of San Antonio and Solek, a Czech renewables developer, signed an agreement to develop a green hydrogen plant to support the port's operations. Electricity for the electrolysers will be provided by energy generated by Solek's 96 MWp Leyda solar photovoltaic plant.
27.	**Ecopetrol Pilot Project**	Colombia	Colombian state oil producer Ecopetrol, Colombia's largest company, has announced that a pilot project for the production of green hydrogen through electrolysis is expected to be in operation during the first quarter of 2022 in its refinery in Cartagena.

Global Hydrogen Development Activity continued

No.	Project	Country	Description
28.	**Promigas Pilot Programs**	Colombia	Promigas, one of Colombia's most prominent natural gas companies, has confirmed that it is advancing two pilot projects in the northern region of the country, one of which will be operational in 2022. Through the projects, Promigas is studying four different market segments: (i) mobility; (ii) distributed generation; (iii) mixed gas pipelines; and (iv) decentralised production.
29.	**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 power purchase agreement for 25 years. In October 2021, CEOG reached financial close and construction commenced.
30.	**Waste-to-hydrogen project**	Martinique	In September 2021, Ways2H Inc., a global supplier of renewable hydrogen systems, and VALECOM, a Caribbean ecological and energy solutions provider, signed a letter of intent to transform up to 9,000 tons per year of waste into renewable hydrogen. The waste-to-hydrogen project will power buildings and municipal buses, utilising plastic films used in the production of bananas (Martinique's main export) as feedstock.
31.	**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. 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.
32.	**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 is supposed to 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 ft^3 per day.
33.	**Hydrogen production projects**	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.

No.	Project	Country	Description
34.	**Hydrogen production plant**	Paraguay	In 2020, Seven Seas Energy Limited announced the construction of a hydrogen production plant based on electrolysis. The estimated 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.
35.	**Itaipu green hydrogen and ammonia facility**	Paraguay	ATOME and Itaipu Technology Park, the research and innovation arm of the Itaipu hydroelectric dam on the Brazil-Paraguay border and Paraguay's first technological park, signed a memorandum of understanding in 2021 for the development of a proposed 250 MW green hydrogen and ammonia facility. The facility is to be located approximately 1 km from the Itaipu hydroelectric dam itself. ATOME's goal is to generate an initial 50 MW of hydrogen by end of 2024, with plans to gradually increase production up to 250 MW.
36.	**Omega Green Project**	Paraguay	ECB Group is developing the Omega Green Project, a production facility in Villeta, near Asunción, Paraguay. The Omega Green Project represents the largest private investment in a single project in the country's history and would be the first advanced biofuels project. Honeywell UOP, who provides technology and engineering services for the project, aims to minimise carbon emissions at the site by designing the facility to be completely fueled by renewable energy. The UOP Ecofining™ unit, which converts vegetable oils and animal fat into renewable diesel and jet fuel, is designed to produce hydrogen from renewable feedstocks.
37.	**NewGen hydrogen production project**	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. During 2020 a feasibility study was conducted 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. It is expected that a final investment decision will be made in the first quarter of 2022.
38.	**Project Verne and ANCAP Small/ Medium Scale Projects**	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. ANCAP expects to tender various projects in 2022 including small-scale green hydrogen production led by public-private initiatives and a medium-scale and industry focused production mostly led by the private sector. In addition, the projects will include local distribution and the export of carrier products –like ammonia, methanol and e-fuels–, piers, tanks and geological storage.
39.	**Offshore Green Hydrogen Project**	Uruguay	An offshore hydrogen project was presented by ANCAP in October 2021 to promote renewable energy production from wind farms installed on an offshore platform. The offering consists of 8 to 16 blocks off the coast. The estimated investment will be between US$1 to 3 billion and the term of the concession is expected to be for 25 years. The bidding round for the offshore H2U project is expected be launched in June 2022.

Global Hydrogen Development Activity continued

Middle East

No.	Project	Country	Description
A	**Demand side**		
1.	**Transport**	Israel	In late 2020, Italian infrastructure company Snam 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.
4.	**Sale of Blue Ammonia to Japan**	Abu Dhabi, UAE	In August 2021, ADNOC agreed to sell three shipments of blue ammonia to Japan, namely to INPEX Corp, Itochu Corp and Idemitsu Corp. for use in power generation in Japan.
B	**Supply side**		
5.	**Green Hydrogen Project with 100 MW Electrolyser**	Egypt	This project is set to become the world's largest green hydrogen project to date. The developers are Norwegian energy company Scatec, Abu Dhabi based Fertiglobe, and the Sovereign Wealth Fund of Egypt. Scatec will build, operate and majority own the facility, while a subsidiary of Fertiglobe (EBIC) will have a long term offtake agreement for the ammonia. The project partners are targeting first hydrogen production by 2024. Construction of the project is due to be completed by Egypt's hosting of COP27 in November 2022.
6.	**First Green Hydrogen Project**	Israel	An Israeli firm – Doral – has won a NIS 3.3 million grant from the Israeli Energy Ministry for a PV facility with a 400 kW capacity to generate green electricity, and then to generate green hydrogen. Doral will use the technology developed by H2Pro which splits water molecules into hydrogen and oxygen.

No.	Project	Country	Description
7.	**Hydrogen production technology start ups**	Israel	H2Pro is an Israeli company developing a novel, efficient and low-cost green hydrogen production technology which is a water splitting device. Known as "ETAC" (Electrochemical – Thermally Activated Chemical), it uses electricity to split out water into hydrogen and oxygen. Unlike electrolysis however, hydrogen and oxygen are produced at separate steps. H2Pro's investors so far included New Fortress Energy, OurCrowd, iAngels, Horizons Ventures, TPY Capital, Contrarian Ventures and Bazan. H2Pro successfully closed its series A2 financing in March 2021, where it received a further US$22 million from the following investors: Breakthrough Energy Ventures (founded by Bill Gates), IN Venture and Sumimoto Corporation CVC Israel. 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. In February 2021, GenCell announced that it would be partnering with a Japanese maker of lithium-ion batteries (TDK Corporation) to develop an environmentally friendly "green ammonia" at low cost.
8.	**NEOM / AirProducts**	Saudi Arabia	NEOM and AirProducts have announced a US$5 billion project (named Neom Green Hydrogen 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. It is intended that Helios will produce 650 tonnes of hydrogen a day by way of electrolysis – which will be enough for conversion to 1.2 million tonnes of green ammonia per year. AirProducts will then buy that Ammonia and convert it back to Hydrogen upon delivery to customers. ACWA Power expects construction work to start on the plan in the first half of 2022.
9.	**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. More recently, the country has confirmed that it will be looking to use a large portion of gas from the US$110 billion Jafurah development in the production of blue hydrogen.
10.	**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'.
11.	**CCUS**	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 CO_2 by 2030. The CCUS technology will be used in part to produce blue hydrogen.

Global Hydrogen Development Activity continued

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.
4.	**South Africa's Hydrogen Valley**	South Africa	A feasibility study was completed in October 2021 for the development of a so-called "hydrogen valley" in South Africa. The hydrogen valley will be located in the Bushveld complex and larger region around Johannesburg, Mogalakwena and Durban. Three catalytic green hydrogen hubs have been identified, which will host pilot projects to launch the hydrogen economy in the Hydrogen Valley.
B	**Supply side**		
5.	**Hydroma Inc. hydrogen-based electricity production**	Mali and other African countries	In early 2021, Hydroma Inc. launched industrial production of hydrogen-based electricity in Mali. Natural hydrogen wells operated by Hydroma Inc. will be 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).
6.	**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 potentials of green hydrogen production from the enormous renewable energy sources within the sub-regions.

No.	Project	Country	Description
7.	**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), which should be operational by 2024 or 2025. 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.
8.	**Green hydrogen and ammonia export hub**	South Africa	Sasol has signed a Memorandum of Agreement with the Northern Cape Development Agency to lead a feasibility study to explore the potential of Boegoebaai as an export hub for green hydrogen and ammonia. The green hydrogen development has been designated as a Strategic Integrated Project in South Africa's National Development Plan and is in the Namakwa Special Economic Zone. The proposed location and special classification are key to the project's potential for success.
9.	**Green hydrogen plant**	Namibia	The Namibian government announced that it has selected HYPHEN Hydrogen Energy as the preferred bidder for a US$9.4 billion green hydrogen project to be developed near the coastal town of Luderitz in southern Namibia. The vertically integrated project will produce 300,000 t/year of green hydrogen and green ammonia for export into regional and global markets from 2026 onwards. The first phase of the project will involve the building of 2 GW of renewable electricity generation capacity. This phase will also involve the development of electrolyser capacity to produce green hydrogen for conversion into green ammonia, and will make use of desalinated water. Once complete, the facility will have renewable generation capacity of 5 GW and electrolyser capacity of 3 GW. Surplus electricity will be fed into the Namibian energy grid and potentially into the southern African regional power pool.

5/

White & Case

5/ White & Case

Global challenges require global resources and local knowledge

White & Case is a truly global law firm, uniquely positioned to help our clients achieve 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 experience in multiple jurisdictions. We work with some 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 adequate 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

The concept of a "hydrogen economy" 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, heavy transport and other sectors that are difficult to abate. While hydrogen will clearly play a role in a decarbonized future, the depth of that role will depend heavily on cost reductions and governmental policies.

Given the range of options for hydrogen production (and its eventual use), prospective market players can tailor their participation in this exciting sector in line with their particular strengths, strategies and risk appetites.

We have a long record of successfully delivering "first of" transactions in emerging markets and sectors around the world. Given the similarities in the value chain and infrastructure requirements for hydrogen and LNG, our deep experience in the LNG industry dating to the 1980s, coupled with our market-leading capabilities in the global renewables sector, provides us with the unique skill set necessary for navigating clients through the complexities of developing and financing projects in this emerging sector. Through understanding intimately the practical and commercial considerations impacting the viability and bankability of these projects, we help our clients realize their net-zero ambitions.

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

&

Global Band 1: Projects & Energy
(17 consecutive years)
Chambers Global 2022

"They are a team that is legally well equipped but also pragmatic and commercial. We have had difficult cross-border negotiations, and they advise us in way that protects us but are also cognisant in handling things in a way that keeps things moving."

Chambers Global 2022

"We keep going back to White & Case because they do a great job."

Chambers Global 2022

"Deep insight in issues and strong commercial understanding. Good at solving problems."

Legal 500 2022

WHITE & CASE

whitecase.com