FLEISHMANHILLARD

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NATIONAL HYDROGEN STRATEGIES IN THE EU MEMBER STATES

A FleishmanHillard overview of national hydrogen strategies

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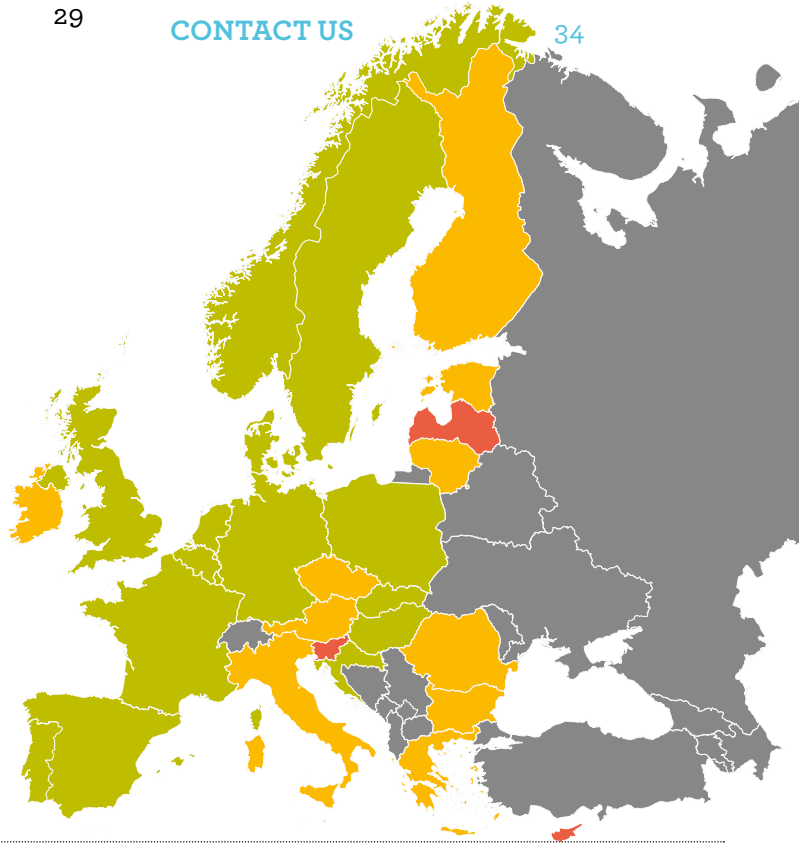
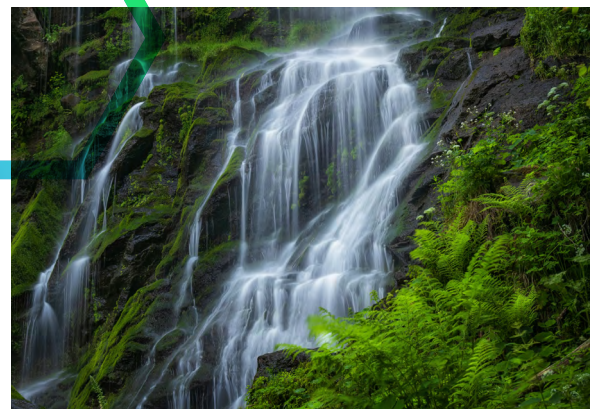


FOREWORD

In March 2020 the European Union announced its ambitious target to become climate neutral by 2050, and hydrogen will be an indispensable means for the decarbonization of the member states' economies[1]. It is fair to say that hydrogen has really been gaining momentum over the past few years, with countries issuing national roadmaps and strategies for its increased deployment. Currently, many envision hydrogen as one of the best alternatives to substitute fossil fuels, especially in hard-to-decarbonize sectors such as heavy industry and transport.



Later in the same year, in July, the European Commission adopted a hydrogen strategy for a climate neutral Europe, highlighting the essential role of hydrogen in decarbonizing the industry, transport, power generation and heating sectors.[2] Over the next 30 years, the Commission intends to gradually increase hydrogen production throughout Europe. Hydrogen also appeared in the "Fit for 55" Package, e.g. the proposal for the revision of the Renewable Energy Directive included a target of 50% for green hydrogen use in industry. Finally, the Commission identified hydrogen as an investment priority in its post-COVID recovery plan "Next Generation EU".

While some member states already had hydrogen strategies before 2020, the publication of the EU hydrogen strategy provided an extra boost. As indicated in the map (see: Figure #), over half of European countries have either already published their strategies or are currently in the process of developing them. This number has increased since October 2021, when FleishmanHillard EU first published the present report to help assess the current degree of readiness and ambition of hydrogen utilization across Europe. In the meantime, member states have continued investing in hydrogen, expanding its national production and deployment, and establishing intra-EU and international hydrogen partnerships. To reflect these

1 European Commission, "Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law)" (2020) <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588581905912&uri=CELEX:52020PC0080>

2 European Commission, "A hydrogen strategy for a climate-neutral Europe" (2020) <https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf>.

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changes, FleishmanHillard EU has updated the report, which now contains the most recent state of play and the key objectives for hydrogen deployment set in national strategies.
The report divides the countries in three sections, (1) **Frontrunners**, (2) **Developers** and (3) **Laggards**. This reflects the status of national hydrogen strategies and does not necessarily indicate the level of maturity of hydrogen technology within countries. Accordingly, some of the states included in the "Developers" and "Laggards" sections may already have wide deployment of hydrogen projects but lack national frameworks. As the report shows, hydrogen-specific legislation is absent in almost all member states, while in others, the unsuitability of the existing legal framework obstructs hydrogen deployment. Therefore, the report provides a useful overview of the status quo, in preparation of upcoming hydrogen-specific laws.

The report's first update comes after the European Commission published its Hydrogen and Gas Market Decarbonization Package on 15 December 2021.[3] As part of the second Green Deal Package, the revised Gas Markets and Hydrogen Directive outlined the rules for the hydrogen system, introducing a new regulatory framework for hydrogen. Overall, the proposed rules for hydrogen infrastructure mirror those in place for gas, mandating the unbundling of hydrogen infrastructure and setting requirements for third party access. Complementing the objectives of the Directive, the Gas Markets and Hydrogen Regulation sets out the principles for operation of hydrogen networks and establishes the European Network of Network Operators for Hydrogen (ENNOH) to promote the development and functioning of the internal market for hydrogen. Complementing the 2020 EU Hydrogen Strategy and national efforts, the Package aims at setting the right regulatory incentives and policy tools for the production and deployment of hydrogen in Europe.

The Hydrogen and Gas Market Decarbonization Package aims at setting the right regulatory incentives and policy tools for the production and deployment of hydrogen in Europe.

Betting on Green: Renewable Hydrogen as the End-Goal

While hydrogen has numerous applications in the energy sector, it is not an energy source, but an energy carrier. This means that hydrogen must be extracted from other sources. Depending on the energy source and the extraction process, there are several types of hydrogen, not all of which are equally suitable to achieve decarbonization. Within the context of EU hydrogen production, grey, blue, and green hydrogen play the most important roles.

According to recent estimations, 96% of hydrogen produced in the EU is the so-called 'grey hydrogen', namely hydrogen generated from fossil fuels such as natural gas via steam reforming. The downside of grey hydrogen is in the large volume of CO_2 emissions released during its production (1 kg grey hydrogen = 9 kg CO_2 emissions). One way to remedy the situation is through capturing emissions generated from the steam reforming process and storing them underground, a process often referred to as carbon capture, utilization, and storage, or CCUS. Where this is done, the hydrogen produced is referred to as 'blue hydrogen', which is considered a low-carbon hydrogen type.

Nevertheless, while CO_2 emissions are lower with blue hydrogen, it does lead to the release of 'fugitive methane' resulting from leaks. To address this issue, the Commission has published its proposal for a regulation on methane emissions reduction in the energy sector in the EU. [4]The new regulation will force member states to designate national authorities that will monitor and report methane emissions of energy and mine operators. Combined with the Gas Markets and Hydrogen Directive and Regulation, establishing a new market design and creating the conditions for a hydrogen market, the proposed Methane Regulation represents an important step towards a significant reduction of the carbon footprint of blue hydrogen production. Finally, 'green hydrogen' refers to hydrogen produced from renewable energy sources via electrolysis. However, due to the high costs associated

3 European Commission, "Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on common rules for the internal markets in renewable and natural gases and in hydrogen 2021/0425(COD)" (2021) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2021%3A803%3AFIN&qid=1639664719844> and "Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal markets for renewable and natural gases and for hydrogen (recast) 2021/0424(COD)" (2021) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2021%3A804%3AFIN&qid=1639665806476>.
4 European Commission, "Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on methane emissions reduction in the energy sector and amending Regulation (EU) 2019/942" (2021) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2021%3A805%3AFIN&qid=1639665806476>.

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with the process and the lack of required infrastructure, green hydrogen currently amounts to only 1% of all hydrogen produced.

To facilitate the production of renewable hydrogen in the EU, the Commission is expected to publish a delegated act to the Renewable Energy Directive in February 2022. This technical tertiary law will lay down requirements stipulating what counts as renewable hydrogen and how its producers must prove its green credentials. These rules will play an essential role in ensuring the EU reaches the objectives of its Hydrogen Strategy. The document highlights renewable hydrogen as an essential means of decarbonizing the economy and creating sustainable growth. The current roadmap envisions production of up to 1 million tons of renewable hydrogen by 2024 and up to 10 million tons by 2030 with large-scale deployment across the hard-to-decarbonize sectors. Concurrently, the EU views blue hydrogen as a transitional path required to support the scale-up of green hydrogen and meet the growing hydrogen demand. Importantly, both green and blue hydrogen are considered 'clean' hydrogen types in the proposals.

Alternatively, the United Kingdom (UK), which also aims at achieving climate neutrality by 2050, placed a high bid on blue hydrogen, highlighting that both types have an important role to play. It remains to be seen which path EU member states will follow. For now, however, it is apparent that more government support is required if the EU is to achieve deep decarbonization. This means that those countries that have not yet announced their hydrogen plans need to do so soon while the frontrunners need to focus on the adoption of hydrogen-specific legislation.

With this report, FleishmanHillard EU wants to provide a concise overview of the national hydrogen strategies of the EU member states, the UK and Norway in this critical time for hydrogen development in Europe. The report has now undergone its first revision, after the publication of the second Green Deal Package in December 2021. We will keep revising it every three months in line with the most recent political developments and readers' feedback. Do not hesitate to reach out to the FH Energy and Transport team to further discuss the state of play of hydrogen and other cross-cutting policy developments in Europe.

THE FRONTRUNNERS

This section provides an overview of the European countries that have a fairly developed national hydrogen strategy to date. Out of the fifteen countries included in the section, France stands out as having one of the most developed hydrogen legal frameworks in Europe (i.e., the Ordinance on Hydrogen). On the other hand, while an official Hydrogen Strategy has yet to become part of the Dutch legislation, the Netherlands accounts for the highest number of large-scale hydrogen projects and pilots currently in operation.

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BELGIUM

1. The Current Status of Hydrogen Deployment

In the past, the primary focus of hydrogen deployment in Belgium lay with the transport sector, including the development of hydrogen-fueled vehicles and refueling stations. As such, Belgium has one of the highest maturity levels for hydrogen technology, with first projects having started operations already in 2009.[1] The use of hydrogen as a "large scale renewable energy storage solution" has also proven economically viable. The demonstration project Don Quichote stored large quantities of renewable energy, thus proving market readiness for hydrogen utilization in road transportation, grid balancing and other areas.

Different national laws govern hydrogen deployment, albeit for now mostly regarding its safety or transportation. Moreover, a permitting system exists for hydrogen projects, such as storage and conversion. Additionally, hydrogen transportation via pipelines falls under the scope of the Royal Decree of 14 May 2002, although no injection of hydrogen into the natural gas network has been conducted so far. Finally, regional laws of Flanders, Wallonia and Brussels govern the licensing process. As part of its new hydrogen strategy published last October, existing laws will be revised to accommodate the development of the hydrogen economy.

2. National Hydrogen Strategy and Future Developments

At the end of October 2021, the Federal Government adopted a national hydrogen strategy.[2] The strategy has four main targets:

1) Position Belgium as an import and transit hub for renewable gases

- Belgium plans to import green hydrogen and use its ports as transit hubs. The aim is to import 3-6 TWh of hydrogen by 2030 and between 100-165 TWh by 2050.

2) Make Belgium a leader in Hydrogen technologies

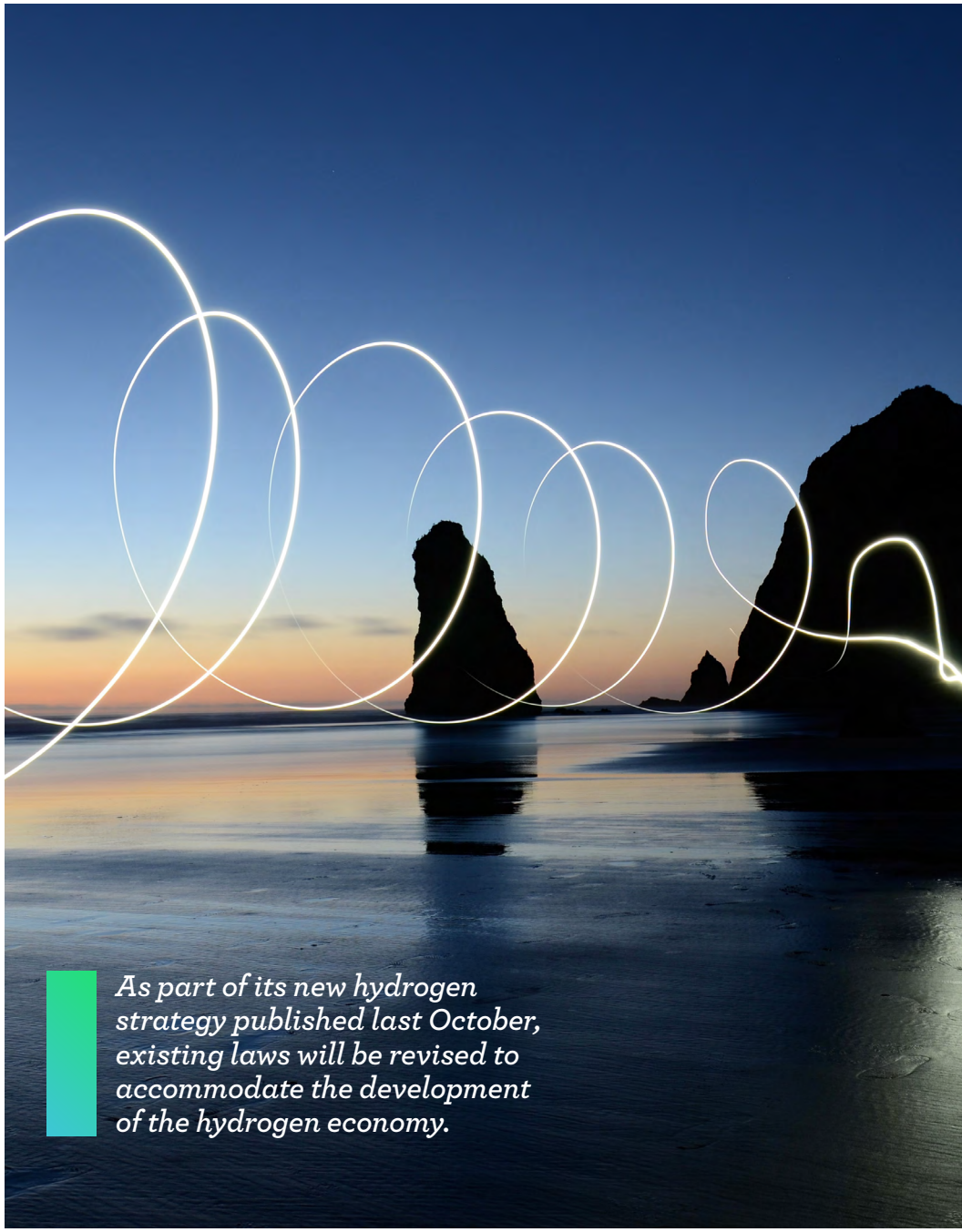
- To consolidate its hydrogen value chain and support innovation, Belgium will continue to fund companies and research institutes, using its existing Energy Transition Fund (EUR 20-30 million/year) as well as a new budget of EUR 60 million (EUR 50 million comes from the Recovery and Resilience Fund). The aim is to have 150 MW of electrolysis capacity by 2026.

3) Create a Hydrogen backbone in Belgium

- Belgium will develop an extensive hydrogen network, building on its existing gas and hydrogen network. The first project consisting of 100-160 km of hydrogen pipelines, will be operational in 2026. By 2030, Belgium plans to connect its hydrogen network with neighboring countries. To achieve these targets, the existing regulations on hydrogen pipelines will be revised in 2022-2023.

4) Invest in hydrogen cooperation

- The government will invest time and efforts into hydrogen partnerships with relevant organizations, institutions, and countries.



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1 WaterstofNet, "Hydrogen in the Flanders – Netherlands region" <https://www.waterstofnet.eu/_asset/_public/WaterstofNet_brochure_ENG.pdf>.
2 Tinne Van der Straeten, "Vision et stratégie Hydrogène" (2021) <https://d3n8a8pro7vhmx.cloudfront.net/tinnevanderstraeten/pages/133/attachments/original/1636365530/H2_strategie_FR.pdf?1636365530>

CZECH REPUBLIC

1. The Current Status of Hydrogen Deployment

The primary focus on hydrogen currently lies with the Czech industry and its transportation sector.[1] With regard to the latter, several small-scale initiatives exist on national and local levels. Moreover, the utility group Skupina ČEZ is currently developing "up to 15 projects for the production and use of hydrogen" with a special focus on public transport.[2]

There is currently no hydrogen-specific legislation in the Czech Republic, which means that the production, transportation, utilization, and storage of hydrogen is regulated within the framework of existing laws.[3] These include the Energy Act, the Chemical Act, and the Act on Protection of Public Health. Notably, the 2017 amendment to the Act on Fuel Substances recognized hydrogen as an alternative fuel. Furthermore, several legislative acts regulating the transport sector explicitly refer to hydrogen.

2. National Hydrogen Strategy and Future Developments

The Czech Republic released its National Hydrogen Strategy in July 2021.[4] Unveiling the strategy, the Czech Minister of Industry and Trade noted that the country "must have the ambition to become an important exporter in this area in the future". The document represents an important tool to help achieve climate neutrality in the Czech Republic as well as in the EU and is based on four main pillars:

1) Production of low-carbon hydrogen
2) Use of low-carbon hydrogen
3) Transport and storage of hydrogen
4) Promotion of hydrogen technologies[5]

The Strategy sets the framework and shows in which direction the development and support of hydrogen technologies will be oriented in the coming years.[6] It sets out three development phases. During the first phase, the Czech Republic intends to focus on balancing the production and use of hydrogen to manage the effective use of already available resources. Importantly, the government did not limit of scope of the Strategy to renewable hydrogen only but is planning to also produce hydrogen from natural gas and nuclear energy. The second phase will begin in 2026 and will involve operational industrial testing of hydrogen deployment. The second phase will start in 2031, by when hydrogen will assumingly be widely used in different areas. However, the Czech Republic envisions hydrogen's key application to be in the transport sector.

The Strategy stresses the importance of ensuring the availability of hydrogen infrastructure, recognizing that the limited nature of renewable energy production in the country, which means it will have to import green hydrogen from abroad. It also sets plans to prepare decrees and laws that will remove obstacles during implementation.

The Hydrogen Strategy was adopted under former Prime Minister Andrej Babiš, which means that it remains to be seen how much of it will be implemented by the new government. Nevertheless, Czech politicians at state and regional levels have been increasingly speaking out in favor of hydrogen use in the last months.

We would like to thank Roman Pavlík, Matěj Hejtmánek and Daniel Krus at FleishmanHillard Prague for their valuable insights and contributions to this section.

1 CMS Expert Guides, "Hydrogen Law and Regulation in the Czech Republic" (2020) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/czech-republic>.
2 Ceenergy News, "Czech Republic unveils Hydrogen Strategy" (2021) <https://ceenergynews.com/hydrogen/czech-republic-unveils-hydrogen-strategy/>.
3 ibid.
4 Ministry of Industry and Trade, "The Czech Republic's Hydrogen Strategy" (2021) <https://www.mpo.cz/assets/cz/prumysl/strategicke-projekty/2021/9/Hydrogen-Strategy_CZ_2021-09-09.pdf>
5 Ceenergy News, "Czech Republic unveils Hydrogen Strategy" (2021) <https://ceenergynews.com/hydrogen/czech-republic-unveils-hydrogen-strategy/>.
6 Ministry of Industry and Trade, "MPO představilo Vodíkovou strategii ČR i konkrétní vodíkové projekty" (2021) <https://www.mpo.cz/cz/rozcestnik/pro-media/tiskove-zpravy/mpo-predstavilo-vodikovou-strategii-cr-i-konkretni-vodikove-projekty--262453/>.

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DENMARK

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1. The Current Status of Hydrogen Deployment

Denmark has one of the most ambitious plans for reducing greenhouse gas emissions in the EU, aiming at cutting them by 70% by 2030 and reaching net-zero in 2050.[1] Utilization of hydrogen is considered essential for achieving these objectives.

There is currently a network of 10 hydrogen-refueling stations in Denmark. However, according to Denmark's NECP, the road transport sector remains less of a priority with little market demand for hydrogen-powered vehicles envisioned before 2025. In 2021, two energy island projects have been approved, with some of the generated renewable energy being used for green hydrogen production.[2]

At the end of 2021, Denmark published its power-to-X and hydrogen strategy. The government aims to use Power-to-X to produce hydrogen and other green fuels, which can then be used to decarbonize heavy industry and heavy-duty transport.

2. National Hydrogen Strategy and Future Developments

On 15 December 2021, the Danish government published its proposal for the "Strategy for the Development and Promotion of Hydrogen and Green Fuels, power-to X".[3] During 2022, the power-to X strategy will be discussed by the Danish Parliament (Folketing), to come to a final text. Currently, the proposal has four specific objectives:

1) Power-to-X must be able to contribute to the realization of the objectives in the Danish Climate Act;

- Aim for ambitious EU legislation, in particular the Fit for 55 package and targets for sustainable aviation fuels.
- Analyze the availability of biological resources for the transition.

2) The regulatory framework and infrastructure must be in place for Denmark to utilize its strengths and allows power- to-X to perform on market terms in the long run;

- Invest DKK 1.25 billion in power-to-x via supporting the production of hydrogen and other power-to-x products.
- Invest DKK 344 million from EU's post-covid cohesion fund (REACT-EU) and the Just Transition Fund into green technologies.
- Conduct a full review of existing hydrogen legislation, including giving Energinet and Evida (Denmark's transmission system operator and distribution system operator, respectively) the possibility to own and operate hydrogen infrastructure.
- Develop a hydrogen market regulation to create transparent market conditions.
- Analyze the availability of green fuels in Danish ports for shipping.
- Invest approximately DKK 850 million into he EU-level coordination project on the development and deployment of hydrogen (a so-called Important Project of Common European Interest or IPCEI).

3) The integration between power-to-X and the Danish energy system must be improved;

- Make geographically differentiated consumption tariffs possible to incentivize less concentration of large energy consumers on the same part of the grid.
- Create a scheme for direct links between large energy producers and consumers.

4) Denmark must be able to export power-to-X products and technologies;

- 4-6 GW of electrolysis capacity by 2030
- Plan hydrogen infrastructure border connections.
- Support a clear framework for European certification of green hydrogen and carbon.

1 Retsinformation, "Climate Law" (2020) <https://www.retsinformation.dk/eli/lta/2020/965>.
2 Danish Energy Agency, "Denmark's Energy Islands" <https://ens.dk/en/our-responsibilities/wind-power/energy-islands/denmarks-energy-islands>.
3 Danish Ministry of Climate, Energy & Utilities, "The Government's strategy for Power-to-X" (2021) <https://ens.dk/sites/ens.dk/files/ptx/strategy_ptx.pdf>.

FRANCE

1. The Current Status of Hydrogen Deployment

France is pursuing the objective of becoming one of the world's leaders in hydrogen deployment. [1]The Government started preparations of a "plan for storage of renewable energies using decarbonized hydrogen" already in 2015 pursuant to Law No. 2015-992. As a result, the Minister for Energy announced the Multiannual Energy Program (hereinafter, PPE) in 2018, which will be addressed in detail below.

France has one of the most developed hydrogen legal frameworks in the EU.[2] The majority of present legal measures govern the deployment of hydrogen in the mobility sector with the 2019 Mobility Orientation Act providing a framework for refueling stations for private vehicles, buses, and ships. The process of hydrogen injection into the gas grid is regulated by the Energy Regulator and falls within the scope of the Energy Code. On top of this, in September 2020, Minister of Ecological Transition Barbara Pompili and the Minister of Economy Bruno Le Maire unveiled the National strategy for the development of carbon-free hydrogen in France[3], aiming at developing favorable conditions for France to be at the forefront of the development of a veritable carbon-free hydrogen market.

2. National Hydrogen Strategy and Future Developments

The PPE pursues three primary objectives:

- Increasing the share of green hydrogen for industrial use.
- Hydrogen deployment in the mobility sector.
- Stabilization of energy networks via hydrogen operationalization.[4]

In 2019, the plan was complemented with a target of 10% of low-carbon hydrogen by 2023 and between 20 and 40% by 2030. Moreover, substantial financial support is envisioned for the hydrogen sector, as stipulated in the Multiannual Energy Program for 2019-2023 and 2024-2028. As such, EUR 50 million is to be invested in hydrogen on an annual basis. Furthermore, targets were set for hydrogen use in power-to-gas installations. These include the goal of 1-10 MW by the end of 2023 and 10-100 MW by the end of 2028. A less ambitious target was included regarding the development of hydrogen refueling infrastructure, with 100 charging stations to be in operation by 2023 and 400-1000 stations by the end of 2028. Regarding hydrogen storage, no short-term goals were established, as the "storage of large amounts of electricity in the form of hydrogen in order to manage renewable energy intermittency should not be required before circa 2050".

The 2020 National Strategy for the Development of Decarbonized Hydrogen fixes three main priorities:

- Creating a French electrolyzer sector, installing enough electrolyzers to boost the decarbonization of the industry.
- Developing heavy mobility using carbon-free hydrogen.
- Supporting R&D and skills development in the sector.

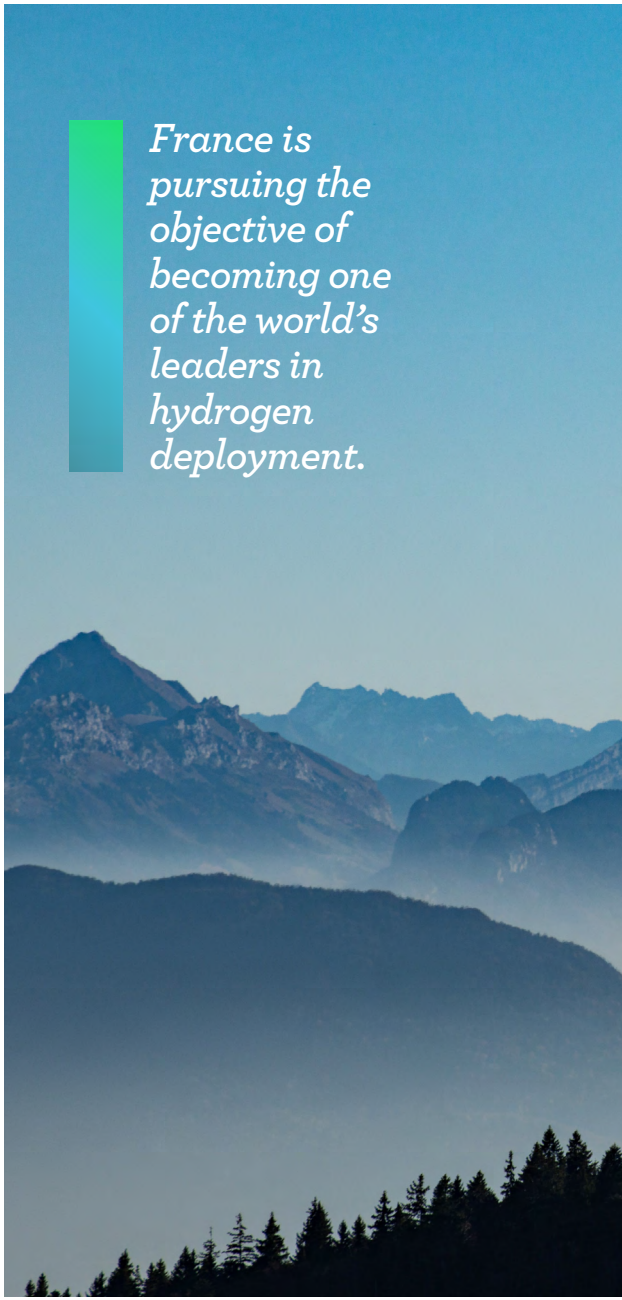
Pursuing the objective of decarbonizing the industry, France is thus betting on carbon-free hydrogen production and planning EUR 7 billion in public support until 2030.

In February 2021, the French government published a draft "Ordonnance n° 2021-167 du 17 février 2021 relative à l'hydrogène" (hereinafter Ordinance on Hydrogen), addressing the following points:

- Taxonomy of hydrogen, categorizing it into renewable, low-carbon and fossil based on production methods and greenhouse gases (hereafter and elsewhere: GHGs) emitted as a result.
- Proposed governmental support schemes for low- and zero-carbon production, setting out the framework for such measures (with carbon capture and storage excluded from support schemes).
- Guarantees of Origin and certification regime for green or low-carbon hydrogen in line with the 2018 Renewable Energy Directive.
- Regulation requirements for the injection of hydrogen and its transportation via the gas grid with a long-term view of building a hydrogen market and contributing to the security of supply.

The Ordinance on Hydrogen was ratified on 5 May 2021 by Minister Pompili. The document is complementary to other national efforts to implement and accelerate the support for the hydrogen sector, e.g., the National Strategy for the Development of Decarbonized Hydrogen implemented within the framework of France Relance, France's post-Covid investment plan.

France is pursuing the objective of becoming one of the world's leaders in hydrogen deployment.



1 CMS Expert Guides, "Hydrogen Law and Regulation in France" (2020) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/france>.
2 WFW, "The French Hydrogen Strategy" (2021) <https://www.wfw.com/articles/the-french-hydrogen-strategy/>.
3 French Government, "Stratégie nationale pour le développement de l'hydrogène décarboné en France" (2020) <https://minefi.hosting.augure.com/Augure_Minefi/r/ContenuEnLigne/Download?id=5C30E7B2-2092-4339-8B92-FE24984E8E42&filename=DP%20-%20Strat%C3%A9gie%20nationale%20pour%20le%20d%C3%A9veloppement%20de%20l%27hydrog%C3%A8ne%20d%C3%A9carbon%C3%A9%20en%20France.pdf>.
4 HSF Energy Notes, "Recent developments in the French hydrogen sector: the draft hydrogen ordinance" (2021) <https://hsfnotes.com/energy/2021/02/12/recent-developments-in-the-french-hydrogen-sector-the-draft-hydrogen-ordinance/>.

GERMANY

1. The Current Status of Hydrogen Deployment

The development of the German hydrogen market is still considered to be at its early stages.[1] Hydrogen is utilized primarily in the industrial sector, in particular in the production of chemicals. Nevertheless, the government has been investing significantly in the hydrogen sector, with EUR 700 million invested in 2016 and up to EUR 1.4 billion on an annual basis from 2017 onwards. Another EUR 7 billion was made available for "speeding up the market rollout of hydrogen technology".

Germany lacks a comprehensive legal framework to the extent that the application of gas legislation to hydrogen remains unclear.[2] In July 2021, the German government did amend the Energy Act to include a regulatory framework on hydrogen networks. However, the German government decided not to introduce legislation on blue hydrogen and CCUS until the publication of the EU Hydrogen and Decarbonizing Gas Market Package, which it plans to implement from 2025.[3] The investments in the pipeline as well as the early release of its National Hydrogen Strategy in 2020 make Germany one of the hydrogen frontrunners in Europe and the recently installed coalition government plans to build on this reputation in 2022.

2. National Hydrogen Strategy and Future Developments

The National Hydrogen Strategy for Germany was announced in June 2020.[4] It is a comprehensive plan aimed primarily at increasing the role of green hydrogen in the energy transition process.

The Strategy identifies 13 goals and ambitions, which can be summarized as the following:

- Increase the production of green hydrogen to 14 TWh by 2030 and to 19 TWh no later than 2040 to meet the growing demand. This will be done through raising the capacity of onshore and offshore renewable energy generation plants.
- Establishing a competitive domestic market for the production and use of hydrogen. This goal will be supported by improving wind and solar technology and taxing fossil fuels in transport and heating.
- Fostering the transition to hydrogen in the industrial sector. This will be done primarily by providing financial support for electrolyzers and launching hydrogen pilot projects.
- Increasing the share of hydrogen-based vehicles, including in aviation and navigation in the long-term.
- Utilizing hydrogen to decarbonize the heating sector. Up to EUR 700 million is to be made available for achieving this objective in 2020-2024.
- Appointing a National Hydrogen Council consisting of 26 experts from various fields. The Council will support the Government through legislative proposals and recommendations.[5]

In September 2021, the German government published a progress report on its national hydrogen strategy. It clarified that there were at the time 62 short-listed hydrogen projects of common interest eligible for the government's hydrogen funds. Moreover, a new Carbon Contracts for Difference Program will be launched in 2022, and the government has created an action plan for steel, focusing on switching from coal to green hydrogen-based production. Lastly, the taxes on renewable energy used by green hydrogen producers will be reduced.[6]

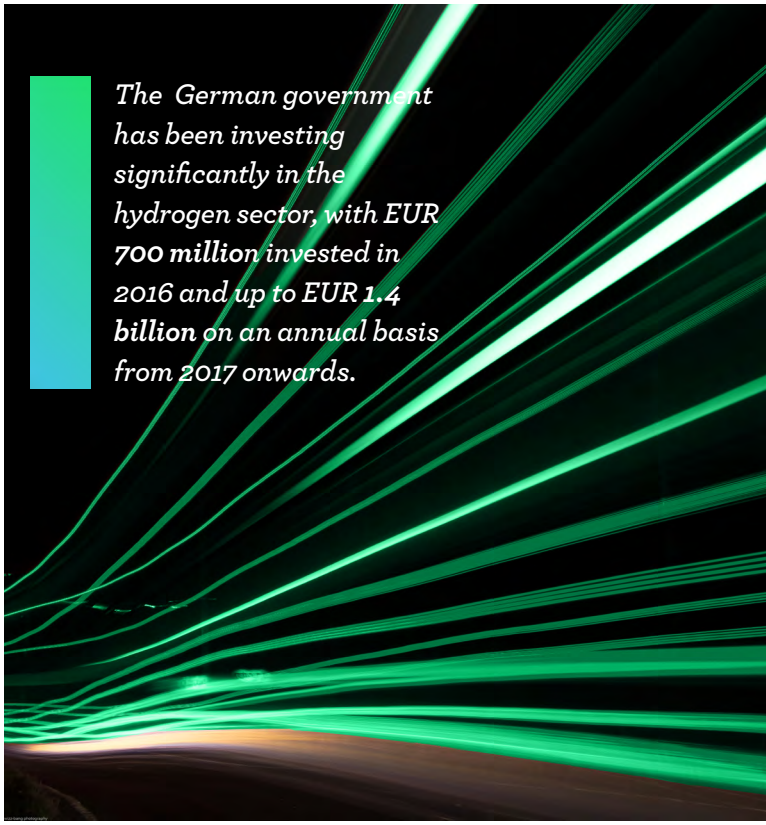
The same month,, a new coalition government was formed. In its coalition agreement, the plan is to increase the country's electrolyzer capacity to 10 GW by 2030, primarily through offshore wind and energy partnerships with other countries. Accordingly, the government will update its hydrogen strategy in 2022. Moreover, the coalition will focus its green hydrogen use on hard-to-abate sectors, which could mean that hydrogen for heating is no longer in the pipeline. Lastly, blue hydrogen will be included as a transitional solution.[7] In December, the Commission also approved Germany's new H2Global state aid scheme, with which the government aims to invest EUR 900 million in green hydrogen in countries outside the EU.[8]

In mid-January, the new coalition government published its plans for two new legislative packages to achieve its new climate targets.

In 2022, the German government will update its national hydrogen strategy to include the following targets:

- Double electrolyzer capacity from 5GW to 10GW by 2030.
- Implement hydrogen IPCEI's as soon as possible, worth EUR 8 billion.
- Establish additional subsidy schemes.
- Set up a Carbon Contracts for Difference framework.

Interestingly, the government does not plan to subsidize blue hydrogen, not even on a transitional basis.[9]



1 CMS Expert Guides, "Hydrogen Law and Regulation in Germany" (2021) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/germany>.
2 ibid.
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HUNGARY

1. The Current Status of Hydrogen Deployment

Hungary has an ambitious agenda for the development of green hydrogen from electricity produced from renewable sources and is currently working on developing and implementing pilot projects. It also has plans for deployment of blended hydrogen in a variety of sectors. One of the key priorities, identified by the government, is the use of hydrogen for greening of the transport sector. In April 2021, the first hydrogen filling station was installed in Budapest.[1] During the opening ceremony the Hungarian power company MVM and the industrial producer LINDE signed a long-term strategic agreement to cooperate on future hydrogen projects in close partnership with the government.[2] Moreover, Hungary is considering a roll-out of hydrogen storage projects in areas of depleted gas fields to store the surplus of renewable energy and balance the electricity grid, this strengthening system integration.[3]

The Hungarian transmission service operator (TSO) FGSZ is currently in the process of reviewing the rules and requirements for natural gas transportation in order to establish a safe level of hydrogen that can be injected into the grid.[4] In January 2022, FGSZ commissioned an assessment of the suitability of one of its pipelines for partial to full hydrogen transport as part of the revision.[5]

2. National Hydrogen Strategy and Future Developments

The National Hydrogen Strategy was announced in May 2021.[6] It sets a number of priority objectives for 2030:

Large-scale production of low- and zero-carbon hydrogen

- 20,000 tons/year of low-carbon hydrogen.
- 16,000 tons/year of green and other carbon-free hydrogen.
- 240 MW electrolyzer capacity.

Decarbonization of industrial consumption

- 20,000 tons/year of low-carbon hydrogen.
- 4 tons/year of green and other carbon-free hydrogen.
- Cumulatively, these measures would result in avoiding 95,000 tons of CO2 emissions.

Green transport

- Hydrogen as an alternative to heavy-duty vehicle traffic.
- 10,000 tons/year of green and other carbon-free hydrogen.
- 20 hydrogen-refueling stations and 40 refueling station points.
- 4,800 hydrogen fuel cell vehicles.
- Cumulatively, these measures would result in avoiding 130,000 tons of CO2 emissions.

Electricity and natural gas support infrastructure

- Establishing infrastructure that will enable the transition to carbon neutrality, and reconstructing current infrastructure.
- 60 MW average cut-off capacity.
- Min 2% per year volume blending ratio in the natural gas system (where appropriate).

Moreover, in its National Energy and Climate Plan (hereafter and elsewhere: NECP), Hungary indicated the objective of achieving consumption of 51 ktoe (kiloton of oil equivalent) of renewable electricity-based hydrogen in the heating and cooling sector[7].

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LUXEMBOURG

1. The Current Status of Hydrogen Deployment

Luxembourg has set a target of a 50-55% GHG emissions reduction for 2030 and hydrogen is seen as a key tool to achieve the national energy transition. The special focus is put on the mobility sector, the industry and on energy storage. Another important consideration involves using existing gas infrastructure for green hydrogen supply.[1] Moreover, the deployment of hydrogen is considered in the conversion of military vehicles.[2] The Luxembourgish government has decided to accelerate the energy transition by prioritizing energy efficiency, increased and consistent development of renewable energy and the share of zero-emission vehicles, including fuel cell electric cars and trucks. In its NECP, Luxembourg also mentions the deployment of green hydrogen filling stations as one of the means with which it plans to achieve its transport decarbonization objectives.[3]Nevertheless, despite the ambitious plans, no comprehensive legal framework is in place.[4]

2. National Hydrogen Strategy and Future Developments

In its National Hydrogen Strategy, published in late September 2021, the government recognizes that in the long-term, green hydrogen can play a role in the integration of certain energy sectors (such as heavy industry and other sectors with hard-to-abate emissions) and to contribute to the government's objective of achieving climate neutrality by 2050. The government does not intend to boost the production of hydrogen produced with fossil fuels (grey or blue hydrogen). Furthermore, energy efficiency and electrification will remain a priority in sectors where this is feasible.[5] As an intermediate objective, the government intends to support the transition from grey to green hydrogen in industry, which stands at a current annual volume of 450 tons. Such a transition can support the commercialization of the technology and enable a role for hydrogen in the decarbonization of other sectors that have emissions that are hard to abate. The Strategy defines 7 measures the government intends to take to promote the production, import and use of renewable hydrogen:

1) Contribute to the definition of a European legal and regulatory framework, with a focus on the certification and production of green hydrogen and infrastructure.
2) Cooperate with EU member states and neighboring and third countries on successful green hydrogen projects.
3) Identify opportunities for R&D and training related to green hydrogen in Luxembourg.
4) Materialize flagship projects, such as a study on the decarbonization of industrial processes, the installation of a hydrogen filling station for trucks or buses, or the implementation of green hydrogen pilot projects.
5) Prioritizing demand for green hydrogen by steering the use of green hydrogen towards certain sectors, such as heavy industry and aviation.
6) Develop instruments to support a developing green hydrogen market and stimulate supply and demand.
7) Implement and continuously improve the taskforce overseeing the implementation of the strategy ("Taskforce H2 Luxembourg"), comprised of a steering group at ministry level and an expert group.

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NORWAY

1. The Current Status of Hydrogen Deployment

The Norwegian government aims to achieve a 90-95% reduction in carbon emissions by 2050, compared to 1990 levels. As a major hydropower producer, owner of significant natural gas reserves and having a significant maritime fleet, Norway has a huge potential to become a leading green and blue hydrogen producer and exporter. Its hydrogen strategy, published in early June 2020, recognizes that hydrogen could be relevant in Norway's transition to a low emission society, although its role will ultimately depend on its comparative strengths compared to other energy sources. As Norway produces a significant stock of renewable energy from sources that require storage for surplus supply (e.g., hydropower and wind and solar energy), hydrogen (infrastructure) can play a crucial role in grid balancing and energy buffering.[1]

To increase its competitiveness with other energy sources, green hydrogen is currently exempt from consumer taxes on energy consumption. Similarly, fuel cell electric vehicles are exempt from a purchase tax, road tax and VAT until 2025 or until the national fleet reaches 50,000 vehicles and they can use free public parking and bus and taxi lanes. As part of Norway's climate policy, taxes on fossil fuel fueled vehicles will also be significantly increased until 2025 to stimulate the uptake of fuel cell and battery electric vehicles.

2. National Hydrogen Strategy and Future Developments

Norway has a long history of developing a policy framework for hydrogen: its first national hydrogen strategy dates from 2005. In its most recent iteration, published in June 2020, while ambitious, the Norwegian government takes a realistic and measured approach. It sees most potential for hydrogen applications in heavy-duty transport, shipping and industrial processes, and less so in heating (a sector that is already virtually emissions-free), energy consumption (as the country already has a robust supply of (renewable) hydropower) and light-duty transport (where batteries will remain more cost-competitive for the foreseeable future).[2] Its strategy is therefore aimed at focusing on the areas with an evident use case for hydrogen in Norway, those that have the greatest potential for emissions savings, those where no readily available alternative exists and those that have an existing or future ability to compete with other energy sources and/or carriers.

The strategy identifies that technology immaturity and high costs currently form barriers to greater use of hydrogen. An important objective is therefore to increase the number of pilot and demonstrator projects in support of commercialization and technology development. In addition to the generation of green hydrogen, as a major gas exporter, the strategy highlights the production of blue hydrogen as particularly interesting from an international competitiveness point of view. It would also link up with the ongoing efforts to develop a full chain carbon capture and storage infrastructure.

Roadmap

The strategy was followed by a roadmap published in June 2021, as part of the broader "Putting Energy to Work" white paper.3 It sets out a comprehensive view on how Norway's future energy needs will be met while implementing the government's climate targets and complements the strategy with policy and targets. The roadmap has a particular focus on the maritime sector, the area where the Norwegian government sees most potential for the application of hydrogen.4 To develop hydrogen technology through pilot and demonstrator projects and to contribute to early market introduction, market development and commercialization, the roadmap sets the following objectives:

- By 2025, establish:
  - 5 hydrogen hubs for maritime transport.
  - 1-2 industrial projects with associated hydrogen production facilities.
  - 5-10 pilot projects for the development and demonstration of new and more cost-effective hydrogen solutions and -technologies.
- Strengthen research & development by setting up a hydrogen and ammonia research center, which starts in early 2022 and will receive annual funding for 7 years.

This ought to contribute to establishing hydrogen as a genuine alternative energy carrier in shipping and as a maturing technology in industrial processes by 2030. Eventually, the government envisages the establishment of a network of geographically dispersed hydrogen production demand-driven hubs with appropriate supply vessels and vehicles, hydrogen-powered vessels in coastal waters, hydrogen to be a commercial alternative to fossil fuels, the establishment of full-scale hydrogen projects with a significant exporting potential, and hydrogen-linked goods and services that develop on a par with the emergence of a European and global market in support of hydrogen's exporting potential.

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THE NETHERLANDS

1. The Current Status of Hydrogen Deployment

The Netherlands is rightly considered one of the leaders in hydrogen deployment in the EU. A significant number of large-scale projects and pilots are currently in operation, with more in development.[1] In 2018, the Dutch TSO Gasunie started the operation of the first public hydrogen pipeline (a former natural gas pipeline), Yara-Dow.[2] Additionally, from 2019 the 1 MW Hystock plant converts solar energy into hydrogen via electrolysis. The Groningen area (the so-called Dutch 'Hydrogen Valley') hosts a hydrogen value chain from production to end-use.[3] Moreover, the Port of Rotterdam with the state company EBN and Gasunie are developing a large-scale "Porthos" carbon storage project in the North Sea which will allow the Netherlands to increase production of blue hydrogen.[4] Finally, hydrogen refueling stations are currently in development in the north of the country.

In 2020, the Gasunie was tasked by the Dutch government to create a 'hydrogen backbone', creating a complete national hydrogen network through mostly repurposing existing gas infrastructure and building some minor new interconnections. Until 2026, the TSO will focus on regional interconnections, including those with Germany. Between 2026-2028, the aim will be to connect large industrial plants to the network. Between 2028-2030, the TSO will connect the national network to the available European interconnections.[5]

So far, there is no hydrogen-specific legislation. The Dutch hydrogen sector is regulated on the basis of gas-related legislation and other energy laws. In particular, the Gas Act governs the licensing process for hydrogen transportation. The injection of hydrogen into the gas grid is regulated by the Gas Quality Decree. The government is currently in the process of revising the Energy Act, which includes the Gas Act, this will mean that the rules for hydrogen network companies will change in the near future.

In December 2021, a new coalition government was formed. In the accompanying coalition agreement, a new climate transition fund was announced amounting to EUR 35 billion for the next decade, aimed at developing sustainable energy infrastructure, EUR 15 billion is reserved for renewable energy carriers, among which is expected to be green hydrogen.[6]

The Port of Rotterdam with the state company EBN and Gasunie are developing a large-scale "Porthos" carbon storage project in the North Sea which will allow the Netherlands to increase production of blue hydrogen.

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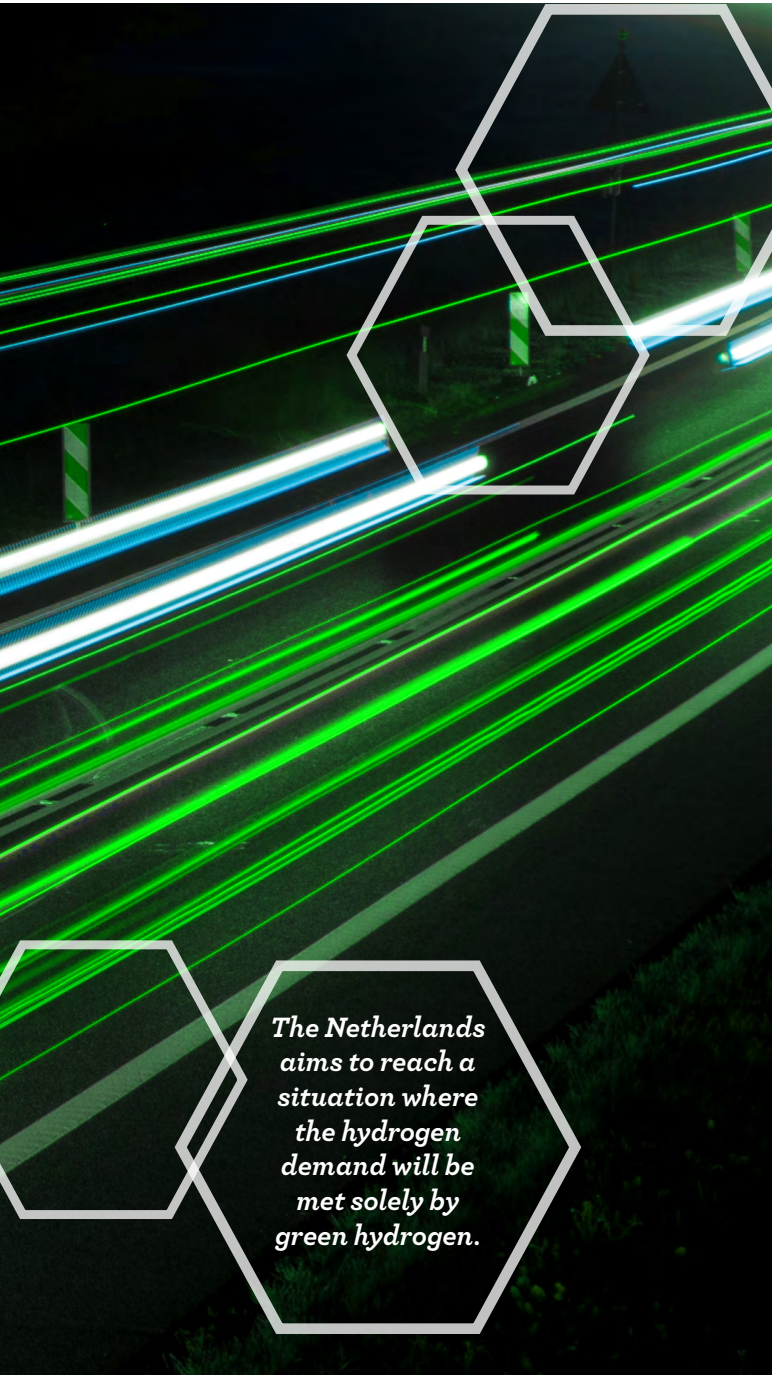

THE NETHERLANDS (continued)

2. National Hydrogen Strategy and Future Developments

In June 2019, the Dutch Government published the Climate Agreement, which included specific targets for hydrogen deployment in 2030 and 2050. Five principal areas of focus have been identified:

1) A carbon-free feedstock for the process industry.
2) Carbon-free carriers for high temperature heat for the process industry.
3) Controllable carbon-free capacity, energy storage for prolonged periods and energy transport over longer distances.
4) Mobility, especially regarding passenger transport ahead of 2025; heavy road transport and shipping for the long-term (2030); committing battery electric transport to hydrogen; special focus on the transition from grey to green hydrogen.
5) Build an environment for sustainable buildings and districts.[7]

The Agreement explicitly indicated green hydrogen as the primary area of focus. Collectively, the objective for green hydrogen was set to achieve an electrolysis capacity of over 800 MW and 15 kilotons from biogenic fuels by 2025. In the long run, the Netherlands aims to reach a situation where the hydrogen demand will be met solely by green hydrogen. Nevertheless, the Agreement also recognized the temporary need in blue hydrogen as a means of meeting the demand of the emerging global hydrogen market, which is predicted to include both green and blue hydrogen. Importantly, blue hydrogen deployment must not impede the growth of the green one.

The Agreement presupposes the initiation of a Hydrogen Program. The main focus of the Program is on upscaling of the green hydrogen production. Accordingly, a reduction of 65% on the capital expenditure on electrolyzers is set to be realized through upscaling by 2030 from EUR 100 million per 100 MW to EUR 35 million per 100 MW. As a result, the electrolysis capacity is expected to reach 3-4 GW by 2030. A particular focus is placed on the offshore wind energy sector as the primary source for energy needed for green hydrogen production. The Program also focuses on the development of hydrogen infrastructure. As such, 50 refueling stations, 15,000 fuel cell vehicles, and 3,000 heavy-duty vehicles are to be in operation by 2025; 300,000 fuel cell vehicles are to be in operation by 2030.

The development presupposed under the Program will be implemented in three phases:

1) 2019-2021: preparatory phase.
2) 2022-2025: scaling up to 500 MW of established electrolysis capacity (if possible); development of the demand for hydrogen; development of regional infrastructure, and the connection of clusters.
3) 2026-2030: scaling up to 3-4 GW of established electrolysis capacity.

The latest developments can be followed on the website of the National Hydrogen Program.

The above-mentioned objectives were reiterated in the letter titled "Government Strategy on Hydrogen" issued in April 2020, sent by the governing coalition to the national parliament. The letter explains the increased focus on hydrogen deployment, stating that without it the Netherlands will not be able to meet the project demand for zero-carbon gases in 2050. The letter also identified large electrolysis facilities and carbon capture and storage as the primary methods of hydrogen production. However, the focus will ultimately be placed on creating a clean hydrogen supply chain.

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POLAND

1. The Current Status of Hydrogen Deployment
Poland is the fifth largest producer of hydrogen worldwide, accounting for 14% of Europe's hydrogen.[1] However, the development of hydrogen projects is currently limited in the member state. Nevertheless, several generation, transportation, and storage projects are in the development stage. The focus of decarbonization is on the transport sector and electricity storage.

Currently, no hydrogen-specific laws are in force in Poland.[2] Those provisions that apply to hydrogen do so primarily with regard to the transport sector within the framework of the Act on Electromobility and Alternative Fuels. Accordingly, the rest of the activities are regulated by general energy legislation. For instance, the injection of hydrogen into the pipeline is done in accordance with the same procedures that govern gaseous fuels under the Energy Law Act. However, the new legal framework for hydrogen is expected to come into force in 2021 and will include an Act on Hydrogen.

2. National Hydrogen Strategy and Future Developments
The draft Polish National Hydrogen Strategy was published in January 2021.[3] After it was subject to a public consultation[4], the Polish Hydrogen Strategy until 2030 with a perspective until 2040 (hereinafter PHS) was officially adopted with a resolution by the Council of Ministers on 2 November 2021. The document sets out 6 primary objectives, namely:

1) Implementation of hydrogen technology in the energy sector (power and heating).
2) Use of hydrogen as an alternative fuel in transport (for low-emissions mobility).
3) Low-emissions hydrogen in hard to decarbonize industry sectors.
4) New installations to increase the production share of low- and zero-emissions hydrogen.
5) Safe and efficient transportation, distribution, and storage of hydrogen.
6) Implementation of a stable regulatory framework to enable the development of a hydrogen market.[5]

The primary objectives are supported by more than 40 actions in the three main sectors: energy, transport, and industry as well as horizontal activities such as boosting R&D efforts in the sector. Moreover, specific targets include:

- 2 GW installed electrolyzer capacity by 2030.
- 800-1000 hydrogen buses in operation by 2030.
- A minimum of 32 hydrogen-refueling stations in operation by 2025.
- At least 5 hydrogen valleys planned by 2030
- Foreseen total investment in hydrogen between 2021-2030 of PLN 11 billion.

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SLOVAKIA

1. The Current Status of Hydrogen Deployment
In Slovakia, hydrogen is produced by chemical plants and is used to meet domestic needs. Additionally, the country is considering low-carbon hydrogen production from nuclear energy.

In recent years, Slovakia has been expressing interest in increasing the number of hydrogen mobility projects and developing the necessary infrastructure.[1] The interest is supported by the country's private sector. As a first step, Slovakia is looking into installing hydrogen refueling stations, some of which would be equipped for relocation.[2] It was expected that the first station would become operational by autumn 2021; however, for now, no projects have been unveiled.

There is no hydrogen-specific legislation in Slovakia.[3] Instead, the hydrogen value chain is governed by national laws on renewable energy and natural gases. Some of the most relevant laws include the Act No. 309/2009 Coll. on the Promotion of Renewable Energy Sources and Highly Efficient Cogeneration, the Energy Act No. 251/2012 Coll. as well as the Act No. 250/2012 Coll. on Regulation in Network Industries.

2.National Hydrogen Strategy and Future Developments
Slovakia released its National Hydrogen Strategy entitled "Ready for the Future" in June 2021.[4] According to the strategy, Slovakia envisages the use of hydrogen in its industrial sectors, in which direct electrification is not possible or not cost-effective. The Government is planning to prioritize renewable hydrogen with low-carbon hydrogen used as an interim solution. Notably, attention will be paid to the use of electricity from nuclear power plants in hydrogen production. It will also focus domestic generation, so that the Slovak economy is "as little dependent on hydrogen imports as possible." The government intends to create a coherent framework for the use of hydrogen, covering production, transportation, distribution, and storage, as well as the use and production of necessary infrastructure and components for the hydrogen economy.

To this end, Slovakia will:

- Introduce measures for the use of low-carbon hydrogen in transport.
- Implement policies for the deployment of low-carbon hydrogen technologies.
- Develop a common standard for CO2 emissions in the low-carbon supply chain.
- Establish common terminology and criteria for quality hydrogen certification.
- Put in place legislative, regulatory, and safety measures to support the readiness of gas infrastructure for the transport, distribution, and storage of hydrogen.
- Establish policies to stimulate demand in the hydrogen end-use sectors.
- Create the conditions for issuing guarantees of origin for renewable hydrogen and extend the issuance of these guarantees to low-carbon hydrogen.
- Ensure national and EU financial support for hydrogen production and utilization.

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PORTUGAL

1. The Current Status of Hydrogen Deployment

There are several small- and large-scale hydrogen projects in operation in Portugal. Some of them focus exclusively on the decarbonization of industry and energy generation. Among the most prominent is the "Green Flamingo" project, envisioned to create a hydrogen solar power plant, and Synthetic Fuel for Aviation that aims at increasing the use of green hydrogen from PV in production of alternative aviation fuels.[1]

Hydrogen is envisioned to play a key role in aiding the attainment of the 2030 GHG emissions reduction goal, even though for now the utilization of low-carbon hydrogen is relatively low.

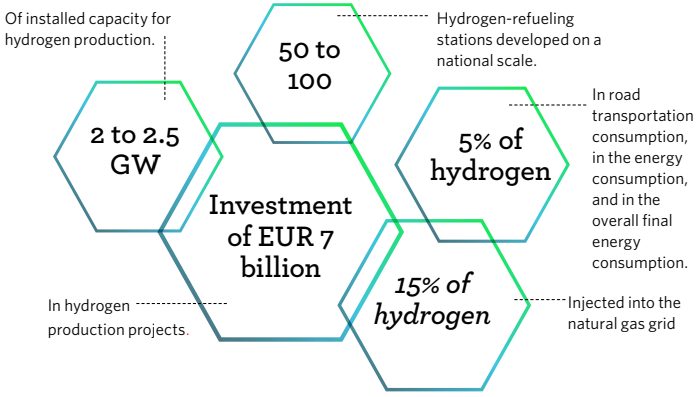
Several national laws regulate the hydrogen sector; however, no uniform law on hydrogen is in place to this day.[2] The Government is expected to introduce separate sections on hydrogen by amending decree laws on transportation, storage, and reception of gases.

2. National Hydrogen Strategy and Future Developments

Portugal's National Strategy for Hydrogen was announced in May 2020 and comprises a number of objectives to be achieved by 2030:

- 5% of hydrogen in road transportation consumption, in the energy consumption, and in the overall final energy consumption.
- 15% of hydrogen injected into the natural gas grid.
- 50 to 100 hydrogen-refueling stations developed on a national scale.
- 2 to 2.5 GW of installed capacity for hydrogen production.
- Investment of EUR 7 billion in hydrogen production projects.

Portugal firmly believes in the importance of renewable hydrogen as playing a key role in the transition and aims to become one of the frontrunners in the production of competitive green hydrogen. In light of this, in April 2021, during the Portuguese Presidency of the Council, Portugal signed a Memorandum of Understanding[3] with the European Investment Bank (EIB) to boost the development of the hydrogen sector in the country and to incentivize investments.



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SPAIN

1. The Current Status of Hydrogen Deployment

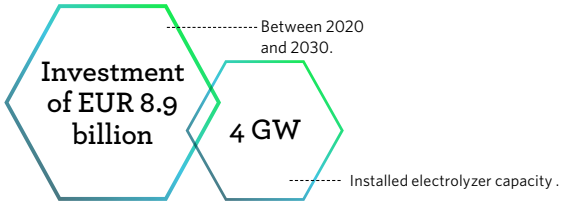
The essential role of hydrogen has been recognized in Spain's National Energy and Climate Plan, with hydrogen deployment prognosed to expand due to the increase in the country's energy production from renewables.[1] Spain currently consumes an estimated of 500,000 tons of hydrogen annually, all of which is fossil fuel based. However, large pilots for green hydrogen productions are in development.

No hydrogen-specific legislation exists in Spain at the moment. However, this is expected to change in the coming future. The injection of hydrogen into the gas network is regulated by the PD-01 Protocol, which sets technical and safety criteria with a reference to the European UNE-EN 16726 standard. The operation of hydrogen plants is subjected to a permitting procedure regulated on a regional level.

2. National Hydrogen Strategy and Future Developments

In 2020, the Hydrogen Roadmap: A Commitment to Renewable Hydrogen was adopted, Spain's national hydrogen strategy.[2] It will be revised based on technological and market developments and the degree of implementation of its objectives every three years. The Roadmap sets the following objectives for 2030:

- 4 GW of installed electrolyzer capacity, with an intermediary target of 300-600 MW by 2024.
- A minimum share of 25% renewable hydrogen of total hydrogen consumption.
- A minimum share of 28% renewable energy consumption in transport, including through:
  - A minimum of 150 to 200 hydrogen-fueled buses.
  - A minimum of 5,000 to 7,500 light and heavy vehicles.
  - The use of hydrogen-powered trains on at least two commercial lines.
  - A network of a minimum of 100 to 150 public renewable hydrogen stations and the introduction of green hydrogen-powered handling machinery at the main five ports and airports.
- An estimated investment of EUR 8.9 billion between 2020 and 2030.



1 CMS Expert Guides, "Hydrogen Law and Regulation in Spain" (2020) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/spain>.
2 Ministry for the Ecological Transition and the Demographic Challenge, "Hoja de Ruta del Hidrógeno" (2020) <https://energia.gob.es/es-es/Novedades/Documents/hoja_de_ruta_del_hidrogeno.pdf>.

SWEDEN

1. The Current Status of Hydrogen Deployment

Sweden set its target of reaching net-zero GHG emissions by 2045 at the latest, which is one of the main drivers of the development of hydrogen technology.[1] A large share of Sweden's electricity is generated from renewable sources, which creates beneficial conditions for expanding the deployment of green hydrogen. In December 2021, the Swedish Energy Agency published its national strategy for green hydrogen, electro-fuels, and ammonia, of which the main aim is to decarbonize the industrial sector.

The deployment of hydrogen-based technology is expected "to be driven by the market".[2] Market instruments, such as car taxes and carbon pricing are used to incentivize low-carbon hydrogen utilization and have proven to be effective, with Sweden recently delivering the world's first fossil fuel-free steel, produced with hydrogen.[3] Most hydrogen currently produced domestically is grey hydrogen, used by the chemical and refinery industries.

2. National Hydrogen Strategy and Future Developments

Previously Fossil Free Sweden—a governmental initiative—had already published a hydrogen strategy that is focused on achieving major milestones in the industries where hydrogen can be deployed most efficiently.[4] Nevertheless, in November 2021, the Swedish Energy Agency also published its own strategy, based on stakeholder consultations.[5] The Agency advises to use hydrogen where it is most economically efficient and provides system benefits. Additionally, it advises Sweden to aim at becoming a net exporter of fossil-free hydrogen. It also advises Sweden to aim at 5 GW of electrolyzer capacity by 2030, and an additional 10 GW by 2045, making a total of 15 GW.

Sweden plans to continue to invest in fossil free iron processing, steel production and fossil fuel-free steel heating through hydrogen. In the refinery and chemical industries, green hydrogen will be used to produce biofuels and synthetic fuels. For transport, investment is aimed at hydrogen trucks, potentially hydrogen freight trains, hydrogen fuel cells for shipping and hydrogen aircrafts. The Agency does flag that the country lacks natural geological conditions for large-scale hydrogen storage, which means Sweden will be dependent on the availability of hydrogen tanks or storage abroad.

In general, the Agency stresses that Sweden's hydrogen strategy will be largely dependent on the EU regulatory framework, therefore it sketches the following scenario in line with the EU Hydrogen strategy:

- Phase 1 until 2030: Expand electrolysis and renewable energy infrastructure, use hydrogen in existing industries and launch pilot projects.
- Phase 2 until 2045: Develop green hydrogen value chains, aim for a high degree of decarbonization in industry through green hydrogen, assess the need for more electrolysis capacity to decarbonize heavy-duty transport.

As future steps, the Energy Agency (in line with Fossil Free Sweden) advises the Energy Market Inspectorate to propose a regulator with a revenue framework for hydrogen pipelines before 2023. It also advises to conduct a study on the role of hydrogen in an integrated Swedish energy market. Moreover, existing environmental regulations should be revised to include hydrogen safety measures and conditions to use hydrogen as a flexibility mechanism for industry should be clarified. The government should also review its guidance on back-up power to include hydrogen fuel cells. Lastly, permitting for hydrogen infrastructure should be streamlined and the government should strengthen cooperation with other stakeholders both internationally, and nationally through a stakeholder platform.

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2 ibid.
3 The Guardian, "'Green Steel': Swedish company ships first batch without using coal" (2021) <https://www.theguardian.com/science/2021/aug/19/green-steel-swedish-company-ships-first-batch-made-without-using-coal>.
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5 Statens Energimyndighet, "Förslag till Sveriges nationella strategi för vätgas, elektrobränslen och ammoniak" (2021) <https://www.energimyndigheten.se/remissvar-och-uppdrag/?page=3>.

THE UNITED KINGDOM

1. The Current Status of Hydrogen Deployment

The UK started using hydrogen as early as the mid-18th century, and hydrogen has been playing a key role in the British economy. Today, most of the hydrogen produced in the UK is used in chemicals and refineries.[1] Hydrogen is also used as a fuel in the transport sector, albeit considerably less.While the predominant amount of hydrogen in the UK is produced from fossil fuels (i.e., grey hydrogen), several low-carbon hydrogen projects are in development across the country.

There is little hydrogen-specific legislation in the UK at the moment, which means that general gas laws regulate hydrogen production and deployment.[2] In particular, the definition of "gas" under the 1986 Gas Act includes hydrogen. The Gas Act also stipulates requirements that must be fulfilled to obtain a license for supply, shipping, or transportation of hydrogen. Moreover, the licensee must comply with various energy codes.The process of injecting hydrogen into the gas grid is regulated by the Gas Safety (Management) Regulations 1996. Finally, a number of health and safety regulations apply.

2. National Hydrogen Strategy and Future Developments

Published in August 2021, the UK Hydrogen Strategy identifies hydrogen as an essential asset in achieving energy transition and becoming net zero by 2050.[3] The Strategy clarifies that steam reforming combined with carbon collection and storage technology (CCS) and renewables-powered electrolysis will not be the only hydrogen production method, listing several additional methods, among which electrolysis powered by nuclear energy. Notably, in contrast with the 2020 EU Hydrogen Strategy that is largely focused on green hydrogen, the UK opts for the broader term "low-carbon hydrogen", with the strategy arguing that both green and blue hydrogen have a key role to play in phasing out fossil fuels. Nevertheless, the government is yet to define what constitutes "low-carbon hydrogen", after it held a public consultation in late 2021.

The UK is planning to deploy hydrogen in decarbonizing several sectors, including the industry, the power sector, and transportation. Importantly and once again in contrast with the rest of Europe, the UK envisions hydrogen to play a role in bringing down emissions from heating buildings, with the strategy document suggesting that hydrogen demand for heat in buildings could be up to 45TWh by 2035.

The strategy sets the following objectives for 2030:

- 5GW of low carbon hydrogen production capacity for use across the economy with a preliminary 1GW capacity in 2025.
- Decarbonization of existing UK hydrogen supply through CCUS and/or supplemented by electrolytic hydrogen injection.
- Lower cost of hydrogen production driven by learning from early projects, more mature markets, and technology innovation.
- End-to-end hydrogen system with a diverse range of users across different sectors.
- Increased public awareness and acceptance among consumers.
- Promotion of UK economic growth and opportunities, including jobs and investment opportunities.
- Over £4 billion of investment is planned to be unlocked throughout the 2020s.
- Emissions reduction under Carbon Budgets 4 and 5 (the legally binding maximum amount of economy-wide CO2 emissions in a 5-year period) while driving decarbonization towards Carbon Budget 6 and net zero.
- Preparation for a ramp up beyond 2030 on a pathway to net zero, with requisite hydrogen infrastructure and technologies as well as regulatory and market frameworks in place.
- Policy development based on evidence from literature and data collected from project deployment.

1 CMS Expert Guides, "Hydrogen Law and Regulation in the UK" (2020) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/united-kingdom>.
2 ibid.
3 HM Government, "UK Hydrogen Strategy" (2021) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1011283/UK-Hydrogen-Strategy_web.pdf>.

THE DEVELOPERS

Member States such as Austria and Italy have been included in "The Developers" group as the hydrogen technologies they possess present a good level of maturity; yet they currently lack a comprehensive hydrogen-specific legal framework. A common thread unifying these states is the focus on hydrogen used primarily in the transport sector, with countries such as Finland setting an ambitious target of a minimum share of 250,000 hydrogen-powered vehicles by 2030.

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AUSTRIA

1. The Current Status of Hydrogen Deployment

Austria relies on hydrogen as one of the energy sources contributing to an increase in the overall national share of renewables in final energy consumption and to comply with its obligations under European legislation.[1] In 2019, former Austrian Chancellor Sebastian Kurz presented a climate protection package, announcing his government's ambition to become the "the world's number one hydrogen nation".[2] Similar to France, Austria's main priority lies with increasing green hydrogen production levels and developing public and private refueling infrastructure.

Austria's main priority lies in increasing green hydrogen production levels and developing public and private refueling infrastructure.

While hydrogen falls outside of the scope of the 2011 Gas Industry Act, there are several legal acts that must be considered in the process of constructing and operating a hydrogen plant. These include the 2000 Environmental Impact Assessment Act and the Austrian Trade Act. Nonetheless, there is currently no hydrogen-specific legal framework in Austria.

For this reason, in 2019 the government launched a Hydrogen Initiative. As part of the initiative, the legal framework was planned to be amended with the introduction of the Renewable Expansion Act, yet, the process has been delayed due to parliamentary elections. Therefore, hydrogen development continues to rely on existing gas legislation and, where national laws are insufficient, EU law applies directly.

There are several large-scale hydrogen initiatives, such as UpHy I and II (focused on green hydrogen for mobility and industry), H2Pioneer (green hydrogen in the light sector), Renewable Gasfield (green hydrogen from polymer electrolysis production), and HyTruck (emissions-free fuels for commercial vehicles) operating in the country.[3] In addition, hydrogen research and deployment is largely supported by the Austrian private sector.

2.National Hydrogen Strategy and Future Developments

The Austrian Hydrogen Strategy was due to be published at the end of 2020, however the process seems to have been delayed, as no document has been made available and no announcements have been made regarding its publication.[4] The strategy will reportedly focus on several objectives. Firstly, the development of hydrogen technology for the economic and transport sectors will be prioritized to achieve Austria's ambition of becoming the number one hydrogen nation. Secondly, more investments are planned to be awarded to the Hydrogen Center Austria to support research and innovation. Despite the delay in the development of a national strategy, currently hydrogen deployment in the country is still supported by numerous projects such as the Renewable Energy Expansion Act (REEA) authorized by the Parliament in July 2021 and the Austrian Climate and Energy Fund supported by the government.[5] Given the interest on hydrogen showed by Austrian companies and providers, a national hydrogen strategy would doubtlessly contribute to keeping the momentum by providing a set of guidelines and more certainty for investors.

1 CMS Expert Guides, "Hydrogen Law and Regulation in Austria" (2020) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/austria>.
2 H2 International, "Austria as hydrogen nation No. 1" (2019) <https://www.h2-international.com/2019/10/13/austria-as-hydrogen-nation-no-1/>.
3 Energy Innovation Austria, "UpHy I & II" <https://www.energy-innovation-austria.at/article/uphy-iii-2/?lang=en>; WIVA P&G, "H2Pioneer" <https://www.wiva.at/v2/portfolio-item/h2pioneer-pave-the-way-for-green-hydrogen-for-early-adopters-in-the-light-industry/?lang=en>; WIVA P&G, "Renewable Gasfield" <https://www.wiva.at/v2/portfolio-item/renewable-gasfield/?lang=en>.
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5 ibid.

BULGARIA

1. The Current Status of Hydrogen Deployment

Bulgaria recognizes hydrogen as a potential area for future development; however, there is currently a limited number of projects operating in the country. Those already in place are primarily within the electricity and transportation sectors. Moreover, most Bulgarian hydrogen is fossil fuel-based, as it is produced by Lukoil in oil refineries. However, there is also localized production of hydrogen for industrial applications with electrolysis.[1] While hydrogen operationalization is expected to increase by 2030 through the deployment of the "Power-to-X" technology, green hydrogen remains expensive. Therefore, significant investments are needed before national producers start experiencing cost reductions associated with technology maturing.

A hydrogen-specific legal framework is extremely limited in Bulgaria. Therefore, until a comprehensive specific legislation is developed, general energy laws apply, such as the Energy Act, the Energy from Renewable Sources Act, Law on Environmental Protections, and the Spatial Development Act.

2. National Hydrogen Strategy and Future Developments

Bulgaria does not have a hydrogen-specific national strategy. However, the development of hydrogen projects in transport and power generation have been included in the Energy and Climate Integrated Plan of the Republic of Bulgaria for the period of 2021-2030.[2] The Integrated Plan sets the target of 32GWh of hydrogen-fueled vehicles by 2030. Moreover, hydrogen refueling stations with a total installed capacity of 20 MW are envisioned for 2030 along with significant investments of 3.5 million EUR in hydrogen projects.

Plans for hydrogen deployment are also included in the country's Sustainable Energy Development Strategy until 2030 with a 2050 horizon.[3] According to the document, Bulgaria intends to gradually prepare key gas infrastructure for hydrogen transportation. The country also sets policy goals for hydrogen, such as the use of hydrogen for heating and electricity production as well as in the transport sector.

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3 Ministry of Energy of the Republic of Bulgaria, "Стратегия за Устойчиво Енергийно Развитие на Република България до 2030 Година с Хоризонтдо 2050 Годи" (2020) <https://balkangreenenergynews.com/wp-content/uploads/2020/09/2020-Bulgaria-Draft-Sustainable-Energy-Development-Strategy-for-2030-with-2050-horizon-in-Bulgarian.pdf>.

CROATIA

1. The Current Status of Hydrogen Deployment

According to the NECP submitted to the European Commission in 2019, Croatia is primarily focused on the development of hydrogen projects in the transportation sector, while its operationalization in industry remains limited.[1] Croatia also envisions hydrogen integration in its energy system.

While there is no hydrogen-specific legal framework in Croatia to date, the country has been reported to be in development of a national program for hydrogen market development.[2] Hydrogen is explicitly included within the scope of the definition of alternative fuels in the Law on the Deployment of Alternative Fuels Infrastructure. This creates beneficial conditions for future hydrogen utilization. Moreover, existing energy laws, such as the Energy Act, the Regulation of Energy Activities, and the Gas Market Act apply.

2.National Hydrogen Strategy and Future Developments

In March 2021, Croatia initiated preparations of the National Hydrogen Strategy for 2050 but no final document has been made available to date. The Strategy is envisioned to contain a long-term plan for the development and deployment of hydrogen in light of the EU's 2050 carbon neutrality goal. The primary objective of the strategy is decarbonization of hydrogen production and its gradual replacement of fossil fuels.

Some of the targets to be included in the National Hydrogen Strategy can be predicted to align with Croatia's NECP. The latter contained several concrete targets. First, a goal of 3.5% of electric or hydrogen-powered vehicles was set for 2030. Moreover, development of the alternative fuel infrastructure was indicated as one of the focal points. Finally, the Law on the Deployment of Alternative Fuels Infrastructure is envisioned to be expanded to include alternative fuels in navigation.

1 Ministry of Environment and Energy, "Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030" (2019) <https://ec.europa.eu/energy/sites/default/files/documents/hr_final_necp_main_en.pdf>.
2 European Commission, "Croatia: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans" (2020) <https://www.fch.europa.eu/sites/default/files/file_attach/Brochure%20FCH%20Croatia%20%28ID%209473034%29.pdf>. See also Euractiv, "'Low hanging fruit': Eastern EU states eye existing gas network for hydrogen" (2021) <https://www.euractiv.com/section/energy/news/low-hanging-fruit-eastern-eu-states-eye-existing-gas-network-for-hydrogen/>.

ESTONIA

1. The Current Status of Hydrogen Deployment

In 2018, Estonia joined the Hydrogen Initiative considering "the use of hydrogen in different economic sectors allows it to move towards a low-carbon economy in the most efficient way".[1] A Hydrogen Working Group was initiated by the Ministry of Environment to analyze the prospects of hydrogen deployment; particular focus was placed on the transport sector. Moreover, increasing the share of green hydrogen produced via electrolysis is considered for the purpose of decarbonizing the electricity sector. In January 2022, 3 important Projects of Common Interest (IPCEIs) were approved by Estonia and the EU, amounting to EUR 111 million in hydrogen investment.[2]

In January 2022, 3 important Projects of Common Interest were approved by Estonia and the EU, amounting to EUR 111 million in hydrogen investment.

While there is no hydrogen-specific legal framework in Estonia, the Hydrogen Working Group is designing a roadmap that will likely include specific policy objectives.[3] The lack of a regulatory framework for hydrogen has been identified as one of the major impediments to green hydrogen deployment. This is foreseen to be partially remedied with the upcoming revision of the EU gas market rules aimed at facilitating hydrogen deployment. As Estonia's Natural Gas Act implements the EU's Third Gas Package, the country is likely to transpose the revised gas rules in the Act as well.

2. National Hydrogen Strategy and Future Developments

On 27 October 2020, the Parliament of Estonia delivered a proposal to the government for the development of a hydrogen strategy.[4] The strategy will cover a variety of sectors, such as transport, energy production and buildings. Moreover, it will address the entire value chain, from production to end use. At the start of 2021, the Estonian government, under the new direction of PM Kaja Kallas, approved an action plan to develop a hydrogen strategy and to allocated EUR 50 million from the national Recovery and Resilience Fund to the deployment of hydrogen technologies.[5] The strategy is under development by the Ministry of Economic Affairs & Communication and the Ministry of the Environment.

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2 Vabariigi Valitsus, "The government supports the development of hydrogen value chain projects in Estonia", (2022) <https://valitsus.ee/en/news/government-supports-development-hydrogen-value-chain-projects-estonia>.
3 European Commission, "Estonia: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans" (2020) <https://www.fch.europa.eu/sites/default/files/file_attach/Brochure%20FCH%20Estonia%20%28ID%209496897%29.pdf>.
4 Next Generation Energy Technology, "Estonian Hydrogen Strategy" (2020) <http://h2est.ee/eng/estonian-hydrogen-strategy/>.
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FINLAND

1. The Current Status of Hydrogen Deployment

Finland aims at becoming carbon neutral already by 2035 and carbon negative by 2050.[1] Large-scale deployment of hydrogen technology is incorporated within these national plans.

> ***Finland aims at becoming carbon neutral already by 2035 and carbon negative by 2050.***

The current hydrogen production level in Finland is at 4.7-5 TWh, yet less than 1% of this hydrogen is produced via electrolysis. 99% of it comes out of refineries that also generate 80% of demand for hydrogen. The remaining 20% is generated by the chemical industry. As such, compared to other Member States, a hydrogen-powered transport system is substantially underdeveloped. To address this, the government has set a sales target of 250,000 electric vehicles by 2030, according to its Medium-term Climate Change Policy Plan for 2030. Nonetheless, the plan does not set a specific target for the number of hydrogen-powered vehicles.[2]

Finland currently lacks a comprehensive hydrogen-specific legal framework. Moreover, no specific targets for hydrogen deployment were included in its NECP. According to the Commission's assessment, there are also "no technology-specific policies to promote fuel cell vehicles and hydrogen refueling stations infrastructure".

However, several policy instruments, such as car taxes and carbon pricing, create an incentive for hydrogen utilization. Additionally, revised legislation on guarantees of origin includes hydrogen and simplifies the process of identifying hydrogen's level of sustainability.[3]

In August 2021, P2X Solutions — a Finnish forerunner of power-to-X technology — announced its intention to build the country's first green hydrogen production plant by 2024.[4]

2. National Hydrogen Strategy and Future Developments

There is no national hydrogen strategy. To promote hydrogen development, the Finnish government appointed a working group on energy system integration, the promotion of the hydrogen economy and Power-to-X technologies.[5] Inter alia, it recommends the government to fund demonstrator projects, promote the production and distribution of electric fuels and to develop a framework to govern and promote the transmission of hydrogen. This report should feed into the government's next climate and energy strategy, which will be presented to Parliament in February 2022.

Moreover, a National Hydrogen Roadmap for Finland was commissioned by Business Finland and was delivered in 2020.[6] The Roadmap contains a list of suggestions for each part of the hydrogen value chain. These, however, lack specific targets and focus primarily on research, development, and innovation.

1 Ministry of the Environment, "Government's climate policy: carbon-neutral Finland by 2035" <https://ym.fi/en/climate-neutral-finland-2035>.
2 Ministry of the Environment, "Government Report on Medium-term Climate Change Policy Plan for 2030 Towards Climate-Smart Day-to-Day Living" (2017) <https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/80769/YMre_21en_2017.pdf?sequence=1>.
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4 FuelCells Works, "First Green Hydrogen Production Plant in Harjavalta Finland" (2021) <https://fuelcellsworks.com/news/first-green-hydrogen-production-plant-in-harjavalta-finland/>.
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GREECE

1. The Current Status of Hydrogen Deployment

While the Greek Government indicated its intention to deploy hydrogen in the future, no projects are expected until early 2022.[1] Greece's NECP mentions that its approach comprises of the production of 'green' hydrogen, the long-term storage of hydrogen, the use of hydrogen to decarbonize transport (particularly in shipping), the use of existing gas infrastructure for the transmission and the promotion of hydrogen-related research and development. Furthermore, the Greek government seeks to grow the share of renewable energy sources in the heating, industrial, electricity and transport sectors to 35% by 2030, but does not set specific targets for hydrogen consumption.[2]

Greece lacks a legal framework for hydrogen. Law 4439/2016 dealing with the development of alternative fuel infrastructures transposes Directive 2014/94/EU.

Greece was also granted funds from the EU's recovery and resilience mechanism in 2021 and plans to accelerate the decarbonization of transport including through green hydrogen, but these plans lack specific elaboration in this regard.[3]

The 2019 NECP is currently being updated, but the government has not announced a publication date yet.

2. National Hydrogen Strategy and Future Developments

At present, there is no National Hydrogen Strategy in Greece. However, in December 2020 it was announced that a special government committee will be assembled to produce a draft strategy plan for the promotion of technologies and applications of hydrogen and other renewable gases.[4] The committee will design:

- A Roadmap for the development and utilization of hydrogen and other renewable gases.
- Policy proposals for the energy sector.
- Estimated costs for the operationalization of hydrogen and other renewable gases.

It is not yet clear when the strategy plan will be published.

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2 Government of Greece, "National Energy and Climate Plan" (2019) <https://ec.europa.eu/energy/sites/default/files/el_final_necp_main_en.pdf> .
3 Government of Greece, "Greece 2.0" (2021) <https://greece20.gov.gr/en/>.
4 WFW, "Hydrogen in Greece" (2021) <https://www.wfw.com/articles/hydrogen-in-greece/>.

IRELAND

1. The Current Status of Hydrogen Deployment

In July 2021 Ireland enacted an ambitious Climate Action and Low Carbon Development Act that set the GHG emissions reduction target for 2030 at 51% relative to 2018 levels.[1] Moreover, Ireland aims to reach climate neutrality by 2050. These targets will require considerable structural changes in the energy sector, with clean hydrogen serving as a complementary solution to wind power—the country's main source of renewable energy.[2]

There are two pathways for hydrogen deployment currently under consideration. The first one focuses on carbon capture and storage with hydrogen produced primarily from natural gas. The second one is carbon-free, presupposing hydrogen production through the electrolysis of water. While more costly, the latter option has great potential to facilitate the country's decarbonization, produce vast amounts of hydrogen for domestic consumption and, ultimately, reduce its dependence on energy imports.[3]

Ireland did not indicate any specific objectives in its NECP submitted to the Commission. Furthermore, there is no comprehensive hydrogen-specific legal framework in Ireland.[4]

2. National Hydrogen Strategy and Future Developments

The Irish Government announced at the end of January that the country will launch their "green hydrogen" national strategy before July, with a public consultation scheduled for the first half of 2022.(1) The decision was taken following the mounting pressure from politicians and associations.[5]

At the end of 2021, Ireland's political party Sinn Féin launched the Hydrogen Strategy Bill 2021. The bill seeks to ensure the state is prepared to realize the full potential of green hydrogen through the preparation of a national hydrogen strategy.[6] If implemented, the bill would oblige the Minister for the Environment, Climate and Communications to draft and publish a hydrogen strategy within six months of its passing.

Several weeks later, the association Wind Energy Ireland called on the state to release a robust hydrogen strategy by the end of Q2 2022, setting out targets across industry, heavy road transport, shipping, aviation and power generation.[7] It also requested establishment of a high-level cross-government group to develop recommendations to cut the price of renewable electricity, so that the country could produce hydrogen "as cheaply as possible", thus securing its international competitiveness.[8]

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2 Interreg Europe, "Renewable Energy in Ireland 2019 Report" (2019) <https://www.interregeurope.eu/news-and-events/news/5265/renewable-energy-in-ireland-2019-report/?no_cache=1&cHash=6c4eb4bb73a6a790f3c5a64928d1b35a>.
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6 Sinn Féin, "Sinn Féin launch Hydrogen Strategy Bill 2021 - Darren O'Rourke TD" (2022) <https://www.sinnfein.ie/contents/62717>.
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8 ibid.

ITALY

1. The Current Status of Hydrogen Deployment

Italy's binding target of reducing national GHG emissions levels is 33% by 2030 under the Effort Sharing Regulation (compared to 2005 levels). Hydrogen deployment has been identified as one of the key instruments to reach this target. So far, only a small share of hydrogen produced in Italy is low- or zero-carbon. However, this number is projected to increase in the upcoming years with the decrease of costs of renewable energy and electrolysis. Furthermore, the greater availability of renewable energy compared to other EU member states, thanks to its favorable geographical position and the existence of a well-developed gas network connecting the southern part of the country to North Africa, places Italy in a good position for the development of green hydrogen in the near future.[1]

The Italian hydrogen framework is fragmented, which renders the commencement of new projects more difficult.[2] In particular, the Italian environmental regulator does not differentiate between hydrogen production through natural gas reforming and through electrolysis. As a result, certain land use prohibitions apply to both processes irrespective of the production method. The only hydrogen-specific piece of legislation is a ministerial decree on "Technical rules of fire prevention for design, construction, and operation of hydrogen distribution facilities for automotive vehicles". Other aspects of the hydrogen sector are governed predominantly by gas and fossil fuel legislation.

2.National Hydrogen Strategy and Future Developments

As outlined in its NECP, submitted in December 2019, Italy is committed to strengthening its commitment to the 2030 decarbonization goals and to the objectives of the European Green Deal.[3] The country acknowledges the importance of scaling up the use of renewables and of energy efficiency, for which hydrogen will play a key role.

In November 2020, the Ministry of Economic Development announced the publication of the National Hydrogen Strategy Preliminary Guidelines. The Guidelines set the vision for hydrogen deployment until 2050. 5 GW of electrolysis capacity is to be installed by 2030 to meet the 2% of hydrogen penetration in the final energy demand. The demand is set at 20% by 2050. The Guidelines presuppose a substantial investment (both at national and European level) in the years 2020-2030 of up to EUR 10 billion. Three models of green hydrogen production are identified:[4]

1) Complete on-site production.
2) On-site production with renewable electricity transportation.
3) Centralized production with hydrogen transportation.

Moreover, the creation of hydrogen valleys and industrial clusters are envisioned. The final version of the Strategy was expected by 2021, yet no official document has been made publicly available. Nevertheless, the key role of hydrogen has been further underlined in the National Recovery and Resilience Plan (NRRP) "Italia Domani", approved by the European Commission in July 2021 as part of the Next Generation EU program. Italy has allocated nearly EUR 60 billion or over 30% of the total value of the NRRP to the energy transition, including boosting the country's share of renewable energy, such as hydrogen.

1 CMS Expert Guides, "Hydrogen Law and Regulation in Italy" (2020) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/italy>.
2 ibid.
3 Ministry of Economic Development, Ministry of the Environment, Ministry of Infrastructure and Transport, "Integrated National Energy and Climate Plan" (2019) <https://ec.europa.eu/energy/sites/ener/files/documents/it_final_necp_main_en.pdf>.
4 IEA, "National Hydrogen Strategy Preliminary Guidelines" (2021) <https://www.iea.org/policies/13087-national-hydrogen-strategy-preliminary-guidelines>.

LITHUANIA

1. The Current Status of Hydrogen Deployment

So far, Lithuania is mainly considering hydrogen deployment from the perspective of research & development and innovation. No specific targets have been included in the NECP submitted to the Commission.[1]

The Commission did not identify a comprehensive legal framework for the deployment of hydrogen in Lithuania.[2] In March 2021, the Law on Alternative fuels was passed with the aimed at facilitating hydrogen and biomethane in coming future. The Law includes the objective of having at least 5% of both gases in the final energy consumption mix in transport by 2030.

2.National Hydrogen Strategy and Future Developments

No national strategy has been developed in Lithuania to this day. Nevertheless, a national study was initiated in 2021 by the Ministry of Energy to prepare National Hydrogen Development Guidelines.[3] The development of the Guidelines was commissioned to the Lithuanian energy transmission group EPSO-G given that green hydrogen will be transported via the national gas grid.

In November 2020, the Minister of Energy of Lithuania established the Lithuanian Hydrogen Platform, a cooperation format that brings together national research institutions, businesses, and the public sector with the goal of developing hydrogen technologies in the country.[4] As of January 2022, 45 organizations participate in the Platform.[5] Furthermore, Lithuania has allocated EUR 20 million from its National Recovery and Resilience Fund and EUR 50 million from the EU Modernization Fund to hydrogen production and pilot and experimental projects. Totally, the country will invest EUR 300 million in development of the hydrogen sector by 2030.[6]

Throughout the spring of 2022, the Ministry of Energy will hold discussions with the members of the Platform to approve the Hydrogen Development Roadmap, which is anticipated to be adopted in April 2022.[7] It will set concrete guidelines for green hydrogen production and identify the priority sectors with the greatest rate of return on investment. The Ministry of Energy aims to use surplus offshore wind electricity to produce green hydrogen and export it via port of Klaipeda or via GIPL, the gas link with Poland which is set to be finished in mid-2022.[8]

The country will invest EUR 300 million in the development of the hydrogen sector by 2030.

1 National Energy and Climate Action Plan for of the Republic of Lithuania for 2021-2030" (2020) <https://ec.europa.eu/energy/sites/ener/files/documents/lt_final_necp_main_en.pdf>.
2 European Commission, "Lithuania: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans" (2020) <https://www.fch.europa.eu/sites/default/files/file_attach/Brochure%20FCH%20Lithuania%20%28ID%209473351%29.pdf>.
3 Ministry of Energy of the Republic of Lithuania, "Ministry of Energy takes the lead in preparing national hydrogen development guidelines" (2021) <https://enmin.lrv.lt/en/news/ministry-of-energy-takes-the-lead-in-preparing-national-hydrogen-development-guidelines>.
4 Ministry of Energy of the Republic of Lithuania, "About the Hydrogen Platform" (2020) <https://enmin.lrv.lt/en/sectoral-policy/hydrogen-platform/about-the-hydrogen-platform>
5Lietuvos Respublikos energetikos ministerija, "Įsibėgėja Lietuvos vandenilio platformos darbai" (2022) <https://enmin.lrv.lt/lt/naujienos/isibegeja-lietuvos-vandenilio-platformos-darbai>.
6 Mokslo Lietuva, "Klimatui neutrali Lietuvos energetika – kaip prie to prisidės žaliasis vandenilis, jūrinis vėjas ir elektromobiliai?" (2021) <http://mokslolietuva.lt/2021/11/klimatui-neutrali-lietuvos-energetika-kaip-prie-to-prisides-zaliasis-vandenilis-jurinis-vejas-ir-elektromobiliai/>.
7 Garbaliauskaitė, Daiva (Viceminister) "Lithuanian Strategy towards Climate Neutral Energy" (2021) <https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1634740424.pdf>.
8 ibid.

ROMANIA

1. The Current Status of Hydrogen Deployment

The deployment of hydrogen remains limited in Romania, with the gas being mainly utilized in refineries.[1] So far, Romania only produces fossil fuel-based hydrogen, which is obtained mainly via steam methane reforming or as a by-product from chlor-alkali production.[2] However, it indicated in its 2020 NECP that the implementation of a few pilot projects in the electricity sector is under consideration.

As part of its energy transition, Romania is currently investing in new gas infrastructure to complement renewable solutions, which it also intends to use for transporting hydrogen. According to its National Recovery and Resilience Plan (NRRP), Romania aims to realize "almost 2,000 km of new gas distribution networks to be prepared for hydrogen injection." By 2026, hydrogen will make up 20% of the blend; after 2030, the infrastructure will be used 100% with hydrogen.[3] On 31 December 2021, the government amended the existing energy law with the main purpose of transporting relevant EU energy legislation. It also introduced provisions on access to hydrogen terminals, commercial exploitation of a hydrogen terminals, hydrogen production installations, and rights and obligations of hydrogen terminal operators.[4]

2. National Hydrogen Strategy and Future Developments

The Ministry of Energy is expecting to publish a national hydrogen strategy at the end of 2022 and implement it in the first quarter of 2023.[5] The strategy will be complemented with a legislative package on the use of hydrogen, also planned for 2023.

Following the Ministry's announcement, EPG (a Romanian energy think-tank) released a paper with key policy recommendations:

- Prioritize clean hydrogen from renewable electricity.
- Target the most promising uses for hydrogen: industry, transport and long-term storage.
- Involve public and private stakeholders to outline a strategic roadmap with targets and potential funding sources.
- Outline measures to develop the hydrogen value chain in Romania, particularly for electrolyzer manufacturing.

The recommendation paper also suggests Romania should support the proposals for hydrogen deployment in the Fit for 55 package and endorse the additionality principle as part of the delegated act on renewable fuels of a non-biological origin to the Renewable Energy Directive.[6]

1 CMS Expert Guides, "Hydrogen Law and Regulation in Romania" (2020) <https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/romania>.
2 HyLaw, "National Policy Paper – Romania" (2018) <https://www.hylaw.eu/sites/default/files/2018-09/HyLAW_National_policy_Paper_Romania.pdf>.
3 Economedia, "Ministerul Energiei promite strategie națională de hidrogen într-un an" (2021) <https://economedia.ro/ministerul-energiei-promite-strategie-nationala-de-hidrogen-intr-un-an.html#.YelHb3rMI2w>.
4 Volciuc-Ionescu, "Long-awaited changes in the energy sector" (2022) <https://www.volciucionescu.com/long-awaited-changes-in-the-energy-sector/>.
5 Economedia, "Ministerul Energiei promite strategie națională de hidrogen într-un an" (2021) <https://economedia.ro/ministerul-energiei-promite-strategie-nationala-de-hidrogen-intr-un-an.html#.YelHb3rMI2w>.
6 EPG, "Clean Hydrogen in Romania – elements of a strategy" (2021) <https://www.enpg.ro/clean-hydrogen-in-romania-elements-of-a-strategy/>.

THE LAGGARDS

This category regroups all EU Member States in which hydrogen-specific legislation is either absent or in its embryonic stage. The countries included in the section differ significantly in their approach to the use of hydrogen. For instance, despite still lacking a national strategy or hydrogen-specific legislation, Latvia considers hydrogen to be an alternative to fossil fuels, particularly in transport. In contrast, hydrogen deployment is not considered a priority in Cyprus and no hydrogen projects have been included in its National Energy and Climate Plan for 2030.

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CYPRUS

1. The Current Status of Hydrogen Deployment

Cyprus is not currently focusing on hydrogen deployment and did not include hydrogen projects in its NECP for 2030.[1] Moreover, the absence of an existing gas network complicates its utilization. No agenda for creating hydrogen-specific infrastructure exists to this day. There are also no plans to invest in research and innovation and no intention to develop hydrogen-based technology even for 2050. Some initial signals seem to have come from the industrial sector, with the Cyprus Hydrogen Association being founded on March 2021 in the context of the Cyprus Employers and Industrialists Federation (OEB) with the main aim to further explore the production of green hydrogen and its use in transport and industry.[2]

In 2021, as it is the case for Malta, Cyprus managed to get a derogation in the revision of the Trans-European Networks for Energy (TEN-E) regulation. As such, the country can develop a gas pipeline interconnection to be funded as an Important Project of Common Interest as it is deemed necessary to secure permanent interconnection between the island and the trans-European gas network.[3]

2. National Hydrogen Strategy and Future Developments

There is currently no strategy for hydrogen and no plans to develop a roadmap in the nearest future. According to the Commission, the creation of a hydrogen-specific legal framework is currently not envisioned in Cyprus.[4]

1 Government of Cyprus, "Cyprus' Integrated National Energy and Climate Plan" (2020) <https://ec.europa.eu/energy/sites/default/files/documents/cy_final_necp_main_en.pdf>.
2 CyprusMail, "Private sector to lead roll out of green hydrogen" (2021) < https://cyprus-mail.com/2021/09/21/private-sector-to-lead-roll-out-of-green-hydrogen/>.
3 Council of the European Union "TEN-E: Council and Parliament reach provisional agreement on new rules for cross-border energy projects" (2021) <https://www.consilium.europa.eu/en/press/press-releases/2021/12/22/ten-e-council-and-parliament-reach-provisional-agreement-on-new-rules-for-cross-border-energy-projects/>.
4 European Commission, "Cyprus: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans" (2020) <https://www.fch.europa.eu/sites/default/files/file_attach/Brochure%20FCH%20Cyprus%20_LowRes%20%28ID%209496949%29.pdf>.

LATVIA

1. The Current Status of Hydrogen Deployment

According to its NECP, Latvia views hydrogen as a "future alternative fuel to replace petroleum products".[1] The primary focus lies in the transport sector, with the first hydrogen-refueling station in operation in Riga since 2016. Latvia's vision for hydrogen deployment in transport is long-term and includes plans for the development of hydrogen infrastructure. Moreover, innovation is prioritized and is to be achieved via the implementation of the national RD&I Smart Specialization Strategy in the period between 2021 and 2027. Furthermore, Latvia continues coordination efforts with the neighboring Baltic countries. Despite all that, no specific objectives were included in the 2019 NECP.

A comprehensive legal framework remains absent in Latvia.[2] Hydrogen is listed as an alternative fuel under national law and its purity requirements are governed by the Standardization Law.

2.National Hydrogen Strategy and Future Developments

No hydrogen strategy has been developed in Latvia so far. Efforts to help the development of a hydrogen economy in the country are being carried out by researchers and businesses within the framework of associations, such as the Latvian Hydrogen Association.

1 Cabinet of Ministers, "Latvia's National Energy and Climate Plan 2021-2030" (2020) <https://ec.europa.eu/energy/sites/default/files/documents/lv_final_necp_main_en.pdf>.
2 European Commission, "Latvia: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans" (2020) <https://www.fch.europa.eu/sites/default/files/file_attach/Brochure%20FCH%20Latvia%20%28ID%209473352%29.pdf>.

Latvian vision for hydrogen deployment in transport is long-term and includes plans for the development of hydrogen infrastructure.

MALTA

1. The Current Status of Hydrogen Deployment

There are three focal points for Malta when it comes to hydrogen deployment according to its NECP: gas infrastructure, decarbonization of the transport sector, and green hydrogen production.[1] Malta also considers hydrogen strategically necessary for ensuring the security of energy supply. However, no specific objectives were included in the NECP.

No comprehensive legal framework regulating hydrogen deployment exists in Malta. So far, hydrogen has only been considered within the scope of the National Transport Strategy. However, "as the cost of the infrastructure is greatly disproportionate to current demand and considering the limited range on the island as well as the highest energy efficiency of battery electric vehicles" electro mobility is currently prioritized over the installation of a hydrogen refueling network.[2]

In 2021, Malta was able to secure a derogation in the revision of the TEN-E regulation, making it possible for a gas pipeline interconnection to be funded as a Important Project of Common Interest.[3] Based on this success, the government is now assessing whether it is technically feasible to transport gas and hydrogen blends in its planned pipeline from Gela (Sicily) to Malta called Melita.[4]

2.National Hydrogen Strategy and Future Developments

There is no national strategy for hydrogen in Malta; moreover, no plans to develop one in the nearest future have been announced.

1 Government of Malta, "Malta's 2030 National Energy and Climate Plan" (2019) <https://ec.europa.eu/energy/sites/default/files/documents/mt_final_necp_main_en.pdf>.
2 European Alternative Fuels Observatory, "Malta" <https://www.eafo.eu/content/malta>.
3 Council of the European Union "TEN-E: Council and Parliament reach provisional agreement on new rules for cross-border energy projects" (2021) <https://www.consilium.europa.eu/en/press/press-releases/2021/12/22/ten-e-council-and-parliament-reach-provisional-agreement-on-new-rules-for-cross-border-energy-projects/>.
4 James Debono (Malta Today) "Malta aims for 2030 hydrogen import through gas pipeline" (2021) <https://www.maltatoday.com.mt/environment/energy/111600/malta_aims_for_2030_hydrogen_import_through_gas_pipeline#.Yekp-HrMLcA>.

SLOVENIA

1. The Current Status of Hydrogen Deployment

According to its NECP, Slovenia views hydrogen as a potential contributor to the overall share of renewable electricity generated (it seeks to achieve a 27% share of renewable energy by 2030), as well as a method of ensuring security of supply and achieving decarbonization.[1] Slovenia is considering to inject green hydrogen into its existing gas network, and according to its own estimations, around 7% of fuel consumption can be met by hydrogen in 2040, particularly in the transport sector. To achieve this, Slovenia intends to develop a market for renewable hydrogen, which will be supported by a guarantees of origin scheme.

So far, no comprehensive legal framework regulates the deployment of hydrogen in Slovenia.[2]

2.National Hydrogen Strategy and Future Developments

At present, Slovenia does not have a national hydrogen strategy. The government has also not released any statement announcing their intention to develop one. Nevertheless, the country's plans for hydrogen are reflected in its NECP and the Resolution on Long-Term Clime Strategy until 2050, released in summer 2021.[3] According to the latter, Slovenia's indicative objective is 10% of renewable hydrogen (or synthetic gas) in the transmission and distribution networks by 2030, inter alia through the implementation of pilot projects. By 2040, the country aims to substitute 25% of natural gas with hydrogen and/or synthetic gas, and by 2050 – to replace it in entirety. To facilitate this transition, Slovenia will promote the establishment of infrastructure and a suitable legislative framework for the use of the two gases.

Slovenia is also considering hydrogen-powered vehicles as an alternative solution to transport means that are challenging to electrify, such as road freight transport.

1 Republic of Slovenia, "Integrated National Energy and Climate Plan of the Republic of Slovenia" (2020) <https://ec.europa.eu/energy/sites/default/files/documents/si_final_necp_main_en.pdf>.
2 European Commission, "Slovenia: Opportunities for Hydrogen Energy Technologies Considering the National Energy & Climate Plans" (2020) <https://www.fch.europa.eu/sites/default/files/file_attach/Brochure%20FCH%20Slovenia%20%28ID%209474178%29.pdf>.
3 The National Assembly, "Resolution on Slovenia's Long-Term Climate Strategy until 2050" (2021) <https://unfccc.int/sites/default/files/resource/LTS1_SLOVENIA_EN.pdf>.

There are three focal points for Malta when it comes to hydrogen deployment according to its NECP: gas infrastructure, decarbonization of the transport sector, and green hydrogen production.

HYDROGEN PARTNERSHIPS

This section gathers identified hydrogen partnerships between EU Member Atates as well as between member states and third countries. For the purpose of this report, this chapter will mainly focus on country-to-country agreements and does not take stock of the great number of agreements among private actors and between private actors and EU Member States (e.g., the Memorandum of Understanding between the European Investment Bank (EIB) and the Portuguese Government, signed in April 2021). The aim of this section is rather to present an overview of the state of play at EU Member State level, which seems to go hand in hand with the degree of development of a national hydrogen framework.

HYDROGEN PARTNERSHIPS
intra-EU member states

The map below gives a visual overview of the number of partnerships established by some EU countries to date. As hydrogen gains momentum and countries are working to set up their own legislative frameworks, we can expect that the number of agreements (including bilateral or trilateral partnerships, memoranda of understanding and declarations of intent) between countries will experience a boost in the near future. Therefore, both the map and the list presented below will be continuously updated to reflect such developments (all countries are listed in alphabetical order).

Hydrogen partnerships intra-EU member states

1. DENMARK-GERMANY
Hydrogen cooperation (2021)

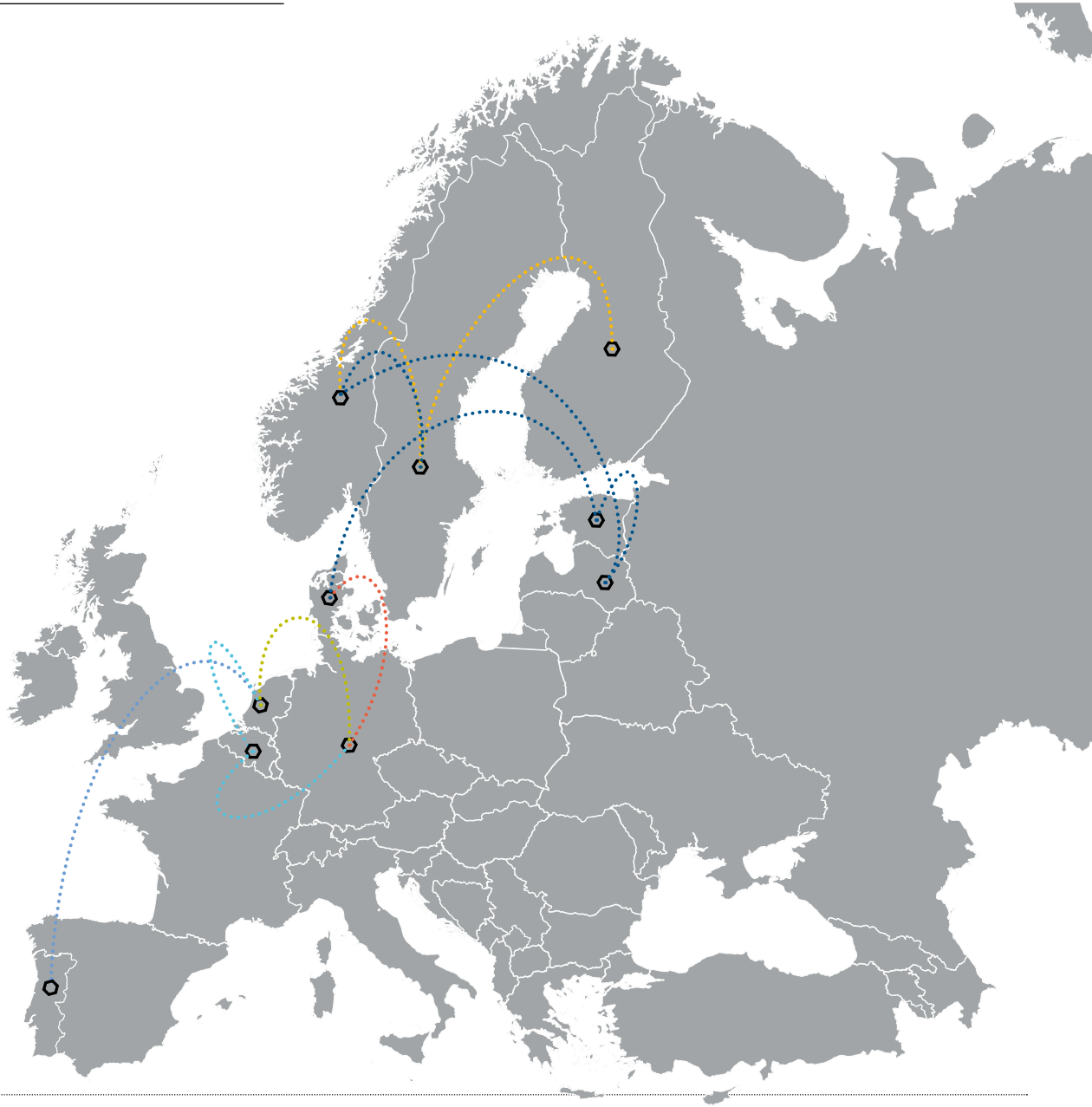
2. THE NETHERLANDS-PORTUGAL
Memorandum of Understanding on production and transport of hydrogen (2020)

3. THE NETHERLANDS-GERMANY
Declaration of intent on hydrogen (2020)

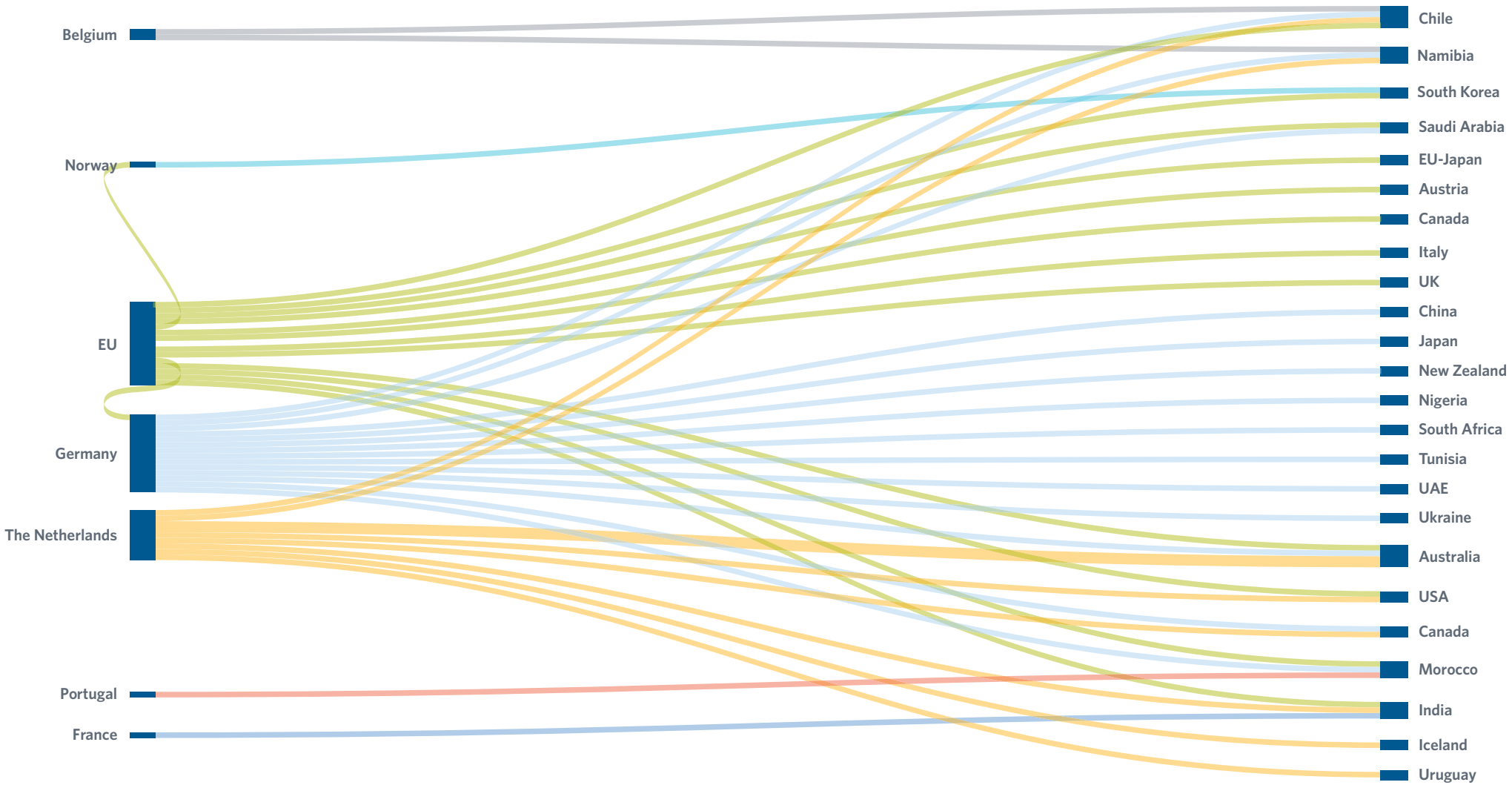
4. THE NETHERLANDS-BELGIUM-GERMANY
Green Octopus partnership on hydrogen network (2019)

5. SWEDEN-NORWAY-FINLAND
Nordic Hydrogen Partnership (2006)

6. DENMARK-ESTONIA-LATVIA-NORWAY-SWEDEN
Memorandum of Understanding on hydrogen as a transport fuel (2017)



HYDROGEN PARTNERSHIPS between EU (Member States) or Norway and third countries



APPENDIX

Hydrogen partnerships intra-EU member states

- Denmark-Germany – Hydrogen Cooperation (2021)
- The Netherlands-Portugal - Memorandum of Understanding on Production and Transport of Hydrogen (2020)
- The Netherlands-Germany - Declaration of intent on hydrogen (2020)
- The Netherlands-Belgium-Germany - Green Octopus partnership on hydrogen network (2019)
- Sweden-Norway-Finland – Nordic Hydrogen Partnership (2006)
- Denmark-Estonia-Latvia-Norway-Sweden – Memorandum of Understanding on hydrogen as a transport fuel (2017)

Hydrogen partnerships between EU (Member States) or Norway and third countries

- Belgium
  - Chile - Port of Antwerp and Port of Zeebrugge Memorandum of Understanding (2021)
  - Namibia – Memorandum of Understanding (2021)
- EU
  - EU-Japan – EU-Japan Green Alliance (2021) – Contains language on hydrogen cooperation
  - (European Commission) Australia, Austria, Canada, Chile, Germany, India, Italy, Morocco, Norway, Saudi Arabia, South Korea, the United Kingdom and the United States launched the "Clear Hydrogen Mission" (2021)
  - (European Commission)-USA-Japan trilateral partnership (2019)
- France
  - India – Memorandum of Understanding on renewable energy (2021) - contains language on hydrogen
- Germany
  - Australia – Hydrogen Accord (2021)
  - Canada – Memorandum of Understanding (2021)
  - Chile – Memorandum of Understanding (2021)
  - China – Energy Partnership looks at hydrogen (2020)
  - Japan – Framework announcement (2021)
  - Morocco – Memorandum of Understanding (2020)
  - Namibia – Hydrogen partnership (2021)
  - New Zealand – Joint research projects (2021)
  - Nigeria – Expansion of 2008 Energy Partnership to include hydrogen (2021)
  - Saudi Arabia – Memorandum of Understanding (2021)
  - South Africa – Investment Program (2021)
  - Tunisia – Memorandum of Understanding (2020)
  - UAE – Joint Declaration of Intent (2021)
  - Ukraine – Memorandum of Understanding on establishing an Energy Partnership (2020) - on hydrogen among other sectors
- The Netherlands
  - Australia
    - (Port of Rotterdam) South Australia – Memorandum of Understanding (2021)
    - (Port of Rotterdam) Tasmania – Memorandum of Understanding (2021)
  - Canada – Memorandum of Understanding on hydrogen cooperation (2021)
  - Chile – Joint statement (2021)
  - Iceland - Memorandum of Understanding with the National Power Company on green hydrogen exports (2020)
  - India - Statement of Intent with NITI Aayog (government think tank) on decarbonization and the energy transition agenda, including hydrogen innovations (2020)
  - Namibia – Letter of intent on cooperation in the field of energy resources (2021)
  - USA – Statement of Intent on hydrogen technology (2020)
  - Uruguay – Joint statement (2021)
- Norway
  - South Korea – Memorandum of Understanding (2019)
- Portugal
  - Morocco – Agreement on cooperation in the field of green hydrogen development (2021)

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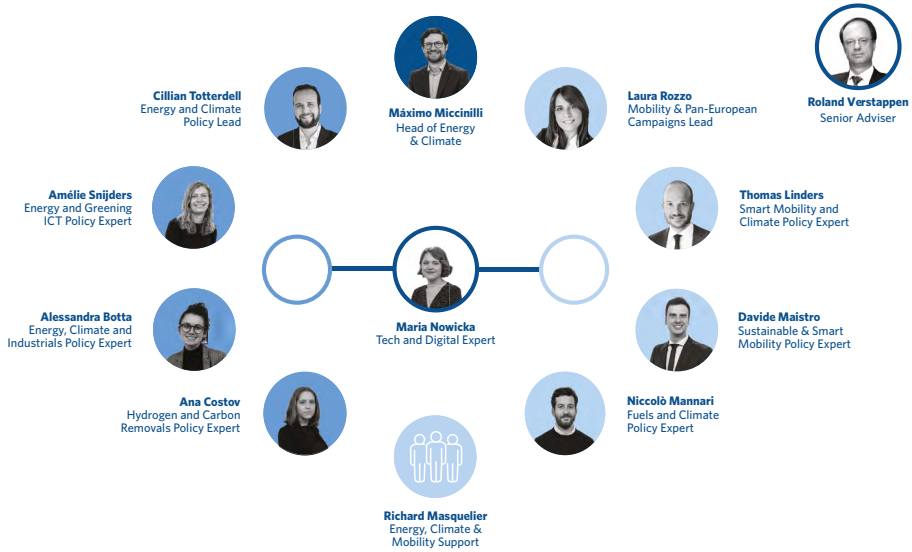

FLEISHMANHILLARD

For further information about the report please contact:

PRESS:
thibault.jacobs@fleishmaneurope.com

ENERGY & CLIMATE PRACTICE:
maximo.miccinilli@fleishmaneurope.com