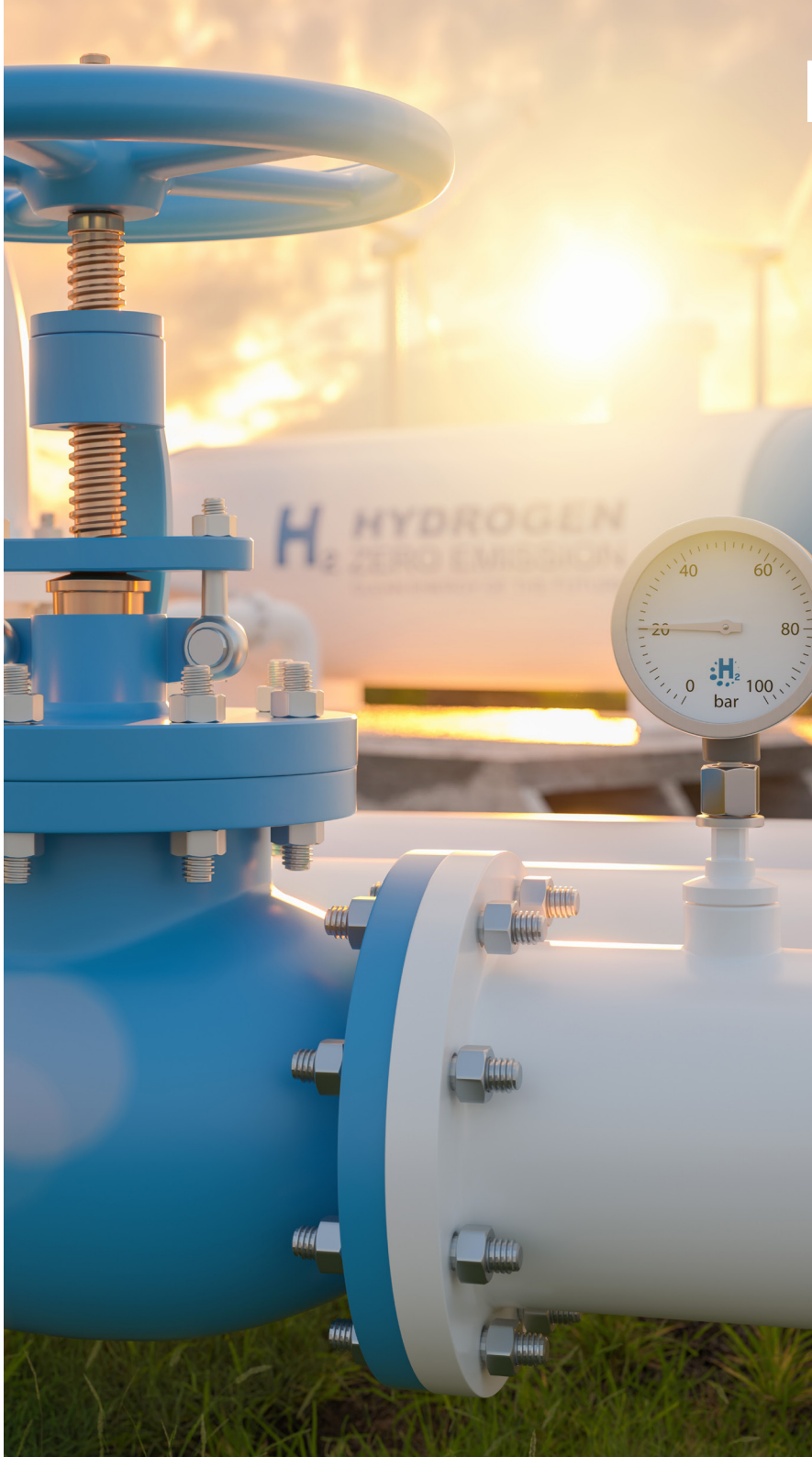
Northwest European Hydrogen Monitor 2024



INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 31 member countries, 13 association countries and beyond.

Source: IEA.
International Energy Agency
Website: www.iea.org

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea
Lithuania
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Republic of Türkiye
United Kingdom
United States

The European Commission also participates in the work of the IEA

IEA association countries:

Argentina
Brazil
China
Egypt
India
Indonesia
Kenya
Morocco
Senegal
Singapore
South Africa
Thailand
Ukraine

Abstract

Northwest Europe is at the forefront of low-emissions hydrogen[1] development. This region accounts for around half of Europe's total hydrogen demand, and it has vast and untapped renewable energy and carbon storage potential in the North Sea. It also has a well-developed, interconnected gas network which could be partially repurposed to facilitate the transmission and distribution of low-emissions hydrogen from production sites to demand centres.

The development of low-emissions hydrogen in Northwest Europe could gradually scale up in the short- to medium-term. Northwest European countries now have the ambition to develop up to 30 to 40 gigawatts (GW) of electrolyser capacity by 2030. However, most low-emissions hydrogen projects are currently in the early stages of development. Their success will depend to a large extent on supporting policies and regulatory frameworks, with continuous monitoring of progress. The cost-efficient development of low-emissions hydrogen markets will also necessitate a regional approach that maximises existing synergies among national markets.

This is the second edition of the Northwest European Hyd Monitor. It provides an annual update of low-emissions hyd market developments in Northwest Europe, and is the re collaboration among the countries involved in the Hydrogen In of the Clean Energy Ministerial (CEM-H2I) workstream e "Roundtable on the North-West European Region" and the hyd working group of the Pentalateral Forum.

The countries analysed in this Monitor are Austria, Be Denmark, France, Germany, Luxemburg, the Netherlands, N Switzerland and the United Kingdom. Market monitor accompanied by regular dialogues with key stakeholders to fa the exchange of information and data collection.

[1] When the term "low-emissions hydrogen" is used, the International Energy Agency refers to hydrogen produced via electrolysis where the electricity is generated from a low-emission source (renewables or nuclear), biomass or fossil fuels with carbon capture usage and storage (CCUS). This does not necessarily reflect the official definitions of the countries involved in the Mo the carbon intensity or sustainability of hydrogen production methods.

Table of contents

Executive summary

Low-emissions hydrogen can play a significant role in decarbonising existing gas and energy systems and will be critical to the countries' efforts to meet their energy and climate targets. In addition to its environmental benefits, low-emissions hydrogen can help reduce reliance on fossil fuel imports in the medium-term, bolstering energy security.

Northwest Europe is at the forefront of low-emissions hydrogen development. The region accounts for around half of Europe's total hydrogen demand. It has vast and untapped renewable energy potential in the North Sea and a well-developed, interconnected gas network which could be partially repurposed to facilitate the transmission and distribution of renewable and low-emissions hydrogen from production sites to demand centres.

Low-emissions hydrogen is defined here as hydrogen produced via electrolysis where the electricity is generated from a low-emissions source (renewables or nuclear), biomass, or fossil fuels with carbon capture, utilisation and storage (CCUS). A detailed overview of the terminology is provided in the Annex.

Northwest European countries are raising their low-emissions hydrogen targets

Adopting and implementing clear hydrogen strategies, including medium- and long-term targets, is considered essential to provide the necessary impetus and guidance for the development of hy markets.

Since Russia's invasion of Ukraine, several Northwest Eu countries have doubled their hydrogen production targets, and are considering increases. The majority of the countries in the adopted production targets for electrolytic hydrogen, while N opted for a technology-neutral approach. Altogether, Nor European countries now have ambition to develop as much a 40 gigawatts (GW) of electrolyser capacity by 2030. Nonetl recent market developments, inflation and cost increases migh countries to revise their targets. In general, the focus has b upscaling hydrogen production in many countries, thoug attention is also rapidly shifting to stimulating demand.

The regulatory framework for low-emissions hydrogen cor to shape up in 2023

In addition to strong policy support, regulatory certainty is es to unlock the investment necessary to scale up a low-em hydrogen market and facilitate cross-border trade.

Northwest European countries and the European Union contir advance regulatory frameworks for low-emissions hydrogen in The delegated acts outlining detailed rules on the EU defin renewable hydrogen were formally published in June 2023. United Kingdom, the Energy Act 2023 received Royal Ass

October 2023. It creates a new comprehensive legislative regime for the energy system, with key provisions related to hydrogen business models and the regulation of hydrogen pipelines, as well as carbon dioxide (CO_2) transport and storage. And at the end of 2023, the European Union reached a formal agreement on the Hydrogen and Decarbonised Gas Markets Package, laying the foundations for the future European low-emissions hydrogen market.

Northwest European hydrogen production could reach 7 Mt by 2030…

Based on the IEA's Hydrogen Production Projects Database, Northwest Europe's production of low-emissions hydrogen (and derivatives) could reach just above 7 million tonnes (Mt) per year by 2030 if all planned projects become commercially operational (and taking into account assumptions on efficiency and utilisation factors). This would equate to approximately 2% of the region's total primary energy demand. Electrolytic hydrogen supply would contribute 55% of total low-emissions hydrogen production, while fossil fuel-based hydrogen projects equipped with CCUS would account for 45%. Based on announced projects, the United Kingdom, the Netherlands, Denmark and Germany are expected to account for three-quarters of Northwest Europe's low-emissions hydrogen production by 2030.

… however, less than 4% of low-emissions hydrogen projects are in advanced stage of development

According to the IEA's Hydrogen Production Projects Database, less than 4% of the projects that could provide low-emissions hydrogen supply by 2030 have been committed, meaning they are ei operation, have reached a final investment decision (FID) under construction. More than 95% are currently unde feasibility studies or are in the concept phase.

In contrast, in North America, 14% of potential low-em hydrogen supply by 2030 is supported by projects which are operational, have reached FID, or are under construction. In projects which are either operational or are in a mature ph development (FID and/or under construction) account for mo half of expected low-emissions hydrogen supply by 2030.

Scaling up of low-emissions hydrogen requires greater attention on demand creation

Creating demand for low-emissions hydrogen is a key instrun stimulate investment in low-emissions hydrogen supply includ quotas, fuel standards and public procurement rules. D security is essential for the conclusion of long-term agreements, which in turn can help to de-risk investment and in the economic feasibility of low-emissions hydrogen projects.

Hydrogen demand in Northwest European currently stands at 4.5 Mt per year, making up about 55% of OECD Europe demand and nearly 5% of total global demand for hydrogen. with the overall global trend, virtually all hydrogen consump Northwest Europe is concentrated in the refining and che subsectors.

In the European Union, the revised EU Renewable Energy Directive (RED III) sets legally binding targets for renewable hydrogen use in industry and transport by 2030. The implied renewable hydrogen demand in Northwest Europe under RED III would be approximately 1.6 Mt by 2030, rising to 2.3 Mt by 2035. This is well below announced low-emissions hydrogen ambitions from Northwest European countries. Combined with the absence of economic incentives to bridge the cost gap between renewable and fossil fuel hydrogen, this helps explain the difficulty many projects developers currently face in securing offtake contracts.

Steep cost reductions are needed to make renewable electrolytic hydrogen competitive with unabated gas-based hydrogen

Initial price discovery suggests that renewable hydrogen prices stood almost three times of the assessed levelised cost of hydrogen (LCOH) from unabated gas in 2023. This highlights the need to improve the cost-competitiveness of low-emissions and renewable hydrogen. Under the IEA's Announced Pledges Scenario (APS), which assumes countries implement national targets in full and on time, the decline in renewable electrolytic hydrogen production costs, together with a carbon price of over USD 135 per tonne of CO_2-equivalent, could ensure that the levelised cost of hydrogen from renewable electrolysis is comparable with the LCOH from unabated gas in the region – and in certain cases, it would be lower.

Support measures should take a holistic approach and sp entire value chain

The relatively low share of committed projects highlights the nee holistic approach to support the nascent low-emissions hy sector. Scaling it up will require an effective, interlocking frame subsidy schemes and support mechanisms along the entire valu – including research and development, production, transportati in particular, demand creation.

Public funding programmes and state-backed risk-sharing mech (such as contracts for difference) can help to de-risk investme improve the economic feasibility of low-emissions hydrogen p Demand creation should be a key instrument to stimulate inve including via quotas and public procurement rules. The European has launched the Hydrogen Bank, a key financial instrument whi to de-risk investment in renewable hydrogen projects. Und auctions carried out through the Hydrogen Bank, renewable hy producers bid for a fixed premium to bridge the gap betwee production costs and the price consumers are currently willing The first auction round, totalling EUR 800 million, attracted 132 bids and accounted for 85 GW of electrolyser capacity, though small fraction of them were funded in the first round.

The Hydrogen Monitor provides a detailed overview of the subsidy schemes and support mechanisms available both at th of the European Union and at national level in Northwest Eu countries.

Northwest Europe is playing a key role in developing international trade in low-emissions hydrogen

Based on announced projects that aim to trade hydrogen or hydrogen-based fuels, 16 Mt of hydrogen equivalent (H_2-eq) could be moved around the globe by 2030. However, three-quarters of export-oriented projects are in early stages of development. Less than one-third in terms of volume by 2030 have identified a potential offtaker. Countries in the Northwest European region account for three-quarters of global import volume by 2030 for which a final destination has been identified.

Instruments such as auctions can be used to create a bidding competition for contracts and help close the gap between production costs and the prices consumers are willing to pay. For example, Germany's H2Global auction-based mechanism will facilitate the conclusion of long-term import contracts for low-emissions hydrogen and hydrogen derivatives. The scale-up of international trade in hydrogen and hydrogen derivatives will also require building up transport infrastructure, including ports. Northwest Europe hosts 13 ammonia-handling facilities and 16 facilities that handle methanol, mainly concentrated in Germany, France and the Netherlands.

Northwest Europe's hydrogen network could increase tenfold by early 2030s, though firm investment commitments are lacking

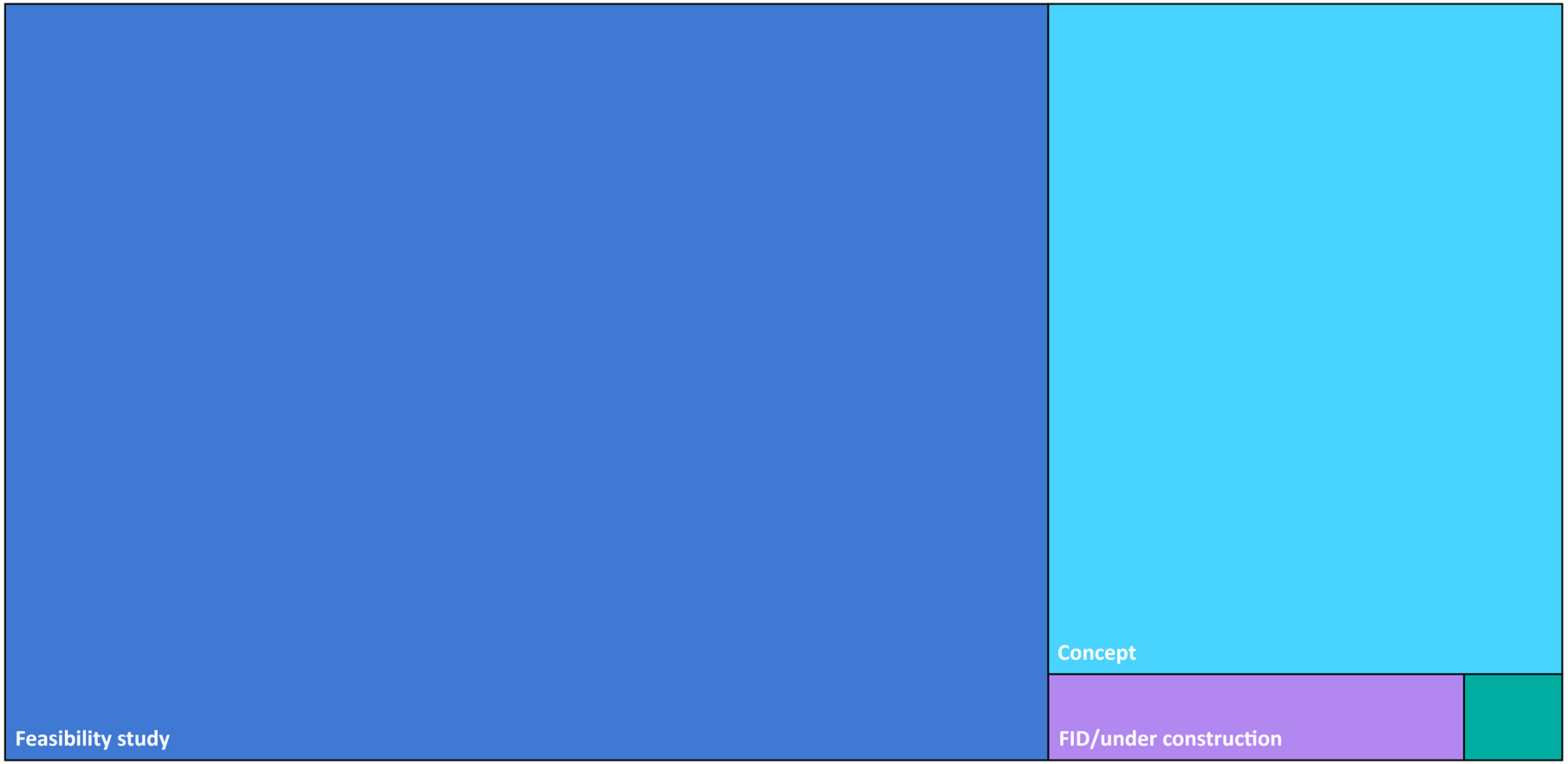
Achieving ambitious targets for low-emissions hydrogen deployment will require accelerating the development of hydrogen infrastructure for transport and storage. Based on pipeline project announce the length of the region's hydrogen network could increase te over 18 000 kilometres (km) by early 2030. However, the maj announced projects lack firm investment commitments, whic reflects current uncertainty in demand. Close to two-thirds hydrogen pipelines that could be operational by 2030 wo repurposed natural gas pipelines. Repurposing existing natu pipelines to serve hydrogen can result in substantial cost savin shorter lead times when compared with new-build hy networks. This, in turn, could translate into lower transmissio and improve the cost-competitiveness of low-emissions hydro

Underground storage is essential to unleash the full pote low-emissions hydrogen as an energy carrier

Developing underground storage capacity for hydrogen will be for it to reach its full potential as an energy carrier and respon evolving flexibility requirements of a more complex energy s Based on the IEA's Hydrogen Infrastructure Projects Dat Northwest Europe could develop over 3 terawatt-hours (T hydrogen storage capacity by 2030. However, just 10% expected capacity by 2030 has reached FID and/or is construction. Considering the relatively long lead times of ne hydrogen pipelines and hydrogen storage projects, concentrat immediate action by all stakeholders would be required to m targets set for 2030.

Less than 4% of projects underpinning the expected low-emissions hydrogen production by 2030 have already reached a final investment decision or are under construction

Potential low-emissions hydrogen production in Northwest Europe in 2030 by status



Source: IEA (2024), Hydrogen Projects Database.

Hydrogen policies and regulation

Northwest European countries strengthened their hydrogen policies and regulations in 202

Strong policy support and a clear regulatory framework are essential for the development of hydrogen markets. In policy terms, hydrogen strategies are crucial to set out the role of low-emissions hydrogen in the broader energy system and setting medium- and long-term targets. And besides strong policy support, regulatory certainty is essential to unlock the investment necessary to scale up a low-emissions hydrogen market and facilitate cross-border trade.

The European Union's Hydrogen Strategy, published in July 2020, sets out a vision to create a European hydrogen ecosystem and scale up production and infrastructure to an international dimension. It sets a target for 40 GW of renewable hydrogen electrolyser capacity by 2030. In Northwest Europe, of the ten countries included in the Monitor, six have already adopted specific production targets by 2030. Altogether, Northwest European countries foresee electrolyser capacity deployment of between 30 GW and 40 GW by 2030.

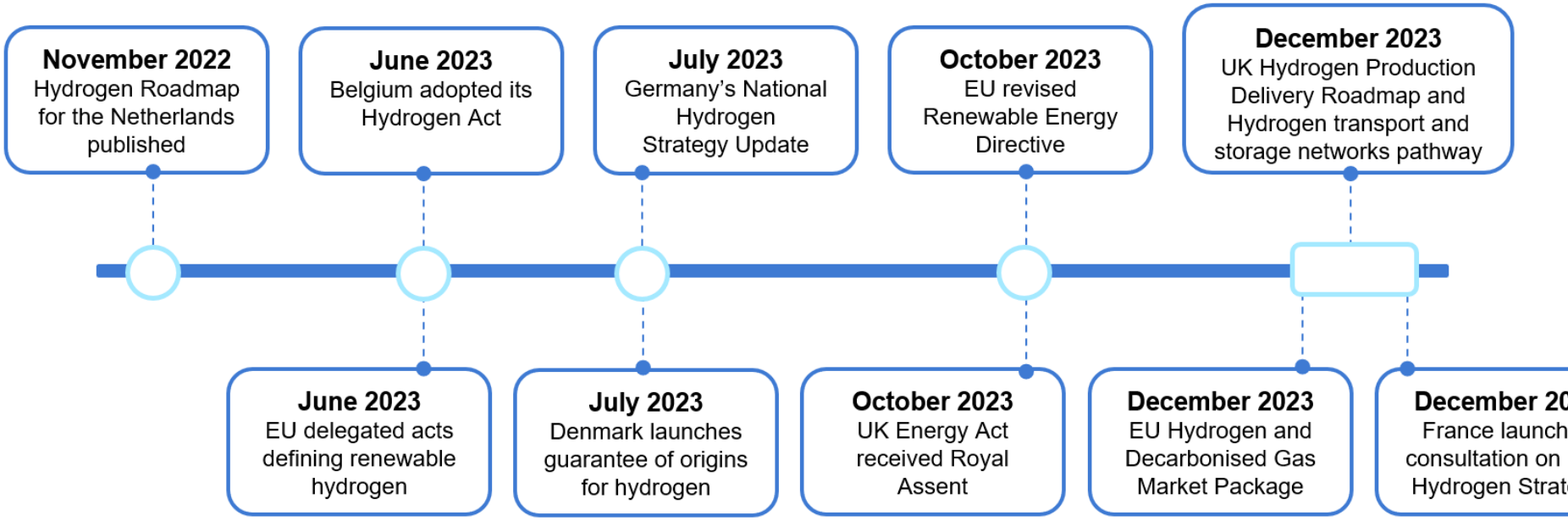
Since Russia's invasion of Ukraine, the European Union has raised its target for hydrogen production from 5.6 Mt to 10 Mt by 2030, complemented by 10 Mt of imports. Similarly, several Northwest European countries have doubled, or are considering increasing, their production targets. They include Germany, which doubled its electrolyser capacity target from 5 GW to at least 10 GW by 2030. The Netherlands is aiming for 3-4 GW of installed electrolyser capacity by 2030, while the Dutch parliament recently called upon the government to set a target of 8 GW installed capacity by 2 April 2022 the United Kingdom doubled its ambition for low- hydrogen production capacity from 5 GW to up to 10 GW by 2 its Hydrogen Production Delivery Roadmap, published in Dec 2023, the United Kingdom set targets for 6 GW of electroly 4 GW of CCUS-enabled hydrogen by 2030.

Northwest European countries and the European Union contin advance the regulatory framework for low-emissions hydro 2023. The delegated acts outlining detailed rules on the EU de of renewable hydrogen were formally published in the EU Journal in June 2023. Belgium adopted its Hydrogen Act in July establishing a regulatory framework for the transport of hydrog pipeline. At the end of 2023 the European Union reached a agreement on the Hydrogen and Decarbonised Gas M Package, which lays the foundations for the future Europea emissions hydrogen market. In the United Kingdom, the Ener 2023 creates a new comprehensive legislative regime for the system, with key provisions related to hydrogen business mode the regulation of hydrogen pipelines, as well as CO_2 transpo storage.

The following section provides an overview of the key hy policies, production targets and regulations adopted by the Eu Union and Northwest European countries covered in this Mon

Europe's regulatory framework for low-emissions hydrogen is shaping up

Key hydrogen policies and regulations enacted in the European Union and Northwest Europe since November 2022



Sources: IEA analysis based on various policy documents (hydrogen strategies, roadmaps and papers).

EU regulation paves the way for an open and competitive low-emissions hydrogen market

The European Union has continued to advance the regulatory framework necessary for the scale-up of a low-emissions hydrogen market. This included the publication of detailed rules on the definition of renewable hydrogen and establishing a regulatory framework underpinning the operation of future hydrogen networks.

Delegated acts on the definition of renewable hydrogen

As foreseen under Articles 27(3) and 28(5) of the Renewable Energy Directive, in June 2023 the European Commission formally published two delegated acts outlining detailed rules on the EU definition of renewable hydrogen:

- The first act defines the conditions under which hydrogen, hydrogen-based fuels and other energy carriers can be considered as renewable fuels of non-biological origin (RFNBOs).
- The second act provides a methodology for calculating life-cycle greenhouse gas (GHG) emissions for RFNBOs to ensure a 70% reduction in CO_2-equivalent compared to the nearest comparable fuel.

The delegated acts provide regulatory certainty both to suppliers and consumers on the definition of renewable hydrogen, which is expected to help channel EU funds towards renewable hydrogen projects as well as guide the approval of national state aid schemes.

Certain industrial players have raised concerns on the comple the delegated acts, claiming that it could put at risk certain p under development. The new rules apply to both domestic hy producers and imports.

Three main criteria define what can be considered as ren hydrogen:

- **Additionality:** Starting from 1 January 2028, ren hydrogen producers will be required to ensure that ele fed into their electrolysers is sourced from renewable installations no older than three years. Project develop exempted from additionality until 2038 if their hy installation is commissioned before 2028.
- **Temporal correlation:** Hydrogen production has matched to renewable electricity production on a n basis up until the start of 2030, when it will have to be m within the same one-hour period.
- **Geographical correlation:** The renewable energy that feed the electrolysers producing hydrogen have located either: (1) in the same bidding zone a electrolyser; (2) in an interconnected bidding zone, pr that electricity prices in the relevant time period on th ahead market in such interconnected bidding zone are to or higher than in the bidding zone where the hydro

produced; or (3) in an offshore bidding zone interconnected with the electrolyser's bidding zone.

When electricity is sourced from the grid, hydrogen producers may count electricity taken from the grid as fully renewable in the following cases:

- If their installations are located in a bidding zone where the average proportion of renewable electricity exceeded 90% in the previous calendar year and the production of RFNBOs does not exceed a maximum number of hours set in relation to the proportion of renewable electricity in the bidding zone.
- If the installation producing the renewable liquid and gaseous transport fuel of non-biological origin is located in a bidding zone where the emissions intensity of the electricity is lower than 18 gCO_2-eq/MJ and the following criteria are met: (1) power purchase agreements with renewable electricity producers are concluded for an amount that is at least equivalent to the amount of electricity that is claimed as fully renewable; (2) the conditions of geographical and temporal correlation are met.
- If the electricity used to produce renewable hydrogen is consumed during an imbalance settlement period during which the hydrogen producer can demonstrate, that: (1) power-generating installations using renewable energy sources were redispatched downwards; and (2) the electricity consumed for the production of hydrogen reduced the need for redispatching by a corresponding amount.
- If the electricity is sourced by meeting the conditio additionality, temporal correlation and geographic corre

The Renewable Energy Directive III sets hydrogen use targ

The revised EU Renewable Energy Directive (published in O 2023) sets legally binding targets for renewable hydrogen industry and transport by 2030. A detailed overview of the dire provided under the Demand section of the Monitor.

Hydrogen and Decarbonised Gas Market Package

In December 2021 the European Commission proposed a hy and decarbonised gas market package to establish common rules for renewable and natural gases as well as hydroge includes the review and revision of Gas Directive 2009/73/E Gas Regulation (EC) No. 715/2009. The Council and the Eu Parliament reached a provisional agreement on the prop December 2023, which is expected to be formally adopted in

The Gas Directive **defines "low-carbon hydrogen"** as hy derived from non-renewable sources, which meets the emission reduction threshold of 70% compared to the fos comparator for RFNBOs. The Commission is to adopt delegat to specify the methodology for assessing GHG emissions s from "low-carbon hydrogen".

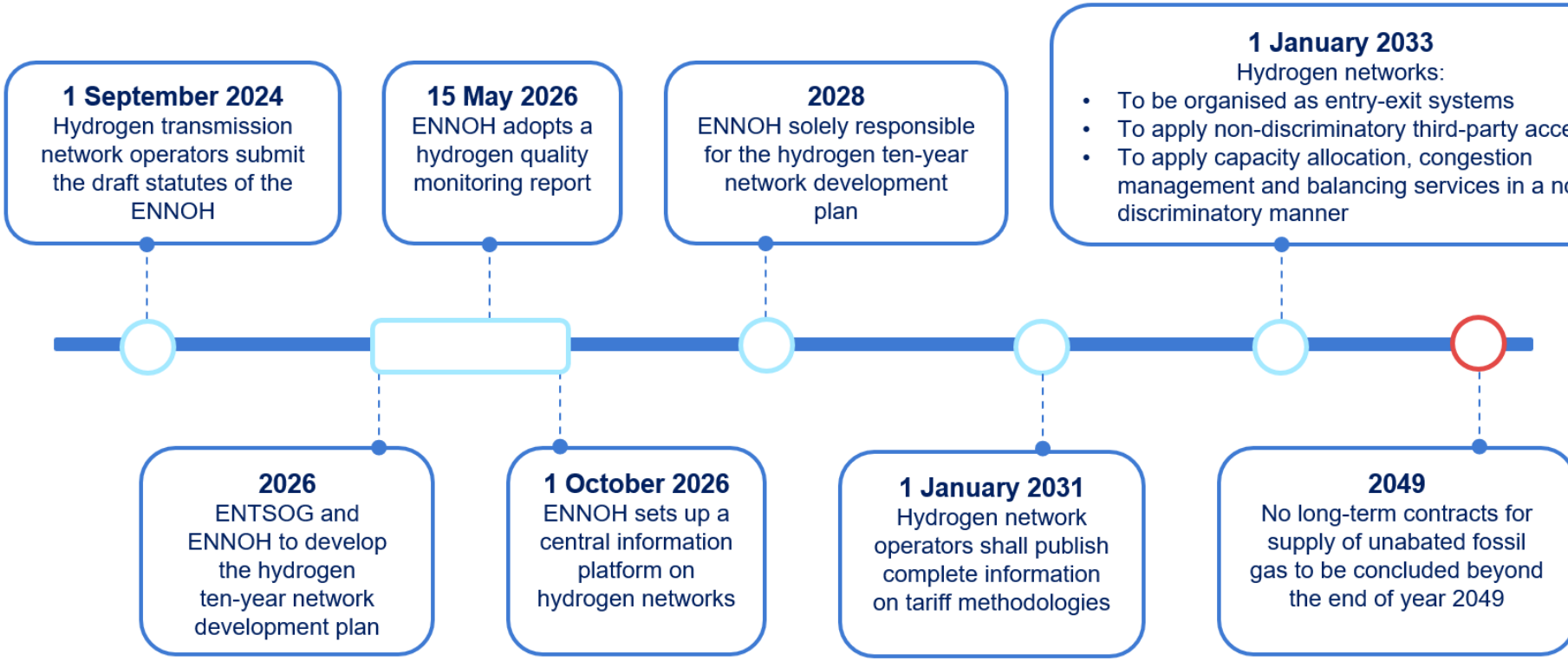
In line with the current EU natural gas regulation, the new reg framework sets guidelines for the gradual implementation o discriminatory third-party **access to future hydrogen net**

blending limits, unbundling, tariffs, network codes and operational transparency. The key provisions related to hydrogen include:

- **Unbundling:** The operation of hydrogen networks should be separated from activities of energy production and supply in order to avoid the risk of conflicts of interest on behalf of the network operators. Hydrogen transmission network operators should be unbundled two years after the entry into force of the directive. Besides ownership unbundling, the independent transmission system operator (ITO) model, which is used in natural gas legislation, is included as a possible unbundling model. Member states have the possibility of granting a derogation to the legal unbundling provisions, while existing hydrogen networks may be granted derogations to these requirements.
- **Non-discrimination:** As of 1 January 2033 hydrogen networks will be organised **as an entry-exit system** and apply rules on third-party access, capacity allocation, congestion management and balancing in a non-discriminatory manner.
- **Tariffs:** The national energy regulator will fix or approve tariffs for hydrogen network access in accordance with transparent criteria or their methodologies, or both. Tariffs should include remuneration for the network owner, which provides for adequate remuneration of the network assets and of any new investments made therein, provided they are economically and efficiently incurred.
- **Hydrogen network development:** Hydrogen transmission network operators are to submit to the relevant regulatory authority every two years a ten-year network developme (while hydrogen distribution network operators are to such plan every four years). The regulatory authority will all actual or potential system users on the ten-year n development plan in an open and transparent manne regulatory authority will publish the result of the cons process, including possible needs for inve decommissioning of assets and demand-side solutio requiring new infrastructure investment.
- **Blending:** The upper percentage limit of blending hydrog natural gas networks is set at 2% at cross-border intercon points. Notably, such blending should be a last resort s as it is less efficient compared to using hydrogen in its pu and diminishes the value of hydrogen.

The new regulation lays down the legal foundation f establishment of the **European Network of Network Operat Hydrogen** (ENNOH). ENNOH will consist of certified hy transmission network operators in member states. By 1 Sep 2024 hydrogen network operators are required to submit European Commission and the EU Agency for the Coopera Energy Regulators (ACER) the draft statutes and procedural r ENNOH that have yet to be established. From 1 Octobe ENNOH will operate a **central web-based platform** to p market participants with all the relevant information neces access the hydrogen network. In addition, ENNOH will be resp for developing ten-year hydrogen network development plans s from 2028.

The European Union's Hydrogen and Decarbonised Gas Markets Package lays the foundati for the future European low-emissions hydrogen market



Notes:
ENTSOG = European Network of Transmission System Operators for Gas.
ENNOH = European Network of Network Operators for Hydrogen.

IEA. CC

Sources: IEA analysis based on European Council (2023), Proposal for a Regulation of the European Parliament and of the Council on the internal markets for renewable and gases and for hydrogen (recast); European Council (2023), 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 (recast).

Northwest European countries continued to strengthen their policy and regulatory framewo for low-emissions hydrogen

Austria set a target for 1 GW electrolyser capacity by 2030

Austria published its National Hydrogen Strategy in June 2022. The clear focus of the strategy is on the deployment of renewable hydrogen. However, apart from renewable hydrogen, it also includes climate-neutral hydrogen in its proposals – especially for use in industry – which encompasses hydrogen produced from fossil natural gas with complete CO_2 separation or pyrolysis. When using hydrogen from fossil natural gas, it has to be ensured that CO_2 separation occurs without the emission of GHGs, and that there are no GHG emissions along the entire value chain (life cycle).

Austria's Hydrogen Strategy has a target of **1 GW electrolyser capacity** for the production of renewable hydrogen by 2030 and aims **to replace 80% of current consumption of fossil-based hydrogen** with climate-neutral hydrogen in energy-intensive industries by 2030. The strategy foresees the creation of a supporting framework for the production of renewable hydrogen, the development of a targeted hydrogen infrastructure and the enhancement of international partnerships for climate-neutral hydrogen. In addition, it aims to the strengthen Austria's innovation and technology potential through the focused development of hydrogen technologies.

To reach these targets, the strategy foresees a number of measures, divided into eight policy fields of action: (1) enabling a timely market ramp-up through flagship projects; (2) support and incentives production of renewable hydrogen; (3) incentivising market- business models and the targeted application of climate- hydrogen in industry; (4) establishing an infrastructure for hy and creating import opportunities; (5) targeted advancem hydrogen technologies in the area of mobility; (6) inten research and development activities; (7) creation of the n hydrogen platform; and (8) setting priorities at the Europea international level.

Furthermore, the government adopted a draft **Renewable G** and submitted it to parliament in March 2024 for approval. T foresees a rising renewable gas quota for biomethane and rene hydrogen. Up to the end of 2030 gas providers will be legally to substitute 7.5 TWh of natural gas sold to customer renewable gas. Details regarding these regulations are cu under discussion.

Belgium adopted its Hydrogen Act in 2023

The Belgian **Federal Hydrogen Strategy** was approved Council of Ministers in October 2021 and was updated in O 2022. According to the Federal Hydrogen Vision and Strate total domestic demand for both H_2 molecules and H_2 derivativ increase to between 125 TWh and 200 TWh per year by

(bunkering fuels included). In its National Recovery and Resilience Plan, Belgium set a target to have at least 0.15 GW of electrolysis capacity in operation by 2026.

Federal hydrogen policy is part of the federal government's broader energy policy, which aims to achieve the European climate neutrality goals. The strategy therefore focuses particularly on the importance of renewable hydrogen and its use to decarbonise industry and transport. More specifically, **the strategy is based on four pillars:**

- Positioning Belgium as a hub for the import of renewable molecules for Europe.
- Consolidating Belgium's leadership in hydrogen technologies.
- Organising a robust hydrogen market.
- Focusing on co-operation.

In July 2023 Belgium's parliament adopted the **Hydrogen Act**, which establishes a regulatory framework for the transport of hydrogen via pipeline and aims to promote the optimal development of the Belgian hydrogen market.

Among its key provisions, the Hydrogen Act:

- Guarantees non-discriminatory access to the hydrogen transport network for all interested parties.
- Defines the rules and procedures for preparing the network development plan and for setting regulated network tariffs.
- Regulates the designation of the hydrogen network operator.
- Designates the Commission for Electricity and Regulation (CREG) as the regulator for hyd transmission.

In line with the procedure laid down in the Hydrogen Act, com may until 30 November 2030 apply to be certified as the hyd transport network operator (HNO). Applications are assessed Directorate-General for Energy of the Federal Ministry of Eco SMEs, Self-employed and Energy and the energy regulator C The HNO will thereafter be designated by the federal Mini Energy by way of ministerial decree. The HNO is expected designated and certified by March/April 2024.

The HNO's key responsibilities will include:

- Managing, developing and operating the hydrogen tra network in a safe, reliable, efficient and econor responsible manner.
- Preparing, every two years, a network development pla
- Providing non-discriminatory access to the hyd transport network on the basis of the conditions set out code of conduct with respect to access to the hyd transport network.

Under the Hydrogen Act, CREG will establish a tariff metho and publish it on its website. The HNO will thereafter propose in accordance with that tariff methodology, which must be app by CREG before they can become effective.

Denmark sets a 4-6 GW target for electrolyser capacity by 2030 and launched guarantees of origin for hydrogen in 2023

Denmark adopted its **Power-to-X Strategy** in March 2022 to accelerate the conversion of electricity into green hydrogen and other e-fuels over ten years.

The strategy aims to promote energy exports in the form of green hydrogen and e-fuels. Under its strategy, Denmark aims to build between 4 GW and 6 GW of electrolysis capacity by 2030. The strategy will support the use of green hydrogen, particularly in hard-to-abate sectors like shipping and aviation, as well as heavy road transport and industry. Reaching the electrolysis capacity target by 2030 is expected to entail CO_2 emission reductions of between 2.5 Mt and 4.0 Mt.

In July 2023 Denmark launched **a guarantee of origin (GO) scheme** for hydrogen and derivatives such as ammonia and methanol. The GO will certify the amount of hydrogen that has been produced with renewable energy sources. The scheme is expected to facilitate the development of hydrogen trading in the future.

In 2023 Denmark decided to allocate responsibility for hydrogen transmission networks to **Energinet** and the task of hydrogen distribution to Evida, the gas distribution company.

France launched a consultation process on its new Hyd Strategy at the end 2023

The National Strategy for the Development of Decarbonise Renewable Hydrogen was published in September 2020. The targets for the decarbonised hydrogen development in I include:

- 6.5 GW of water electrolysis capacity.
- Developing clean mobility, in particular for heav vehicles, with the goal of abating more than 6 Mt c emissions by 2030.
- Developing an industry along the whole value ch hydrogen and creating between 50 000 and 150 000 jo

At the end of 2023 France launched a consultation process **new Hydrogen Strategy**. The government identified the fol strategic guidelines:

- **Production capacity targets:** Install 6.5 GW of elec hydrogen production capacity by 2030 and 10 GW by 2
- **The scale-up of hydrogen transport infrastructure** priority to the development of a network of hydrogen h particular the hubs of Fos-sur-Mer, Dunkirk, Havre-E de la Seine, and Vallée de la Chimie, and their connec storage infrastructure.

- **Unequivocal support from the government:** Create a support mechanism worth EUR 4 billion for the deployment of decarbonised hydrogen production over 10 years.
- **A strategy open to the world:** Provide support to the French hydrogen sector in its international development, and support the emergence of a global market for hydrogen and its derivatives.
- **Focus on hydrogen-related technologies:** Strengthen the integration of the hydrogen ecosystem around French flagship projects and ensure coverage of all key products and technologies in the value chain.
- **Ensure that hydrogen can contribute to power system flexibility**, including through the development of hydrogen storage.
- **Guarantee the framework conditions necessary for the development of the French hydrogen sector:** Develop the regulatory framework, access to skills and land, and connection to the electricity network.

Germany adopted its National Hydrogen Strategy Update in 2023, targeting at least 10 GW of electrolytic hydrogen capacity by 2030

Germany published its National Hydrogen Strategy (NHS) in June 2020. The NHS laid down a coherent framework for the future production, transport and use of hydrogen and its derivatives, as well as setting a target for 5 GW of electrolytic hydrogen capacity by

In July 2023 the German government published the N Hydrogen Strategy Update (NHS 2023) in order to meet climate protection targets and new challenges relating to the market after Russia's invasion of Ukraine.

NHS 2023 expects that around **95-130 TWh** of hydrogen needed by 2030 (up from 90-110 TWh in the previous NH cover part of this demand, Germany plans to establish up to **a 10 GW of generation capacity by 2030** (doubling the pr target of 5 GW). According to the federal government's asses based on analysis of the current scenarios, around 50-70% 90 TWh) of the 95-130 TWh demand forecast for 2030 covered by imports from abroad (in the form of hydroge hydrogen derivatives).

NHS 2023 sets out the following work programme and target 2030:

- **Accelerated market ramp-up of hydrogen:** The ramp-up of hydrogen, its derivatives and hydrogen appl technologies will be significantly accelerated.
- **Domestic hydrogen production:** The target for do electrolyser capacity in 2030 will be increased from 5 at least 10 GW. The remaining demand will be cove imports.

- **Development of an efficient hydrogen infrastructure:** By 2027/28 a hydrogen start-up grid with more than 1 800 km of repurposed and newly built hydrogen pipelines will be established in Germany. With the continued expansion of the hydrogen grid, all major production, import and storage centres will be connected to the relevant consumers by 2030.[2]

- **Implementation of hydrogen applications in the sectors:** By 2030 hydrogen and its derivatives will be used in industrial applications, heavy-duty commercial vehicles in particular, and increasingly in aviation and shipping. In the power sector, hydrogen will contribute to the security of energy supply.

- **Technology leadership:** German suppliers are increasing their technology leadership and now offer the entire value-added chain of hydrogen technologies from production (e.g. electrolysers) to a variety of applications (e.g. fuel cell technology).

- **Creation of appropriate framework conditions:** Coherent regulatory conditions at national, European and, if possible, international level will support the market ramp-up.

An **import strategy** is planned as a follow-up to the NHS 2023. It is expected to cover topics such as technology imports, infrastructure, energy security and supply diversification. Furthermore, a **s development strategy** (SDS) is being developed. The SDS provide a framework that guides subsequent processes, such development plans for electricity and gas, as well as hydroge

Luxembourg's Hydrogen Strategy targets hard-to-decarbon sectors

Luxembourg's Hydrogen Strategy was presented in Septembe 2021, with a focus on sectors that are difficult to decarbonise through direct electrification, such as heavy industry. Luxembo has annual consumption of fossil hydrogen of about 450 tonn The immediate objective is to substitute fossil hydrogen with renewable hydrogen to cut GHG emissions by over 5 kt per ye

The Netherlands' Hydrogen Roadmap calls for higher hydro production targets

The Netherlands' strong hydrogen ambitions were initially back in 2019 in the National Climate Agreement and reinfo 2020 with its Hydrogen Strategy. They continue to receive sup legislation and funding. The Hydrogen Strategy focuses on s up hydrogen production by means of electrolysis and settin nationwide hydrogen transport infrastructure.

[2] Since the publication of the NHS, German gas transmission system operators have submitted a draft application for a "core hydrogen grid" to the national grid regulating authority. The draft foresees approximately 9 700 km of new and repurposed pipelines to be operational by 2032.

In the meantime, the current government allocated up to EUR 10 billion in funds for the support of hydrogen projects along the entire value chain, with more than half of the budget aimed at supporting electrolysis projects.

The Netherlands' **short- to medium-term targets** are as follows:

- 500 MW of electrolyser capacity in 2025 and at least **3-4 GW of electrolyser capacity in 2030**.
- Targets for the use of renewable hydrogen in industry that align with the European Union's Fit for 55 target.
- For mobility, 50 hydrogen refuelling stations in 2030, supplying renewable hydrogen (including use in refineries) in line with the European Union's Fit for 55 target.
- Home heating pilot schemes for approximately 1 000 homes by 2030.
- Development of a national hydrogen backbone of approximately 750-1 000 km of pipelines and approximately four salt caverns for hydrogen storage to be available by 2030.

In November 2022 the Dutch National Hydrogen Programme [3] published the Hydrogen Roadmap for the Netherlands, commissioned by the Ministry of Economic Affairs and C Policy. The roadmap suggests the **scaling up of prod targets**: 600 MW of electrolyser capacity by 2025 and 6-8 installed capacity by 2030, based on two conditions: (1) develo of the offshore wind roadmap as planned; and (2) exp government budgets to counter increasing costs. This would the production of around 80 PJ/yr of hydrogen by 2030 (equa approximately 44% of the Netherlands' current industrial hy consumption). The roadmap foresees **potential deman renewable and low-carbon hydrogen** rising to 40-80 PJ industrial sector and to 18-58 PJ in the transport sector by 2 also expects **hydrogen imports** to scale up post-2025 a development of a **hydrogen network** that provides access to s facilities and connects all the large industrial clusters to one a and the Netherlands to its neighbours in about 2027-203 regards **storage**, the roadmap foresees the development of th four salt caverns with a total volume of 750-1 000 GWh by 203

The **hydrogen market will be regulated** as of 2033 followi regulations established in the EU Hydrogen and Decarbonise Markets Package. This will include regulations on tariffs, thir access and the roles of private and public sector parties in tra storage and import infrastructure. Until then, the transp hydrogen has been declared a Service of General Economic I

[3] The Dutch National Hydrogen Programme is a public-private partnership for the joint realisation of ambitions and agreements in the field of hydrogen. It consists of representatives from the entire hydrogen sector, and relevant officials.

and a **Hydrogen Network Operator** (HyNetwork Services or HNS, state-owned and a subsidiary of Gasunie) has been appointed to operate it. A subsidy grant of EUR 750 million is to be provided to HyNetwork Services to cover its losses during the start-up phase.

The government also provided a policy framework for the import of hydrogen and hydrogen carriers in its letter to parliament, **Energy Diplomacy and Hydrogen Imports** (June 2023), stressing the importance of active energy diplomacy aimed at future security of supply of (renewable) hydrogen. The framework expresses a commitment to developing an integrated EU hydrogen market and the creation of a Northwest European onshore and offshore hydrogen backbone. Close co-operation with neighbouring countries will be crucial in this respect. The Netherlands is committed to developing bilateral strategic partnerships for the development of "**hydrogen corridors**" for trade within the European Union and for imports from beyond. The diversification of imports from a broad group of countries is important to reduce risks caused by strategic dependency.

To achieve this, the Dutch government:

- Has signed bilateral agreements on hydrogen and energy with strategic partners such as Australia, Canada, Chile, Denmark, Indonesia, Japan, Morocco, Namibia, Norway, Oman, Portugal, Saudi Arabia, Spain, Uruguay, the United Arab Emirates, the United States and South Africa.
- Is deploying the expertise and resources of state-owned entities (Invest International, Port of Rotterdam Authority, Gasunie) to develop hydrogen corridors and other nec infrastructure.
- Is working closely with Germany through participat H2Global (joint tender worth EUR 600 million to be lau by the end of 2024) and by working with Germany trila with future exporting countries to develop corridors to Northwest Europe.
- Is participating in the EU Hydrogen Bank.
- Is playing an active role in international organisations w aim of creating a transparent and stable intern hydrogen market, including through the Intern Partnership for Hydrogen & Fuel Cells in the Economy (the Clean Energy Ministerial Hydrogen Initiative (CEM the IEA Technology Collaboration Programme and the International Hydrogen Trade Forum.

The government is currently working on policies for **hyd safety**. These policies are intended to provide guidance for p and initiatives that fall outside the scope of current regul Several government bodies are working together to develo policies, both to identify the most pressing subjects and projec to discuss and specify the policies themselves.

Several sections from the Hazardous Substances Publication (or PGS from the Dutch acronym) are also important for hyd roll-out. The PGS guidelines contain requirements and criter can be used in environmental licensing, drafting general rule

supervising companies for occupational safety, environmental safety and fire safety.

Norway adopted its export-oriented Hydrogen Strategy

Norway adopted its Hydrogen Strategy in June 2020 and its Hydrogen Roadmap in June 2021. Both documents lay the necessary foundation for Norway to become a low-emissions society by 2050. Norway does not have a specific production target and has a technology-neutral approach.

The Hydrogen Roadmap sets several targets for hydrogen development in Norway:

- Collaborate with the private sector to develop five hydrogen hubs for maritime transport.
- Develop "one or two" industrial projects associated with hydrogen production plants.
- Establish five to ten pilot projects for the development and demonstration of new, more cost-effective hydrogen solutions and technologies.
- Create five to ten pilot projects for the development and demonstration of new, more cost-effective hydrogen solutions and technologies.

Switzerland is set to publish its Hydrogen Strategy in 2024

Switzerland's **National Hydrogen Strategy** is currently under development and is expected to be published in 2024. Hydrogen is expected to contribute to the decarbonisation of the energy sy which is why the Hydrogen Strategy is expected to focus on th production of hydrogen from CO_2-neutral production processe

The **Pipelines Ordinance** was revised as of 1 July 2023. This regulates supervisory responsibility and the division of compe between the federal government and the cantons and extends area of application of the Pipelines Act to hydrogen.

The United Kingdom sets out production vision and a new Energy Act lays the foundation of hydrogen regulation

In its Hydrogen Strategy, published in August 2021 United Kingdom set an ambition for 5 GW of low-carbon hyd production capacity by 2030. However, in April 2022, in the Energy Security Strategy, the production capacity ambitio doubled to up to 10 GW by 2030, with at least half of thi electrolytic hydrogen. The Hydrogen Investor Roadmap wa published in April 2022, following several public consultations design of funding schemes.

The United Kingdom's main ambitions for hydrogen develo are:

- 1 GW of electrolytic hydrogen capacity under construc operational **by 2025, with up to 2 GW of hyd production capacity overall** (including CCUS-e hydrogen) in operation or under construction by 2025.

- **CCUS** deployed in at least two industrial clusters by the mid-2020s, identified through the CCUS Cluster Sequencing Process, and two additional clusters by 2030.
- **Up to 10 GW of low-carbon hydrogen production capacity by 2030**, with at least half of this from electrolytic hydrogen. The Hydrogen Production Delivery Roadmap (published in December 2023) sets targets for 6 GW of electrolytic and 4 GW of CCUS-enabled hydrogen by 2030.

At the end of 2023 the United Kingdom announced the outcome of its first hydrogen allocation round, totalling 125 MW of electrolytic production capacity across 11 projects and backed by over GBP 2 billion in revenue support over 15-year contracts. It also opened a second hydrogen allocation round, with a target of up to 875 MW capacity.

The UK Low Carbon Hydrogen Standard sets out a methodology for calculating the GHG emissions from hydrogen production, and sets a threshold of 20 g CO_2-eq/MJ LHV and other compliance criteria for hydrogen to be considered "low-carbon". The United Kingdom is committed to setting up a certification scheme from 2025, to demonstrate compliance with the Low-Carbon Hydrogen Standard.

The Energy Act 2023 (EA 2023) received Royal Assent in October 2023. It creates a new comprehensive legislative regime for energy production, energy security and the regulation of the energy sector in the United Kingdom. The key provisions relating to hydrogen include:

- The introduction of **business models** given effect t revenue support contracts for the production, transpo storage of hydrogen. A more detailed overview business models and funding available to low-emi hydrogen is provided under the "Support mechanis subsidy schemes" section of this report.
- Powers providing robust and reliable **options for fu** these business models: levy funding and exchequer fu The Hydrogen Production Business Model will initia exchequer funded, with the intention to transition t funding in 2026, subject to consultation and legislation in place. No decision has yet been taken with regard the hydrogen transport and storage business models funded.
- The establishment of a **regulatory framework fo transport and storage**. The EA 2023 gives legal pow Ofgem as the economic regulator of CO_2 transpo storage.
- The foundation for the **establishment of the indepe system operator** ("national energy system operat NESO).

In addition, the Hydrogen Transport and Storage Networks Pa sets out the intention to launch the first allocation roun government support for hydrogen infrastructure, with the amb support up to two storage projects at scale and associated pip to be under construction or operational by 2030. The pathwa

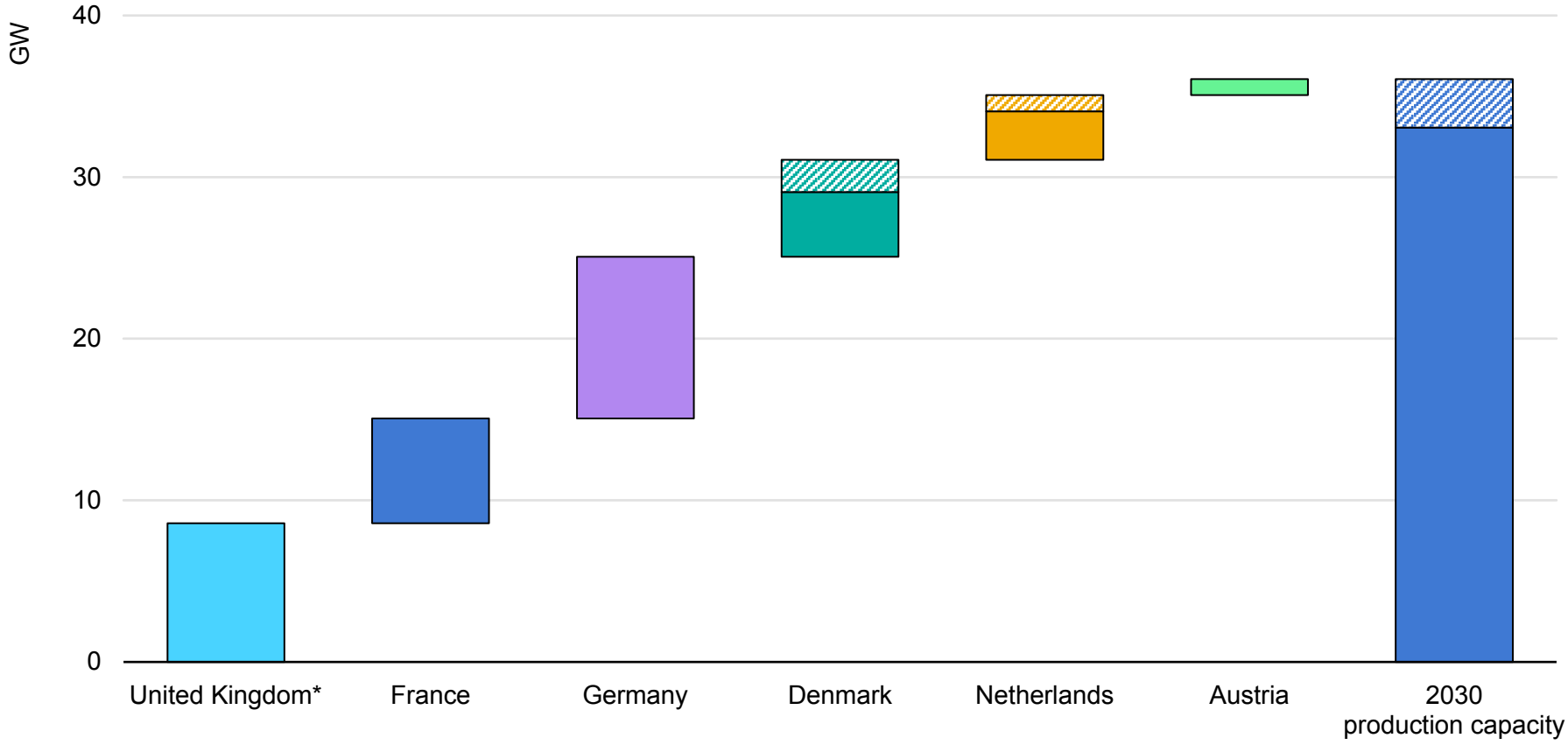
the ambition that the NESO takes on strategic planning activities for hydrogen transport and storage infrastructure from 2026.

In December 2023 the United Kingdom stated that it sees potential strategic and economic value in supporting the blending of up to 20% hydrogen by volume into the GB gas distribution networks in certain circumstances that align with the strategic role of blending. When deciding whether to enable blending in the GB gas distribution networks, the government will consider safety evidence from industry trials and tests, as well as any implications on the economic case.

In the absence of an overarching consenting framework for offshore hydrogen pipelines and storage, in September 2023 the UK government introduced secondary legislation to extend existing offshore oil and gas pipeline and storage regulatory frameworks to cover offshore hydrogen pipelines and storage.

Northwest Europe is targeting at least 30 GW of installed electrolysis capacity by 2030

Electrolysis capacity targets in Northwest Europe by 2030



IEA. CC

* The values for the United Kingdom have been estimated assuming 70% efficiency.
Note: The shaded areas represent targets under discussion and/or the higher range of announced targets.
Sources: IEA analysis based on various policy documents (hydrogen strategies, roadmaps and papers).

Subsidy schemes and support mechanisms

Subsidy schemes and support mechanisms play a crucial role in unlocking the full potenti low-emissions hydrogen in Northwest Europe

Support mechanisms and subsidy frameworks remain a key piece of the puzzle in developing markets for hydrogen. Early-stage state aid across various segments of the hydrogen value chain can help reduce risk, from R&D to the production stages, enabling projects to surmount uncertainty linked to the relatively nascent nature of the low-emissions hydrogen market. This section provides an overview of principal recent evolutions in subsidy and support mechanisms at both the EU and national levels in Northwest Europe.

European Union

Key among the EU funding programmes for hydrogen is the **European Hydrogen Bank**, announced in the September 2022 EU State of the Union speech and for which high-level details were communicated throughout 2023. In August 2023 the European Commission published the final terms and conditions surrounding the funding attribution mechanism and rules for participation, both central elements in stimulating European domestic production of hydrogen.

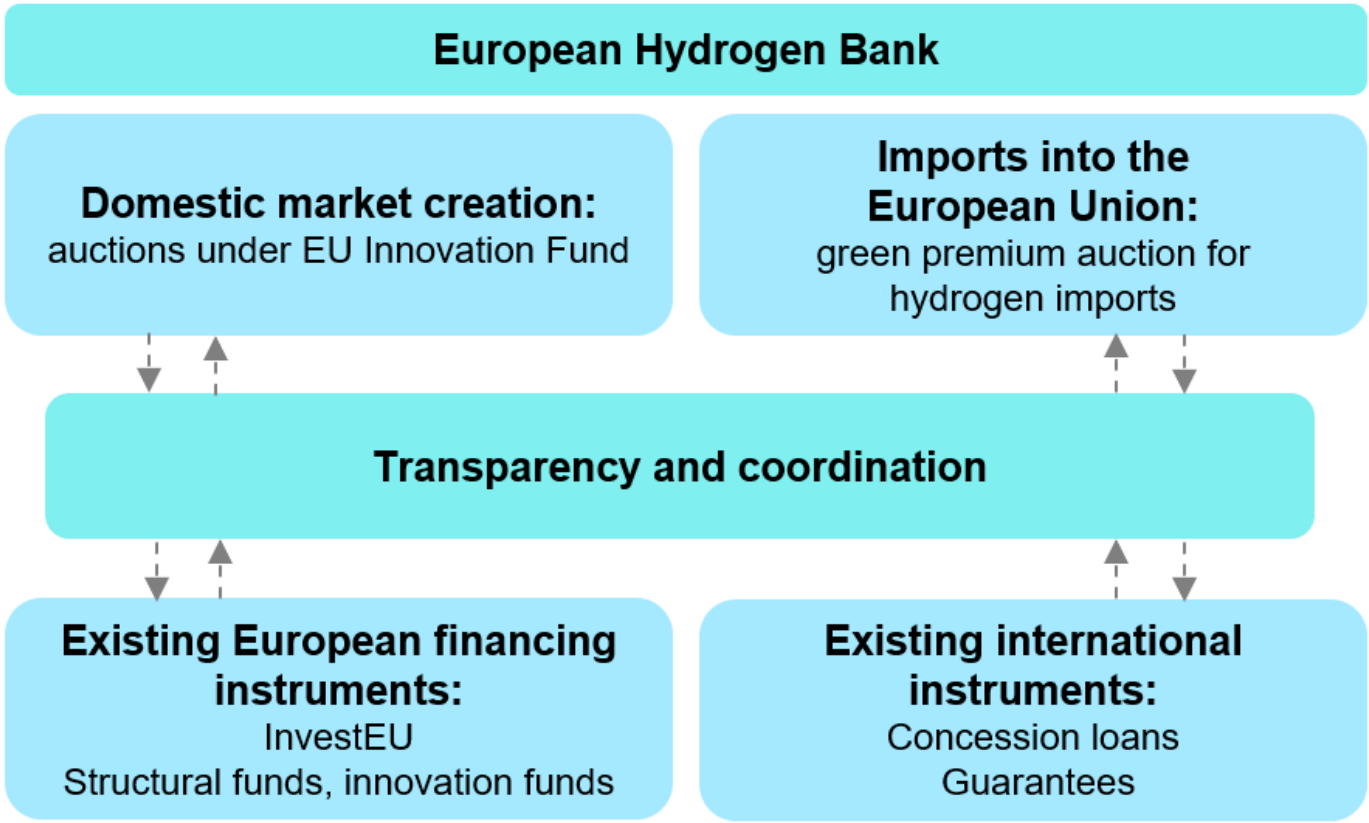
Hydrogen production subsidies, in the form of a fixed premium per kilogramme of low-emissions hydrogen produced, are set to be funded from the EU Innovation Fund, itself financed from EU Emissions Trading System (ETS) revenues. Funds will be attributed through an auction system — a system successfully tested in renewable power capacity deployment — allowing participants to submit bids for the lowest fixed premium they would be re accept in order to reduce the gap between their production cos those of fossil-based hydrogen. Cost discovery through the a system is expected to be a key benefit of the mechanism, pr transparency in the early steps of a budding hydrogen mark first auction round, totalling EUR 800 million, was launch 23 November 2023 and was finalised in early February attracting 132 project bids and accounting for 85 GW of elect capacity.

Some of the rules on funding attribution and participation mechanism leave more leeway to project promoters than pre expected. Notably, the maximum available premium a participa bid for is set at EUR 4.5/kg (up from a previously sug EUR 4/kg) and the maximum delay allowed from the time of av project commissioning increased to 5 years from 3.5.

The terms and conditions also allow a degree of flexibility reg project promoters' electricity sourcing strategies, re "demonstration that [a] project has a credible plan… towards se renewable electricity" through reporting requirements cove least 60% of total electricity requirements. Importantly, the pu terms and conditions also outline the rules for the cumula auction support with other public support mechanisms.

The European Hydrogen Bank aims to unlock private investment in renewable hydrogen

European Hydrogen Bank: Proposed activities



Sources: IEA analysis based European Commission (2022), Communication from the European Commission to the European Parliament, the Council, the European Economic Social Committee and the Committee of the Regions on the Hydrogen Bank.

The **Important Projects of Common European Interest** (IPCEI) scheme at the European Union level is also a key vehicle to channel EU member state funding to the development of the hydrogen value chain. Since 2022, three individual IPCEIs pertaining to hydrogen have been approved:

- **Hy2Tech** (July 2022), covering a wide part of the hydrogen technology value chain, from generation to end-user applications, with 15 member states providing up to EUR 5.4 billion of public funding.
- **Hy2Use** (September 2022), focusing on hydrogen production (electrolysers) and transport infrastructure, as well as on the integration of hydrogen into industrial processes, with 13 member states providing up to EUR 5.2 billion of public funding.
- **Hy2Infra** (February 2024), targeting the deployment of (1) large-scale electrolysers, (2) new and repurposed hydrogen transmission and distribution pipelines, (3) large-scale hydrogen storage facilities, and (4) port infrastructure for liquid organic hydrogen carriers. In total, seven member states are set to provide up to EUR 6.9 billion of public funding.

Austria

Austria has continued its progress in implementing hydrogen support mechanisms, building on existing subsidy programmes spanning the industrial and transport sectors on the demand side, as v programmes aimed at supporting renewable hydrogen proc (see 2022 Northwest European Hydrogen Monitor).

The publication of the National Hydrogen Strategy in June 202 an important step in setting targets and guiding principles to the direction of domestic hydrogen developments, providing on which to implement further subsidy programmes.

As part of the Climate and Energy Fund (*Klima- und Energie* the Energy Research Programme 2023 included hy technologies as a sub-topic, directing up to EUR 10 million specific electrolysis and fuel cell concepts.

Additionally, Austria announced in February 2024 that it dedicate a further EUR 400 million, potentially through the Eu Hydrogen Bank's second auction round in 2024, to s renewable hydrogen projects.

Previously announced or existing programmes include:

- The Hydrogen Production Support Act (WFöG) forese participation of Austria in the European Hydrogen through the "auction as a service" mechanism. A EUR 400 million is to be made available to fund ren hydrogen production projects through this mechanism, fixed premium per produced unit of renewable hydroge

a timespan of ten years. The act is currently under public consultation.

- The **Renewable Expansion Act (EAG)** earmarked EUR 40 million per year through to 2030 to support investment costs relating to electrolysis projects of 1 MW or higher, and exempts them from certain grid-related fees.
- The **Transformation of Industry** funding programme makes EUR 2.975 billion available through to 2030 for the decarbonisation of energy-intensive and hard-to-abate industries, a portion of which is targeted at hydrogen applications, notably in industrial segments such as iron and steel, chemicals and cement. A first call was launched in 2023, with a budget of EUR 175 million.
- The **Domestic Environmental Support (UFI)** programme funds climate protection measures taken by companies, municipalities and associations with a focus on the use of renewable heat, waste heat utilisation, energy efficiency measures and resource efficiency, as well as pilot and demonstration facilities in production processes, providing EUR 150 million per year until 2026.
- The **Transformation of Economy** funding programme totals EUR 100 million until 2026 under the Recovery and Resilience Facility framework.
- ***Vorzeigeregion Energie*** (Model Energy Region) targets analysis, realisation, development and demonstration along the entire hydrogen value chain with EUR 40 mil funding.
- **The Emission-free Buses & Infrastructure (EBIN Emission-free Commercial Vehicles & Infrastr (ENIN**) programmes are transport-oriented, design promote zero-emission vehicle fleets, whereby hyd powered solutions are eligible for funding among othe emission solutions. A total of EUR 256 million is av under EBIN between 2022 and 2026 and a to EUR 365 million under ENIN.
- The **Zero Emission Mobility** programme supports inn research and development projects with EUR 8 million to make emission-free mobility more accessible to the g public.
- **COMET Centre** on "Hydrogen Research Centre Austri providing nearly €10 million over the 2023-26 period to in hydrogen.

Belgium

In 2023 Belgium held two important tenders providing fi support to R&D and development-phase projects in the hy space, spanning both the supply side and demand side.

The **Clean Hydrogen for Industry** project call awarded a EUR 30 million to six projects in its first tender in 2022, and a award a further EUR 19 million in its 2023 call, which was ope October 2023 to the end of January 2024. The call aims to p

various project phases (R&D, demonstration) and, by doing so, help shape the federal Hydrogen Strategy.

A more general call, **Clean Hydrogen for Belgium**, held its second tender simultaneously, aiming to award EUR 10 million to hydrogen projects, with no more than EUR 8 million going to any single project and with requested support representing no more than 70% of any project's budget. Both calls are financed under the **federal Recovery and Transition Plan**.

In addition to these financing initiatives, a EUR 250 million budget has been earmarked to award a subsidy to the hydrogen network operator (HNO) in the context of work being undertaken on the first phase of a hydrogen network. This amount, which supplements the initial EUR 95 million set aside to kickstart construction, will help facilitate HNO investment in expanding the grid and ensuring interconnections with neighbouring markets.

Further support mechanisms include a EUR 6 million subsidy for the **development of green steel**, as well as ongoing negotiations for the **easing of the tax burden** on green investments, also applicable to hydrogen technologies.

Denmark

Following Denmark's Climate Act of 2020, further emphasis has been given to hydrogen through specific funding programmes. In 2022 the Danish government agreed to earmark DKR 1.25 billion (EUR 167 million) to support the production of green hydro feed into derivative fuels (Power-to-X [PtX]) for use in hard-to sectors. In 2023 the government concluded its first PtX selecting six winning projects for a total electrolysis capa 280 MW. The financial support is set to be paid as a fixe premium over a ten-year period.

Further funds have been earmarked or allocated to hy projects, including DKK 850 million (~EUR 110 million) in fun Danish IPCEI participation, DKK 500 million (~EUR 67 milli innovative green technologies via funds from the REACT-EU ir and the Just Transition Fund, and DKK 400 million (~EUR 53 from the Energy Technology Development and Demons Programme (EUDP) for the development of PtX solutions.

France

France announced a significant financing package for hydrogen p in its September 2020 Hydrogen Strategy, earmarking EUR 7.2 through to 2030, up from an initial EUR 100 million sum announc 2018 hydrogen deployment plan for the year 2019. Couple additional financing commitments made in 2021, total ann funding reached approximately EUR 9 billion.

In May 2023 an additional EUR 175 million of financing from the " 2030" investment plan was announced, targeting the developr hydrogen ecosystems that combine different segments of the hy value chain, from production to distribution and end use.

In September 2023 the French government announced details of the allocation of the first tranche of funding from these commitments, totalling EUR 4 billion to support 1 GW of electrolyser capacity. The money is set to be allocated through three rounds of auctions scheduled for 2024, 2025 and 2026, with the first-round envelope of EUR 700 million in 2024 targeting a total capacity of 150 MW. The two subsequent annual rounds would aim to select projects totalling 250 MW and 600 MW, respectively.

The tenders will be open to both renewable and low-carbon hydrogen projects, although eligibility conditions disqualify projects relying on carbon capture from receiving aid. Furthermore, rules would set limits on the end-use segments benefiting from this production and would limit the export of subsidised hydrogen volumes.

Germany

In Germany around 45 funding measures and schemes are at least partially dedicated to hydrogen and its derivatives, with over 25 measures directly aimed at hydrogen projects. Total announced funding dedicated solely to hydrogen and its derivatives amounts to over EUR 10 billion.

The **H2 Global** scheme, a private initiative that receives government funds, is the largest such programme with EUR 4.4 billion earmarked over the 2022-2036 period to facilitate the ramp-up of hydrogen demand in Germany. Through the programme, renewable hydrogen is set to be purchased abroad and resold domestically through an auction system, with the price premium compensated by government grants over a maximum period of ten years. Ove the losses are expected to be reduced, as the willingness to sustainable energy sources increases. The investment and pl security provided by H2Global enables companies on the supp to set up production facilities on an industrial scale. On the use companies will be able to purchase renewable energy sou economic prices for the first time and thus drive forwar decarbonisation. H2Global thus enables production establishment of international supply chains and the applica renewable hydrogen and its derivatives ahead of time – bef market emerges – and gives the economy the associated com advantage.

The hydrogen core network is not directly subsidised, but th provides subsidiary financial protection against unforeseeable in the development and use of the network by a so **“amortisation account”**. The core network is to be financed fees. In the initial years of operation of the core grid, a diff between the high investment costs and the scarce income fr fees is to be expected, given the small number of initial user difference is to be financed temporarily from the amor account.

The **Carbon Contracts for Difference** (CCfD) programme is run over the 2024-2045 period with a total budget in the mid- digit billion euro range. It aims to support industrial companies

ammonia, cement and lime) by compensating for the cost premium of transitioning to low-carbon and carbon-free processes. Through cost compensation, the programme aims to drive early demand for both electrolytic hydrogen produced with renewable electricity and hydrogen produced through steam methane reforming with carbon capture and storage. A first funding round of EUR 4 billion was allowed under EU state aid rules as of February 2024.

The **German Power Plant Strategy** includes tenders for up to four 2.5 GW hydrogen-ready gas-fired power plants, allowing the use of both electrolytic and fossil-based hydrogen, as well as in-situ CCS. The plants are eligible for public funding from the Climate and Transformation fund, up to a total of approximately EUR 15-20 billion.

In December 2023 Germany announced that it would allocate EUR 350 million to the domestic arm of the European Hydrogen Bank pilot auction through its “auctions as a service” scheme.

Germany has made a total of EUR 1.5 billion available for **overall support of renewable fuels** through the production and market ramp-up stages. The concept provides for four funding measures: (1) funding guidelines for measures to develop renewable fuels; (2) promotion of a development platform for power-to-liquids for air and water transport; (3) funding guidelines for investments in plants for the production of renewable fuels; and (4) funding guidelines for the market ramp-up of power-to-liquids kerosene production.

The **Decarbonisation in Industry Funding Programme** su
energy-intensive industry, from the R&D phase to the large
application of emissions-reducing processes. The programm
from 2021 to 2024 with a budget of approximately EUR 3 billi

Living Laboratories of the Energy Transition (a funding
within the 7th Energy Research Programme) intends to clo
technological development gap for innovations between appli
oriented research and broad implementation.

Funding through the **Hydrogen Innovation and Technology
(ITZ)** is intended to create joint development environme
nascent hydrogen-focused projects and companies, reduci
need for investment by individual players and facilitating co-op
in product development. ITZ funding runs from 2021 to 2024
budget of up to EUR 290 million.

Further subsidies exist that support co-operation in the f
hydrogen with third countries. These include HySupply, a G
Australian feasibility study on hydrogen from renewable ener
a budget of EUR 1.7 million, the implementation of the G
Moroccan Hydrogen Alliance with a budget of up to EUR 88.5
in grant funding, and the promotion of green hydrogen in
(EUR 34 million) and South Africa (EUR 40 million) betwee
and 2023.

In addition, the Federal Ministry of Economic Affairs and C
Action (BMWK) finances programmes such as the **PtX-Hub** a

H2Uppp (International Hydrogen Ramp-up Programme), which support investment in hydrogen and its derivatives primarily in developing and emerging countries.

Luxembourg

The Luxembourg government is developing a subsidy scheme for the production of renewable hydrogen. A final concept paper was published in 2023. With a view to launching an initial tender for both CAPEX and OPEX aid, the Ministry of the Economy held a public consultation between December 2023 and 29 February 2024. Luxembourg is also in contact with H2Global and is awaiting further details on the European Hydrogen Bank domestic and international Global European Hydrogen Facility (REPowerEU). Luxembourg is working on implementing the General Block Exemption Regulation, which will also entail possible subsidies along the hydrogen value chain, including infrastructure.

Netherlands

Approximately EUR 60 million was awarded to hydrogen projects through subsidy schemes in 2020 and 2021 in the Netherlands. Building on these allocations, 2022 and 2023 marked two equally important years with the development of specific instruments to mobilise previously earmarked funding, supplementing existing funding mechanisms. In total for the period to 2030, over EUR 10 billion in hydrogen subsidies is expected to be allocated using specific instruments, with further subsidies potentially av from more general funding programmes.

Programmes range from R&D to the promotion of hydro different end-use sectors, and include:

- The **OWE scheme** (Ramping up Hydrogen Proc Through Electrolysis) supports electrolysis projects ran subsidy intensity per MW of installed ca EUR 250 million was allocated in 2023 and up to EUR 1 is allocated for 2024, with around EUR 3.9 billi available for future tenders.
- Along with Germany, the Netherlands has p EUR 300 million through the **H2 Global** scheme Germany above) towards a joint tender for the im renewable hydrogen starting in 2027.
- The **MOOI scheme** (Mission-Driven Research, Develo and Innovation) supports industrial research and experi development. It is targeted at integrated solution contribute to climate goals.
- The **DKTI scheme** (Demonstration of Climate Techno and Innovations in Transport) supports projects that fo mobility and transport. A total of EUR 64.8 million was on hydrogen between 2017 and 2021.

- The **DEI+ scheme** (Demonstration of Energy and Climate Innovation) supports practical experiments, pilots and demonstrations. In June 2022 there was a specific call for hydrogen and low-carbon chemistry via DEI+, with a budget of EUR 30 million.
- The **TSE Scheme** (Top Sector Energy Scheme) supports projects at the feasibility study stage relating to innovative pilot or demonstration projects. The TSE Scheme was established specifically for R&D and supports projects that can reduce CO_2 emissions from industry cost-effectively by 2030.
- The **SDE++ scheme** (Sustainable Energy Transition Subsidy) supports the deployment of renewable energy generation technologies and other CO_2-reducing techniques.
- The **HER+ scheme** (Renewable Energy Transition) is intended to achieve cost reductions for technology categories that are supported under the SDE++ scheme. These projects lead to CO_2 reduction by 2030 and save on future subsidy expenditure in accordance with the SDE++ scheme.
- The **MIT scheme** (Innovation Stimulation Region and Top Sectors) is available for small and medium-sized enterprises.
- ***GroenvermogenNL*** (Green PowerNL) is a programme that focuses on accelerating the scaling up of hydrogen and low-carbon chemistry, with a maximum budget of EUR 838 million between 2021 and 2028. It focuses on R&D, demonstration projects and human capital develo including training. The aforementioned EUR 30 millio scheme is part of this programme.

Norway

Over recent years, Norway has provided public funding for hy projects through various public bodies and schemes, in Enova, Innovation Norway, *Forskningsrådet* (Research Cou Norway), PILOT-E, and *Grønn Plattform*. Funding announce totalled NOK 1.757 billion (~EUR 153 million) in NOK 2.315 billion (~EUR 201 million) in 2022, and NOK 861 (~EUR 75 million) in 2023.

Switzerland

The Swiss government plans to publish a National Hydrogen S in 2024 and, as such, does not currently have specific hy targets in place. Furthermore, there are as yet no direct s schemes in place to support the production and development carbon hydrogen. Nevertheless, public funding opportunities application-oriented R&D for hydrogen and fuel cell techn through the Swiss Federal Office of Energy.

In Switzerland, certain standards and tax exemptions provide i support for hydrogen in certain end-use sectors, notably tra For example, fuel cell trucks are exempt from both the heavy

tax and the mineral oil tax, while emissions standards for passenger and light-duty vehicles provide support for fuel cell electric vehicles.

Looking ahead, revisions of various laws are underway, which could include further support mechanisms for hydrogen production in the future. Entry into force of these laws is planned for 2025.

United Kingdom

In October 2023 the Energy Act, the largest piece of energy legislation in the country's history, received Royal Assent, setting out policy and governance foundations for the future UK energy system, including hydrogen. Among the key measures, the act provides a framework for various business models to support hydrogen production (see the Hydrogen Production Business Model below), hydrogen transport and hydrogen storage.

Although funding details are set to come from future complementary legislation, the Energy Act confirms the statutory footing for revenue support contracts in developing a hydrogen market.

A regulated asset base will form the basis of the hydrogen transport business model. An external subsidy mechanism will be created alongside a regulated asset base to ensure that charges to users of the pipelines and/or networks are not prohibitive, while allowing hydrogen transport providers to make a reasonable return on their investment.

The hydrogen storage business model is set to be centred pr
around support for geological storage, putting in place a mi
revenue floor so as to mitigate both price and volume ri
revenues from activity increase, the subsidy is set to decreas
ensuring an incentive to maximise facility usage. Howev
support mechanism is not set to erase all risks, such as develo
technology or decommissioning risks. Over time, as wi
hydrogen transport business model, the objective is for subsi
give way to a self-sustaining industry segment.

The **Hydrogen Production Business Model** (HPBM) has
established to provide revenue support for producers to ove
the operating cost gap between low-emissions hydroge
alternative high-carbon fuels. Following the first joint Ne
Hydrogen Fund/HBPM electrolytic hydrogen allocation round (
in 2022, the UK government announced the successful project
offered contracts in December 2023, totalling 125 MW and
by over GBP 2 billion in revenue support. HAR 2 was launched
2023 with a capacity target of up to 875 MW and is set to cl
applications around mid-April 2024.

In addition, the **Net Zero Hydrogen Fund** (NZHF) is set to p
GBP 240 million of funding to support the development of ne
carbon hydrogen production plants through the 2020s, w
toward the 10 GW low-carbon hydrogen target by 2030.

The NZHF has four strands: (1) support for front-end engineeri
design (FEED) studies and post-FEED costs; (2) CAPEX for p

that do not require hydrogen business model support; (3) CAPEX for non-CCUS-enabled projects that require hydrogen business model support; and (4) CAPEX for CCUS-enabled projects that require hydrogen business model support.

The first 15 winning projects from round 1 of strands 1 and 2 were selected in 2023, for total support of GBP 37.9 million. Seven successful applicants from the NZHF strands 1 and 2 round 2 competition were announced in March 2024, which were allocated GBP 21 million.

Multiple smaller-scale financing schemes and competitions have been set up to provide direct funding to low-carbon solutions, including to hydrogen-oriented projects. These funding streams target various end uses, notably transport and industry. The table below provides a summary of the government funding available for low-emissions hydrogen in the United Kingdom.

Summary of UK government funding for hydrogen since the publication of the Hydrogen Strategy

Fund or competition	CAPEX	DEVEX	OPEX	Available or allocated funding	Status
Production					
Net Zero Hydrogen Fund (NZHF)	X	X		GBP 240 million total funding delivered across 4 NZHF strands. GBP 58.9 million allocated across rounds 1 and 2 of NZHF strands 1 and 2.	Ongoing, running to Marc 2025.
Hydrogen Allocation Rounds: NZHF/Hydrogen Production Business Model (HPBM)			X	Funding available across lifetime of contracts dependent on negotiations with individual projects. Over GBP 2 billion revenue support from HPBM and over GBP 90 million for construction from NZHF.	Successful HAR1 project announced. See Hydrogen Economy Roadmap for timelines of future HARs and cluster sequencing process.
Net Zero Innovation Portfolio (NZIP) Low-Carbon Hydrogen Supply 2 competition	X	X		GBP 62 million allocated.	Ongoing, running to Marc 2025.
NZIP Direct Air Capture and Greenhouse Gas removal programme	X	X		GBP 10 million; hydrogen spend only.	Ongoing, running to Marc 2025.
NZIP Hydrogen BECCS Innovation Programme	X	X		GBP 31 million allocated.	Ongoing, running to Marc 2025.

Fund or competition	CAPEX	DEVEX	OPEX	Available or allocated funding	Status
Networks and storage					
NZIP Longer Duration Energy Storage competition	X	X		GBP 9 million; hydrogen spend only.	Ongoing, running to Marc 2025.
Hydrogen Transport Business Model	X	TBD	X	TBD	Intention for first allocatio round to open end of 202
Hydrogen Storage Business Model	X	X	X	TBD	Intention for first allocatio round to open end of 202
Use of hydrogen					
Industrial Energy Transformation Fund	X	X		GBP 289 million available across all technologies, plus a further GBP 185 million.	Ongoing, Phase 3 runnin 2028 subject to business case approval.
NZIP Red Diesel Replacement Competition		X		GBP 26 million for 6 projects, 5 of which are hydrogen-focused.	Ongoing, running to Marc 2025.
NZIP Industrial Hydrogen Accelerator	X	X		GBP 13 million allocated.	Ongoing, running to Marc 2025.
NZIP Industrial Fuel Switching 2 Competition	X	X		GBP 23 million; hydrogen spend only.	Ongoing, running to Marc 2025.
NZIP Green Distilleries Competition	X	X		GBP 6 million; hydrogen spend only.	Ongoing, running to September 2024.

Fund or competition	CAPEX	DEVEX	OPEX	Available or allocated funding	Status
Local Industrial Decarbonisation Plans Competition		X		GBP 5 million available.	Ongoing, completing in December 2024.
Clean Maritime Demonstration Competition rounds 1-4		X		Rounds 1-4: GBP 128 million allocated.	Rounds 1 and 2 complete rounds 3 and 4 running to March 2025.
Zero Emission HGV and Infrastructure Demonstrators	X	X		GBP 200 million available.	Ongoing, running to 2030
Advanced Fuels Fund		X		GBP 135 million allocated.	Ongoing, running to Marc 2025.
APC's Collaborative R&D Competition – round 22		X		GBP 77.1 million joint government and industry funding allocated.	Ongoing, running to late 2026.
Zero Emission Vessels and Infrastructure Competition	X	X		GBP 80 million available.	Ongoing, running to Marc 2028.
Tees Valley Hydrogen Transport Hub Fund		X		Phase 1: GBP 2.6 million allocated. Phase 2: GBP 13 million allocated.	Ongoing, running to Marc 2025.
Zero Emission Flight Infrastructure Project	X			GBP 4.2 million allocated.	Completed March 2023.

Notes: CAPEX = capital expenditure; DEVEX = development expenditure; OPEX = operating expenditure.
Source: UK Department for Energy Security and Net Zero (2023), Hydrogen Strategy Delivery Update

Hydrogen demand

The European Union and Northwest European countries have set out demand targets for emissions hydrogen

The willingness of end users to opt for low-emissions hydrogen will be key in the development of this market. The uptake of low-emissions hydrogen will be a gradual process and necessitate the support of governments to incentivise demand creation at the early stages of market development.

Recent hydrogen demand trends in the European Union and Northwest Europe

The European Union's current hydrogen consumption totals approximately 7.5 Mt (250 TWh) per year, almost all of which is fossil-based and whose use is concentrated in refining and in the production of ammonia, methanol and other chemicals. According to data from the European Hydrogen Observatory, Northwest European hydrogen demand currently stands at around 4.5 Mt (150 TWh) per year, making up about 55% of total European demand and nearly 5% of total global demand for hydrogen. In line with the overall European trend, virtually all Northwest European consumption is concentrated in the refining and chemicals subsectors. Within chemicals, ammonia production is by far the largest application, followed by methanol.

Germany and the Netherlands together account for approximately 60% of Northwest European hydrogen demand. The United Kingdom, France and Belgium make up a further third of the Northwest European market.

The European Union has set out hydrogen use targets in in and the transport sector

By 2030 the European Union is aiming for a market total o (660 TWh) of renewable hydrogen, half of which wou domestically produced and half imported.

In 2023 EU policy continued to highlight the key role for hydro decarbonising the bloc's energy consumption over the decades. The revised Renewable Energy Directive (RED III) e into force in November 2023, setting out requirements for the of hydrogen use across certain sectors, notably in indust transport. As in prior EU discussions, these are the two sectors low-emissions hydrogen is seen as playing an immediat significant role. EU member states have agreed that renewabl of non-biological origin (RFNBOs) should account for at least hydrogen use (for final energy and non-energy uses) in indu 2030. By 2035 the share of renewable hydrogen rises to 6 transport, RED III establishes that 1% of all fuel supplied to the by 2025 must either fall under the advanced biofuel or classification, or comply with RFNBO rules. This share rises t by 2030, with a minimum contribution of 1% from RFNBOs.

However, particularities and exemptions feature in reaching targets. In industry, an exemption to the RFNBO rule is pos

(1) a member state is on track to meet its renewable energy targets, and (2) 23% or less of its hydrogen consumption comes from fossil fuels by 2030, and 20% or less by 2035. Meeting these two requirements effectively allows for a share of non-renewable hydrogen – including nuclear-derived hydrogen, for example – to count in meeting the RFNBO targets. In transport, EU rules allow for every unit of RFNBO consumed to account for more than one unit toward the RFNBO target, a measure put in place to partly compensate for the high relative cost of these fuels. RED III establishes an additional multiplier effect for the shipping and aviation sectors, set to steer more RFNBO use in these particularly cost-sensitive segments. In practice, this will lead to a reduction in the actual amount of renewable hydrogen required to attain the objectives set out in the directive.[4] The ReFuelEU Aviation initiative, also adopted in late 2023, extends renewable hydrogen objectives to air transport specifically. Concretely, the directive requires 1.2% of all aviation fuel to be of green hydrogen-derived synthetic origin by 2030. This share would then progressively rise to 35% by 2050.

Industry could drive more than 7 Mt of low-emissions hydrogen demand by 2030 across all of Europe

Industry is expected to continue to account for the vast majority of low-emissions hydrogen consumption in the short to medium term. According to the Clean Hydrogen Monitor, in 2030 industrial low-emissions hydrogen demand across Europe could reach be 7.1 Mt and 7.4 Mt (230 TWh to 245 TWh) based on the annc project pipeline. By then, ammonia and steel production are ex to be the two largest consuming subsectors of low-em hydrogen, compared to refining activities making up the larges of current – largely fossil-based – hydrogen consumption region. Based on this project pipeline, Northwest European d could reach around 3.5 Mt (115 TWh) per year by 2030, mak just about half of total European industrial demand for low-em hydrogen. This would account for virtually all European hy demand in the steel sector, just over half of ammonia-driven de and about a quarter of refining sector demand.

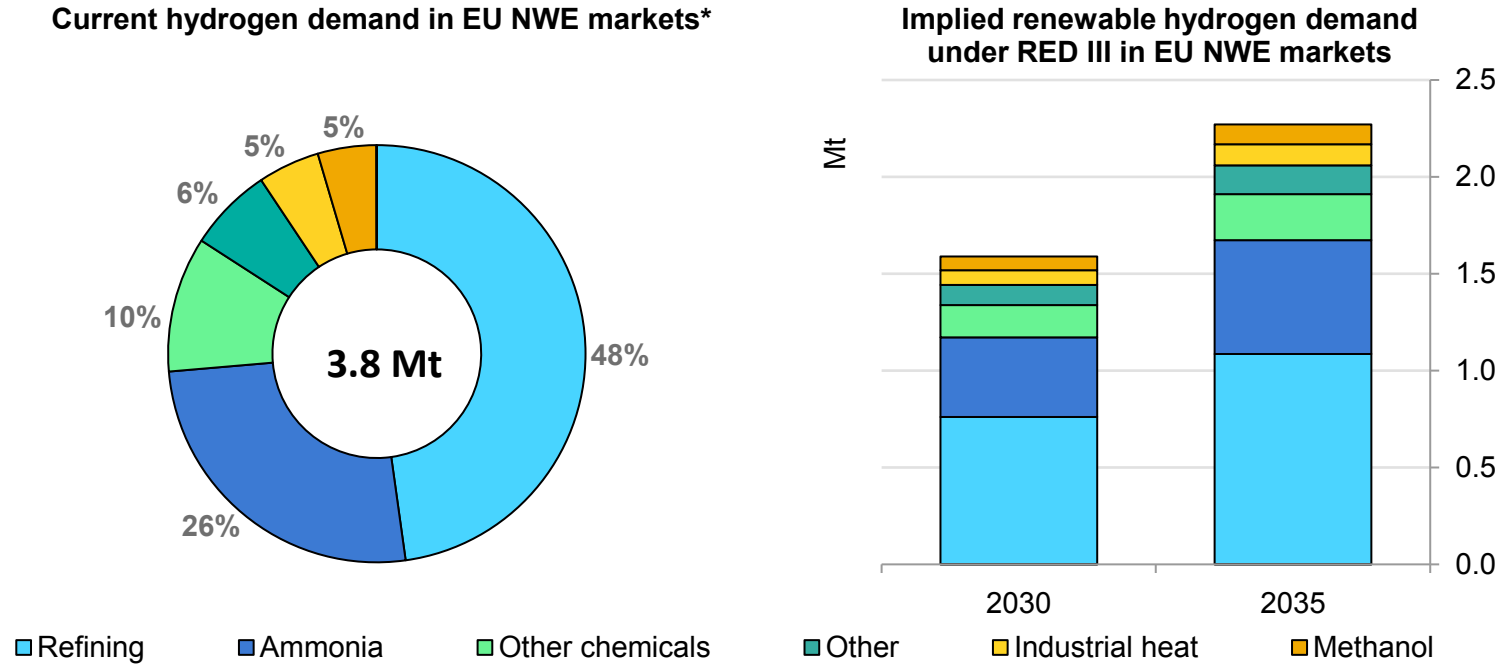
Northwest European countries are setting hydrogen use tar

Several – though not all – Northwest European countries ha demand targets or put forward potential ranges for low-em hydrogen in their strategies, roadmaps and policy papers. Ba these announcements, Northwest Europe's low-emissions hy consumption could reach above 6 Mt (200 TWh) per year by with demand concentrated mostly in industry. These countr aiming, in the first stage, to replace current consumption of hy from fossil fuels with low-emissions hydrogen. The following s provides an overview of current hydrogen consumption a prospects for low-emissions hydrogen demand in Northwest E

[4] See the amendment to Article 27 in Directive (EU) 2023/2413.

Industry is set to drive initial demand creation for low-emissions hydrogen

RED III implications for current hydrogen consumption in industry



* “EU NWE markets” comprise the EU markets covered in this report: Austria, Belgium, Denmark, France, Germany and the Netherlands.

Notes: The RED III directive states that 42% of industrial hydrogen use must comply with RFNBO rules by 2030, and 60% by 2035. If applied to current hydrogen consump in EU NWE markets, this would imply approximately 1.6 Mt and 2.3 Mt of renewable hydrogen consumption in 2030 and 2035, respectively.

Source: IEA analysis based on European Hydrogen Observatory (2024), Datasets.

Austria

Hydrogen consumption in Austria is approximately 120 kt/year, largely natural gas-based and concentrated in ammonia production and refining. By 2030 Austria aims to progressively replace 80% of current fossil-based hydrogen consumption with climate-neutral hydrogen. Among the driving measures in this respect is the Transformation of Industry programme, supporting hydrogen demand in difficult-to-decarbonise industrial sectors, where a majority of the country's current hydrogen demand resides.

Further demand stimulation comes through programmes supporting zero-emissions mobility (including hydrogen solutions) in buses, trucks and aviation.

Belgium

One of the four pillars around which the Belgian Federal Hydrogen Strategy is centred is the positioning of the country as a European import and transit hub for hydrogen. By 2030 domestic demand for renewable hydrogen is estimated to reach between 2 TWh and 6 TWh. This compares to current total annual hydrogen consumption of around 12.5 TWh (0.4 Mt).

The federal strategy identifies a key role for hydrogen and hydrogen derivatives in various applications, including in industry, transport and buildings, as well as in providing flexibility for the grid.

Denmark

The Danish Hydrogen Strategy is centred on developing solutions to decarbonise hard-to-abate sectors, tying into country's electrification strategy. The country's ambitions are only to reduce its domestic emissions through th developments, but also to contribute to decarbonisation beyon borders. As such, Denmark is positioning itself as a gr hydrogen exporter to neighbouring markets, including Germa Sweden, the Netherlands and Belgium.

Despite an export-driven strategy, Denmark considers hydrogen also has emissions reduction potential domestic Although hydrogen demand is likely to remain relatively lim before 2030, total potential CO_2 emissions reductions could ra from 1.3 Mt CO_2 to 5.1 Mt CO_2 annually by then, with the larg potential being in heavy transport such as shipping and aviati

France

French hydrogen consumption is estimated at around 0.9 (30 TWh) per year in recent years, although it is likely to h fallen in 2022 as overall industrial energy demand fell year- year. In contrast to certain neighbouring EU member states, French Hydrogen Strategy prioritises domestic hydro production to fulfil domestic demand needs. The strategy focu foremost on decarbonising existing hydrogen uses, particular

refining and ammonia production, giving other applications such as transport secondary priority.

Under existing plans, including the Plan France 2030 and the National Low-Carbon Strategy (SNBC), France could aim for domestic electrolytic hydrogen production of around 23 TWh (0.7 Mt) by 2030, growing to around 40 TWh (1.2 Mt) by 2050. Of the 2050 total, 20 TWh (0.6 Mt) would go to industry, 15 TWh (0.5 Mt) to the power sector and the rest to other sectors.

Germany

Germany is the largest hydrogen market in Europe, currently consuming around 57 TWh/year. As per the July 2023 update to the German National Hydrogen Strategy, consumption is expected to reach 95-130 TWh by 2030, growing to 290-440 TWh by 2050.

Industry remains the priority sector for hydrogen use, particularly in those subsectors most difficult to decarbonise through alternative options (e.g. electrification). In this sector, Germany has put forward Carbon Contracts for Difference (CCfD), a financial mechanism aiming to compensate companies for the additional costs associated with switching industrial processes to lower-emission methods and fuels.

The transposition of EU measures has partly driven German policy support for hydrogen demand, particularly in the transport sector.

Further domestic initiatives have also added to the support for sector, notably through a March 2023 funding call for pub accessible hydrogen refuelling stations for heavy-duty vehicle

In February, Germany laid out the essential elements of a Power Plant Strategy. The strategy foresees tenders for u 10 GW of hydrogen-ready gas-fired power plants, in which types of hydrogen would be allowed. The first tender rounds expected in Q4 2024 and are aimed at projects that contribut decarbonising the electricity system. The tenders are to supported with public funding of approximately EUR 15-20 bil The strategy foresees a shift from natural gas to hydrogen us 2035-2040, the exact date to be determined in 2032.

Developing hydrogen and hydrogen-ready infrastructure is als central element in Germany's approach. In a first instance, applies to gas importing infrastructure through the L Acceleration Act, by requiring hydrogen readiness to ensure operation of assets beyond 2044.

Finally, the National Hydrogen Strategy Update sideli hydrogen use in heating, restricting it to limited applicatio judging that sufficient viable alternatives can be deployed decarbonise the sector.

Luxembourg

Luxembourg's industrial hydrogen consumption is around 19 GWh/year (or 0.6 kt H_2/year). According to its Hydrogen Strategy, the country aims to switch 100% of its fossil-based hydrogen consumption to renewable hydrogen by 2030. This would cause GHG emissions to drop by over 5 kt/year. In the ramp-up phase of increasing hydrogen demand in industry, the government will allow for the use of low-emissions hydrogen as long as renewable hydrogen is not available in sufficient quantities and at competitive cost.

Netherlands

The Netherlands' current hydrogen use totals approximately 50 TWh/year, essentially as a feedstock for industry, including in refining and chemical processes (e.g. ammonia production). The goal is to substitute these volumes with clean hydrogen and to generate additional demand for hydrogen as an energy carrier or feedstock in other (industrial) sectors over time.

Targets are put forward for hydrogen use in other sectors, including the objective of rolling out a network of 50 hydrogen filling stations by 2025 for road transport. In shipping, the target is for 150 zero-emission inland vessels by 2030, encompassing hydrogen and hydrogen-based options such as ammonia and synthetic fuels. In aviation, the national target is for the sector to use 14% renewable fuels by 2030, based on renewa hydrogen supply.

In the built environment, the objective is for pilot projects to co 1 000 homes heated by hydrogen by 2030, although a defini role for the energy carrier in this sector is uncertain and will dep on multiple factors.

Clean hydrogen will also play a role in the energy system balance supply and demand through underground storage addition, the intent is to have a CO_2-neutral power sector by 2 in which renewable and low-carbon hydrogen will replace nat gas in gas-fired power plants.

Norway

Norway's hydrogen strategy, published in 2020, gives partic attention to hydrogen's potential role in decarbonising segme of the transport sector. Key among these is maritime bunker notably targeting ferry routes. The Norwegian government's ac plan for green shipping also outlines hydrogen's potential rol this sector, particularly where pure electrification would be feasible due to scheduling, distance or speed constraints.

While pilot projects for hydrogen use have been put forwar other sectors, Norway could position itself as a hydrogen expo under the right policy and market conditions.