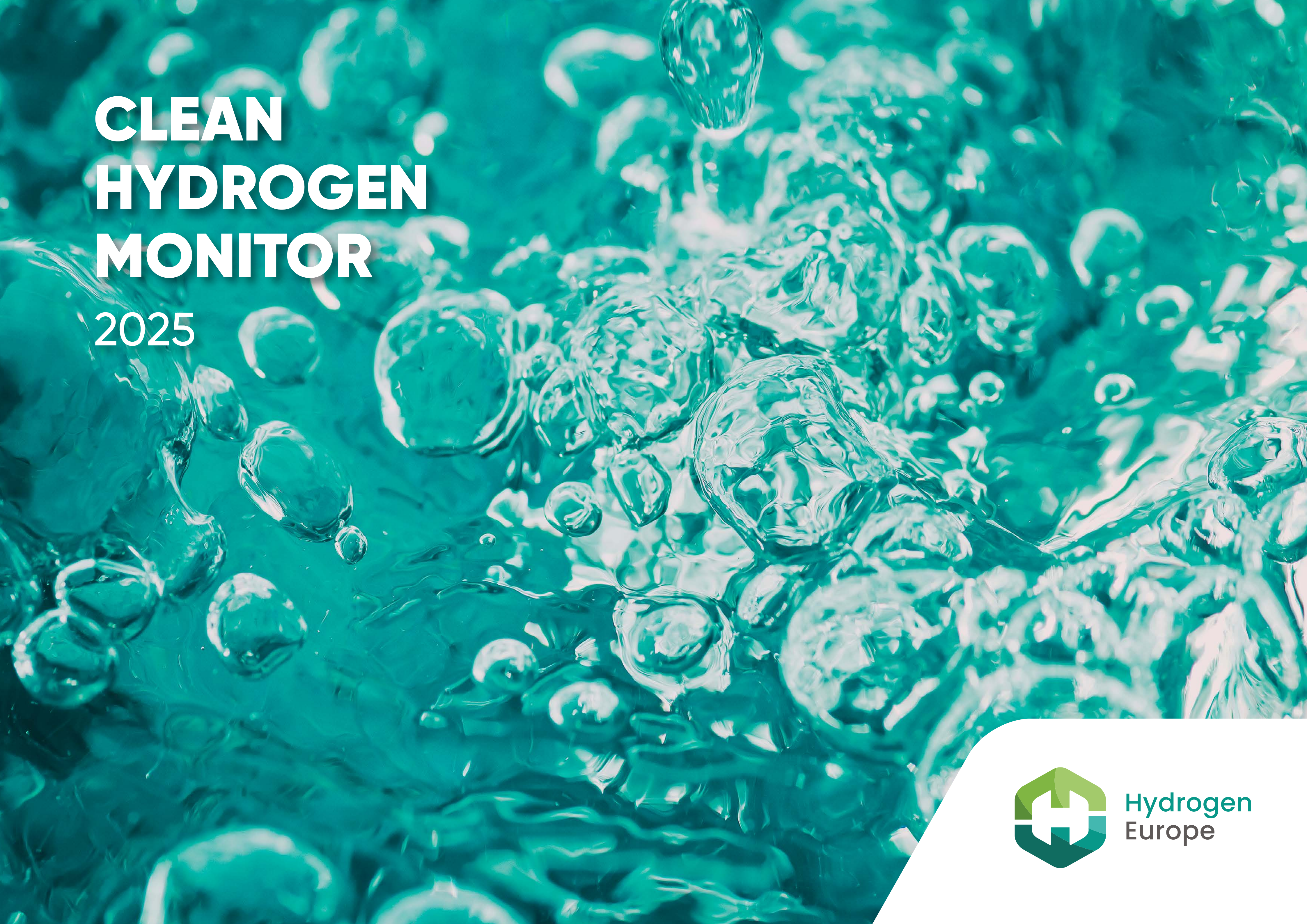
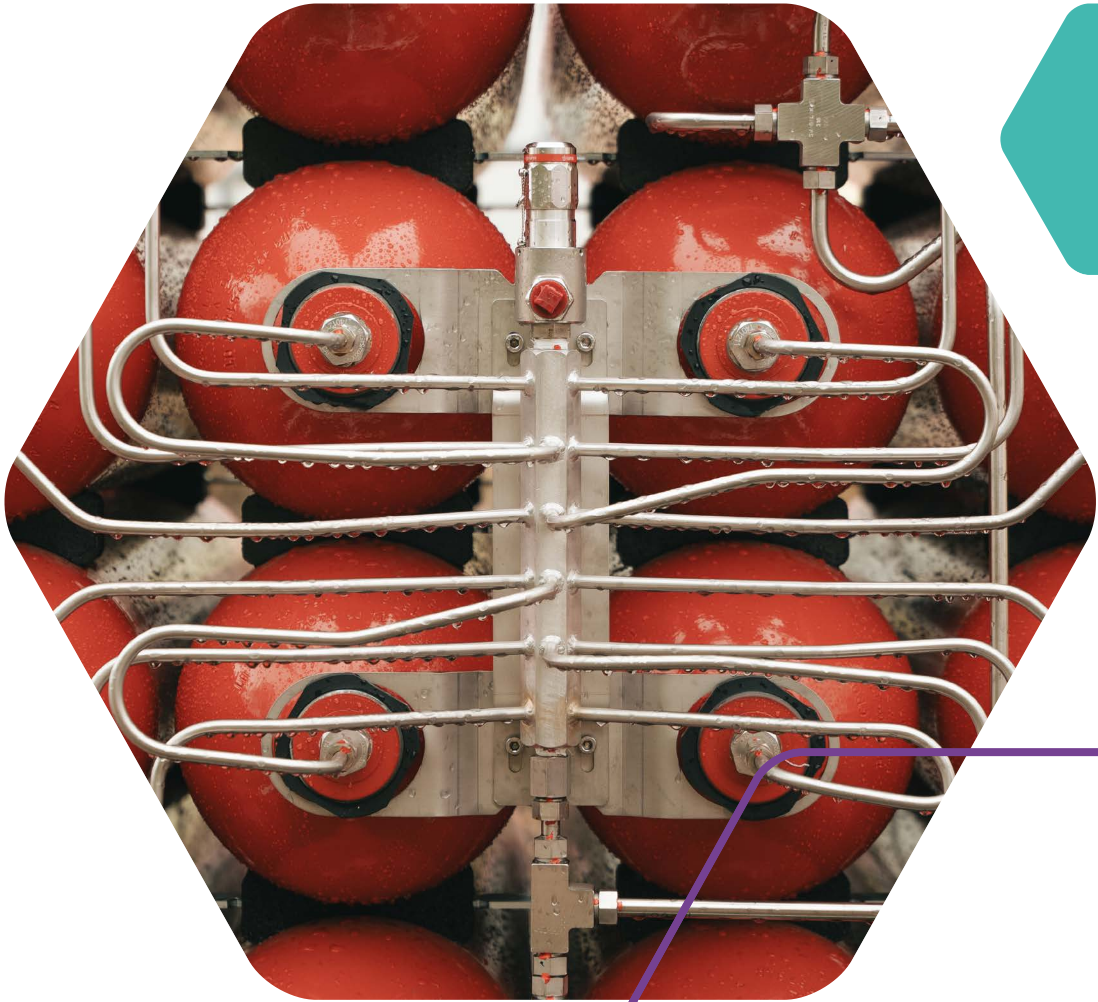
CLEAN HYDROGEN MONITOR

2025



Hydrogen Europe



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Foreword

2025 – When political ambition meets reality

I'm pleased to share the 2025 Clean Hydrogen Monitor with you all. Our yearly report comes during a challenging time for the hydrogen sector, with yet still some uncertainty ahead. However, there is still plenty of positive development and progress to report, and this year's Monitor takes stock of it all.

Two clear trends have emerged since last year's report. First, ambition and concrete measures in the transport sector, with fuel supplier obligations and the creation of national credit markets under the REDIII implementation, along with strong regulation in the aviation sector is an encouraging uptake. Almost half of all the estimated regulatory demand could be driven by the transport sector, and we believe this market can deliver.

Second, the other half of the regulatory demand is set to come from energy intensive processes in industry, where the situation remains a lot less clear and economically challenging. Member States, in most cases, have not even put concrete implementation proposals for consultation with industry. And with the ongoing debate about Europe's energy intensive industry competitiveness, shifting government positions and lack of political leadership, the situation will require strong re-thinking.

In this Clean Hydrogen Monitor 2025 report we estimate that only 60% of the total regulatory demand could be met by 2030. For this to happen, we will need to see exponential growth of final investment decisions (FID) in the next 18 months. So far, only a quarter of the expected 2030 operational capacity has taken FID. Offtaker incentives and effective funding schemes are critical to advance the more mature projects and close the cost gap between clean hydrogen and its fossil alternatives. The IPCEIs and Innovation Fund, including the European Hydrogen Bank, have supported the sector but the jury is still out regarding their effectiveness as many of the funded projects struggle to secure demand, deal with permitting, and secure affordable, RFNBO-compliant renewable electricity.

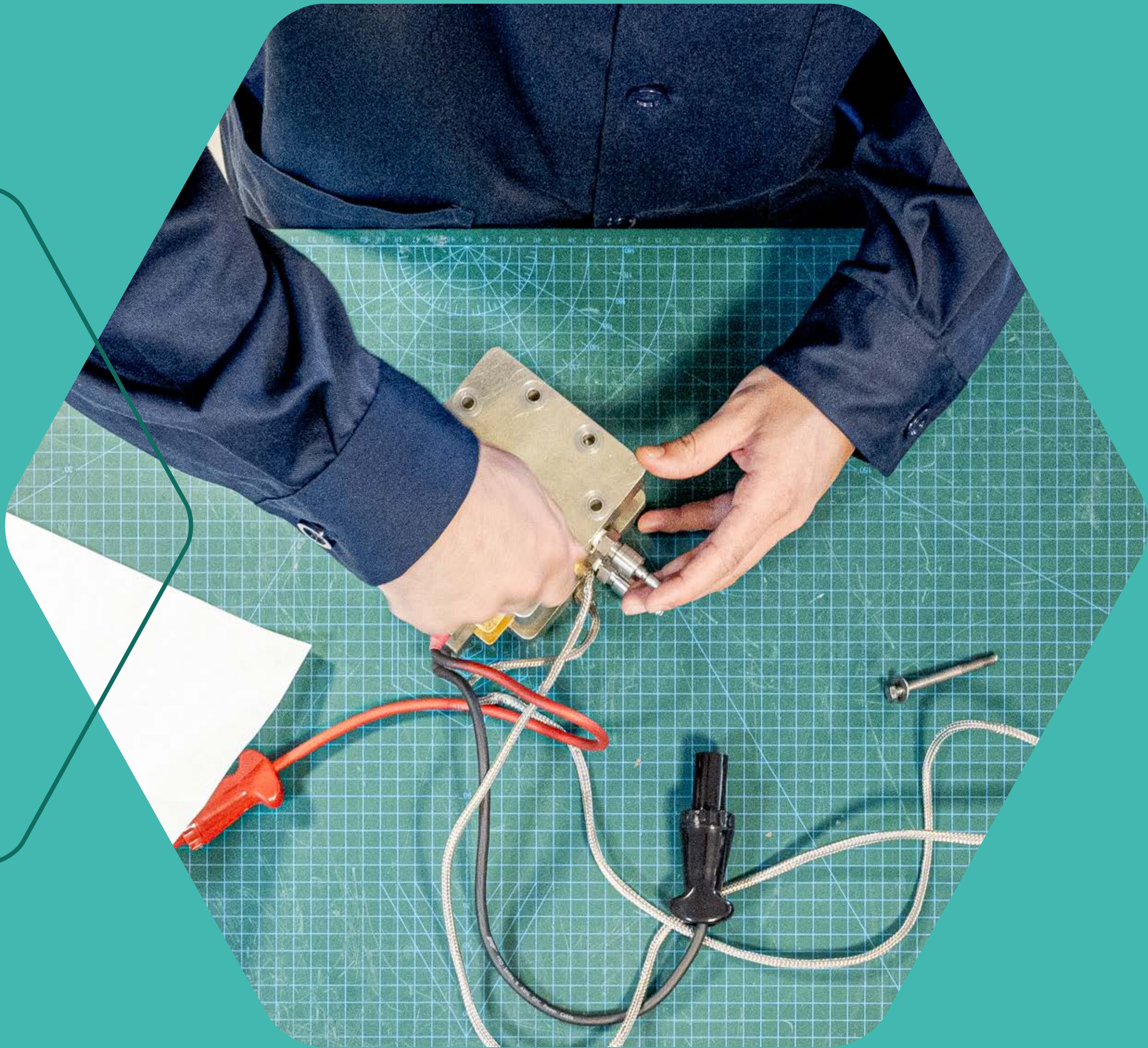
While imports play an increasingly important role, what is more remarkable is the speed at which China and India are progressing on the hydrogen journey. They are establishing themselves both as hydrogen production hubs as well as technology suppliers in an increasingly fragmented global market. With a pragmatic approach on their definition of green hydrogen and their state-backed offtake support, they are achieving incredible competitive costs for green ammonia and methanol. And more importantly, they are enabling a strong clear growth path for their domestic industry, tapping into economies of scale and rapid innovation.

Europe is at a crossroads today, not only at risk of failing to achieve its own climate goals, but of becoming a spectator of the revolution the hydrogen sector is about to experience globally. Policymakers still have time to set the correct implementation paths and enable the technology to not only support decarbonisation but also improve the resilience of the European energy system.

We hope you will find this year's report insightful and useful.

Sincerely,
Daniel Fraile

Executive summary



There are 571 MW_{el} of operational water electrolysis plants, with 2.8 GW_{el} under construction, 94% is concentrated in just 8 countries

- 571 MW_{el} of installed water electrolysis in July 2025, 48% increase compared to 385 MW_{el} in September 2024.
- 2.84 GW_{el} is under construction in Europe but the EU Hydrogen Strategy target of deploying 6 GW_{el} by 2024 has not been achieved.
- Between September 2024 and July 2025, only 517 MW_{el} reached final investment decision (FID). This indicates a slowdown, as in Q3 2024 alone, 730 MW_{el} had reached FID.
- Germany leads with 993 MW_{el} under construction.
- Out of 2,840 MW_{el} under construction in Europe, 94% of that capacity is located in just 8 countries.
- 2025 saw the first two 50+ MW_{el} electrolysers deployed in Germany and Denmark as installations are scaling up. 2026 should see first 100+ MW_{el}.
- Between June 2024 and June 2025, the average project size entering into operation reached ~18 MW_{el}, up from ~2.9 MW_{el} for the same period in 2023/24 - a 520% increase.

FIGURE A

Operational and under construction water electrolysis capacity by July 2025

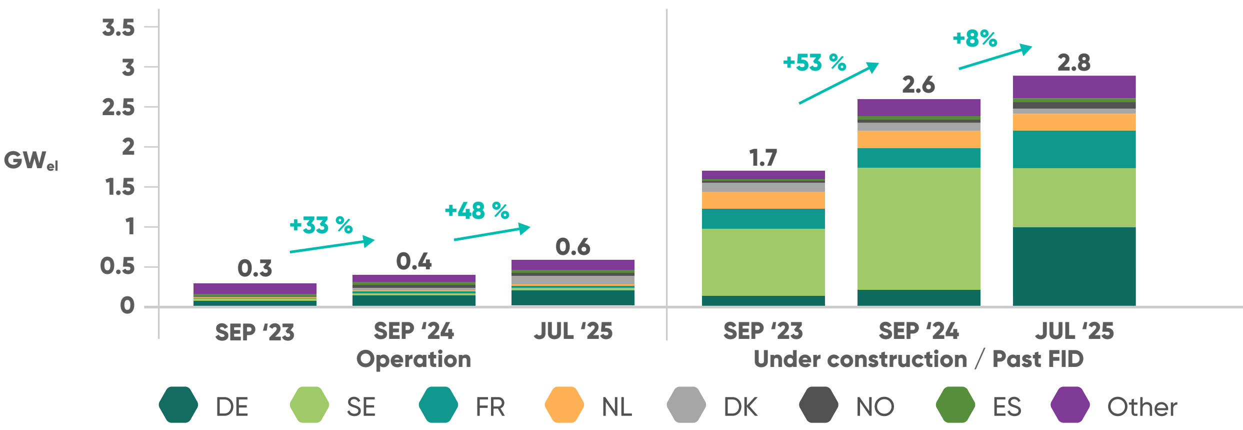
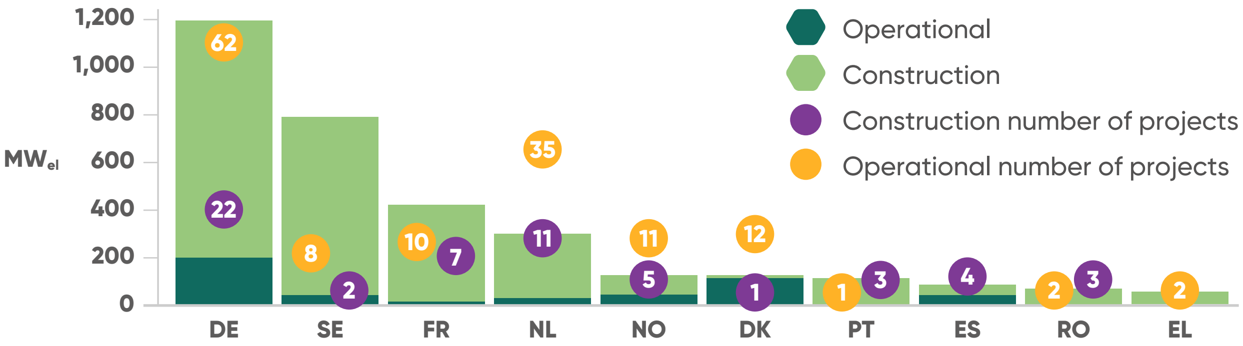


FIGURE B

Top 10 countries in Europe with largest operational and under construction water electrolysis capacity and number of projects by July 2025



Europe can expect a domestic supply of 2.3 Mt of clean hydrogen by 2030, with 1.7 Mt water electrolysis, although only 26% is under construction so far. With 0.63 Mt, refining is currently the largest use case

- We expect 2.3 Mt of clean hydrogen supply by 2030, 1.7 Mt of which is electrolytic and 0.6 Mt clean thermochemical. Although only 26% is so far under construction: 0.3 Mt (2.84 GW_{el}) of water electrolysis and 0.3 Mt of clean thermochemical.

- Despite a 9% decrease in capacity, from 16.4 GW_{el} to 15 GW_{el}, our electrolytic outlook remains the same, at 1.7 Mt. The relative lack of FIDs in late 2024 and in 2025 is offset by relatively ambitious REDIII transpositions or drafts in countries like Germany and Spain.

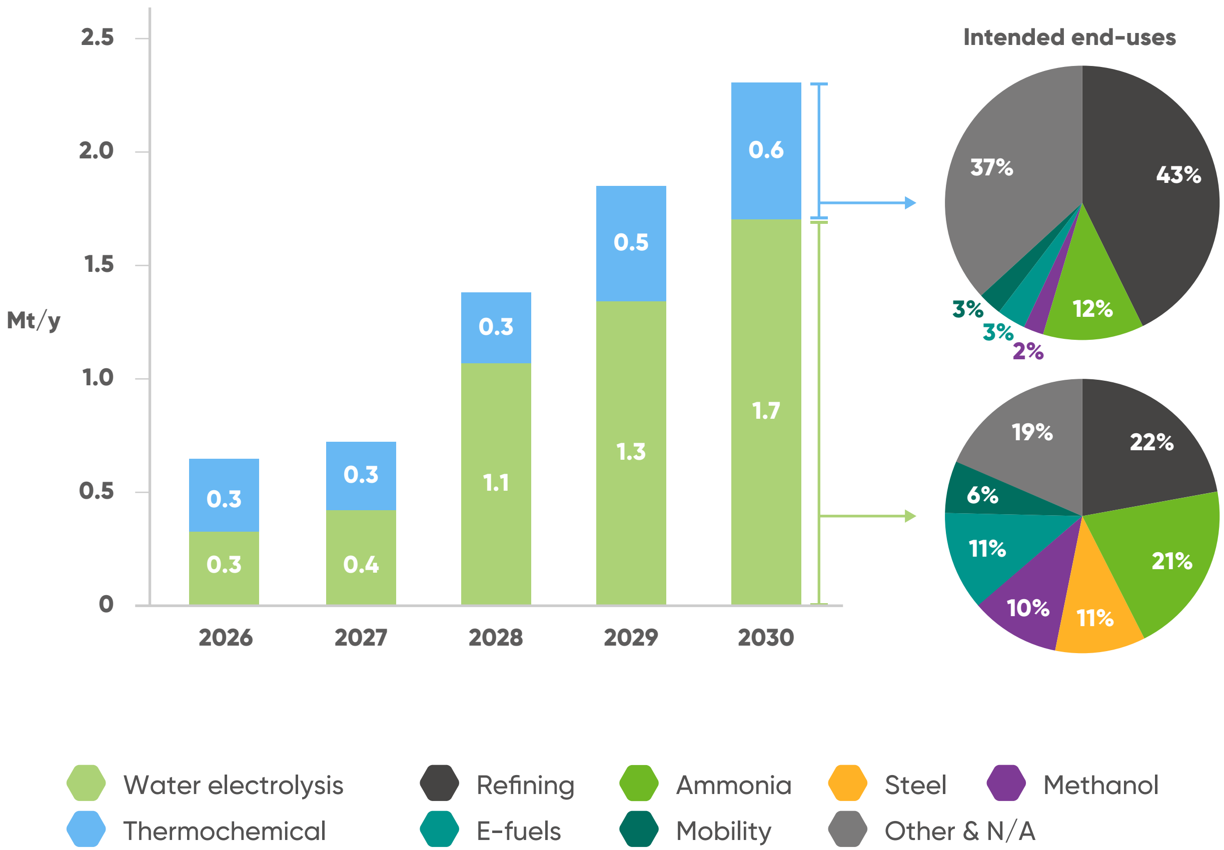
- Thermochemical outlook was revised down by 25%, mainly due to lack of progress in large reforming projects with carbon capture, particularly in the UK and Benelux.

- 43% of the clean thermochemical and 22% of the electrolytic volume expected to come online will be for refining which is a testament to the importance of the REDIII transport target and ETS as drivers for clean hydrogen production.

- In the absence of hydrogen infrastructure, ammonia is the most accessible derivative despite the lesser willingness-to-pay in fertiliser production.

FIGURE C

Clean hydrogen supply outlook in Europe up to 2030 by end-use



Notes: E-fuels as an end-use includes all synthetic fuels produced using clean hydrogen as a feedstock, excluding methanol and ammonia. This includes mostly e-methane and e-kerosene/e-SAF production projects. Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses.

More than 50% of the 1.7 Mt electrolytic hydrogen supply is concentrated in the Nordics and Iberia while UK and Benelux will drive thermochemical deployment

- The Nordics lead with 0.51 Mt forecasted electrolytic supply by 2030 driven by decarbonised grids, strong offtaker interest, and government support. Despite expanding CO_2 infrastructure in Norway, thermochemical projects have made little progress due to lack of offtakers and delivery infrastructure.

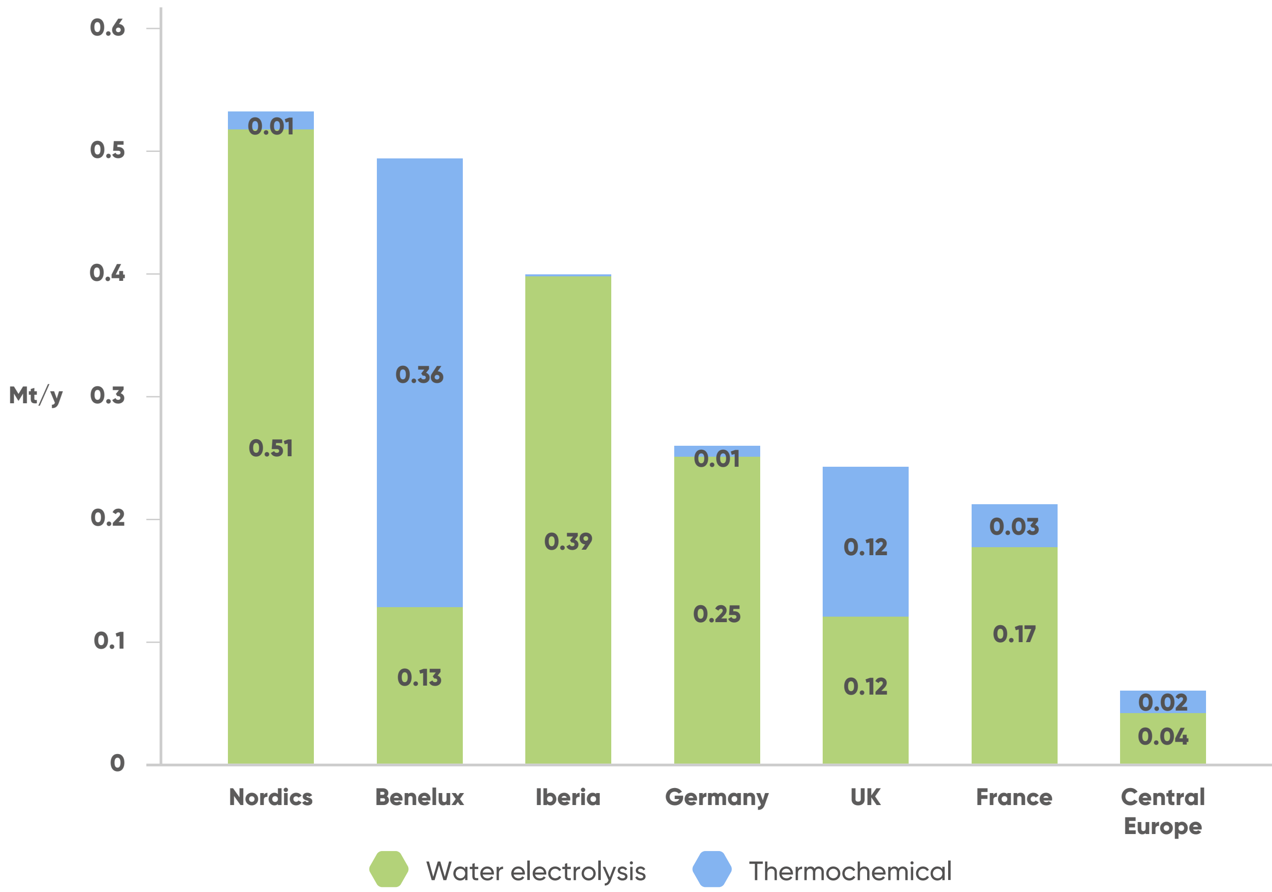
- Iberia is forecast to reach 0.39 Mt, mostly from electrolysis, based on strong renewable potential, funding, and solid project pipeline. While FIDs remain limited, REDIII transposition and recent funding are likely to unlock major FIDs in 2025/early 2026.

- Existing hydrogen consumers with large regulatory demand like Benelux, Germany, and others will not be able to cover their demand with domestic production and will need to focus both on intra- and extra-European imports.

- Central Europe will likely be the largest laggards constrained by high production costs, low renewables availability, and slow infrastructure rollout.

FIGURE D

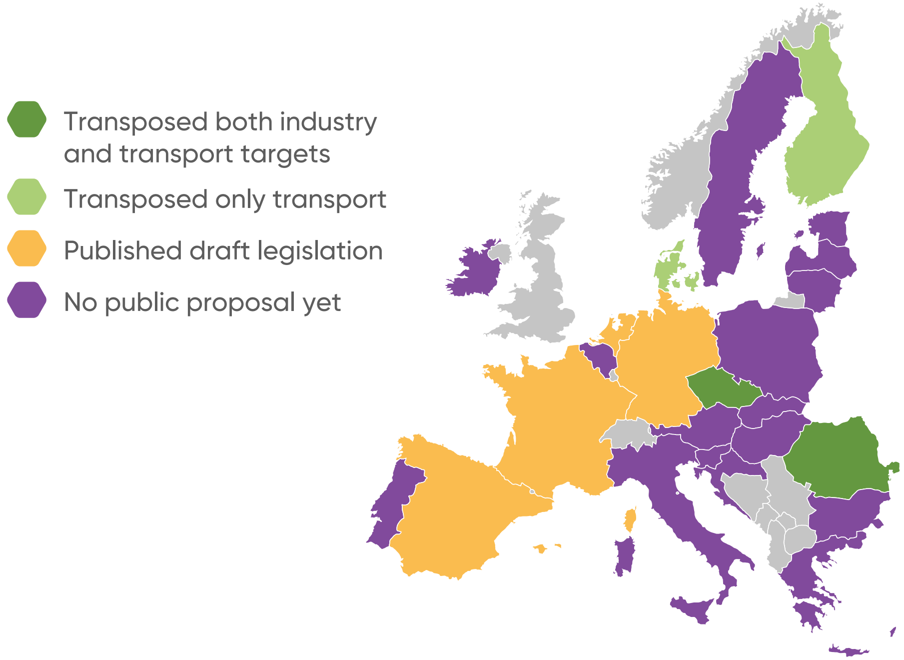
Clean hydrogen supply outlook in different regions in Europe by 2030



Regulation could drive an estimated demand of 2.8 Mt of RFNBO by 2030, but a slow transposition and lack of strategy for industry applications endangers its timely achievement

FIGURE E

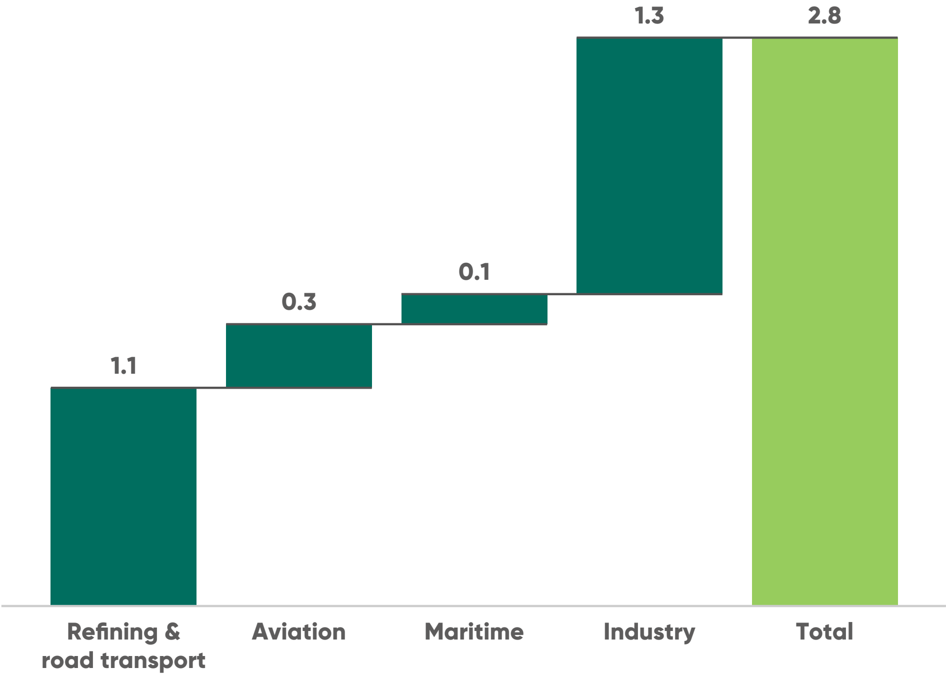
Status of the transposition of the REDIII regarding hydrogen objectives, as of August 2025



REDIII is the key regulatory driver creating demand for clean hydrogen, however only 4 out of 27 EU Member States have transposed it fully or partially as of August 2025.

FIGURE F

Estimated regulatory demand for RFNBO hydrogen in the EU by 2030 (Mt/year)



If properly implemented and enforced, REDIII, together with ReFuelEU Aviation and FuelEU Maritime, could create regulatory demand for RFNBO hydrogen of 2.8 Mt by 2030. The 1.3 Mt from the Industry target is very uncertain as transposition is less clear and is lacking incentives for companies.

By 2030, the EU is expected to supply only ~60% of its estimated regulatory hydrogen demand through domestic production and imports

- By 2030, the EU-27 is expected to produce ~1.43 Mt/year of domestic electrolytic hydrogen, supplemented by at least ~0.25 Mt from extra-EU imports* under existing binding agreements, bringing the total electrolytic supply to ~1.7 Mt.

- Main electrolytic hydrogen producing regions will likely be the Nordics (0.51 Mt/year) and Iberia (0.39 Mt/year) while Benelux (0.13 Mt/year) and Germany (0.25 Mt/year), with major ports and strong industrial demand, will also rely on hydrogen/derivative imports.

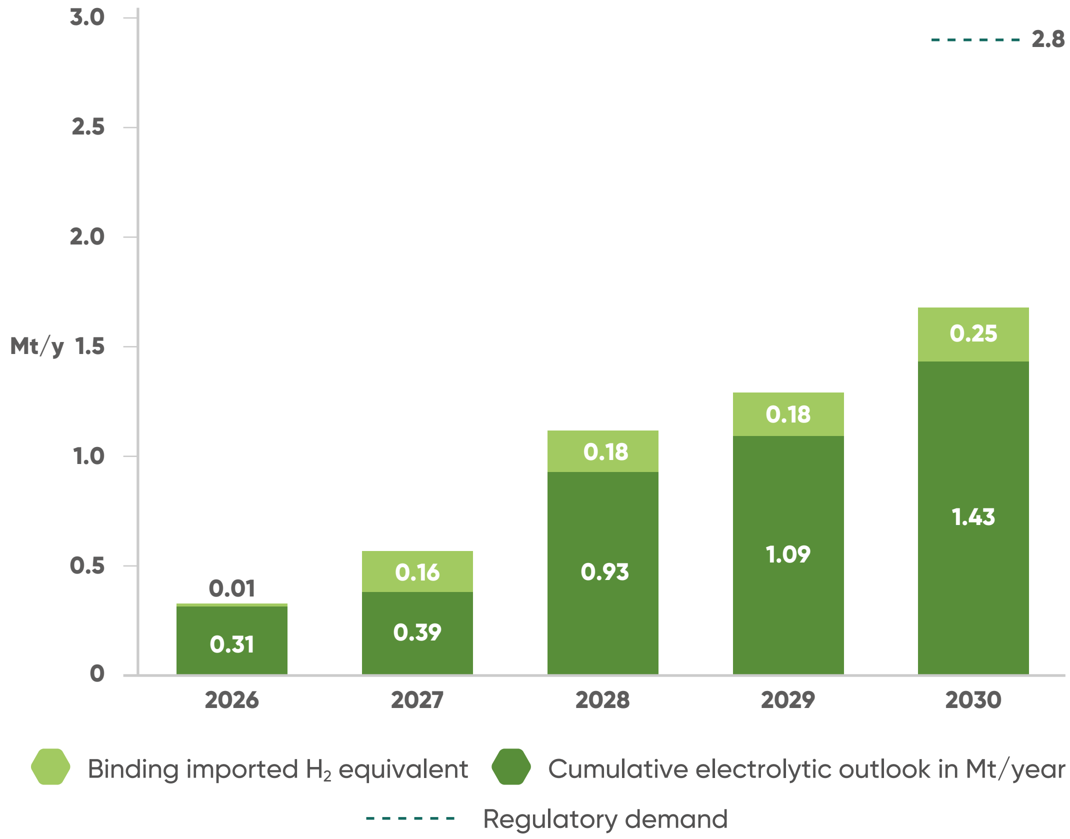
- Regulatory hydrogen demand in the EU is projected to be 2.8 Mt by 2030, requiring ~26 GW_{el} of electrolysis capacity. So far, only ~60% of it would be fulfilled by 2030 as the necessary offtake incentives to make more projects viable are lacking.

- Reaching the 2.8 Mt will depend on country transposition of REDIII and associated incentives/penalties. Existing transpositions incentivise the transport target more than the industry target and we expect much of the regulatory demand in industry not to be met.

- There is a need for urgent action through clear support mechanisms, greater funding opportunities and a simplification of the regulatory framework to allow projects to succeed.

FIGURE G

EU-27 electrolytic hydrogen supply outlook and binding imports vs regulatory demand by 2030



Notes: *Import data is from BloombergNEF's Hydrogen Offtake Agreements Database last accessed June 2025, and H2Global's Fertiglobe offtake agreement.

Insufficient EU funding must evolve to support projects with more flexibility and faster implementation, adding new derisking instruments

	Innovation Fund grants	European Hydrogen Bank	H_2 IPCEI	CEF-T/AFIF	CEF-E
Description					
Sector	Production, Manufacturing, Offtake	Production	Production, Manufacturing, Offtake, Infrastructure	Mobility Infrastructure	Infrastructure
Funding body	European Commission (possibility of MS participation through Grant-as-a-Service)	European Commission (possibility of MS participation through Auction-as-a-Service)	Member States (each project needs notification by European Commission)	European Commission	European Commission
Allocated funding	€4.3bn allocated	€694m allocated, €992m in grant preparation, €836m reserved or allocated for AaaS	€13.8bn allocated	€352m allocated	€250m allocated for H_2 studies
Assessment					
Speed of funding allocation					
Administrative accessibility					
Effective funding intensity					

Needed improvements

1. Expand available funding envelopes dedicated to hydrogen.
2. Accelerate Member State implementation of REDIII to enable project development and compliance
3. Establish a guarantee mechanism to enhance project bankability and attract private investment.
4. Improve assessment of project maturity to ensure funding targets viable projects.
5. Introduce more flexible funding allocation to adapt to evolving project needs.
6. Streamline evaluation and approval processes, with a target maximum duration of one year.

Notes: CEF-E has not been evaluated in-depth, as only hydrogen studies have been funded. National aid, such as those stemming from the Recovery and Resilience Fund, are out of the scope.

Oil refining emerges as the largest demand sector for clean hydrogen - benefitting from clear REDIII incentives, while chemical and fertiliser sectors struggle due to inability to pass on costs and strong global competition

Sector	Drivers	Constraints	Current and potential market by 2030 (Mt/y)	Feasibility (incl. willingness to pay)
Refineries	REDIII fuel supplier obligation (lowest cost compliance option) Existing demand for hydrogen Limited impact on conventional fuel prices	Costs Grid capacity and land availability Lack of infrastructure Risk of refinery route limits imposed by MS	CD 2.6 RD 1.1 Pipeline 1.4 Adv.proj. 0.7	
Road mobility	REDIII and AFIR mandates CO_2 standards for light duty and heavy-duty vehicles	Higher costs than BEV in many applications High cost of FCEV Lack of refuelling infrastructure	CD RD 1.1 Pipeline 0.4 Adv.proj. 0.2	
Other industries (ammonia, methanol, other chemicals)	Strong mandates: REDIII New applications in aviation and maritime sectors Use as H_2 carriers for imports Phase-out of ETS free allowances	Dependent on MS REDIII transposition Limited ability to pass over costs to end consumers High risk of carbon leakage and offshoring Weak CBAM	CD 2.8 RD 1.3 Pipeline* 4.3 Adv.proj. 1.7	
E-fuels	ReFuelEU Aviation obligations FuelEU Maritime long term investment technology choices IMO Net zero framework in the future	High cost compared to conventional fuel and alternatives (biofuels) Limited market appetite for long-term offtake agreements No binding targets in maritime	CD RD 0.4 Pipeline 1.2 Adv.proj. 0.4	
Steel	High CO_2 abatement potential Strong political/economical support for domestic premium steel Low impact on some end-use product price (cars, etc.)	Costs Lack of standardised label for low-carbon steel Limited market demand for green steel Lack of infrastructure	CD RD Pipeline 0.9 Adv.proj. 0.5	
Power generation	Flexibility and long-term storage Limited grid capacity and congestions for data centres	High cost Lower efficiency than BESS	CD RD Pipeline 0.2 Adv.proj.	

Notes: CD refers to "Current demand" estimated in 2024 Europe including United Kingdom, Norway, Switzerland and Iceland. (for refineries it excludes the H2 demand in refineries of by-product). RD refers to "Regulatory demand". RD for refineries and road mobility is the same target. Pipeline 2030 refers to the total number of clean announced (both water electrolysis and thermochemical) projects with expected start dates by 2030. Advanced projects encompass those that are operational, under construction, or in the preparatory stages and larger than 500 tonnes/year. *For other industries pipeline includes also use of ammonia and methanol as e-fuel (for aviation and maritime sector) and other chemical industry with use of hydrogen as feedstock.

Policy and regulatory actions for developing the European clean hydrogen market

	Challenges	Solutions
EU regulatory framework	Stringent RFNBO rules Legal uncertainty on certification Lack of regulatory definition for all production pathways	Review RFNBO definition by 2026 Provide solution for certification challenges, especially regarding imports
National implementation	Slow transposition of REDIII Lack of strategy to reach the RFNBO industry target under REDIII	Finalise REDIII transposition by end 2025 with ambition, intermediary targets, and adequate penalties for fuel suppliers Facilitate industry target with book and claim, a system of company obligations with lead market and financial support
Lead markets	Lack of market demand for clean hydrogen-based products Lack of common definitions for green and low-carbon customer products	Introduce mandatory quotas in public procurement and apply downstream obligations/incentives to private buyers Develop EU-wide carbon footprint labels
Infrastructure	Slow infrastructure buildout Lack of integrated strategy among the power grid and the hydrogen infrastructure	Accelerate transposition of the "Gas package" at national level, designating a hydrogen network operator, clarifying TPA, and funding framework Develop a European hydrogen grid and storage strategy, and strengthen cross-sectoral system planning via better scenarios and modelling tools
Funding	EU funding is limited and complex while national level funding is dispersed and lacking Most of the money addresses only a share of CAPEX and is in a grant form	Funding volumes needs to increase, incorporating guarantee mechanisms to support project bankability The assessment and approval of projects needs improving, allowing more flexible allocation methods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01 Current market review

Conventional fossil fuel-based production methods still account for over 95% of Europe's hydrogen production capacity. While clean hydrogen is being deployed, it accounts for only 1.1% and must scale rapidly to decarbonise the 7.8 Mt of hydrogen consumed in Europe in 2024, as well as to replace fossil fuels in transport, energy storage, and emerging industrial uses such as steelmaking.

- Hydrogen consumption in Europe remained stable at 7.8 Mt, compared to 2023's 7.9 Mt, but has shown a 15% decline since 2020. Refining remains the largest consuming sector (58%). Ammonia and methanol production remains at low levels since 2022, after natural gas prices spiked. In some cases, hydrogen demand for ammonia and fertiliser production has been permanently replaced by imports of nitrogen-based fertilisers.

- Installed water electrolysis capacity in Europe reached 571 MW_{el}, with ~288 MW_{el} of capacity being installed between June 2024 and June 2025, doubling the electrolytic capacity available in Europe. 2025 saw the first two 50+ MW_{el} electrolyser systems being deployed in Germany and Denmark.

- There are 63,000 tonnes/year of operational hydrogen production capacity with limited CO_2 abatement, largely through CCU. Future thermochemical capacity will need to meet the threshold of 3.38 $kgCO_2/kgH_2$ to be considered low-carbon hydrogen (e.g. to receive support and/or qualify as a clean maritime fuel).

Water electrolysis's share increased from 0.4% in 2023 to 0.6% in 2024, but fossil fuel-based hydrogen production capacity still accounts for 95.3%

Hydrogen production capacity in Europe amounted to **10.9 Mt per year** at the end of 2024, split among 588 installations. This remained stable compared to 2023's 10.8 Mt.

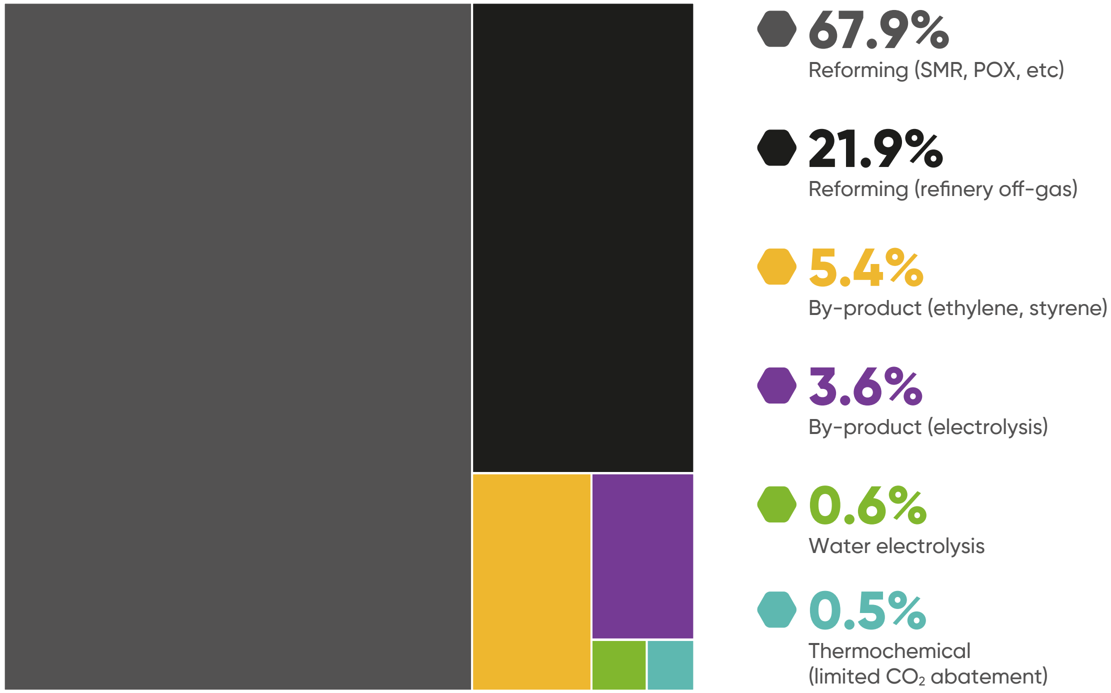
The conventional production methods, based on fossil fuels, of reforming, partial oxidation, gasification, by-product production from refining operations, and by-product production from ethylene and styrene represent 95.3% of total capacity. By-product hydrogen production via electrolysis of brine accounts for 3.6%. Thermochemical plants with limited CO_2 abatement (most of which is based on carbon capture and utilisation, for now) accounts for 0.5%. **These percentages and absolute values have remained stable over the years.**

In 2022 shutdowns were caused by exceptionally high natural gas prices. Many plants did not resume operation once prices stabilised in 2023, and some have been mothballed since. 2024 saw 5 closures including an ammonia plant in Romania and a methanol plant in Germany. **European made ammonia and methanol are increasingly replaced by imports due to other geographies' lower gas prices and less strict environmental measures.**

Water electrolysis represents 0.6% of the European production capacity, increasing from 0.4% in 2023. While water electrolysis deployment is increasing every year, the size of these projects is too small to be significant in the overall hydrogen capacity. At the end of 2024, water electrolysis could produce a total of around 65,000 tonnes of hydrogen.

FIGURE 1.1

Hydrogen production capacity in 2024 in Europe by production process (% of total)



Notes: In this report, Europe refers to the EU, EFTA and UK regions. The operational thermochemical projects shown here mostly operate CCU rather than CCS and are unlikely to be below 3.38 $kgCO_2/kgH_2$. The developers using these production pathways in the future want to produce abated hydrogen and thus the assumption is that future emissions will be maximum 3.38 $kgCO_2/kgH_2$ as most of the new plants will use autothermal reforming and will store the captured CO_2. Totals may not add up to 100% due to rounding.

Electrolytic hydrogen production in Europe is now 571 MW_{el}. Capacity is growing rapidly, but the EU's Hydrogen Strategy target of 6 GW_{el} by 2024 has not been met

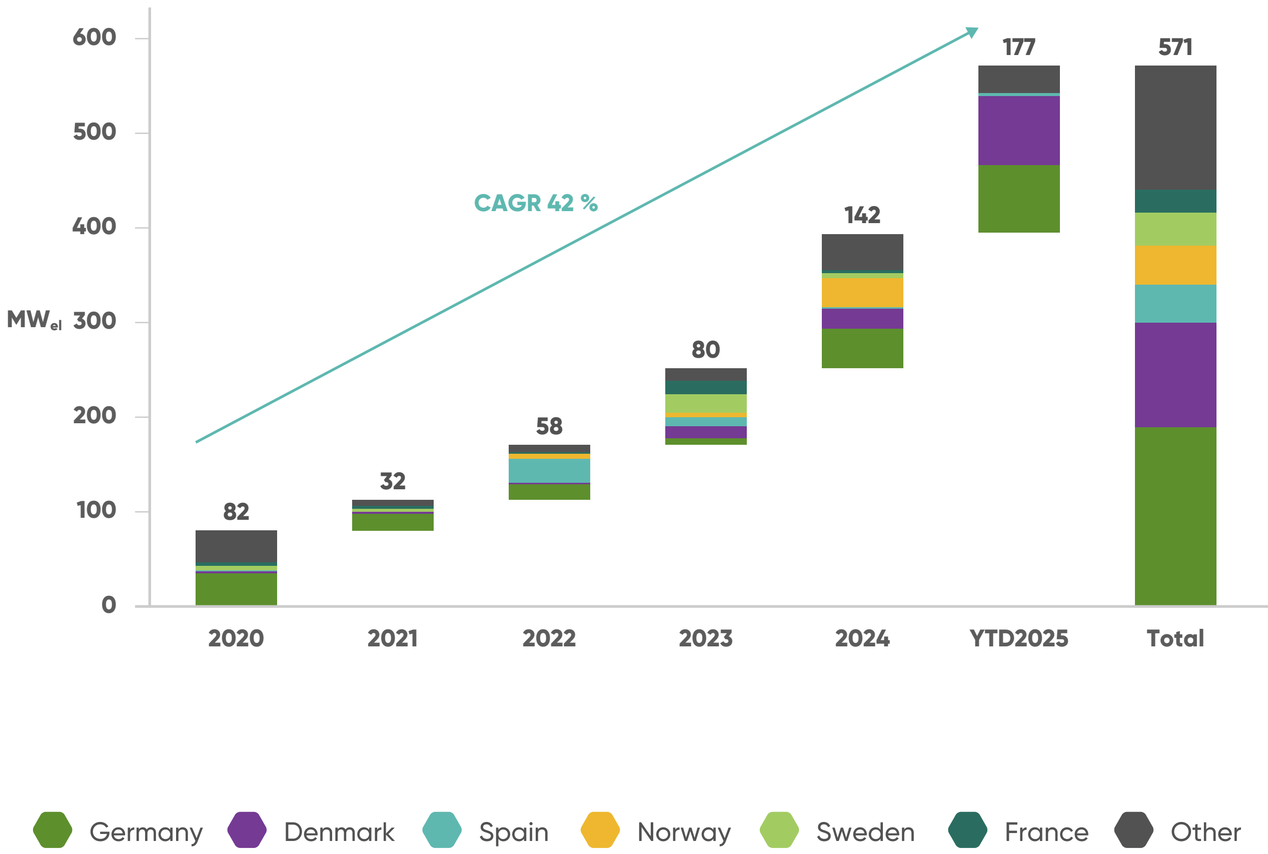
By June 2025, installed water electrolysis capacity in Europe reached at least **571 MW_{el}**, or ~94,000 tonnes of H_2/year, from 229 identified plants. **~288 MW_{el} of capacity were installed between June 2024 and June 2025, doubling the electrolytic capacity available in Europe.**

While the size of commissioned water electrolysis projects in Europe remains relatively small compared to operational projects in China (ranging from 100-500MW_{el}), there is a **trend in increasing installation size. The average project size installed between June 2024 and June 2025 was ~18MW_{el}**, compared to ~2.9MW_{el} for the same period in 2023/24, **representing a 520% increase.** 2025 saw the first two 50+ MW_{el} electrolysers being deployed at two different industrial sites: the largest being BASF's 54 MW_{el} system installed at their Ludwigshafen plant in Germany, and the second largest being European Energy's 52.5 MW_{el} system installed at their Kassø methanol plant in Denmark.

The EU Hydrogen Strategy target of deploying 6 GW_{el} by 2024 has not been achieved. 15 European countries have published 2030 electrolyser targets in their National Hydrogen Strategies and/or National Energy and Climate Plans (NECPs). **Achieving the combined targets of 53 GW_{el} by 2030 would only be possible if capacity grew at a compounded annual rate of 149%.** This would mean more than doubling water electrolysis capacity every year until 2030, while the compounded annual growth rate (CAGR) since 2020 is 42%.

FIGURE 1.2

Installed and operational water electrolysis capacity installed in Europe by June 2025



Notes: Actual capacity is slightly higher due to untracked small-scale electrolysers of less than 0.3 MW. CAGR is calculated only up until YTD 2025, not the end of 2025.

In 2025, the first two plants exceeding 50 MW_{el} in Europe were deployed in Germany and Denmark, driven by a favourable funding and policy environment

The deployment of **larger-scale water electrolytic projects is driven by already existing high hydrogen demand and decarbonisation needs, coupled with a positive regulatory framework and available funding,** as seen in Germany, or large potential and ambitious plans, as seen in the Nordics and Iberia.

Germany is the largest hydrogen consumer in Europe and has the largest installed water electrolysis capacity in Europe, with over 193 MW_{el} in operation. Its biggest electrolyser is BASF's 54 MW_{el} plant commissioned in 2025.

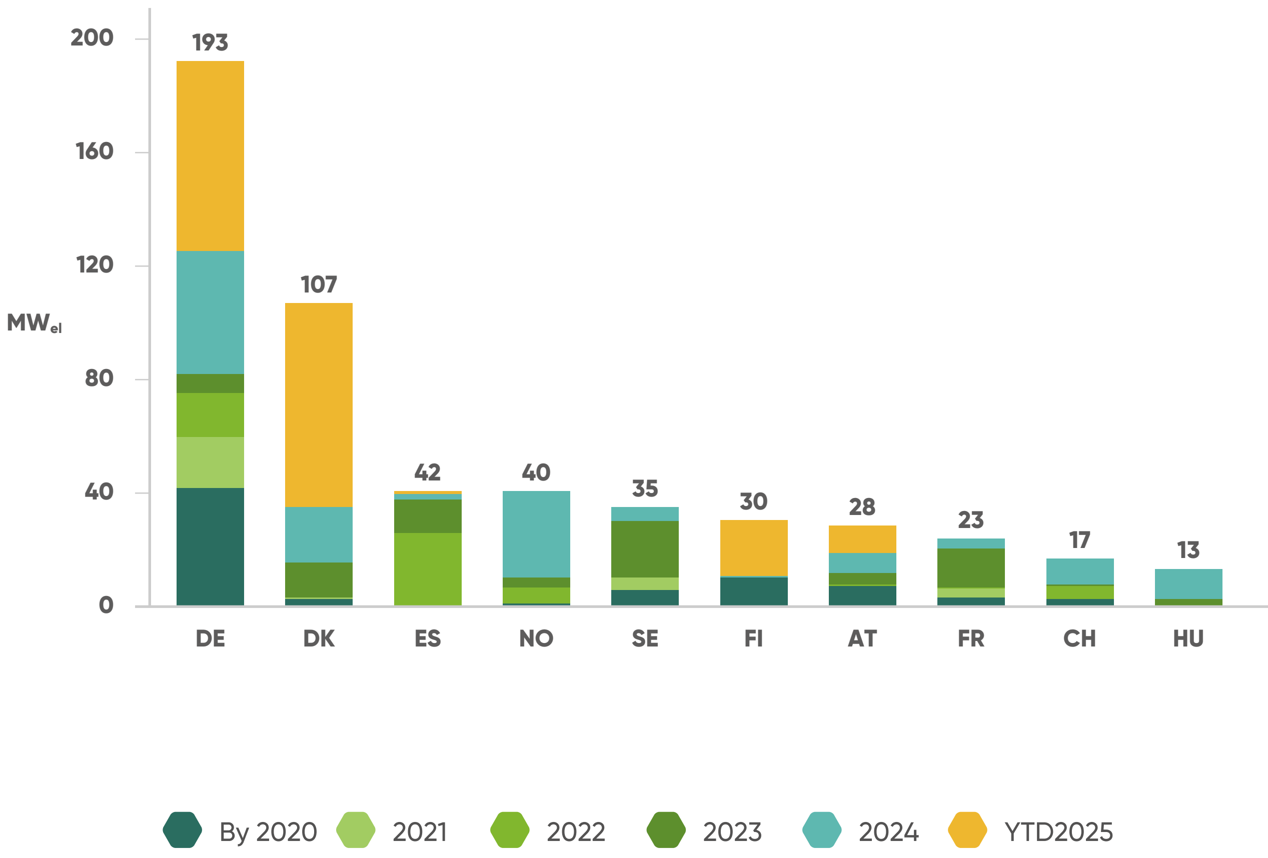
Denmark, with large production potential and ambitions, has 107 MW_{el} installed, with 52.5 MW_{el} of it coming from a single installation, Europe's first large-scale e-methanol production plant. Finland's P2X Harjavalta commissioned a 20 MW_{el} electrolyser in 2025 to produce e-fuels. Other large deployments in 2025 include Everfuel's 20 MW_{el} at the Fredericia refinery in Denmark, and OMV's 10 MW_{el} at the Schwechat refinery in Austria, which produces hydrogen for the refining, chemical, and e-fuel industries.

Most of these early deployments are pilots, or smaller scale commercial facilities, located near existing fossil-based hydrogen users. This trend will likely continue over the coming years, as a significant amount of future hydrogen production in Europe will be directed toward decarbonising existing end-uses.

Chapter 3 provides more information about European project pipelines and Hydrogen Europe's supply outlook to 2030.

FIGURE 1.3

Installed and operational water electrolysis capacity for the top 10 countries in Europe 2025 by year (until June 2025)



Notes: The values represent installations larger than 0.5 MW_{el}. Hydrogen Europe's project tracking might omit installations smaller than 0.5 MW_{el} and in some cases the number of these installations can be significant. Chapter 3 Methodological note further expands on the data collection process.

There is 63 kt/y of operational thermochemical capacity with limited CO_2 abatement, largely CCU based, but newer projects aim to meet clean threshold of 3.38 $kgCO_2/kgH_2$

By June 2025, installed thermochemical production capacity with limited CO_2 abatement in Europe reached **63,300 tonnes/year of hydrogen,** from 7 identified plants. **Around 2,200 tonnes were installed between January 2024 and June 2025, representing a 4% increase compared to the end of 2023.**

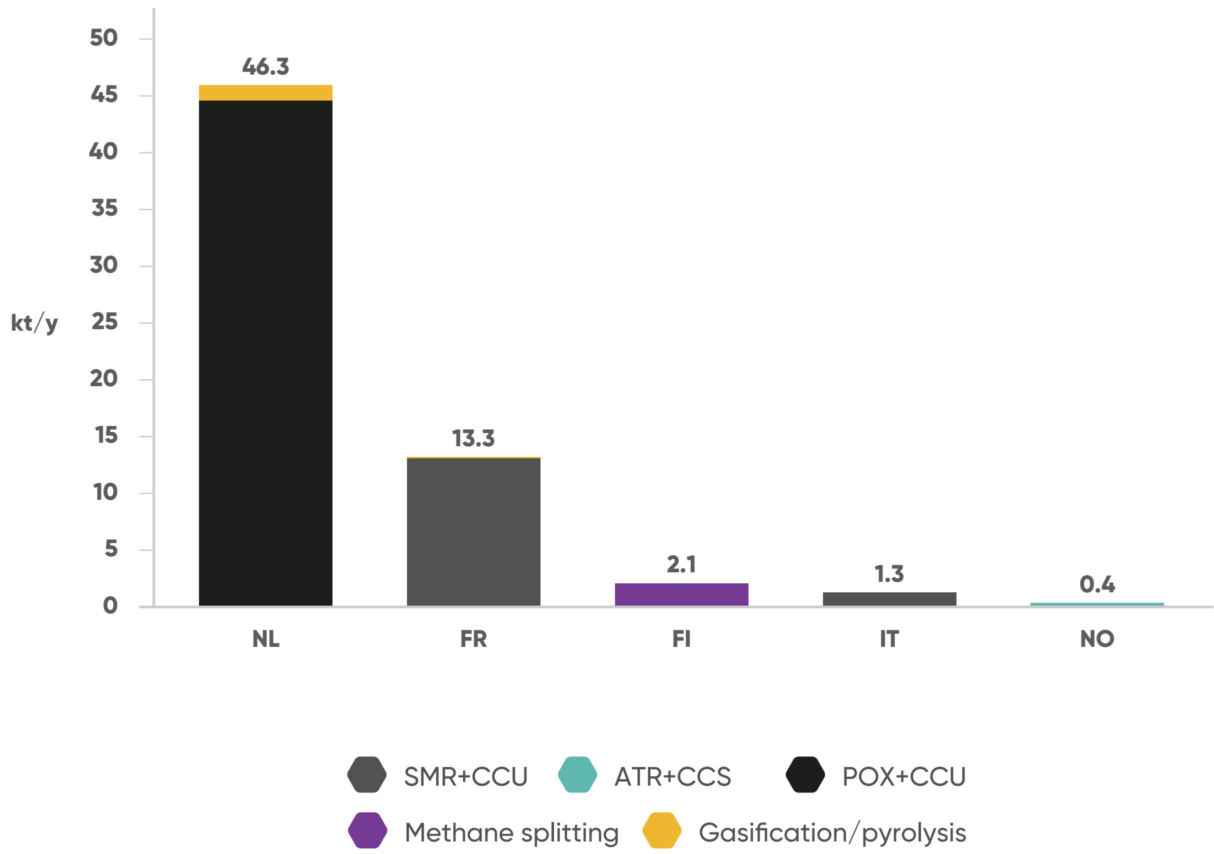
A further **21,000 tonnes of hydrogen capacity are under construction planned to commence production by the end of 2025.** While future thermochemical (limited abatement) capacity plans to produce hydrogen with **emissions of max. 3.38 $kgCO_2/kgH_2$,** most of the existing plants, though capturing CO_2 for utilisation, are above this value and therefore can only be considered partially clean or low-carbon.

Other emerging technologies include gasification and pyrolysis, which involve the production of hydrogen from various feedstocks. Hycamite's 2,100 t/y methane splitting plant in Finland commenced operation in 2024, and Haffner Energy's 130 t/y pilot thermolysis plant in France commenced operation in 2025.

Steam methane reforming (SMR) is the dominant industrial method for producing hydrogen today. Existing SMRs can be retrofit with carbon capture, most commonly achieving a carbon capture rate of around 60%. Air Products and Air Liquide's SMR+CCS projects at the Port of Rotterdam are currently under construction and will have a combined capacity of 216 kt/y by 2026. Future projects are planning to use autothermal reforming (ATR) which has carbon capture rates above 90%.

FIGURE 1.4

Installed thermochemical capacity with limited CO_2 abatement in Europe by June 2025 by technology



Notes: Most of the operational thermochemical projects shown here operate reformers or gasifiers of fossil fuels with utilising the captured CO_2(CCU) rather than storing it(CCS). They are highly unlikely to be below 3.38 $kgCO_2/kgH_2$. The developers using various clean thermochemical production pathways in the future want to produce abated hydrogen and thus the assumption is that future emissions will be maximum 3.38 $kgCO_2/kgH_2$, as most of the newly built plants will use autothermal reforming and will store the captured CO_2 or use other technologies to remain below the limit.POX+CCU refers to partial oxidation with carbon capture and utilisation

Total demand remained stable at 7.8 Mt in 2024, with around 5.2 Mt of non-by-product hydrogen consumption replaceable by clean hydrogen

Hydrogen demand in the EU, EFTA, and UK was **7.8 Mt/year in 2024, a slight 1% decrease from 2023 (7.9 Mt/year) and almost 15% lower than in 2020.** Hydrogen is mostly consumed as a **feedstock in refining, fertiliser, and chemical sectors,** making demand directly tied to the utilisation of these industrial plants.

In 2024, **refining accounted for 58%** of total hydrogen demand in Europe, followed by ammonia production with 25%. Refining demand has risen, driven by increased domestic output following embargoes on Russian refined oil products.

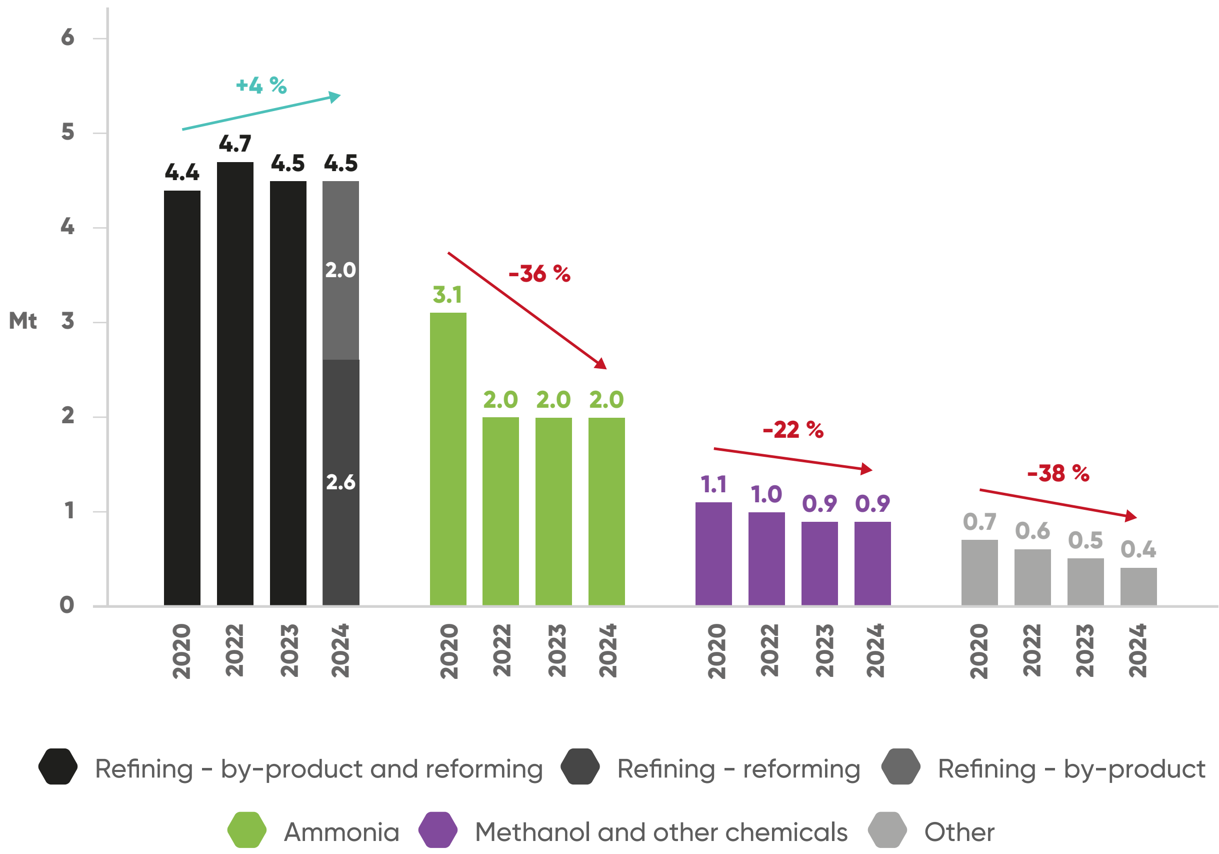
In contrast, hydrogen use in ammonia production dropped by 36% compared to 2020, primarily due to high natural gas prices. Although gas prices mostly stabilised below €40/MWh in 2024, demand did not recover. **Several ammonia plants, including InterAgro (Romania), and CF Fertilisers (UK), were shut down in 2024 and did not restart.** Operators cited high operating costs, environmental compliance, and increased Russian fertiliser imports as key reasons for decommissioning. Similar trends are visible in methanol and other chemical sectors.

Hydrogen use outside of industry remains limited. Use in industrial heating is emerging but remains minimal, while transport demand is still negligible, only around 6,800 tonnes in 2024, up from 5,000 tonnes in 2023.

Overall, the total volume of non-by-product hydrogen consumption that could be replaced with clean hydrogen is 5.2 Mt.

FIGURE 1.5

European hydrogen demand per sector 2019–2024



Notes: 2021 values are not available as Hydrogen Europe did not estimate hydrogen demand for that year. Refining by-product include both refinery off-gas (by-product from the refinery) and by product from ethylene and styrene production. Refining numbers for 2020,2022, and 2023 show total values of both reforming and by-product H_2 production in refining.

55% of current hydrogen demand is concentrated in 5 countries: Germany, Netherlands, Poland, Spain and Italy

55% of the total hydrogen demand is located in just five countries, (Germany, The Netherlands, Poland, Spain, Italy). A large portion is situated in industrial hubs that have restricted access to affordable renewable energy, posing challenges for the decarbonisation of current and future hydrogen demand in Europe.

Germany, the largest hydrogen consumer, leads in installed electrolysis capacity and has ambitions for domestic production and imports, while Poland, as the third largest consumer, has, thus far, seen limited electrolysis development, and limited government ambitions and support.

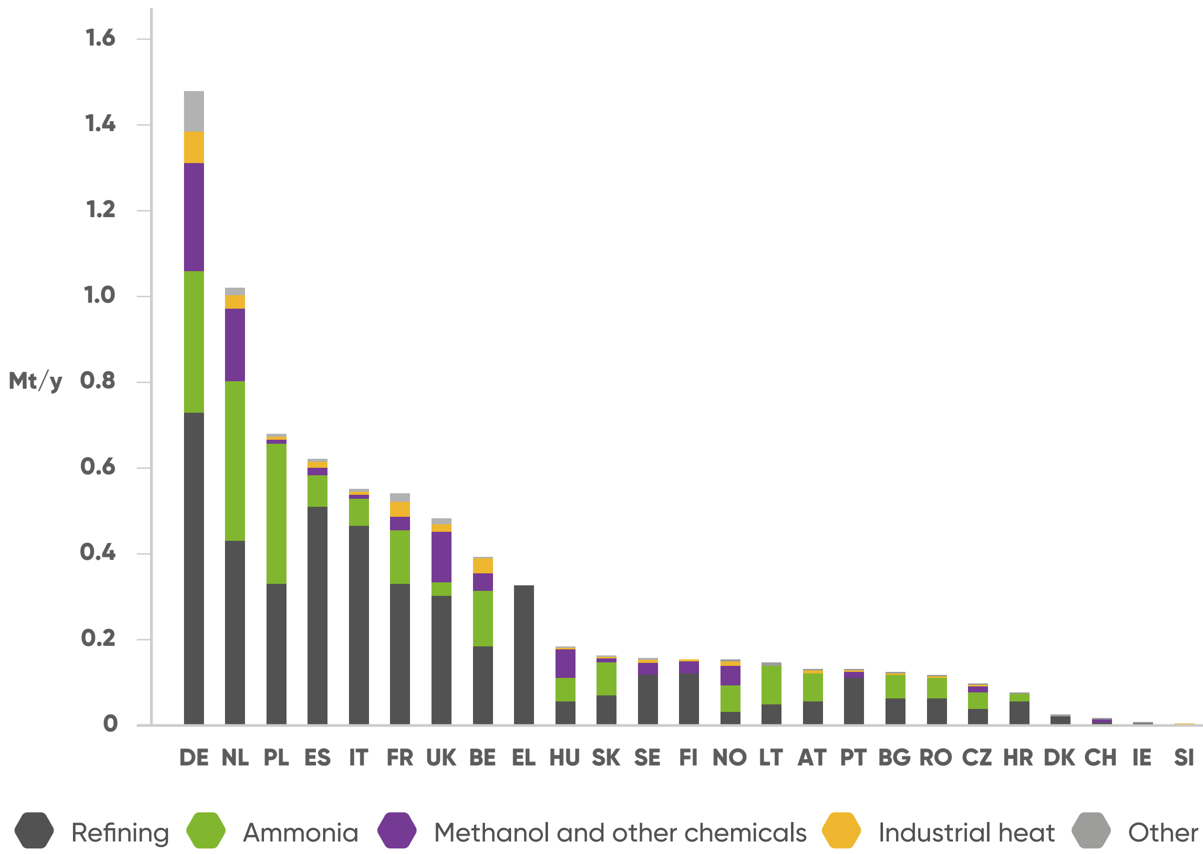
In most countries, hydrogen is primarily used in oil refining. In Italy, Greece, and Denmark, over 90% of hydrogen consumption is concentrated in this sector. By the end of 2024, there were over 70 refineries in Europe consuming approximately 4.53 Mt of hydrogen, with Germany (16%), Spain (11%), Italy (10%), and the Netherlands (10%) leading.

The largest ammonia producers are the Netherlands (19%), Germany (17%) and Poland (16%), with European plants consuming around 1.98 Mt of hydrogen. Methanol production is more concentrated, with Germany accounting for 68% and Norway for 28% of output, consuming 0.16 Mt of hydrogen.

Ammonia and methanol producers face pressure to decarbonise their hydrogen consumption due to the Renewable Energy Directive target, which requires that **at least 42% of industrial hydrogen consumption comes from renewable fuels of non-biological origin (RFNBO) by 2030,** excluding hydrogen used in fuel refining processes.

FIGURE 1.6

Hydrogen demand per country and sector in Europe in 2024



Notes: Industrial heat as an end-use includes the combustion of hydrogen in boilers for the production of steam, combined heat and power systems or other processes with the intention of producing heat in the industrial sector.

Fertiliser supply is shifting from domestic production to imports, putting sector competitiveness and decarbonisation at risk

Ammonia and fertiliser industries benefit from a well-established trade infrastructure and longstanding imports, with **16% of EU ammonia supply coming from abroad.**

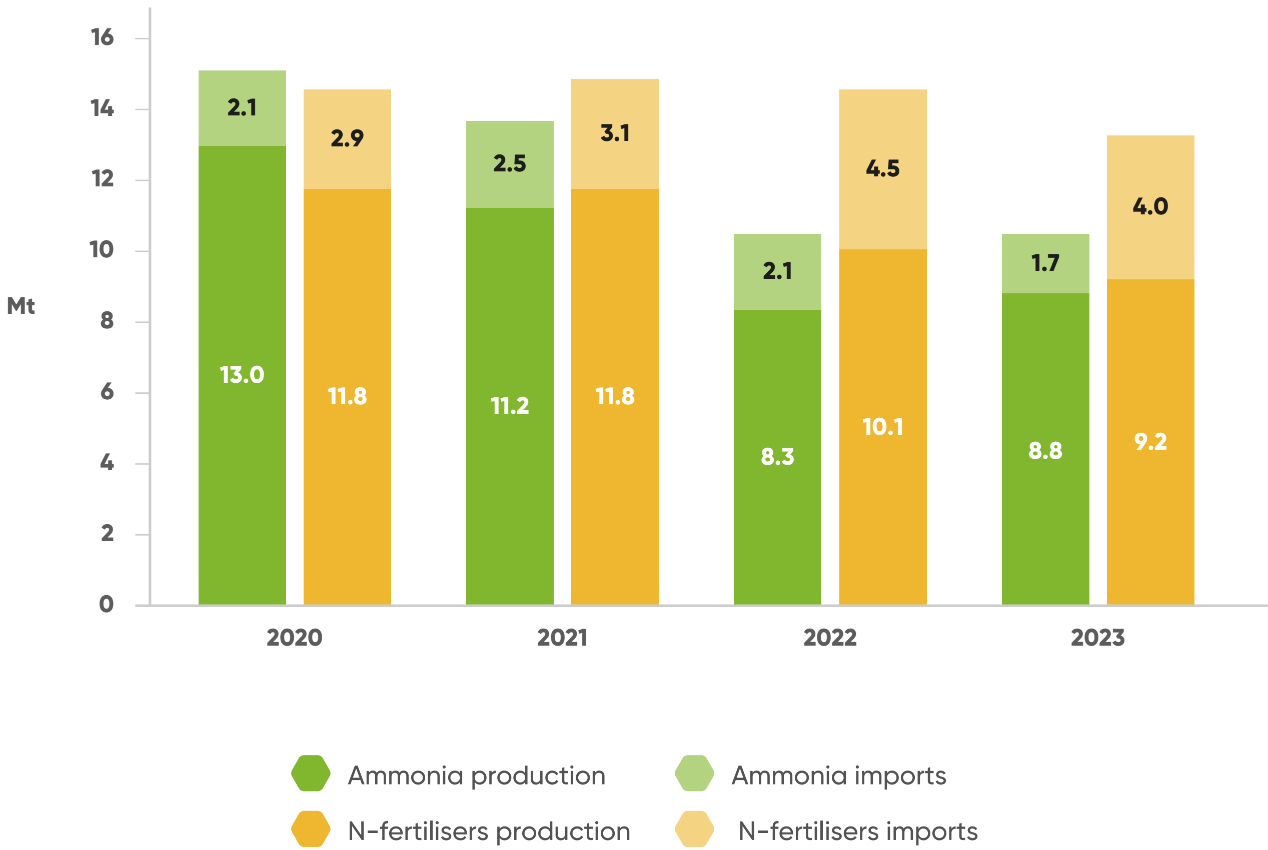
Around 80% of domestic ammonia production is used for nitrogen-based fertilisers (N-fertilisers). **Total ammonia supply has declined significantly since 2020 (30% between 2020 and 2023).** Meanwhile, imports of N-fertilisers rose sharply (increase of 40%)[1], suggesting a shift toward importing final products rather than producing or importing ammonia.

RED industry targets require ammonia producers to replace 42% of hydrogen use with RFNBOs, pressuring them to either decarbonise, reduce production, or switch to imports. Under CBAM, from 2026, fertiliser importers will gradually have to pay for embedded emissions at the ETS carbon price. By 2034, CBAM will cover 100% of the embedded emissions. **However, even with full CO_2 emission coverage, the impact of CBAM is unlikely to be sufficient to prevent carbon leakage.**

Several pilot projects are already underway to replace fossil-hydrogen use, including 24 MW_{el} in Porsgrunn, Fertiberia's 20 MW_{el} in Puertollano, and BASF's 54 MW_{el} in Ludwigshafen. Project location is a decisive factor for competitiveness of domestic clean production versus imports. Given the different production conditions across the EU, **without stronger public support and faster infrastructure rollout, RED industry targets risk being reduced with imports of unabated products.**

FIGURE 1.7

EU domestic production and imports of ammonia and nitrogen-based fertilisers (in Mt of Nitrogen) from 2020-2023



Notes: EU production of N-fertilisers and imports data was sourced from Eurostat's Prodcom and International Trade database.

FCEV growth continued in 2024, driven by a 69% surge in truck registrations and a 32% rise in buses, Germany ranked first in total FCEV registrations in Europe

Fuel cell electric vehicle (FCEV) registrations in Europe have shown consistent growth in recent years, with 2024 seeing a continued rise compared to 2023.

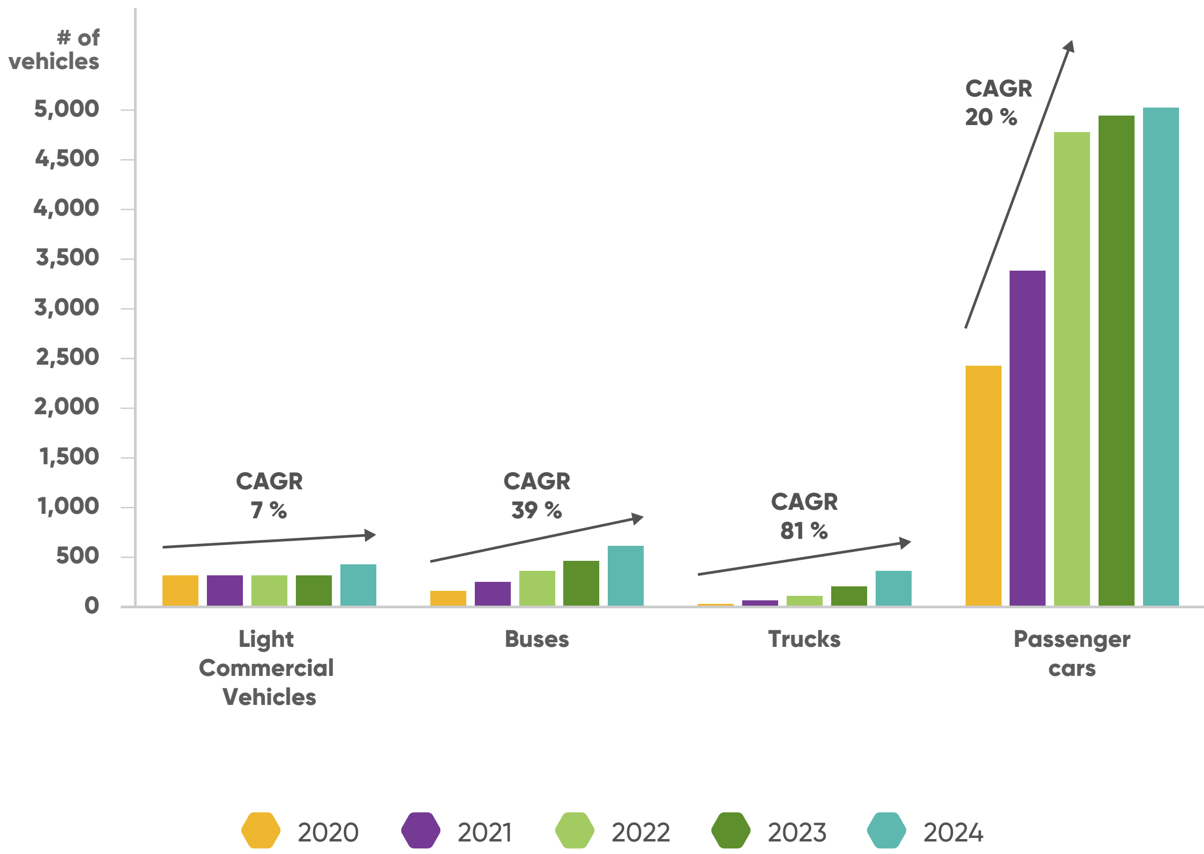
By the end of 2024, 6,509[2] FCEVs were registered in Europe, with passenger cars representing 78%. The number of passenger cars from 2023 to 2024 increased only 4%, whereas trucks increased 69%, and buses increased 32%. Germany had the highest number of total FCEV registrations, with 1,858 passenger cars, 151 buses, 122 trucks and 96 light commercial vehicles.

Between 2023 and 2024, the number of hydrogen-fuelled trucks in Europe increased by 69%. Due to higher mileage and energy requirements, trucks can consume 50 times more hydrogen than passenger cars, therefore, an increase of its fleet can significantly increase the overall consumption of hydrogen in mobility. Recent developments in the sector, including the establishment of funding programmes such as the Dutch Hydrogen in Mobility Subsidy Scheme (SWIM), have facilitated uptake. **Main countries of deployment include the UK and Germany, who increased their truck fleets by 43% and 39%, respectively.**

The number of hydrogen-fuelled buses increased 32% in 2024 compared to 2023. Promising projects have been successful in Italy and Germany. As of June 2025, Solaris[3] has delivered the first 37 of 137 hydrogen buses for deployment in Bologna. Cologne, Germany, currently has the largest number of hydrogen-fuelled city buses deployed at 130 units[4], targeting a total of 160 buses by the end of 2025.

FIGURE 1.8

Fuel cell electric vehicles fleet in Europe by year



Notes: Hydrogen consumption is estimated based on the number of vehicles registered each year and considering an average yearly consumption for each type of vehicle; 120 kg/vehicle for passenger cars, 750 kg/vehicle for light commercial vehicles, 6,000 kg/vehicle for buses, 6,000 kg/vehicle for trucks.

The average renewable hydrogen production cost in projects submitted to the Hydrogen Bank auction in 2025 was around 7.1 €/kg, down from 8.4 €/kg in 2024

The average levelised cost of hydrogen for renewable hydrogen production projects submitted to the second Hydrogen Bank auction in 2025 was 7.1 €/kg[5], a significant decrease compared to 2024 when the average cost was 8.4 €/kg. While the trend is positive, it's mostly a result of a more competitive auction with lower participation from high-cost countries – rather than a solid indication of cost reduction. **For Spain, the country with highest participation in both auctions, the average costs fell 5% from 5.8 €/kg in 2024 to 5.5 €/kg in 2025.**

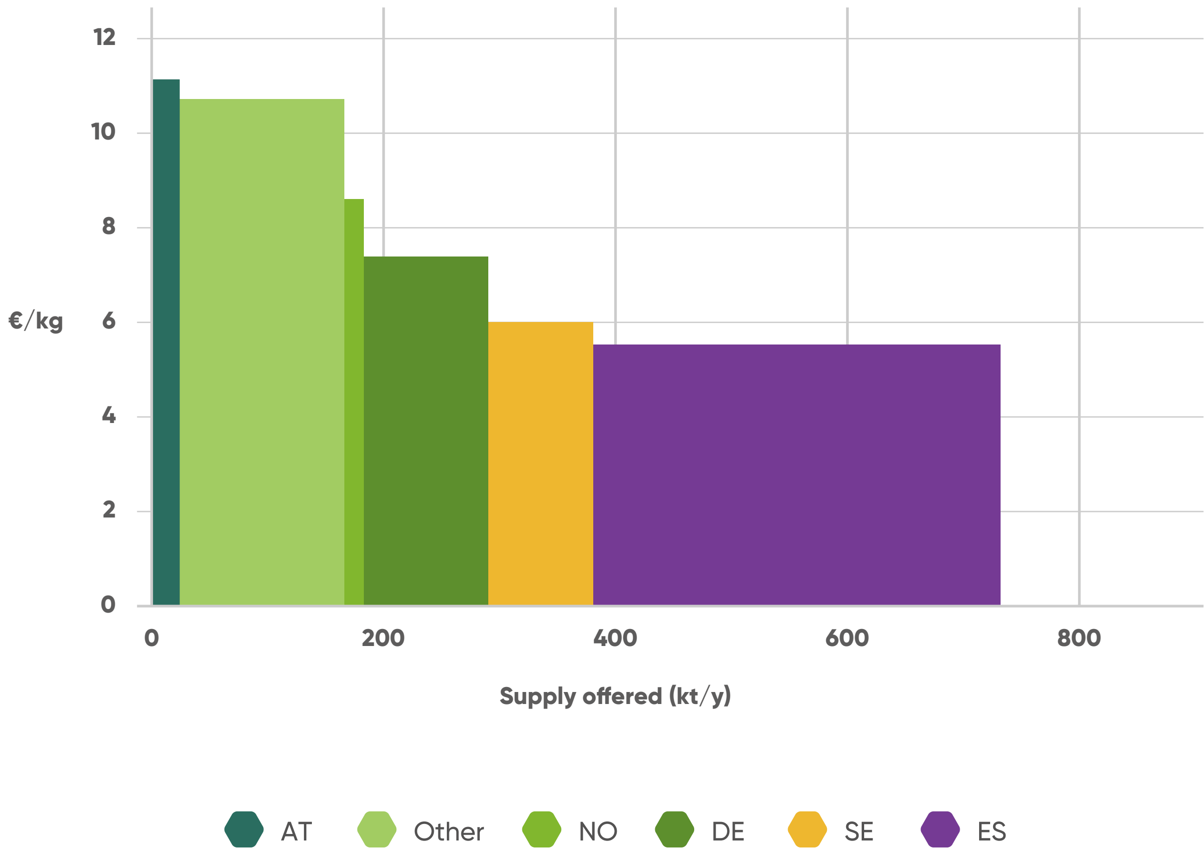
The Hydrogen Bank auction **highlights significant differences between renewable hydrogen production costs** in countries with abundant low-cost renewables (e.g. Spain with 5.5 €/kg) or where project developers have access to cheap and decarbonised grid electricity (e.g. Sweden – 6.0 €/kg), and rest of Europe, where the average reported production cost was 9.4 €/kg.

In Germany – the largest industrial consumer of hydrogen in Europe - the average reported renewable **hydrogen production costs were 7.4 €/kg.** This is a similar level to that shown by the HYDRIX index[6] (~8 €/kg) and is **still significantly above the production costs of conventional hydrogen.**

The average strike price in the UK's first Hydrogen Allocation Round (HAR1), a competitive auction designed to support the development of green hydrogen production projects, was ~9.2 €/kg[7], which would indicate a production cost of at least 10-11 €/kg. However HAR2 is expected to yield much lower prices due to larger scale of supported projects.

FIGURE 1.9

Results of the second Hydrogen Bank auction – average levelised cost of hydrogen of submitted bids (€/kg)



Notes: "Other EU" includes projects from Denmark, Finland, the Netherlands, Portugal and Poland, aggregated for confidentiality purposes as only one bid from each country was submitted.

Methodological Note

GEOGRAPHICAL SCOPE: This chapter covers 32 countries in the EU, European Free Trade Area, and UK, which are referred to as "Europe" in the text. Results in this chapter may purposefully exclude some countries depending on the quantity and quality of the collected information. Reference to the EU covers only the 27 countries of the European Union.

TERMINOLOGY: Reforming (SMR, POX, etc) refers to conventional fossil-fuel based dedicated production of hydrogen, while Reforming (refinery off-gas) refers to the production of hydrogen as a by-product in refining processes (e.g. during catalytic reforming). A separate category is shown for hydrogen produced as a by-product from ethylene and styrene production, and another for hydrogen produced as a by-product from the electrolysis of brine. Water electrolysis projects include all potential sources of electricity. Reforming with carbon capture projects can include CCU projects where the captured carbon is used or CCS projects where the captured carbon is permanently stored. Thermochemical plants with limited abatement refers to plants that mostly operate CCU rather than CCS and are unlikely to be below 3.38 $kgCO_2/kgH_2$. This category also includes other production pathways from for bio and non-biowaste like gasification and pyrolysis for which the emission intensity isn't clear.

Further terminology explanation can be found at the end of the report in the Terminology section.

DATA SOURCES: Hydrogen production capacity data is collected mostly from public sources, with the validation from national associations and/or companies whenever possible. The authors collect this information to the best of their abilities but cannot guarantee the absolute completeness or accuracy of the collected data. The annual utilisation of total capacity is based on public announcements from the companies. Whenever this is unavailable, sectoral utilisation rates are taken from public sources such as Eurostat, the Energy Institute, Eurochlor, and CEFIC.

PRODUCTION CAPACITY ASSUMPTIONS: The conversion between electrolysis capacity expressed in MW_{el} and tonnes per year is made using a 53 kWh/kg efficiency and assuming 8,760 full load hours.

CONSUMPTION ASSUMPTIONS: Actual production and consumption of hydrogen in Europe is estimated based on known utilisation of industrial conventional plants and electrolytic hydrogen production plants, the consumption of registered fuel cell electric vehicles and the balance between the imports and exports of hydrogen in Europe.

The following assumptions are taken regarding the annual consumption of hydrogen in fuel cell electric vehicles:

- 120 kg/vehicle for passenger cars
- 750 kg/vehicle for light commercial vehicles
- 6,000 kg/vehicle for buses
- 6,000 kg/vehicle for trucks.

Endnotes

1 / Eurostat, 2025
2 / European Alternative Fuels Observatory, 2024
3 / Sustainable Bus, 2025
4 / Energia Mercato, 2025
5 / European Commission, 2025
6 / EEX, 2025
7 / Argus, 2025

02

Clean hydrogen outlook in Europe by 2030

The outlook forecasts supply of 2.3 Mt of clean hydrogen in Europe by 2030, but only 26% or 0.6 Mt is under construction with just five years remaining. Despite 2.8 GW_{el} of water electrolysis (largely for refining use) being under construction, further progress continues to be hindered by slow infrastructure development, limited or ineffective funding mechanisms, slow or lacking transposition of REDIII failing to create sufficient early demand, and the reluctance to pay for green products from end-users in some sectors like fertilisers.

- Regulatory demand for RFNBO hydrogen is projected to reach ~2.8 Mt by 2030, driven by REDIII, ReFuelEU Aviation, and FuelEU Maritime. However, only a few Member States have adopted credible transposition plans, mostly in transport. Fuel supplier obligations under REDIII have been the main driver of electrolytic Final Investment Decisions (FIDs) on the continent with potential regulatory demand of 1.1 Mt. Industry end-uses remain the most at risk, endangering the potential 1.3 Mt market.

- European electrolytic supply is forecast to reach 1.7 Mt (15 GW_{el}), similar to last year's outlook with the Nordics and Iberia leading due to low-cost renewable electricity while Central and Eastern Europe are lagging. Major hydrogen consumers with large regulatory demand like Benelux, Germany, and others will not be able to cover their regulatory demand with domestic production. With 0.3 Mt under construction, 2030 clean thermochemical outlook stands at 0.6 Mt, down 25% due to slow progress in the UK and Benelux projects.

- Intra-EU hydrogen trade can support the development of clean hydrogen consumers, but infrastructure is needed and lagging. Extra-EU imports of hydrogen and hydrogen derivatives will play a role in the mid to long-term future to help meet Europe's energy needs and decarbonisation goals. So far, only 0.3 Mt/y Mt hydrogen of binding agreements signed to arrive in Europe by 2030, largely in the form of ammonia.

Europe can expect a supply of 2.3 Mt of clean hydrogen by 2030, driven by regulatory demand but highly dependent on regulatory constraints, access to funding, and the development of pan-European infrastructure

The clean hydrogen supply forecast for Europe is 1.7 Mt of electrolytic and 0.6 Mt of thermochemical hydrogen by 2030. That is a 5% decrease from the 2.5 Mt projected in the 2024 Clean Hydrogen Monitor (CH2M 2024). The forecast is based on the existing project pipeline, the known available funding, government strategies, binding targets, and the current state of the market.

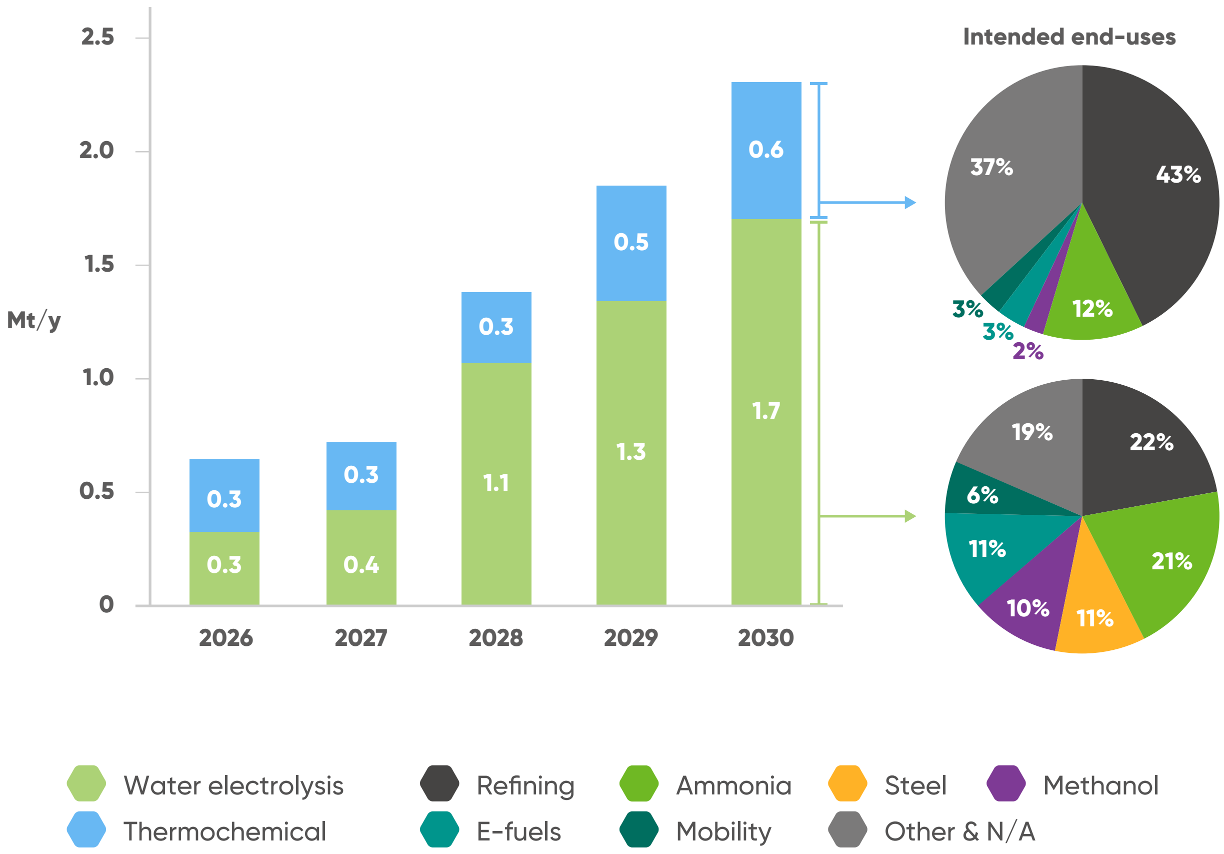
Despite progress on CO_2 infrastructure buildout and the Commission's adoption of the Low-Carbon Hydrogen Delegated Act, **the absence of regulatory demand and premium-paying offtakers for non-RFNBO hydrogen reduces the viability of large thermochemical projects. As a result, the 2030 forecast was revised down by 25%,** mainly due to lack of progress in large reforming projects with carbon capture, particularly in the UK and Benelux.

Electrolytic hydrogen forecast remained steady at 1.7 Mt, but **saw a 9% decrease in capacity,** from 16.4 GW_{el} to 15 GW_{el}, due to utilisation adjustments based on the 2nd Hydrogen Bank auction results. Despite a shortage of large-scale FIDs since CH2M 2024, the electrolytic project forecast in Europe has stayed relatively stable as project pipelines have been maturing, various national funding schemes have been allocated, and REDIII transposition has begun which increases the expectations for future regulatory demand.

Similar to last year, developers continue to grapple with high PPA costs to achieve decent utilisations (e.g., compliance with temporal correlation), tedious funding processes, missing infrastructure, and lacklustre demand.

FIGURE 2.1

Clean hydrogen supply outlook in Europe up to 2030



Less than 5% of the project pipeline is under construction and 37% of the project pipeline is in an advanced stage of development

Hydrogen Europe is currently monitoring **862 announced clean hydrogen production projects with plans to come online by 2030 with a total production volume of 12.7 Mt.**

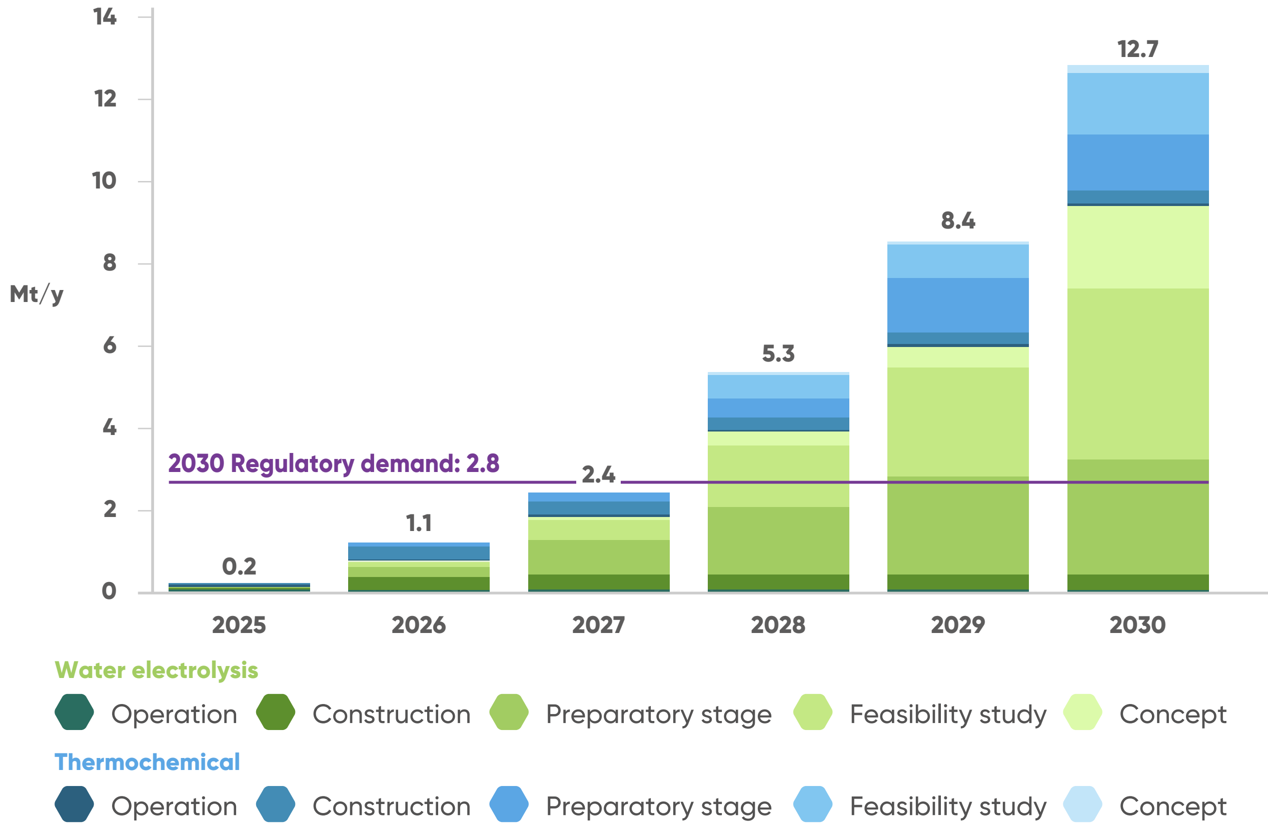
These include 818 electrolytic projects amounting to 9.3 Mt/year by 2030 and 44 clean thermochemical projects amounting to 3.4 Mt/year; the latter planning to reform natural gas and capture the associated emissions, split methane, or otherwise produce abated hydrogen from various waste streams.

Compared to last year's report, the total announced clean hydrogen capacity by 2030 decreased by 12% from 14.4 Mt/year. The decrease does not represent a stark change in market dynamics, but rather a re-evaluation of project timelines from developers and cancelling projects based on methodology. The water electrolysis pipeline increased by 0.3 Mt, while the thermochemical pipeline decreased by 2.1 Mt, mostly due to cancellations resulting from projects' inactivity, and the undefined support framework for low-carbon fuels.

4.7% of the project pipeline by 2030 is under construction compared to 4% last year. That equates to ~3% or 0.3 Mt (2.84 GW_{el}) of water electrolysis and ~9% or 0.3 Mt of clean thermochemical project pipeline being under construction. 37% of the total project pipeline is in an advanced stage (pre-FEED, FEED, construction) compared to 34% last year equating to 3.1 Mt (27 GW_{el}) of electrolytic projects and 1.6 Mt of thermochemical projects.

FIGURE 2.2

Cumulative announced clean hydrogen production capacity up to 2030



Notes: Data does not represent a forecast, but the announced production project pipeline. For methodology and terminology clarifications, please consult the methodological note at the end of the chapter and the terminology section at the end of the report.

Electrolytic hydrogen supply is concentrated in the Nordics and Iberia; Benelux and Germany will depend on imports and thermochemical due to limited domestic electrolytic capacity

Figure 2.3 provides an overview of countries and regions, each with unique market dynamics based on resources, ambitions, and demand.

The Nordics: Lead with **0.51 Mt forecasted electrolytic supply by 2030.** Growth is driven by decarbonised grids, strong offtaker interest, and government support. Despite expanding CO_2 infrastructure in Norway, thermochemical projects have made little progress due to lack of offtakers and delivery infrastructure.

Benelux: Expected to produce **~0.5 Mt by 2030,** with clean **thermochemical hydrogen supplying more than electrolytic,** supported by three CCS retrofits under construction. With limited electrolysis potential, major ports, and strong industrial demand, Benelux will likely become **one of the first markets with regional trade and maritime imports.**

Iberia: Forecast to reach **0.39 Mt,** mostly from electrolysis, based on strong renewables potential, funding, and solid project pipeline. While FIDs remain limited, **REDIII transposition and recent funding are likely to unlock major FIDs in 2025/early 2026.**

Germany: Europe's largest hydrogen consumer, already has **1 GW_{el} under construction, but limited access to additional renewables supply means imports and infrastructure will play a key role.**

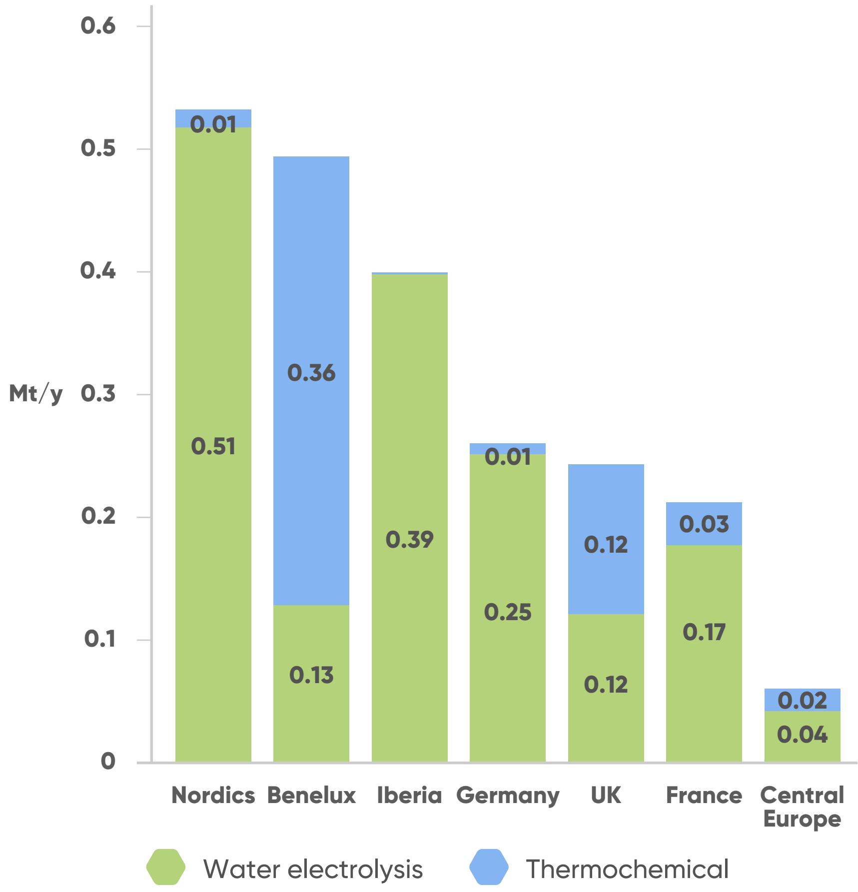
The UK: Forecast supply is **split evenly between electrolysis and thermochemical.** Despite few FIDs, funding mechanisms aim to deliver ~1 GW_{el}. At least one thermochemical project is likely to materialise.

France: Has limited electrolytic FIDs with the CfD mechanism expected to accelerate developments.

Central Europe: Remains the least ambitious, constrained by **high production costs, low RES availability, and slow infrastructure rollout.**

FIGURE 2.3

Clean hydrogen supply outlook in different regions in Europe by 2030



Notes: The Nordics includes Denmark, Finland, Norway, and Sweden. Iberia includes Spain and Portugal. Central Europe includes Poland, Czechia, Slovakia, Hungary.

Regional forecasts shifted unevenly, with thermochemical pathways revised downward and electrolytic growth driven by national funding, project maturity, and REDIII progress

Between 2024 and 2025, regional clean hydrogen supply forecasts for 2030 evolved differently, reflecting each region's unique market dynamics tied to resources, ambitions, and demand.

The Nordics: 5% decrease in total supply to 0.52 Mt, mostly electrolytic. This reflects an upward revision for Finland, and lower expectations in Denmark and Norway, driven by project maturity, national ambition, and adjusted utilisations. **Thermochemical production remains stalled in Norway.**

Benelux: Declined 15% to 0.5 Mt. Thermochemical hydrogen remains dominant, but limited new developments beyond committed CCS retrofits and a downward revision of Dutch electrolytic supply (closer to funded capacity) explain the reduction.

Iberia: Rose by 13% to 0.39 Mt, reflecting a more advanced project pipeline, reinforced by national funding and progress on REDIII implementation.

Germany: 11% decrease largely reflects delays of existing projects up to 2030.

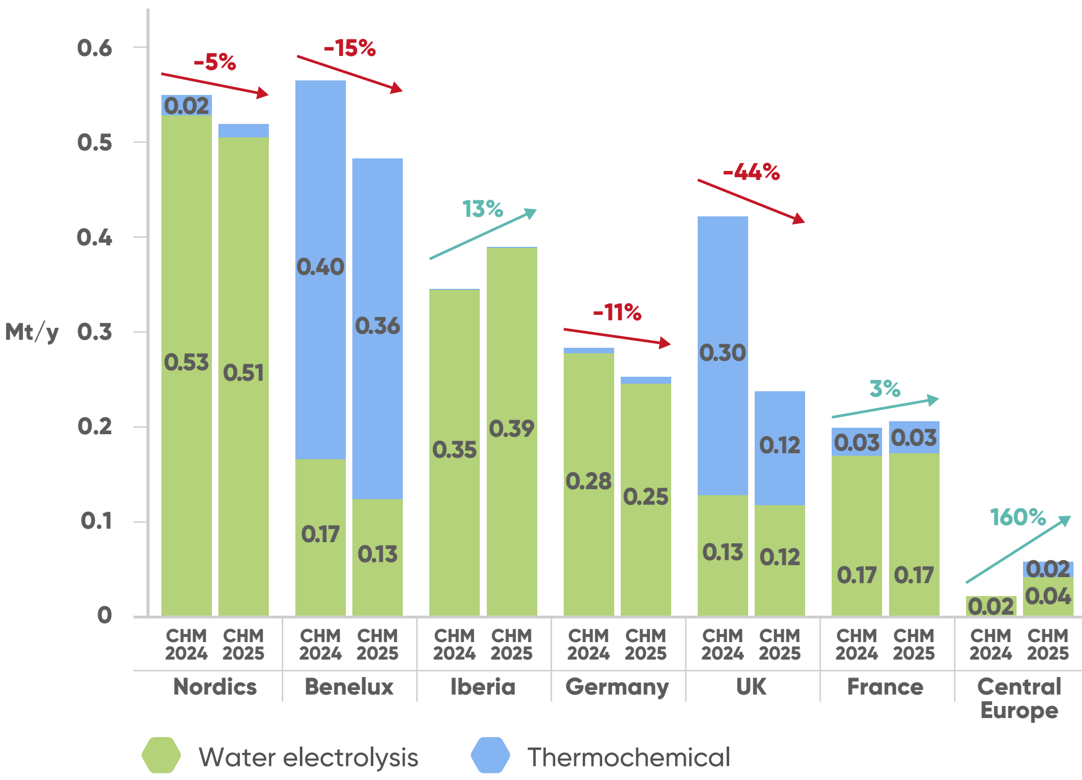
France: Held steady at 0.21 Mt as lack of progress has been balanced by the launch of a CfD scheme.

The UK: Forecast fell by 44% from 0.42 Mt to 0.24 Mt, **mostly due to uncertainty around thermochemical project timelines,** despite CO_2 infrastructure funding for HyNet and East Coast Clusters.

Central Europe: Outlook increased to 0.06 Mt, mostly due to five projects being awarded funding in Poland, but **remains the least ambitious.**

FIGURE 2.4

Annual comparison of clean hydrogen supply forecasts for different regions in Europe by 2030



Notes: The Nordics includes Denmark, Finland, Norway, and Sweden. Iberia includes Spain and Portugal. Central Europe includes Poland, Czechia, Slovakia, Hungary.

2.1

REDIII implementation and regulatory demand

REDIII is the key regulatory driver creating demand for clean hydrogen, however, implementation of the Directive is lagging behind

The REDIII is a major regulatory driver for the clean hydrogen market, defining provisions to promote renewable energy use – particularly RFNBO – in transport and industry. **While Member States had until 21st May 2025 to transpose the Directive's provisions into law, only a few have done so.** The resulting landscape is fragmented, with governments adopting varying approaches.

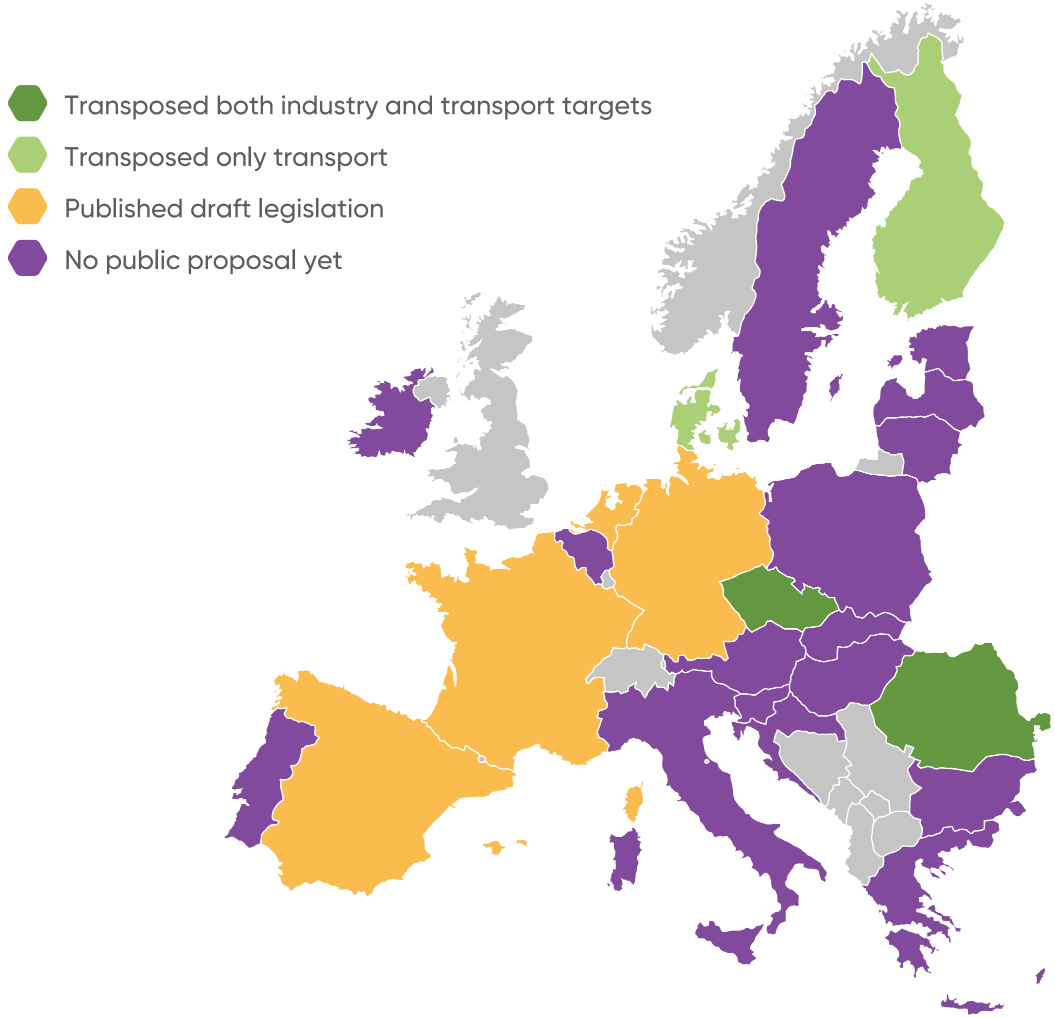
In transport, the progress is slow but improving. Romania and Finland adopted ambitious RFNBO blending mandates of 5% and 4% by 2030. In contrast Czechia and Denmark set the targets at just 1% and 0.9%. Furthermore, through the application of multipliers (Czechia) or narrowing the scope (Denmark) **the real obligation is just 0.5% - well below the minimum 1% required by the Directive.**

Among countries publicly consulting their proposals, Germany deserves attention, not only because it's the largest transport market in the EU but also because **its proposal is standing out for its clear and ambitious obligations extending up to 2040, with a 12% RFNBO mandate.**

In industry, where the 42% target is much higher and where Member States are the obligated party (as opposed to fuel suppliers under the transport target), the challenge is greater. **So far, none of the top 5 countries where hydrogen is consumed for industrial applications (DE, NL, PL, BE, FR) have managed to propose a credible plan to fulfil their obligations to replace 42% of it with RFNBO by 2030.**

FIGURE 2.5

Status of the REDIII transposition concerning hydrogen objectives by August 2025



If properly implemented and enforced, REDIII, together with ReFuelEU Aviation and FuelEU Maritime will create regulatory demand for RFNBO hydrogen of 2.8 Mt by 2030

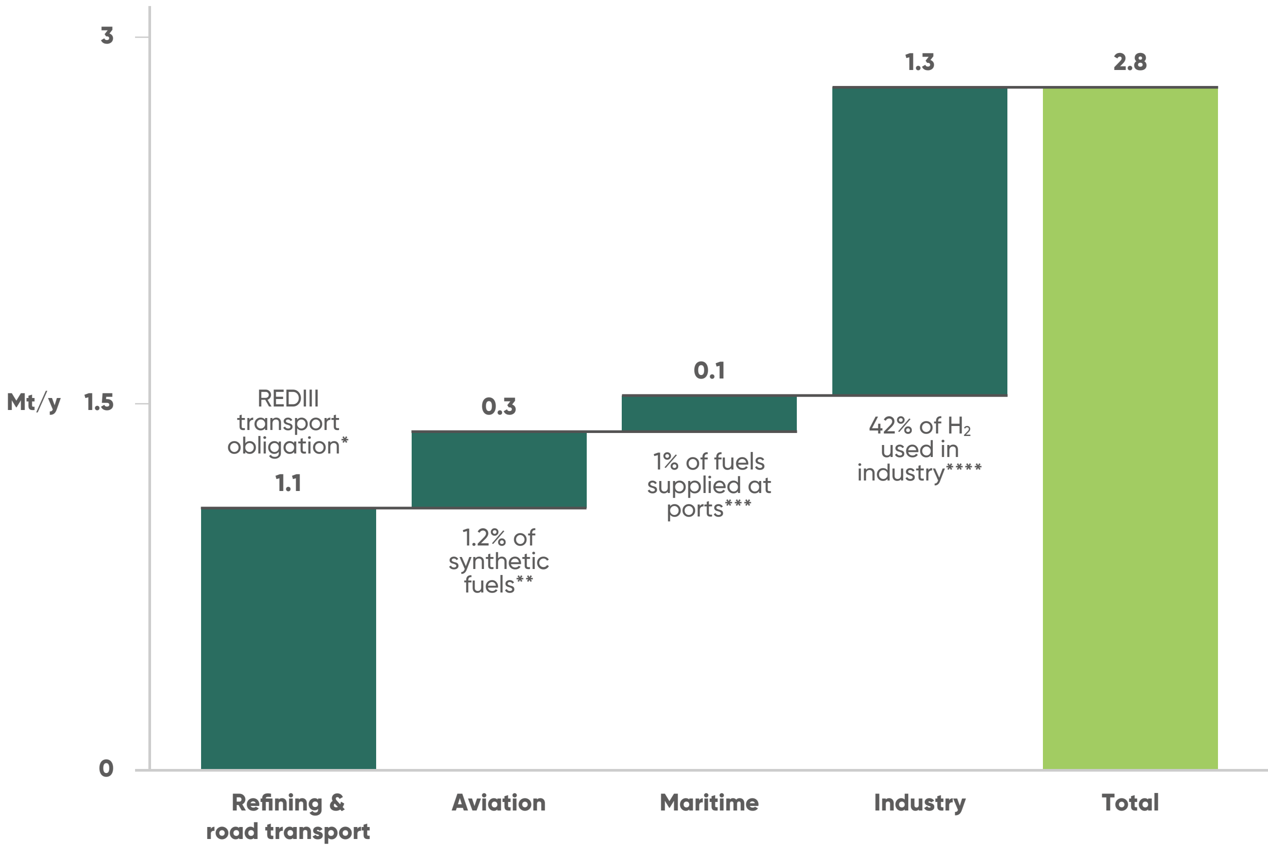
REDIII requires fuel suppliers to progressively replace conventional fuels with renewable alternatives. Specifically, 5.5% of all energy delivered must come from RFNBOs or advanced biofuels (incl. biohydrogen), with at least 1% exclusively from RFNBOs. This **should generate around 1.5 Mt of demand for RFNBO hydrogen in transport by 2030.** While large shares of RFNBO will likely be used as intermediate in fuel production and not directly as fuels, ReFuelEU Aviation and FuelEU Maritime regulations will ensure the use of clean hydrogen also in these two sectors. ReFuelEU Aviation requires at least 1.2% of aviation fuels in 2030 to be synthetic fuels based on RFNBO or electrolytic low-carbon hydrogen. FuelEU Maritime, reinforced by ETS, REDIII, and possibly also by the new IMO Net-zero Framework, should ensure at least 1% RFNBO market share. Together these regulations should drive **at least 450kt of clean hydrogen demand by 2030.**

Estimating the regulatory demand for RFNBO in industry is more difficult due to the uncertainty around the approach from Member States. So far only Romania has legislated the obligation, while others lean towards subsidies as the main tool. **If fully enforced this could generate around 1.3Mt of RFNBO hydrogen demand in industry by 2030.**

In total, the regulatory demand for RFNBO hydrogen by 2030 is estimated at around 2.8Mt. Additional demand for biohydrogen and hydrogen from waste is expected, but harder to quantify due to the absence of sub-targets.

FIGURE 2.6

Regulatory demand for RFNBO hydrogen in the EU by 2030



Notes: * Use of RFNBOs in refining and other transport estimated based on adopted or proposed REDIII transposition for countries that have done so and assuming 1% RFNBO share in road transport in countries that haven't.
** ReFuelEU Aviation requires aviation fuel suppliers to supply at least 1.2% as synthetic aviation fuels, based on renewable and low carbon electrolytic hydrogen.
*** The FuelEU Maritime 1% RFNBO share target is non-binding, however as REDIII required MS to take action to reach at least 1.2% share, it is assumed that the FuelEU Maritime objective will be reached.
**** The 42% RFNBO share in industry covers both existing hydrogen use in industries such as ammonia or methanol, but also new emerging industrial application for hydrogen i.e., primary steel-making.

REDIII transposition process is delayed, but suggests that the ambition for RFNBO use in transport will far exceed the minimum required level, leading to a potential 1.5 Mt demand by 2030

The REDIII transposition is not progressing smoothly prompting the European Commission to start infringement procedures against all but one Member State. When it comes specifically to the use of RFNBO in transport, only 4 countries so far have adopted regulations required to ensure the obligation is met (RO, CZ, DK and FI). Furthermore, the landscape emerging from the various regulatory proposals is very disjointed, with countries adopting different approaches to the level of targets, scope of the targets or applied multipliers. France even decided to include low-carbon fuels as a valid compliance option. Yet, despite these difficulties, **REDIII is already proving to be a major driver behind most transport related RFNBO production projects in development.**

Hydrogen Europe's previous transport demand expectation was far lower, at only 0.5 Mt/year by 2030, due to an assumption that Member States would opt for the minimum required of them. This risk has indeed materialised in some cases, where – like in Denmark and Czechia – the proposed transposition will only be sufficient to enforce half of the minimum 1% RFNBO share by 2030. However, with other countries deciding to implement obligations even more than 3x higher than the minimum (RO and FI), **the current estimate, based on adopted and advanced regulations, is at around 1.5 Mt/year in all transport sectors,** with around 1.1 Mt of that in road transport and refining.

FIGURE 2.7

Projected RFNBO share in transport by adjusting the final or draft fuel supplier obligations in selected EU countries, adjusted for multipliers

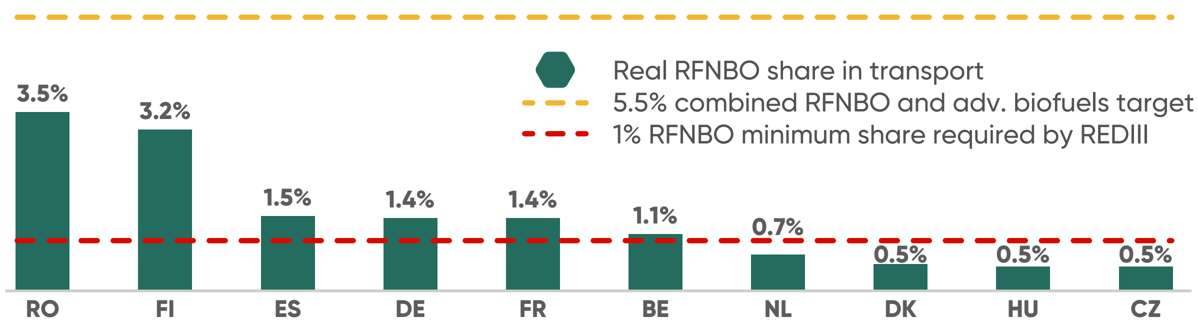
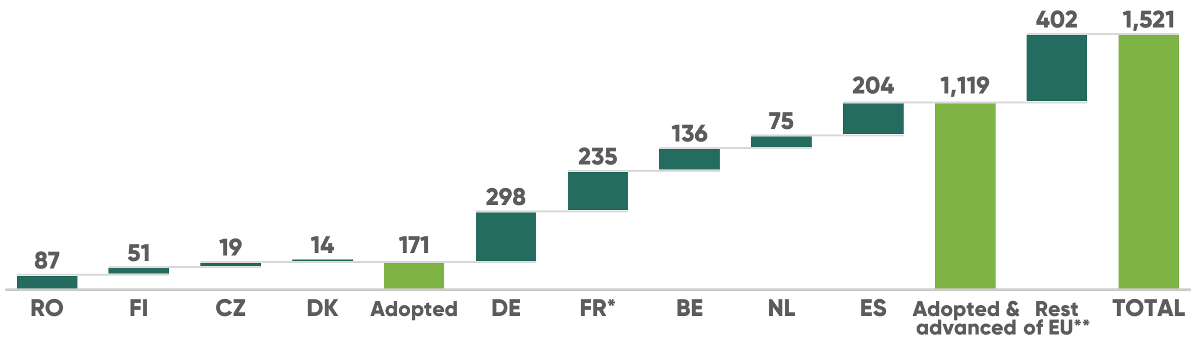


FIGURE 2.8

Estimated demand for RFNBO hydrogen by 2030 (in kt/y) driven by REDIII obligations in transport (incl. aviation and maritime)



Notes: * In France, the obligation for the use of hydrogen in road transport (1.5%) is also open for low-carbon electrolytic hydrogen (up to 0.8%).
** Quantity for the rest of Europe is calculated assuming that in all remaining countries the transposition will ensure at least a minimum 1% RFNBO share (in real terms). Data sourced from Hydrogen Europe.

2.2

European electrolytic outlook by 2030

Only 3% or 2.8 GW_{el} of Europe's electrolyser pipeline is under construction, however REDIII transpositions and national funding will unlock FIDs

3% of the 9.3 Mt (84.2 GW_{el}) electrolytic project pipeline capacity is under construction, representing just 0.3 Mt (2.8 GW_{el}). This is the same percentage as last year as neither FID activity nor the size of the pipeline has changed significantly. However, **there is a positive trend as 194 MW_{el} came online between September 2024 and July 2025, and 2,840 MW_{el} are under construction.** In comparison, between September 2023 and September 2024 156 MW_{el} came online and 2,600 MW_{el} were under construction.

Projects under construction are mainly concentrated in Nordic, Iberian, and Western European countries, driven by renewables availability, low-cost grid electricity, government support, and offtaker interest.

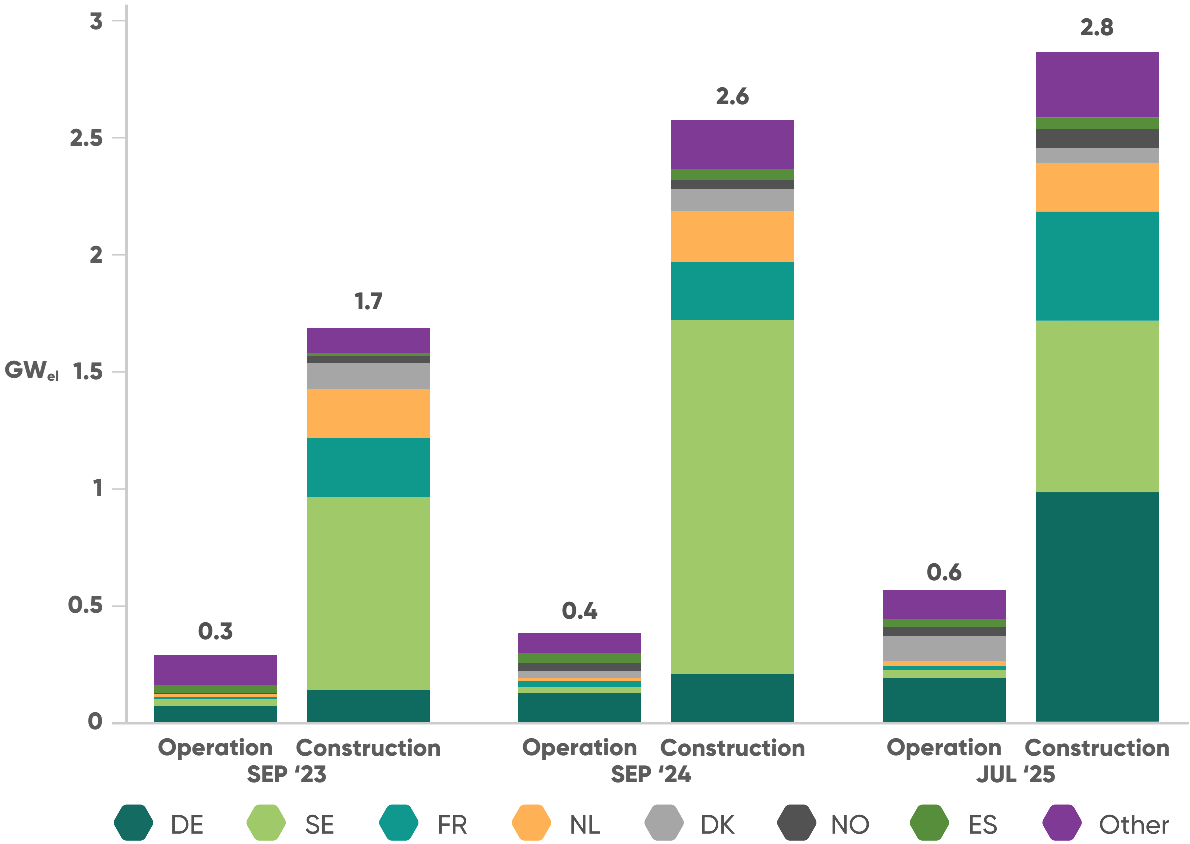
A common factor in project success is alignment between developers and offtakers aiming to be first movers. Spain attracts developers with its high renewable potential, while the Nordics offer affordable, low-carbon grid electricity. In Germany, most projects are near industrial clusters where first movers benefit from available grid capacity, opportunities to gain early operational experience, and government support.

The average project size is increasing. Between June 2024 and July 2025, the average size to come online was ~18 MW_{el}, compared to ~2.9 MW_{el} for the same period in 2023/24, a **520% increase.**

More FIDs are expected soon as REDIII targets are transposed and as countries continue to award national funding. Major markets where investment decisions are likely to include Spain, France, Portugal, the Netherlands, the Nordics, Germany, and the UK.

FIGURE 2.9

Operational and under construction water electrolysis capacity progression in Europe over the last three years to July 2025



Notes: The values represent installations larger than 0.5 MW_{el}. Hydrogen Europe's project tracking might omit installations smaller than 0.5 MW_{el} and in some cases the number of these installations can be significant.

The Nordics lead in clean hydrogen volumes by 2030 due to decarbonised grids and low electricity prices, but growth is limited by export infrastructure

The Nordics' forecasted electrolytic hydrogen supply by 2030 is 0.51 Mt (3.9 GW_{el}), similar to 0.53 Mt (4 GW_{el}) last year. Their decarbonised grids enable high utilisation, in turn lowering hydrogen costs. The forecast supply represents ~15% of the large project pipelines in the region reflecting these favourable conditions, with **26 GW_{el} and 3.4 Mt of electrolytic hydrogen projects announced by 2030.**

The largest project under construction is Stegra's 740 MW_{el} project for steel production. An additional 100 MW_{el} are under construction across the region, and almost 4 GW_{el} received European or national funding and thus have a higher likelihood of coming online.

Further supply potential is limited by the modest existing regional demand of 0.5 Mt (mainly refining) and insufficient export infrastructure to continental Europe and the Baltics. As a result, developers are pivoting towards derivative products like ammonia, methanol, and e-fuels, like e-SAF and e-methane, for transport to Europe. In addition, greenfield steel projects are able to absorb large domestic production.

The existing regulatory demand for Denmark, Finland, and Sweden of 0.18 Mt is mostly due to REDIII transport target, FuelEU Maritime, and ReFuel EU Aviation. Surprisingly, refinery-related demand plays only a minor role among developers.

FIGURE 2.10

Electrolytic supply outlook and regulatory demand in the Nordics by 2030

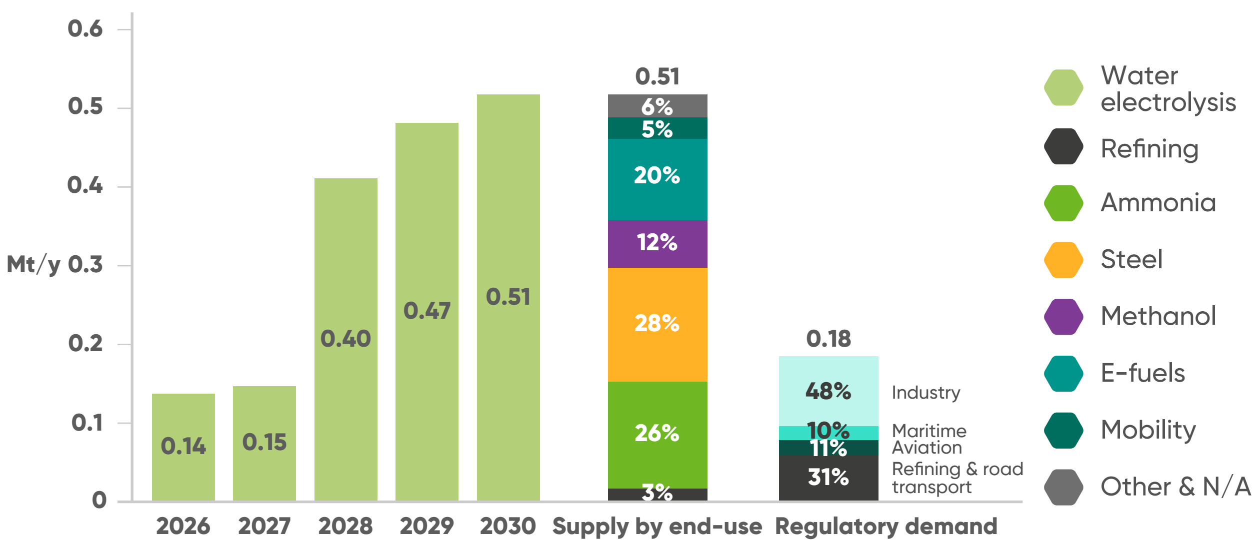
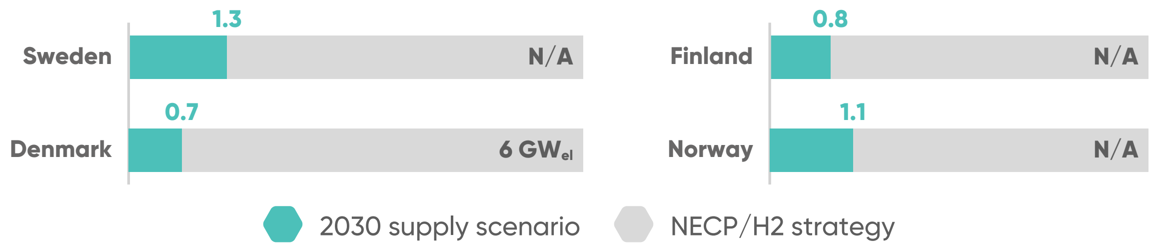


FIGURE 2.11

Electrolytic supply scenario in GW_{el} by 2030 and NECP or H_2 strategy targets



Notes: Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses. Finland's NECP aims to deploy 200 MW_{el} of electrolysis by 2025 but has not defined 2030 ambition. Regulatory demand is calculated based on 2024 consumption and does not omit any volumes from the target due to specific national exclusions. Displayed regulatory demand doesn't include Norway as it is not part of the EU.

Benelux is emerging as a hydrogen hub, with large industrial demand and infrastructure; it will rely on imports and low-carbon hydrogen to meet targets

Benelux's forecasted electrolytic hydrogen supply by 2030 is 0.13 Mt (1.5 GW_{el}), down from 2024's estimate of 0.17 Mt (2.4 GW_{el}). This represents ~20% of the region's estimated 0.6 Mt (7.7 GW_{el}) project pipeline. About 0.44 GW_{el} is currently under construction, and an additional 1.6 GW_{el} have received national or EU funding. The Dutch national ambition is 3-4 GW_{el} of capacity by 2030 but is expected to reach only ~1.4 GW_{el}.

Most of the capacity under construction includes Shell's Holland Hydrogen 1 and Air Liquide's ELYgator projects in the NL, and Virya Energy's 25 MW_{el} HyoffWind in BE. In July 2025, 11 Dutch projects were awarded subsidies, totalling ~0.6 GW_{el} of electrolysis capacity. **With a mandated realisation period of 5-7 years, part of this capacity is likely to be operational by 2030.**

With large industrial clusters and major ports, Benelux consumes ~1.4 Mt of hydrogen per year. Further development in the NL is constrained by high electricity grid fees but supported by significant regulatory demand. **RFNBO targets are estimated at 0.32 Mt in the NL and 0.22 Mt in BE,** while only 0.13 Mt of domestic electrolytic supply is expected. **Both countries are therefore positioning themselves as import and transit hubs.**

The Dutch and Belgian governments are also working on the REDIII industry target to allow low-carbon hydrogen to account towards industry target obligations, especially in retrofitted SMR plants already under construction in the Port of Rotterdam.

FIGURE 2.12

Electrolytic supply outlook and regulatory demand in Benelux by 2030

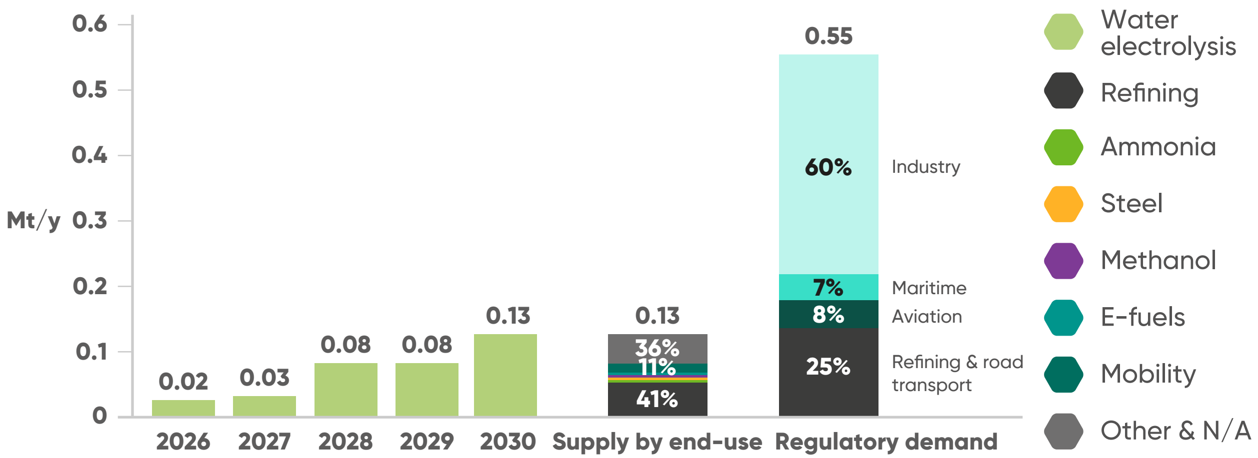
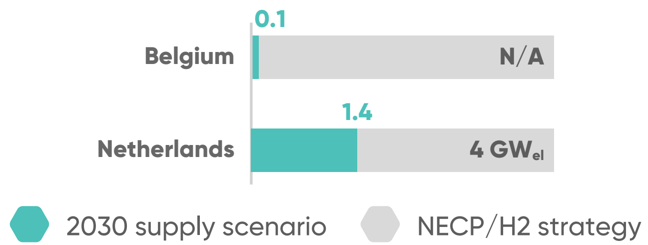


FIGURE 2.13

Electrolytic supply scenario in GW_{el} by 2030 and NECP or H_2 strategy targets



Notes: Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses. Regulatory demand is calculated based on 2024 consumption and does not omit any volumes from the target due to specific national exclusions. Belgium NECP aims to deploy 150 MW_{el} of electrolysis by 2026, but no defined 2030 ambition.

Iberia's strong renewables and ambitious targets drive hydrogen project interest, but export constraints and REDIII transposition shifts focus to domestic refining demand

The supply forecast for Iberia (Spain and Portugal) reaches 0.39 Mt (3.9 GW_{el}) by 2030, up from 0.35 Mt (3.7 GW_{el}) in last year's estimate. **The region's high renewable energy potential, limited grid capacity, and structural oversupply of cheap renewables continue to position it as a key future hydrogen producer.** The 3.9 GW_{el} represents only 17% of the regional project pipeline and less than 1/3 of the countries' ambitions presented in their NECPs/ Hydrogen Strategies.

So far, few projects have reached FID. The largest under construction include GALP's 100 MW_{el} refinery project in Sines and BP's 25 MW_{el} plant in Castellon. Most large projects that received EU or national funding are still waiting to take FID, including MadoquaPower2X 500 MW_{el} (Portugal), Moeve's Onuba 400 MW_{el} (Spain), and CIP's Catalina 500 MW_{el} project (Spain). Together with 2025 Hydrogen Bank results, more than **5 GW_{el} have been awarded funding in Spain but have yet to take FID. Many depend on grid connection permits, environmental approvals, and hydrogen grid timelines.**

The current hydrogen demand in Iberia stands at 0.7 Mt, with 0.6 Mt for refining. Regulatory demand totals 0.27 Mt, which could be met by domestic production.

In the absence of pipeline exports, developers focus on hydrogen derivatives like ammonia, while several announced projects are geared toward serving local refining demand to meet REDIII targets. Spain's draft REDIII transposition may further shift export-oriented projects toward the domestic market, especially refining.

FIGURE 2.14

Electrolytic supply outlook and regulatory demand in Iberia by 2030

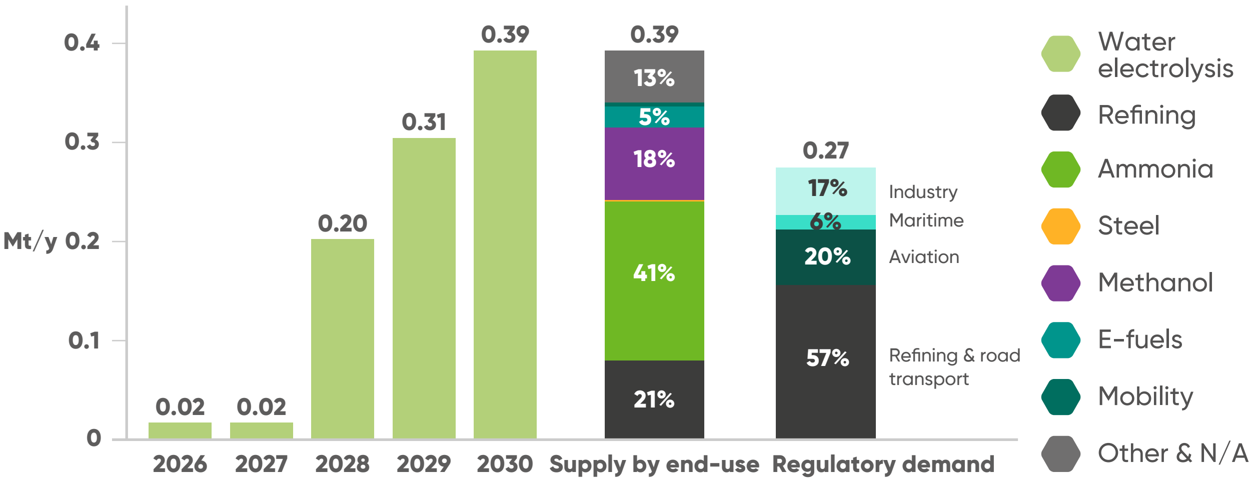
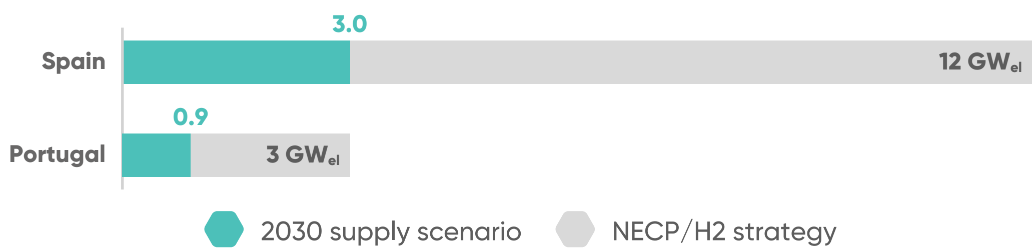


FIGURE 2.15

Electrolytic supply scenario in GW_{el} by 2030 and NECP or H_2 strategy targets



Notes: Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses. Regulatory demand is calculated based on 2024 consumption and does not omit any volumes from the target due to specific national exclusions.

Germany's regulatory demand will be largely unmet due to insufficient offtake incentives; with limited domestic supply potential, imports and infrastructure will play a key role

Germany's forecasted electrolytic hydrogen supply by 2030 is 0.25 Mt (2.2 GW_{el}), slightly down from 0.28 Mt (2.9 GW_{el}) last year. This represents 23% of Germany's 1.03 Mt (10.5 GW_{el}) project pipeline. **The NECP targets 10 GW_{el} by 2030, with nearly 1 GW_{el} already under construction,** including among others EWE's 280 MW_{el} Clean Hydrogen Coastline, RWE's 300 MW_{el} GetH2Nukleus, Shell's 100 MW_{el} Refhyne 2, and Salzgitter's 100 MW_{el} SALCOS.

In 2024, 0.77 Mt (52%) of Germany's 1.46 Mt hydrogen demand went to refining, and 0.33 Mt to ammonia. **Forecasted domestic supply could meet only 18% of total demand. Recent REDIII implementation proposals imply 0.6 Mt of regulatory demand by 2030, more than double the expected domestic supply.** Depending on adopted penalties, domestic supply is likely to focus on refining as is evident in the intended end-use of supply projects and existing FIDs.

Although the REDIII targets do not account for hydrogen demand in steel making, Germany granted **state aid for DRI** under conditions to progressively consume RFNBOs before 2030. The timeline and volume of clean hydrogen uptake in steel depends on ongoing negotiations between the German government, industry, and the European Commission.

Similarly to Benelux, Germany will rely on hydrogen and derivative imports as outlined in its import strategy. Its hydrogen core network will distribute imported hydrogen and connect producers in the north with consumers elsewhere. Few other countries have as many supply-only projects dependent on pipelines.

FIGURE 2.16

Electrolytic supply outlook and regulatory demand in Germany by 2030

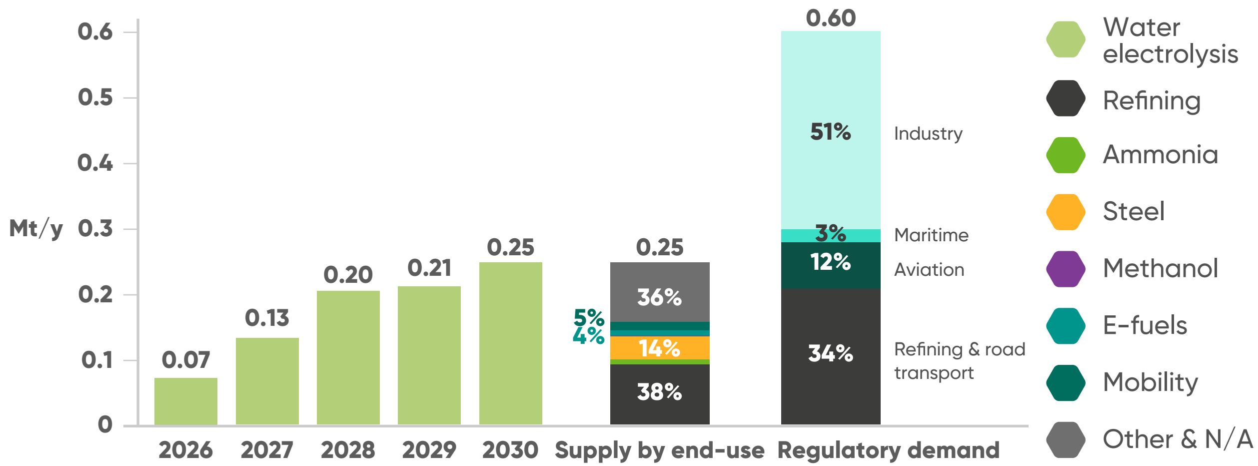
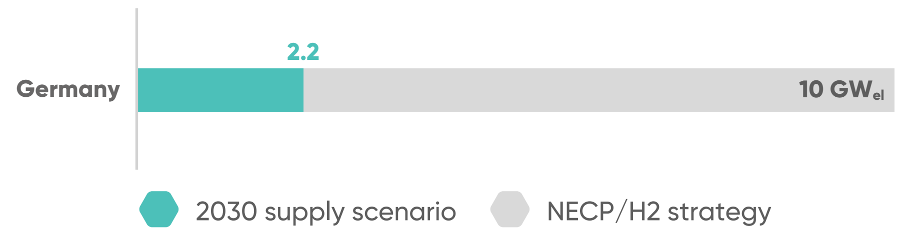


FIGURE 2.17

Electrolytic supply scenario in GW_{el} by 2030 and NECP or H_2 strategy targets



Notes: Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses. Regulatory demand is calculated based on 2024 consumption and does not omit any volumes from the target due to specific national exclusions.

France's hydrogen ambitions face delays and a supply gap; more incentives are needed to meet regulatory demand and boost domestic production

France's forecasted electrolytic hydrogen supply by 2030 reaches 0.17 Mt (1.25 GW_{el}), similar to last year's forecast. This accounts for 15% of its electrolytic project pipeline, which totals 1.13 Mt (8.2 GW_{el}).

The latest French hydrogen strategy targets **4.5 GW_{el} of capacity by 2030, but only 0.27 GW_{el} is under construction.** There is only one large project past FID (Airliquide's Normand'Hy 200 MW_{el}) and multiple others in the 5 to 20 MW_{el} range. **FIDs have been limited due to lack of funding and uncertainty regarding nuclear electricity treatment under the Low Carbon Delegated Act.** The government is currently evaluating results from its CfD mechanism aimed at supporting 1 GW_{el} of electrolysis.

Demand in 2024 amounted to 0.55 Mt and the **draft REDIII transposition could lead to regulatory demand of 0.32 Mt, which will be largely unmet under current market and funding conditions.** As French strategic documents focus on local hydrogen production, this gap could trigger more support for domestic supply projects to meet targets in transport (including refining), maritime, aviation, and existing industrial uses such as ammonia. The regulatory demand sectors are well reflected among the projects in the pipeline, with projects aimed at refining, e-fuels (e-SAF for aviation) and methanol (much of it for methanol-to-jet) having large capacities.

While domestic infrastructure development is relatively limited, French and Spanish gas TSOs are advancing on the Barcelona-Marseille leg of the H2Med project, potentially enabling imports from Iberia.

FIGURE 2.18

Electrolytic supply outlook and regulatory demand in France by 2030

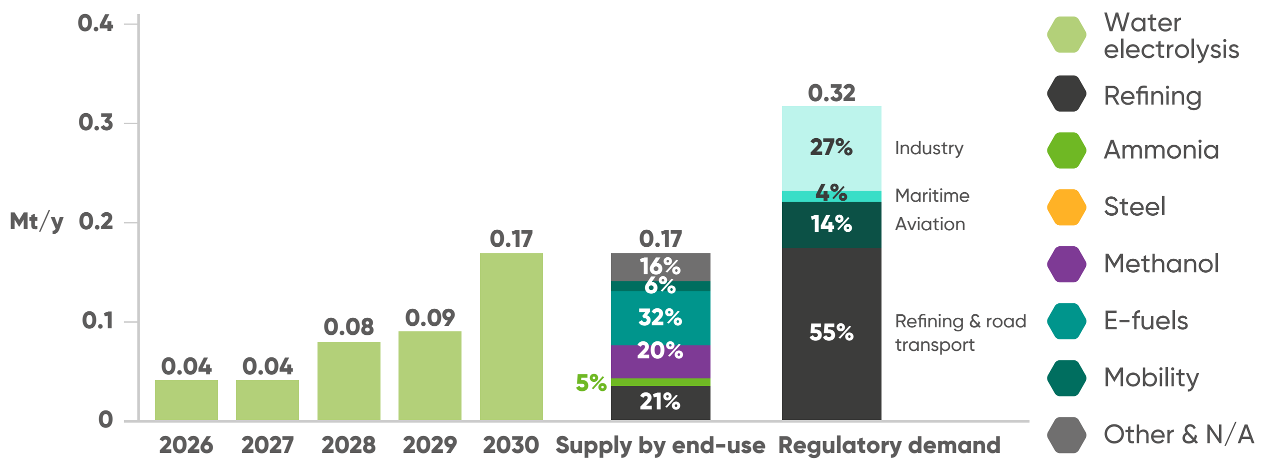
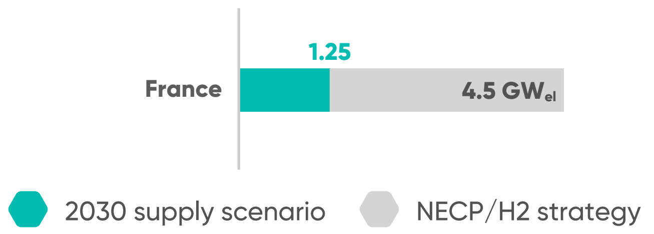


FIGURE 2.19

Electrolytic supply scenario in GW_{el} by 2030 and NECP or H_2 strategy targets



Notes: Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses. Regulatory demand is calculated based on 2024 consumption and does not omit any volumes from the target due to specific national exclusions.

The UK is expected to reach 1 GW_{el} of electrolysis capacity by 2030 despite limited FIDs, driven by solid funding support from HAR1 and HAR2

The UK's forecasted electrolytic hydrogen supply by 2030 reaches 0.12 Mt (1.05 GW_{el}), similar to last year's forecast and well below the government's 5 GW_{el} target by 2030. This accounts for 25% of its electrolytic project pipeline, which totals 0.47Mt (4 GW_{el}).

Deployment is supported by the Hydrogen Allocation Rounds (HAR) via Contracts for Difference (CfD). **HAR1 aimed to allocate 125MW_{el}. In July 2025, 10 projects signed low-carbon hydrogen agreements at an average strike price of ~€9.2/kg.** These projects are expected to reach FID soon, begin construction, and become operational before 2030.

HAR2 targets up to 875 MW_{el} of additional capacity by 2029. Its 27 shortlisted projects, most of which are significantly larger than those in HAR1, are still in negotiation. A third HAR is expected after 2026 and is unlikely to deliver operational capacity by 2030.

Because of the availability and generosity of public funding, few projects have progressed outside of these allocation rounds. As a result, most capacity is projected to come online only in 2029 or 2030. Planned end-uses include refining, ammonia, and other industrial processes.

The UK government remains committed to electrolytic hydrogen production and plans to exempt electricity used in electrolysis from the Climate Change Levy. The government is developing an economic regulatory framework for hydrogen transport infrastructure, including pipelines, to support the scale-up of regional production hubs and enable future electrolytic deployment.

FIGURE 2.20

Electrolytic supply outlook in the United Kingdom by 2030

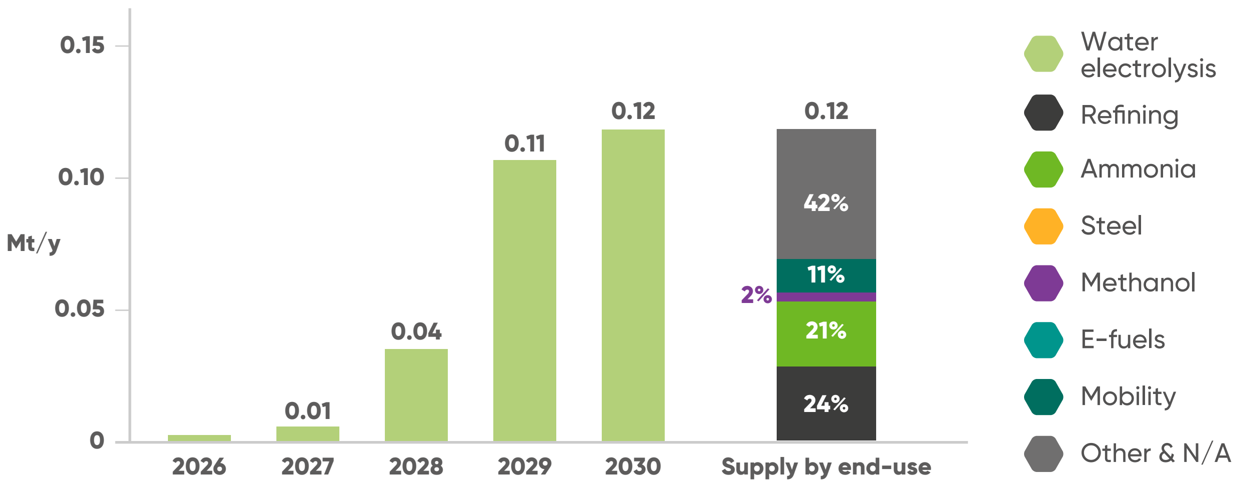
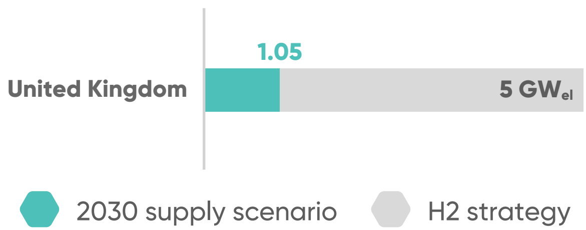


FIGURE 2.21

Electrolytic supply scenario in GW_{el} by 2030 and H_2 strategy targets



Notes: Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses.

Central Europe remains the least ambitious region relative to current demand as it struggles with high RFNBO costs and slow infrastructure development

The central European countries (CZ, SK, PL, and HU) face similar constraints for clean hydrogen production. The **electrolytic supply forecast for the region is just 0.04 Mt (0.4 GW_{el}) by 2030, doubling from last year, but small compared to expected regulatory demand of 0.35 Mt and current demand of 1.1 Mt.**

The regional project pipeline remains small at 0.11 Mt (0.9 GW_{el}) due to **high production costs and limited renewable energy deployment making RFNBO production particularly challenging.** For example, all of Slovakia's installed wind and solar capacity would be insufficient to produce RFNBO hydrogen for its ammonia plant.

The largest operational project remains MOL's 10 MW_{el} electrolyser at its refinery in Hungary. Larger FIDs are expected in the next two years from funded projects such as Polenergia's 105 MW_{el} H2Silesia, Orlen's 100 MW_{el} Gdansk project and Hydrogen Eagle.

Central Europe consumes 14% of European hydrogen, with Poland alone accounting for 9%. Refineries and fertiliser plants across the region create regulatory demand of 0.35 Mt. While Czechia targets 400 MW_{el} and Hungary 240 MW_{el}, these ambitions will be largely unmet under current conditions. Based on this outlook, **only 11% of the region's regulatory demand would be met if REDIII targets were transposed in full.**

Imports could help bridge the gap, but grid development is slow. PCI projects are underway to bring hydrogen from the Baltics and connect to the European backbone via Czechia, but these are unlikely to materialise before 2030.

FIGURE 2.22

Electrolytic supply outlook and regulatory demand in Central Europe by 2030

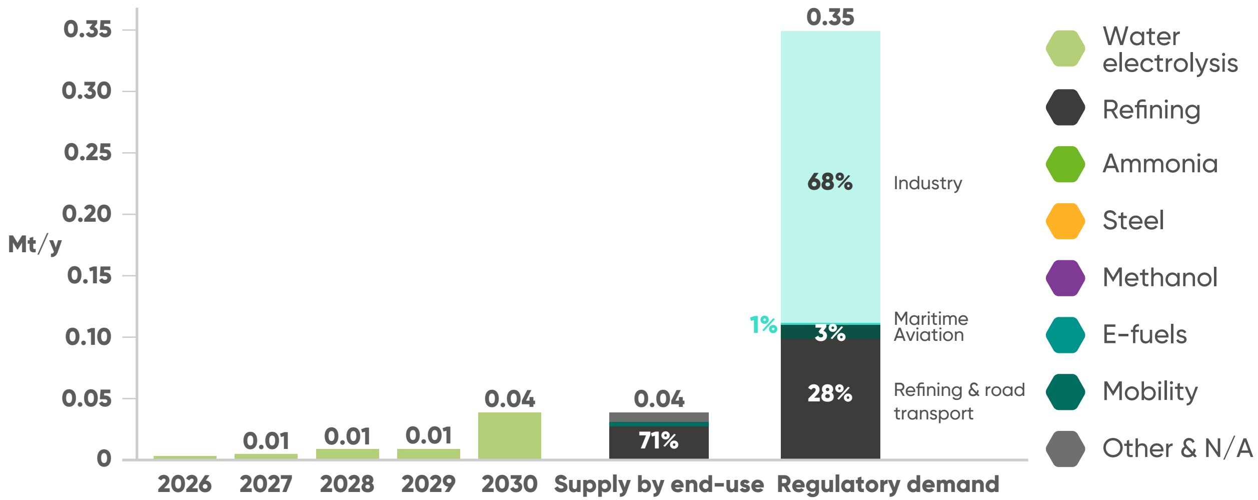
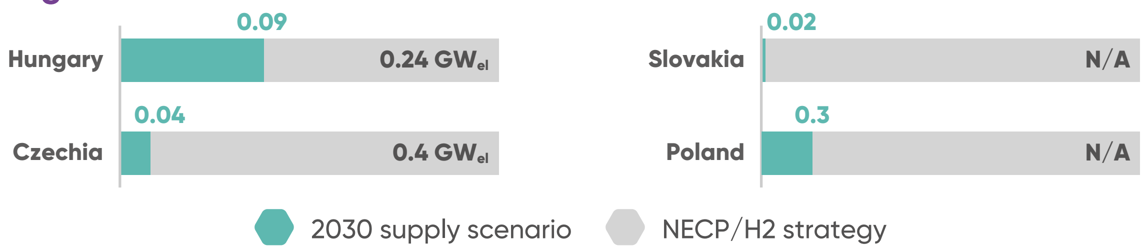


FIGURE 2.23

Electrolytic supply scenario in GW_{el} by 2030 and NECP or H_2 strategy targets



Notes: Other & N/A end-uses include industrial heat, power generation, residential heat, blending, other industry, and undefined end-uses. Regulatory demand is calculated based on 2024 consumption and does not omit any volumes from the target due to specific national exclusions. Poland's NECP estimates around 2GW for low carbon sources by 2030, this includes both electrolytic and thermochemical.

Current policies and market conditions suggest Europe may reach just a fraction of its 2030 hydrogen goals, with deployment likely falling well below national targets

This outlook forecasts the deployment of ~13 GW_{el} electrolysis capacity in EU-27 by 2030 while regulatory demand in the EU is projected to be 2.8 Mt by 2030, requiring around 26 GW_{el} of electrolysis capacity.

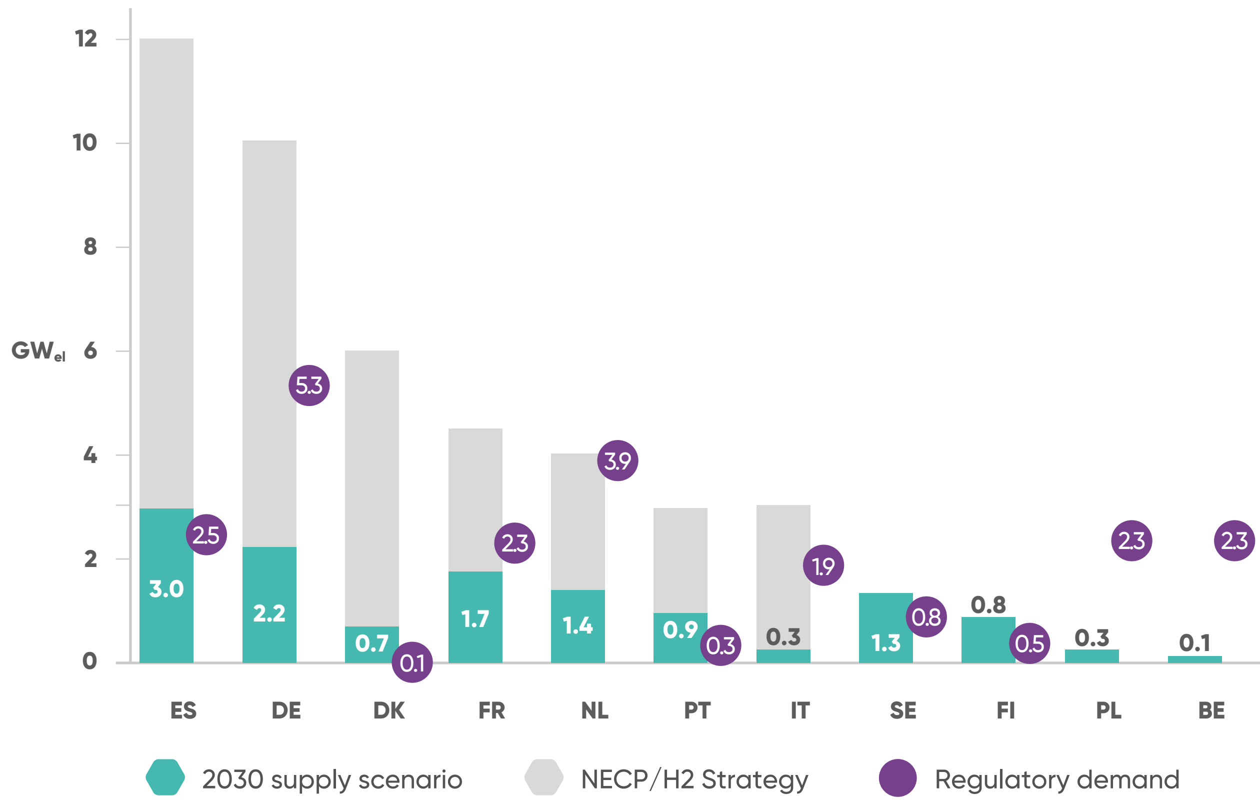
At national level, only 14 out of 27 Member States have set electrolyser targets to 2030, totalling to a combined goal of 48 GW_{el} . Most countries' NECPs and hydrogen strategies exceed what is realistically deployable. Given this outlook, which forecasts ~13 GW_{el} of electrolytic hydrogen supply from domestic production, **only 27% of the total projected targets outlined in the NECPs and hydrogen strategies are expected to be achieved by 2030.**

Spain has the EU's largest electrolyser target (12 GW_{el} by 2030). Although only a quarter is expected to be achieved, it would be enough to satisfy its regulatory demand. France lowered its electrolyser target from 6.5 GW_{el} to 4.5 GW_{el} by 2030, but its expected outlook won't be enough to satisfy its regulatory demand. Italy has set an ambitious electrolyser target of 2.7 GW_{el} and has an expected regulatory demand of ~1.9 GW_{el} by 2030, however this outlook estimates only 0.3 GW_{el} will be installed by 2030.

Existing market and regulatory conditions are not sufficient to trigger the needed investments. Most countries will likely achieve only 20-30% of their NECP ambitions by 2030.

FIGURE 2.24

Electrolytic supply outlook by 2030 vs NECP/hydrogen strategies and regulatory demand in selected countries by 2030



Notes: Poland's NECP estimates around 2GW for low carbon sources by 2030, this includes both electrolytic and thermochemical, therefore it has been omitted from this figure which includes only electrolytic supply.

2.3

European clean thermochemical outlook by 2030

With 0.3 Mt under construction, Europe's 2030 clean thermochemical hydrogen outlook stands at 0.6 Mt, down 25% due to slow progress in UK and Benelux projects

The total clean thermochemical hydrogen outlook for 2030 in Europe decreased by 25% from last year's 0.8 Mt to 0.6 Mt despite 0.3 Mt currently under construction. This is due to limited developments in the UK and Benelux where despite progress on CO_2 infrastructure, thermochemical production has been delayed.

Benelux offers favourable conditions due to ports, hydrogen pipelines, and CO_2 infrastructure. In Rotterdam, Air Products, Air Liquide, and Yara are retrofitting SMRs with CCS, supported by SDE++. **These contribute to 0.36 Mt of expected supply, mostly for refining,** followed by ammonia. **Dutch and Belgian governments aim to count low-carbon hydrogen towards REDIII industry targets,** increasing CCS retrofit appeal, especially with CO_2 infrastructure like Porthos.

In the UK, approx. £20 billion in government support for HyNet and East Coast Clusters has advanced CO_2 infrastructure. However, **only 0.12 Mt of the 1.2 Mt pipeline is expected by 2030, down from 0.3 Mt,** due to delays.

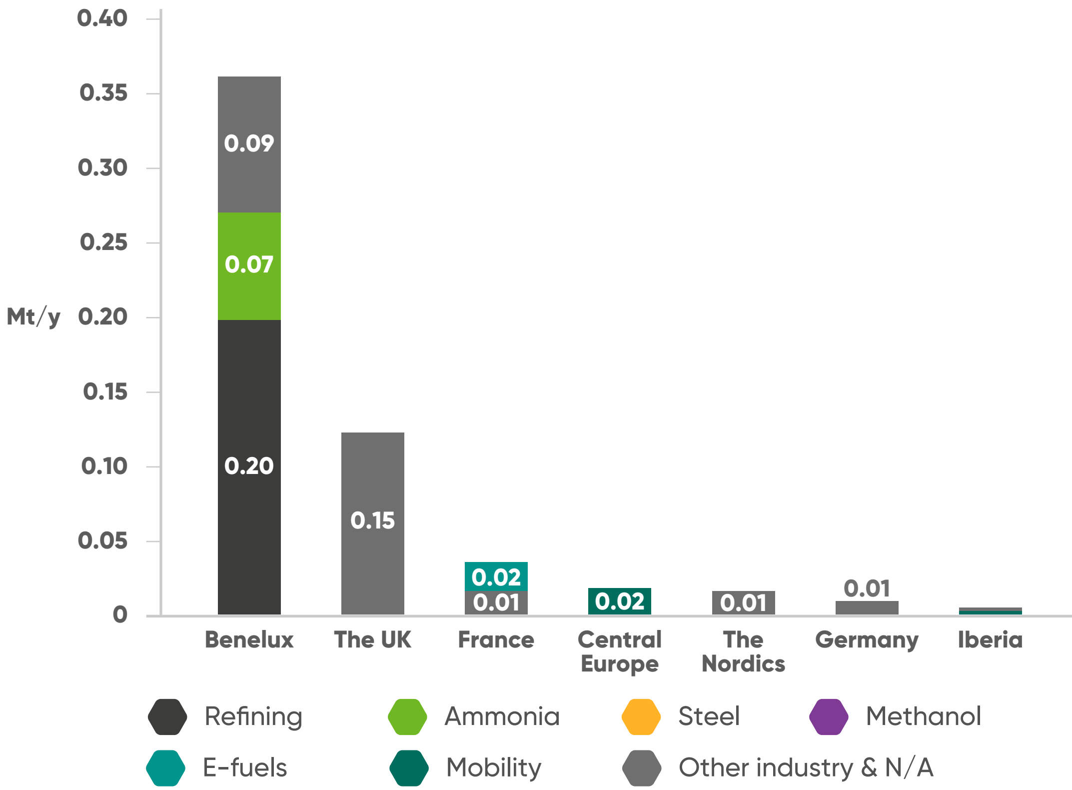
Plans exist for CCS retrofits in France, mostly for refining. In Norway, no major production projects are expected by 2030 despite developing CO_2 storage infrastructure, due to limited demand and export infrastructure.

In **Germany, Iberia, Central Europe, and France, methane splitting and waste-to-hydrogen projects** are emerging at pilot or small commercial scale.

Clean thermochemical hydrogen is not driven by mandatory targets, which, except for FuelEU Maritime, are mostly reserved for RFNBO and advanced biofuels. As lower-emission fuels, they can however reduce ETS/CBAM compliance costs.

FIGURE 2.25

Clean thermochemical supply outlook in selected regions in Europe by 2030 by intended end-use



Notes: Clean thermochemical hydrogen production includes reforming, gasification, or partial oxidation of fossil fuels coupled with CCS of the emissions, methane splitting, biowaste-to-hydrogen, non-biological waste-to-hydrogen. The developers using these production pathways want to produce abated hydrogen and thus the assumption is that the emissions will be maximum 3.38 $kgCO_2/kgH_2$. It is important to point out that many of the FIDed projects in this category are retrofitting carbon capture technology on existing SMRs. The capture intensity is difficult to identify but the emission intensity could be above or below the 3.38 $kgCO_2/kgH_2$.

2.4

Imports within and to Europe

Intra-EU hydrogen trade can support 2030 REDIII targets, but infrastructure is needed, and extra-EU imports will be required

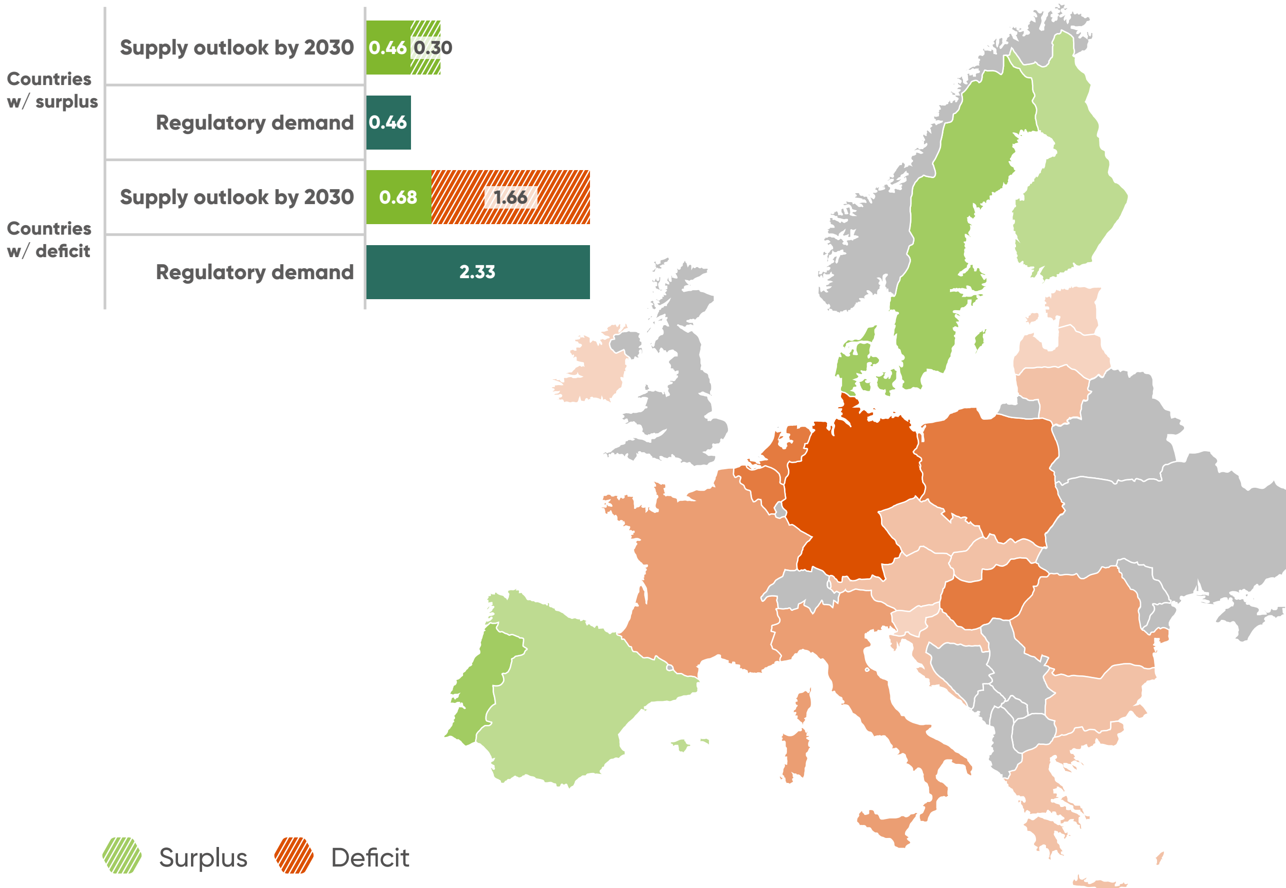
Regulatory demand in the EU by 2030 could amount to ~2.8 Mt of renewable hydrogen. **For countries with high industrial demand, such as Benelux, Germany, and parts of Central Europe, producing these volumes competitively may not be feasible.**

By 2030, these regions could face a deficit of around 1.6 Mt/year compared to regulatory targets. Part of this gap could be covered by intra-EU flows, as Iberia and the Nordics could produce 0.3 Mt/year more than needed to satisfy targets, based on the 2030 outlook. This highlights the urgent need for cross-border infrastructure (especially pipelines and import/export terminals for hydrogen derivatives) and coordinated EU-wide funding to enable internal market flows. Without accelerated efforts, ~1.3 Mt/year may need to come from extra-EU imports, or it will not be met.

Germany plans to import 50–70% of its 2030 hydrogen demand, while Belgium is developing 3 import terminals. Cross-border pipeline projects are advancing, including H2Med, recently backed by EU funding, and the SouthH2 Corridor, now entering permitting. In contrast, Equinor's Norway–Germany pipeline was cancelled, and others are slightly delayed (DK to DE, NL to DE) due to regulatory and demand uncertainties. Cross-border partnerships are emerging including those by TotalEnergies with RWE and Air Liquide. Maritime shipment agreements are also emerging with Spain and Norway planning exports to the Netherlands and Germany (Moeve to the ACE Terminal in Rotterdam and North Ammonia to the Höegh Evia terminal in Lubmin).

FIGURE 2.26

Electrolytic hydrogen supply outlook vs. regulatory demand in 2030: national surpluses and deficits



Notes: Regulatory demand is calculated based on 2024 consumption and does not omit any volumes from the target due to specific exclusions. Countries in grey on the map are not included in the analysis.

Extra-EU imports of hydrogen and hydrogen derivatives will play a role in the mid to long-term future to help meet Europe's energy needs and decarbonisation goals

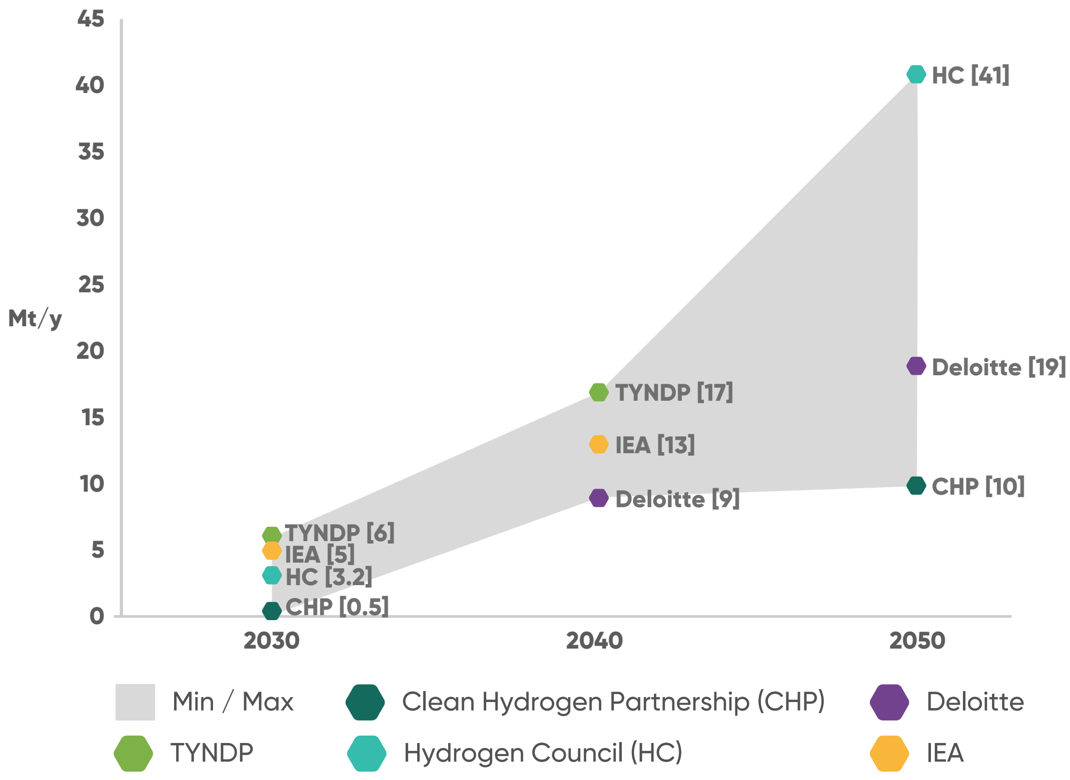
Imports of clean hydrogen and its derivatives are expected to play a significant role in meeting European hydrogen demand in the coming decades. Europe is a net energy importer, **in 2023 Europe imported 58.4% of its energy consumption[1].** Europe's size and population density, diverse landscapes, and varied renewable energy potential make clean hydrogen imports a necessary complement to domestic production in reaching climate and industrial decarbonisation goals. **Current clean hydrogen trade into Europe remains minimal.** However, ammonia and methanol, with high contents of hydrogen are globally traded commodities.

Modelling exercises and import expectations conclude that Europe will likely be a large importer of hydrogen and its derivatives, however, import volumes and exporting regions differ across studies. As shown in figure 2.27, **Europe could import between 10-41 Mt/y of clean hydrogen and its derivatives by 2050.** The main exporting regions include the US, North Africa, Australia, the Middle East and Latin America. The projections to 2050 vary widely, reflecting uncertainty in market developments, infrastructure readiness, and domestic production capabilities in Europe.

To facilitate clean hydrogen imports to Europe **further infrastructure development is needed across all hydrogen carriers.** Existing infrastructure (terminals, ships & pipelines) can be used or repurposed for the import of ammonia, methanol, and e-kerosene, however more investment and scale-up is needed. Pipeline infrastructure projects which could facilitate hydrogen imports are currently underway, with a pipeline being developed to connect North Africa to Europe.

FIGURE 2.27

Potential import volumes of clean hydrogen into Europe based on various scenarios from 2030 to 2050



Notes: The studies represented on figure 2.27 can be found here. IEA refers to 'IEA Global Hydrogen Review 2024', Hydrogen Council refers to 'Global Hydrogen Flows 2023', TYNDP refers to 'TYNDP 2024 Final Scenarios Report', Deloitte refers to 'Hydrogen4EU 2022' and Clean Hydrogen Partnership refers to the joint Deloitte study 'Study on Hydrogen in Ports and Industrial Coastal Areas 2023'. Where a report has more than one modelling scenario, the more conservative scenario was chosen for this figure.

Only 20% of hydrogen import agreements to Europe so far are legally binding, totalling some 0.3Mt of hydrogen equivalent, with ammonia as the preferred carrier

Signed offtake agreements tracked by BloombergNEF show ~2.2 MtH_2/y of announced clean hydrogen imports to Europe by 2030[2]. **So far, only ~20% (~0.3 MtH_2/y) are legally binding, with >50% considered early concept agreements.**

Ammonia is expected to be the dominant hydrogen carrier by 2030, followed by methanol and e-fuels.

Europe can enhance its import readiness by following models from Japan and South Korea. Both are preparing to import large volumes of clean hydrogen and its derivatives by advancing long-term contracts between suppliers and offtakers, infrastructure investments, public-private coordination, and tools like auctions and certification schemes.

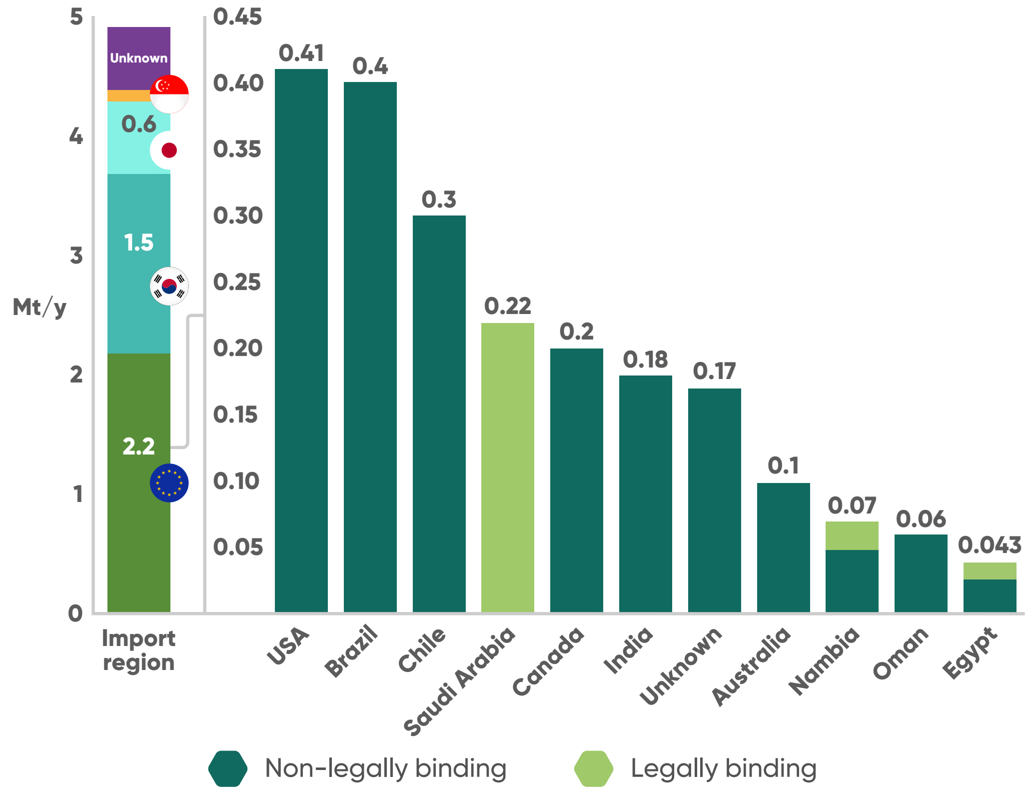
In Europe, Germany's H2Global is a first-mover instrument. One early beneficiary is Fertiglobe's Egypt green hydrogen project, set to deliver green ammonia to Germany from 2027. Other deals include NEOM's project in Saudi Arabia which has signed two legally binding offtake agreements to Europe totalling 0.22 MtH_2/y. Namibia has secured a similar binding agreement with Germany for green steel, equating ~0.02 MtH_2 /y.

The second H2Global auction, launched in February 2025, includes four regional lots (North America, South America & Oceania, Africa, and Asia) for hydrogen, ammonia, or methanol, and one global hydrogen lot. Total budgets are €474 million (per region) and €567 million (global), which could equate to approximately 0.5 MtH_2 over a period of 10 years.

While H2Global helps de-risk early international projects, its national scope and limited funding highlight the need for broader EU coordination and a scaled-up, pan-European import mechanism.

FIGURE 2.28

Potential largest exporting countries to Europe by 2030 based on the legitimacy of signed offtake agreements as tracked by BloombergNEF



Notes: Data is from BloombergNEF's Hydrogen Offtake Agreements Database last accessed June 2025, and H2Global's Fertiglobe offtake agreement. H2Global second auction hydrogen supply estimation was based on the €2.5 billion total budget and assuming HPA price of 5€/kg of hydrogen based on results of 1st auction.

Methodological Note

GEOGRAPHICAL SCOPE: This chapter covers 32 countries in the EU, the European Free Trade Area, and the UK, which are referred to as "Europe" in the text. Results in this chapter may purposefully exclude some countries depending on the quantity and quality of the collected information. Reference to the EU covers only the 27 countries of the European Union.

PROJECT PIPELINE METHODOLOGY: The list of projects that form a basis for the project pipeline and subsequent supply outlook analysis have been collected by Hydrogen Europe from both public and confidential sources. The authors collected this information to the best of their abilities but cannot guarantee the absolute completeness or accuracy of the collected data. The authors have adopted an inclusive approach when compiling this list of projects to develop the most exhaustive compilation of European power-to-hydrogen/water electrolysis and clean thermochemical projects. The data collection closed in early July 2025.

The authors are not judging the feasibility of announced facilities but are reporting various public and private data points. As a result, project pipeline outputs include projects in all stages from concept, feasibility study, preparatory stage (FEED, detailed design, and permitting), and construction (post FID). Advanced projects refer to projects either under construction or in a preparatory stage. If the authors of this report refer to specific projects and provide any project details, this information is public. Years refer to end of the year. By 2030 refers to "by the end of 2030". While project announcements are common for hydrogen production projects, cancellations are rarely publicised. The authors cancel projects if they find confirmation or if there are no news for at least 18 months. If only estimate ranges have been given for capacity or start dates, the authors adopted the average of the provided values.

The term "project" refers to an individual project or a project phase with a separate FID. One project can have multiple phases that gradually enlarge its capacity. For the purposes of this report, each phase of a project with three phases of 10 MW_{el}, 100 MW_{el}, and 300 MW_{el} in the same location and with the same project partners is counted as a separate project.

UTILISATION ASSUMPTIONS: The data on collected projects tracks their production capacity in MW_{el} (electrolysis) and MW (thermochemical) respectively. To achieve outputs in Mt of hydrogen, the following utilisation assumptions have been used:

Thermochemical/clean thermochemical - 8,000 hours a year at full capacity.

Power-to-hydrogen/water electrolysis – For projects connected to the grid, capacity factors are based on the results from European Hydrogen Bank pilot and second auction. For countries with no or few projects in the European Hydrogen Bank auctions, assumptions were based on country characteristics. In real life, there will be grid connected projects that will have significantly higher and lower utilization than those assumed. For projects that are planning to be directly connected to their renewable energy sources and do not plan to rely on a grid connection, the electrolyser capacity factor is equal to solar/onshore wind/offshore wind's capacity factor for the top 10% available locations in that Member State as reported by Joint Research Centre's ENSPRESSO dataset from 2019 and adjusted for oversizing the renewables to the electrolyser.

CONVERSION ASSUMPTIONS: The conversion between electrolysis capacity expressed in MW_{el} and tonnes per year is made using a 53 kWh/kg efficiency and assuming 8760 full load hours.

SUPPLY OUTLOOK METHODOLOGY: It was created using a bottom-up approach based on the project pipeline for each country adjusted for different project maturity, development timelines, country ambitions, REDIII transposition, and available funding.

The assumed conversion factor before country adjustments:

Phase	Outlook supply
Construction/FID	*1*
Preparatory stage with funding	*0.6*
Preparatory stage with offtaker	*0.4*
Preparatory stage	*0.3*
Feasibility with funding	*0.3*
Feasibility with offtaker	*0.1*
Feasibility	*0.1*
Concept	*0.05*

REGULATORY DEMAND refers to RFNBO demand from REDIII, ReFuelEU Aviation, and FuelEU Maritime by 2030 calculated based on EU directives and regulations, and/or their transpositions or drafts on the national level available by July 2025. If no draft of national REDIII transposition exists then the quantities were estimated assuming at least the minimum targets stipulated in the Directive.

Endnotes

1 / Eurostat Energy Statistics, 2025

2 / BloombergNEF offtake agreements database, 2025

03

Funding

To meet the regulatory demand of 2.8 Mt/y by 2030 (26 GWel), the hydrogen sector requires investments of at least €263 billion. While both national and European funding for the sector are increasing, current public support remains insufficient to meet these ambitions.

- Important Projects of Common European Interest (IPCEI) programme struggles to deliver impact: Due to delays in EU notification processes and slow national-level funding allocation, there has only been limited progress. To date, only 22% of IPCEI hydrogen projects have reached Final Investment Decision (FID), and 27% of allocated funding remains unspent five years after the programme began.

- Innovation Fund (IF) grants and the European Hydrogen Bank (EHB) auctions still need to show results: The IF grants have allocated €4.3 billion in grants to 65 projects, however, only one is so far operational, while seven are in construction. The EHB is still waiting for its first final investment decision. Operations for winners of the first auction must start by October 2029.

- CEF funding is increasing for hydrogen projects, proving useful to infrastructure development: For the first time, in 2025, CEF-Energy allocated €250 million for hydrogen studies. Additionally, since 2021, CEF-Transport has allocated €352 million to hydrogen refuelling stations (HRS), with 41 out of 197 funded HRS currently operational.

The hydrogen sector requires over €260 billion of investment to meet the 2030 regulatory demand. And the sector needs over €200 billion just in public funding by 2034 to align with the 2040 climate target. Current EU funding is insufficient

Meeting the regulatory demand of 2.8 Mt/year by 2030 (26 GW_{el}) requires an investment of €263 billion (including CAPEX and OPEX of electrolytic hydrogen production, and CAPEX of infrastructure and industrialisation). In addition, to align with the 2040 climate targets of 27 Mt of electrolytic hydrogen and considering that public funding supports 60% of the funding gap for production and 50% of the funding gap for infrastructure and industrialisation, Hydrogen Europe estimates public funding needs of €214 billion until 2034.

At EU-level (excluding national funding like IPCEIs and other schemes), the public funding allocated to hydrogen projects has reached €6.9 billion by the end of 2023[1], which is estimated to grow to €9.4 billion by the end of 2024, as shown in Figure 3.1. Funding has been mainly allocated through the Innovation Fund and Horizon Europe. For the first time, in 2024, €250 million has been distributed to hydrogen infrastructure studies under the Connecting Europe Facility for Energy (CEF-E).

Bridging the gap between the funding needed and the funding currently allocated to the sector is essential to meet the development goals. **Funding envelopes for infrastructure, production, and manufacturing must be increased, along with a stronger focus in enabling offtakers to remain competitive while decarbonising.** In parallel, **there should be greater emphasis on OPEX support and risk-mitigation tools** such as guarantees to develop the market at a lower cost for society.

FIGURE 3.1

Annual EU-level funding allocated to hydrogen

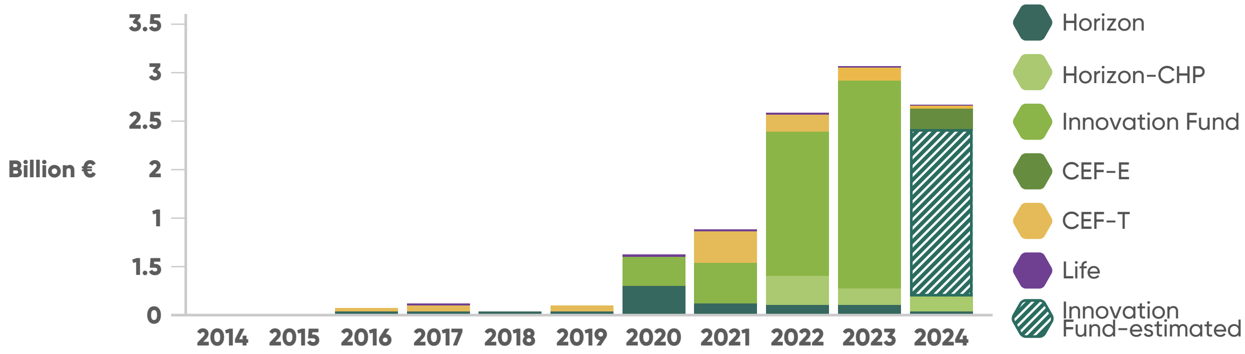
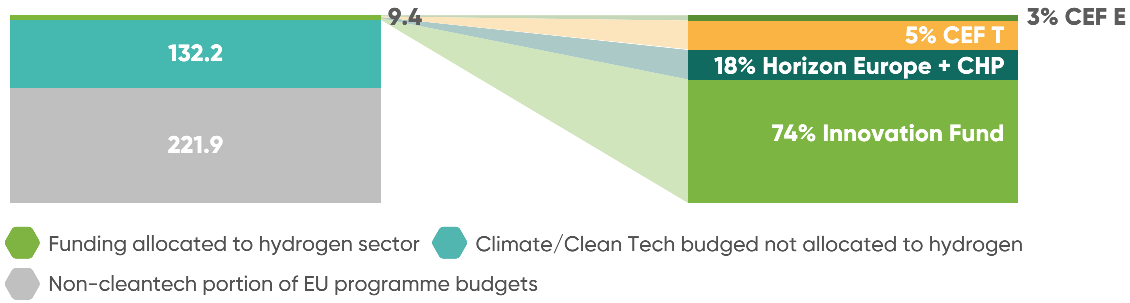


FIGURE 3.2

Cumulative EU funding for climate, clean tech, and innovation 2014-2024

FIGURE 3.3

Distribution of the 2014-2024 EU funding for hydrogen



Notes: The funding gap is identified as the difference between the marginal cost of production renewable hydrogen using Steam Methane Reforming (SMR) and the cost of producing hydrogen (LCOH). This gap is calculated for a specific year, when the hydrogen volumes expected three years later are committed. These funding rates correspond to current Innovation Fund's and Connecting Europe Facility. Hydrogen Europe assumes a learning curve for the electrolyser costs (from 1.6 to 0.72 million EUR per MW up to 2040).

Member states have allocated €13.8bn for IPCEI projects, but due to slow disbursement and complex market conditions only 22% of projects have reached FID

The hydrogen IPCEI, launched in 2020, has been rolled out in four waves to support projects along different parts of the hydrogen value chain. **15 Member States (MS) announced up to €18.9 billion in state-aid** for 122 projects across all waves[2]. **As of June 2025, €13.8 billion of this funding has been allocated by MS.**

Figure 3.4 shows the gap between the funding announced by each MS and the funding which was actually allocated by the MS. In total 27% of funding has not yet been allocated. Greece, Poland, Portugal, Slovakia and Finland have allocated close to none of the announced funding, either due to a lack of reserved funding for the H2 IPCEI projects or due to the cancellation of projects.

Hydrogen Europe found that **22% of the 122 selected projects have reached FID[3].** The analysis also found that **11% off the 122 projects have been cancelled.** The lack of consistency in the funding allocation process complicates coordination between European projects preventing a unified European approach to hydrogen market development.

Patience is required for the rollout of IPCEI projects, given ongoing delays in funding disbursement and slow market development. Many developers are awaiting REDIII transposition to advance their projects, while key offtakers, such as in the steel sector, are postponing investment decisions due to weak market signals.

FIGURE 3.4

IPCEI funding announced vs. funding allocated per participating Member State

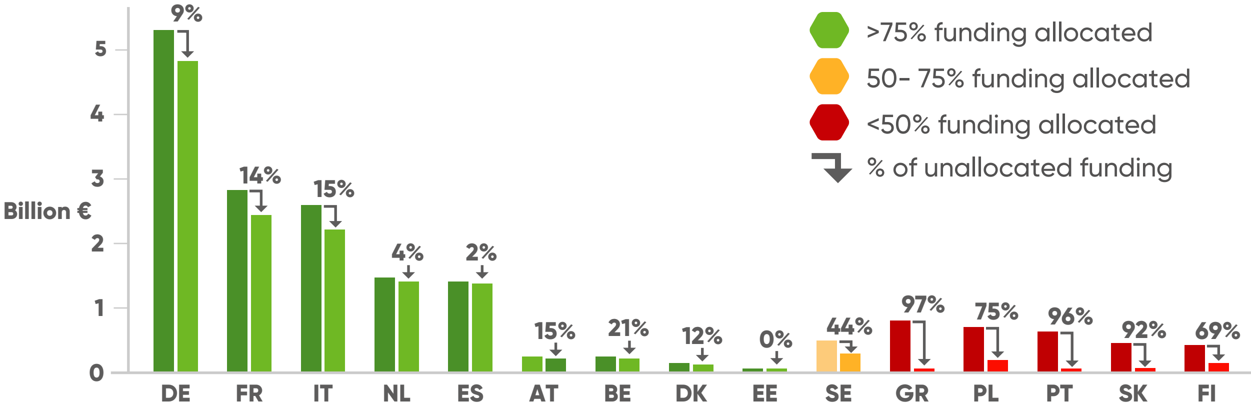
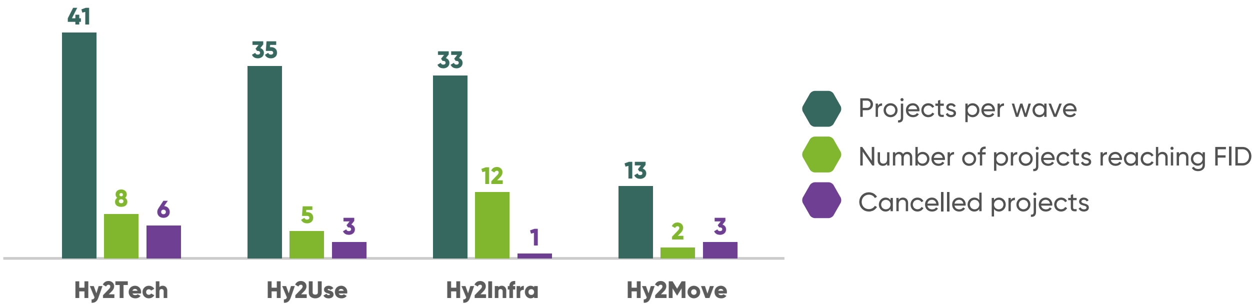


FIGURE 3.5

Number of projects per IPCEI wave, including projects having reached FID and cancelled projects



Notes: Since Hydrogen Europe's last IPECI update in February 2025, Spain's funding gap has decreased from 40% to 2%, Austria's funding gap has decreased from 48% to 15%, Italy's funding gap has decreased from 20% to 15%, and Poland's funding gap has decreased from 96% to 75%. This is due to the further allocation of funding from Member States to projects, increasing the commitment to they hydrogen sector (for more information, see The-Hydrogen-Europe-Quarterly_10_DIGITAL.pdf, p.10 onwards).

The Innovation Fund grants have allocated €4.3 billion to 65 hydrogen projects. Only one hydrogen project is operational, and seven are under construction

Hydrogen projects have emerged as one of the IF key focus areas. **Since its launch in 2020, IF grants have allocated €4.3 billion, or around 40% of its total budget.** In the 2022 large-scale call, the European Commission directed more than half (51%) of available funds to hydrogen. In the 2023 call, 27 hydrogen projects received €1.8 billion (43% of awarded funding)[1]. In total 65 projects have been awarded, out of which 8 have been cancelled.

The IF's small-scale hydrogen projects are progressing slower than projects using other technologies, and most hydrogen projects remain in early stages, working toward financial close (seven projects have reached financial close). However, timelines still align with the Fund's 48-month limit to reach financial close. Depending on the call year, the **deadline to reach financial close is between December 2025 and March 2029[4].**

While a third of the hydrogen production projects have not disclosed the intended use of the produced hydrogen, about 17% would be dedicated to supply steel, 12% to ammonia production, closely followed by methanol, as shown in figure 3.7.

The main challenges are linked to low funding intensity, permitting and risk allocation barriers, as well as lack of willingness to pay. Solutions include more flexible funding allocation with possible exit strategies, dedicated baskets for ready-to build projects and a guarantee mechanism to improve bankability of new companies.

FIGURE 3.6

Status of IF portfolio according to the implementation status

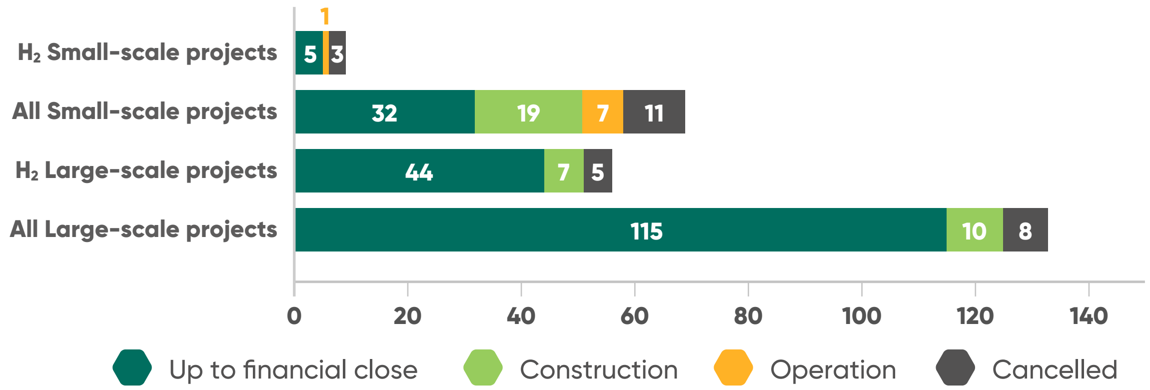
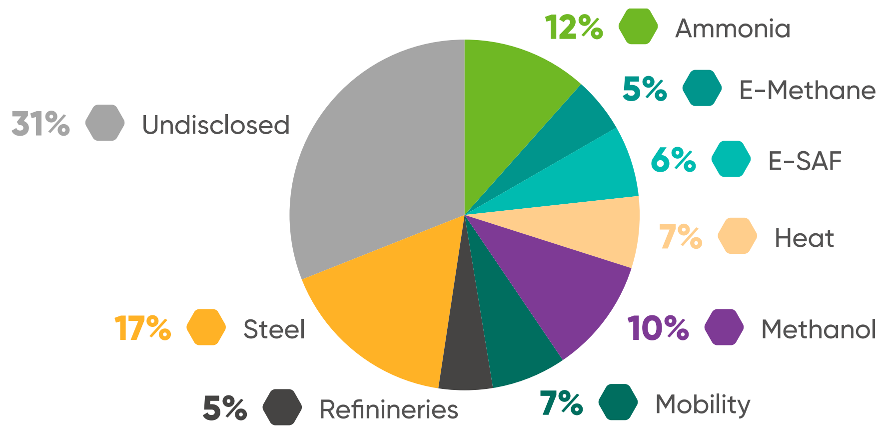


FIGURE 3.7

End-use sector of hydrogen production projects (only electrolysis) in the Innovation Fund



The projects under the European Hydrogen Bank continue to advance, albeit with delays and a challenging context, with no FIDs taken so far

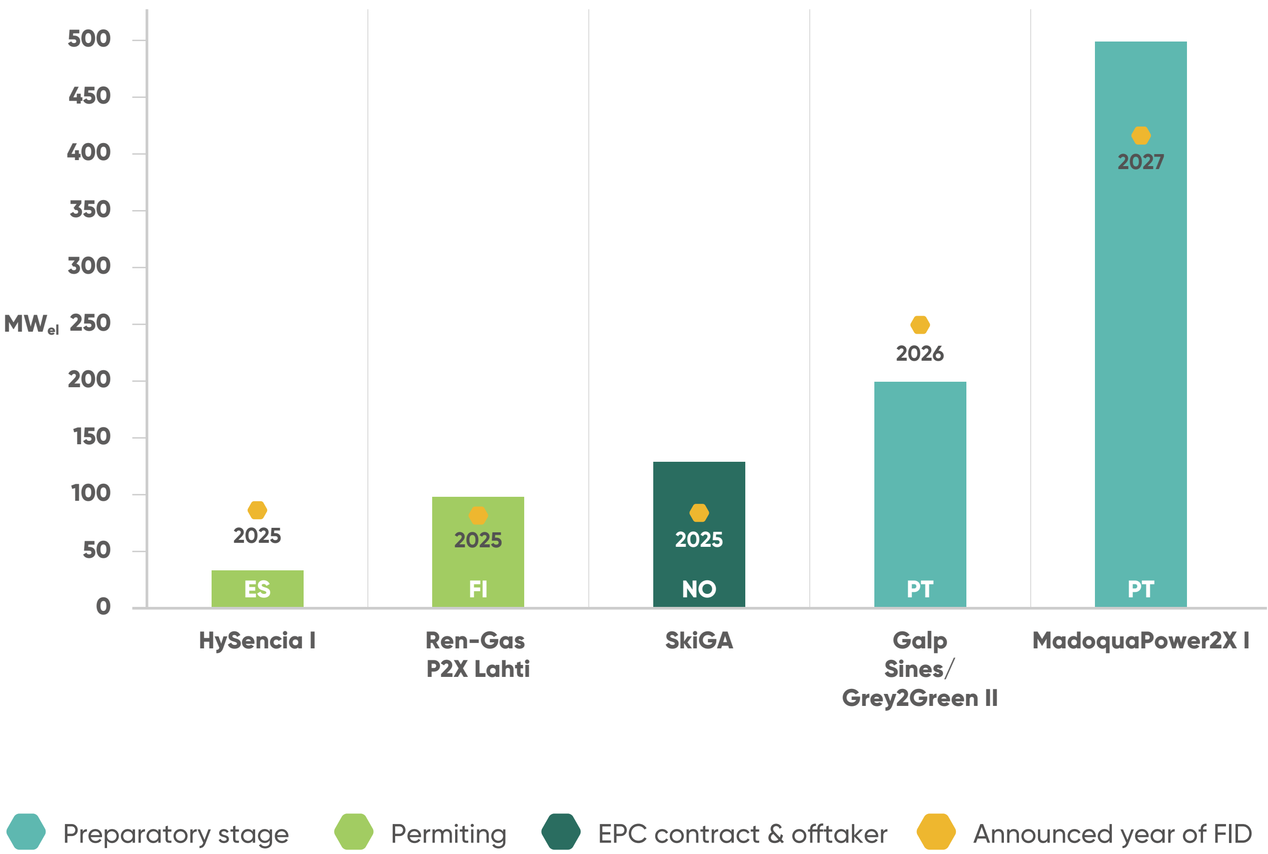
In the first EHB auction, premiums ranged from €0.37 to €0.48/kg. The second round saw similar bids in the general basket (€0.20–€0.60/kg), with projects in the maritime basket requesting higher premiums (€0.45–€1.88/kg)[5]. **Out of the seven projects awarded in the first auction, six signed the grant and aimed to produce 1.58 Mt of hydrogen over 10 years.** More recently, Project Catalina has withdrawn after receiving funding through the Spanish Hydrogen Valleys scheme (more attractive rates and less stringent rules for possible delays).

Hence the remaining five projects keep developing under a changing financial, regulatory and infrastructure context. Figure 3.8 shows that the **three smaller projects are more advanced and plan to reach final investment decision (FID) already in 2025.** While the Entry into Operation (EiO) for three of the five projects has been delayed by 2-5 years, it is still within the timeframe set by the Commission (October 2029).

Under the second auction, the specific basket and strong participation in the Auction-as-a-Service (AaaS) have helped increase the premium, showing encouraging results: In Austria, OMV's 140 MW project has declared a conditional FID, subject to receiving the anticipated Auction-as-a-Service funding. In Norway, the results prompted Møre Sjø to order two hydrogen-powered bulk carriers to transport hydrogen produced regionally from GreenH AS, who has been awarded with a premium of €1.88 per kg.

FIGURE 3.8

Stage of development of EHB projects and their announced year of FID



Hydrogen road mobility funding AFIF and SWIM (the Netherlands) drive market development beyond grant allocation

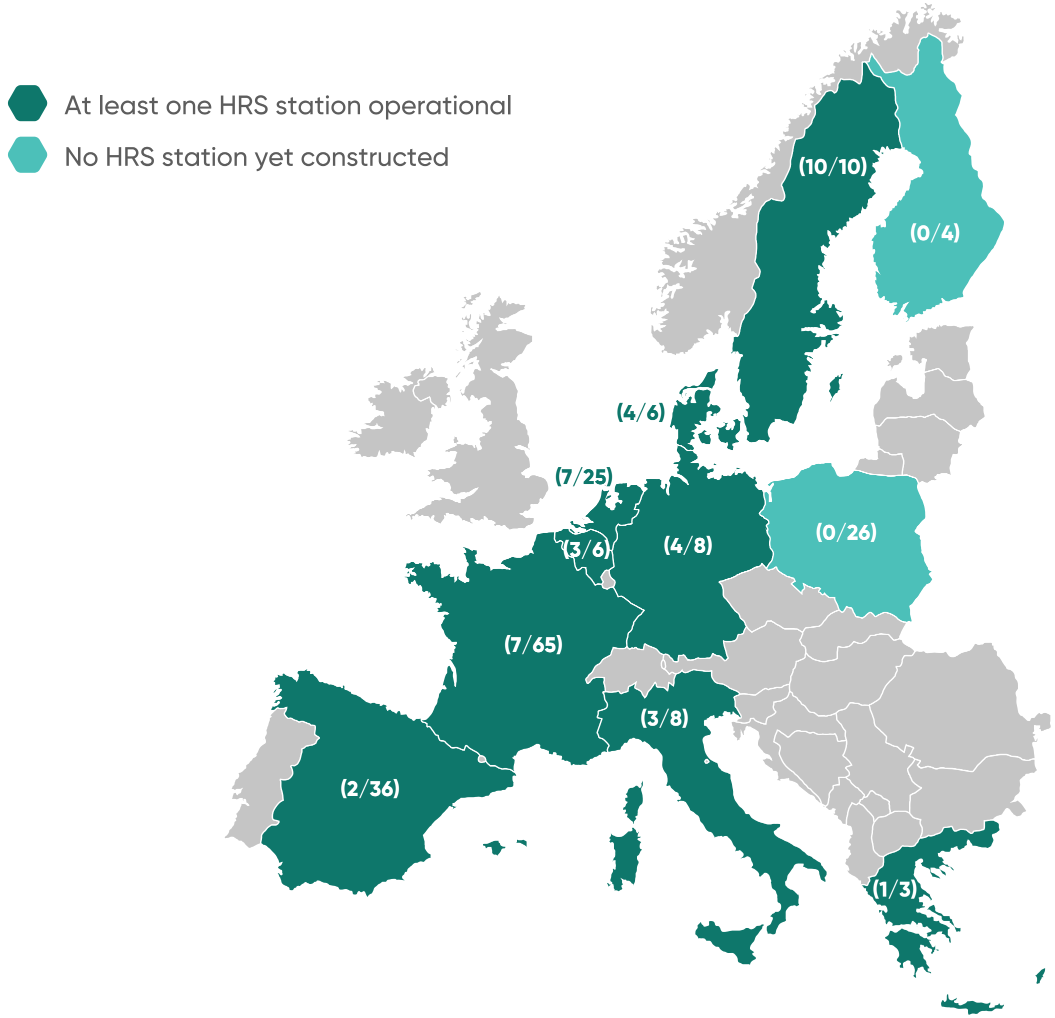
Since 2021, the Connecting Europe Facility Transport (CEF-T) has awarded €352 million to 41 hydrogen projects through its Alternative Fuels Infrastructure Facility (AFIF) programme. **Nine projects are completed, resulting in 41 operational hydrogen refuelling stations (HRS) today out of 197 funded HRS[1].** The average EU funding per HRS is €2 million. 40 additional stations are expected to become operational in 2025, with the rest planned for 2026 and 2027. **A key strength of the AFIF programme is its blended finance model:** every funded project must secure co-financing from a national development bank, the European Investment Bank (EIB), or a commercial bank. This structure attracts additional capital and actively involves multiple stakeholders in infrastructure development.

At national level, the **Dutch Subsidy for Hydrogen in Mobility (SWIM) funded nine HRS projects in 2024 and aims to support 12-15 more in 2025[6].** Running until 2029, the scheme increased its funding envelope by 30% between 2024 and 2025 due to strong demand. Beyond funding HRS construction or expansion, SWIM also supports the acquisition of hydrogen-fuelled vehicles for both light and heavy-duty transport. **By combining supply and demand infrastructure, the scheme seeks to overcome the chicken-and-egg problem** that often hampers early hydrogen markets.

Hydrogen road mobility funding shows that impact goes beyond simple grant allocation. It can structurally involve third parties, such as banks, and address multiple challenges by supporting several parts of the hydrogen value chain in parallel.

FIGURE 3.9

Countries with operational HRS funded by AFIF (Number of HRS constructed/ Total HRS funded)



Innovation Fund grants are the most efficient funding tool for hydrogen production, while hydrogen IPCEI funding falls short of expectations

	Innovation Fund grants	European Hydrogen Bank	H_2 IPCEI	CEF-T/AFIF	CEF-E
Description					
Sector	Production, Manufacturing, Offtake	Production	Production, Manufacturing, Offtake, Infrastructure	Mobility Infrastructure	Infrastructure
Funding body	European Commission (possibility of MS participation through Grant-as-a-Service)	European Commission (possibility of MS participation through Auction-as-a-Service)	Member States (each project needs notification by European Commission)	European Commission	European Commission
Allocated funding	€4.3bn allocated	€694m allocated, €992m in grant preparation, €836m reserved or allocated for AaaS	€13.8bn allocated	€352m allocated	€250m allocated for H_2 studies
Assessment					
Speed of funding allocation	🟠	🟢	🔴	🟢	🔴
Administrative accessibility	🔴	🟢	🔴	🟠	🔴
Effective funding intensity	🟠	🔴	🟢	🟢	🟢

Needed improvements

1. Expand available funding envelopes dedicated to hydrogen.
2. Accelerate Member State implementation of REDIII to enable project development and compliance
3. Establish a guarantee mechanism to enhance project bankability and attract private investment.
4. Improve assessment of project maturity to ensure funding targets viable projects.
5. Introduce more flexible funding allocation to adapt to evolving project needs.
6. Streamline evaluation and approval processes, with a target maximum duration of one year.

Notes: CEF-E has not been evaluated in depth, as only hydrogen studies have been funded. National aid, such as those stemming from the Recovery and Resilience Fund, are out of the scope.

Data sources

The data on EU funding schemes and projects was collected by the Hydrogen Europe team from the European Commission's official online resources. The research focused on identifying funding schemes and projects specifically targeting hydrogen technologies, as well as broader initiatives that may include hydrogen-related components. The information was sourced directly from the European Commission's website to ensure accuracy and reliability.

Terminology

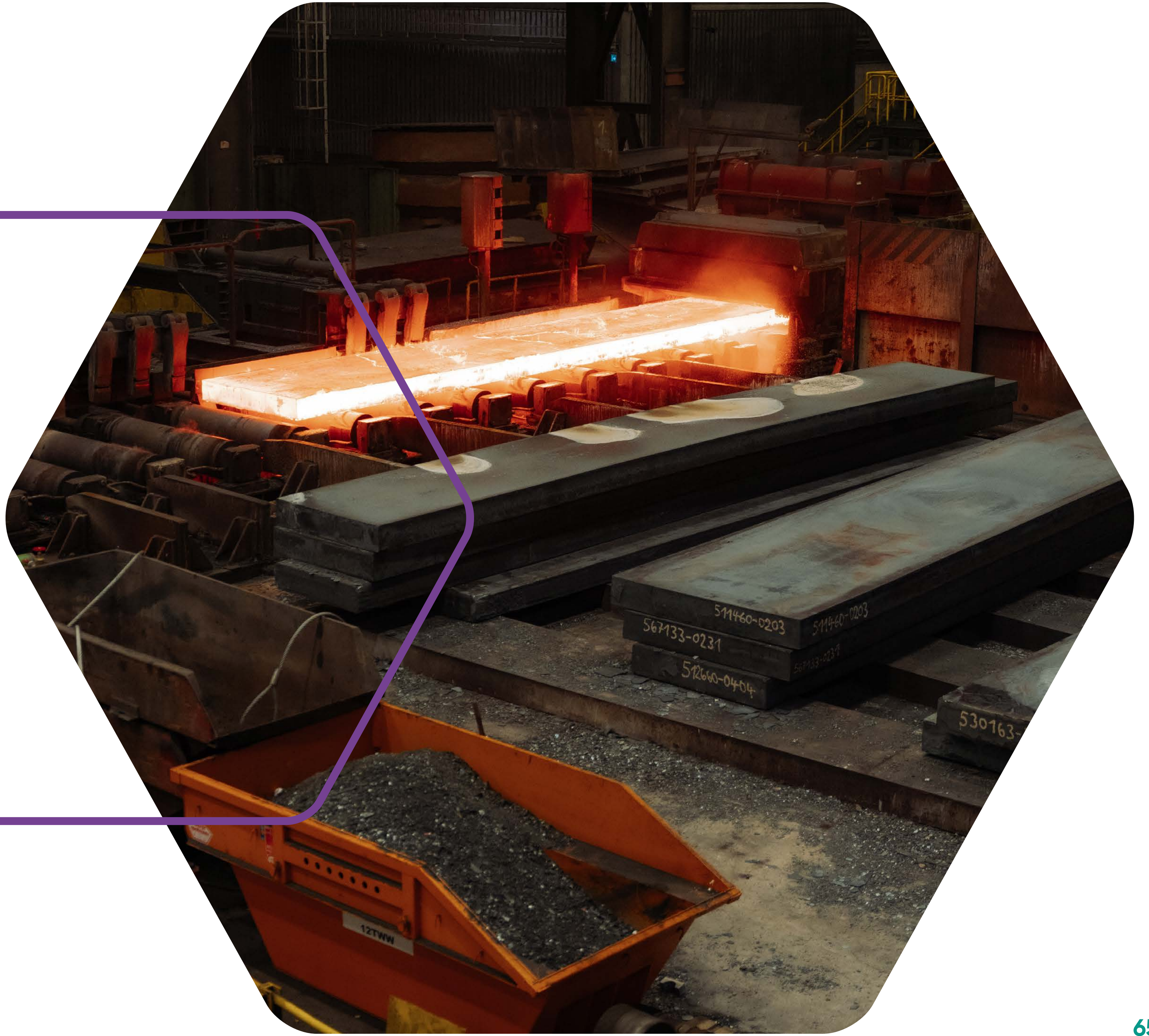
"Funding allocated" refers to the funding that has been allocated to projects, where projects have signed their grant agreements.

"Innovation Fund" incorporates both the Innovation Fund grants and the Innovation Fund auction, unless specified otherwise.

"Innovation Fund estimates" include the IF24 call and the 2nd European Hydrogen Bank (EHB) auction. It is assumed that 42% of the IF24 call will be allocated to hydrogen. Additionally, it is assumed that all projects chosen in the 2nd auction of the EHB will sign their grant agreements.

Endnotes

1 / CINEA (2025)
2 / IPCEI Observatory
3 / European Commission (2025-1)
4 / European Commission (2025-2)
5 / European Commission (2025-3)
6 / RVO NL (2024)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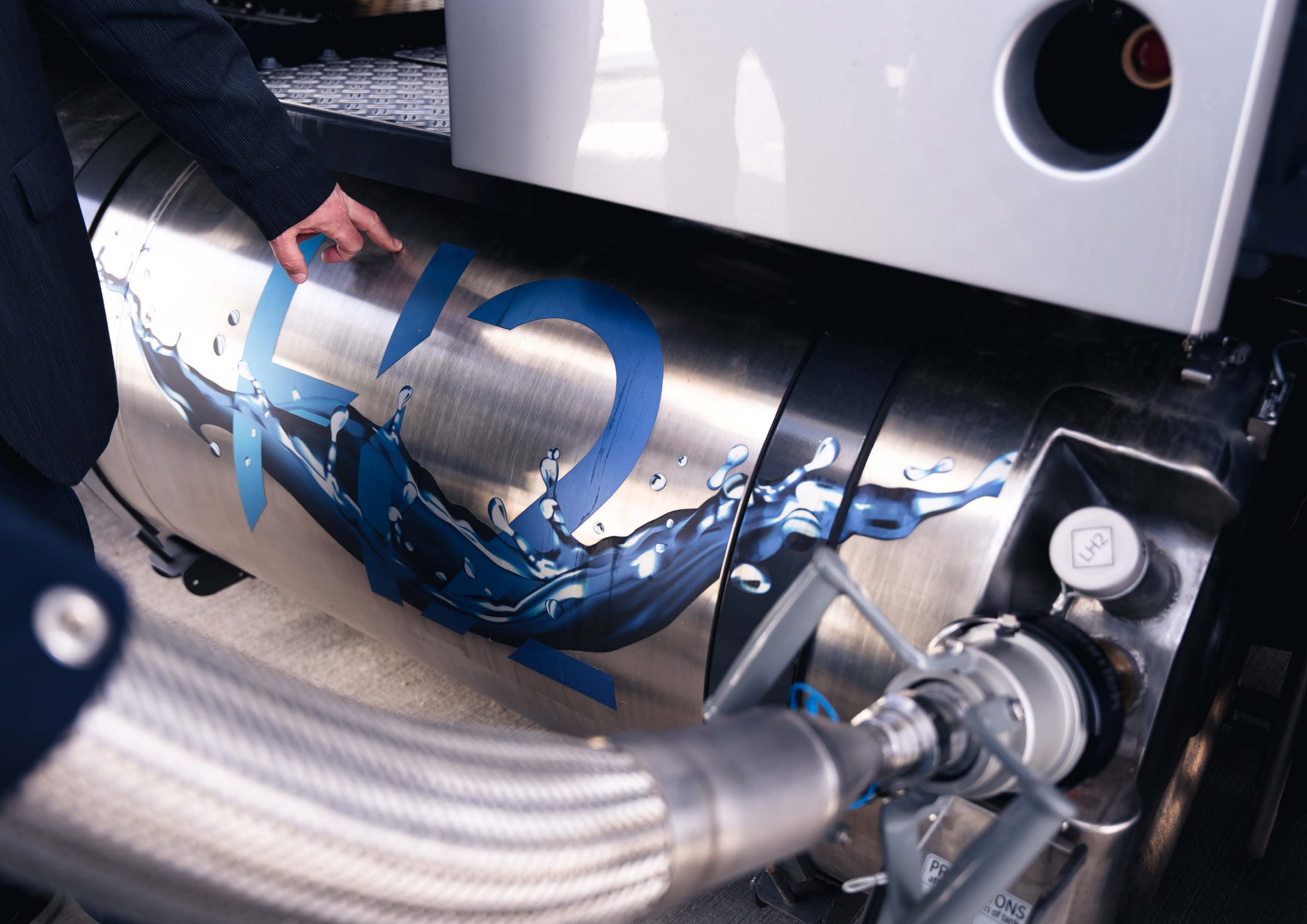
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04

End-use perspective

Clean hydrogen has multiple potential end-uses. As clean hydrogen remains expensive, the market is currently shaped by varying policy targets that drive the willingness to pay. Refining dominates in the short term, while progress in e-fuels and industry remains limited.

- Refining and road mobility lead early deployment: refineries are set to become the main market for clean hydrogen in the short term with projects planned for 0.7 Mt/year by 2030 already in advanced development stage. REDIII is the main driver, shaping both the willingness to pay (through penalties) of up to 10 €/kg as well as the market size, with the regulatory demand for 2030 estimated at 1.1 Mt/year.

- Ammonia and methanol show early momentum in new applications: While REDIII RFNBO industry target should require up to 1.3 Mt/year of RFNBO consumption in industry by 2030, the risk of carbon leakage and weak REDIII transposition mean there is limited willingness to pay, and few projects reach FID. As a result, early developments in these sectors are driven mostly by new applications such as fuels in the maritime sector and – in the case of methanol – as intermediates in e-SAF production.

- Emerging sectors: Clean steel and e-SAF production are the top two new clean hydrogen applications with projects planning to consume 0.5 and 0.4 MtH2/year respectively in advanced stage of development. Hydrogen in power generation is limited but could support backup and storage needs, especially in data centres.

Clean hydrogen has various potential end uses, but market conditions and incentives differ across sectors

Sector	Drivers	Constraints	Current and potential market by 2030 (Mt/y)	Feasibility (incl. willingness to pay)
Refineries	REDIII fuel supplier obligation (lowest cost compliance option) Existing demand for hydrogen Limited impact on conventional fuel prices	Costs Grid capacity and land availability Lack of infrastructure Risk of refinery route limits imposed by MS	CD 2.6 RD 1.1 Pipeline 1.4 Adv.proj. 0.7	Green
Road mobility	REDIII and AFIR mandates CO_2 standards for light duty and heavy-duty vehicles	Higher costs than BEV in many applications High cost of FCEV Lack of refuelling infrastructure	CD RD 1.1 Pipeline 0.4 Adv.proj. 0.2	Orange
Other industries (ammonia, methanol, other chemicals)	Strong mandates: REDIII New applications in aviation and maritime sectors Use as H_2 carriers for imports Phase out of ETS free allowances	Dependant on MS REDIII transposition Limited ability to pass over costs to end consumers High risk of carbon leakage and offshoring Weak CBAM	CD 2.8 RD 1.3 Pipeline* 4.3 Adv.proj. 1.7	Red
E-fuels	ReFuelEU Aviation obligations FuelEU Maritime long term investment technology choices IMO Net zero framework in the future	High cost compared to conventional fuel and alternatives (biofuels) Limited market appetite for long-term offtake agreements No binding targets in maritime	CD RD 0.4 Pipeline 1.2 Adv.proj. 0.4	Green
Steel	High CO_2 abatement potential Strong political/economical support for domestic premium steel Low impact on some end-use product price (cars, etc.)	Costs Lack of standardised label for low-carbon steel Limited market demand for green steel Lack of infrastructure	CD RD Pipeline 0.9 Adv.proj. 0.5	Orange
Power generation	Flexibility and long-term storage Limited grid capacity and congestions for data centres	High cost Lower efficiency than BESS	CD RD Pipeline 0.2 Adv.proj.	Orange

Notes: CD refers to "Current demand" estimated in 2024 Europe including United Kingdom, Norway, Switzerland and Iceland. (for refineries it excludes the H_2 demand in refineries of by-product). RD refers to "Regulatory demand". RD for refineries and road mobility is the same. Pipeline 2030 refers to the total number of clean announced (both water electrolysis and thermochemical) projects with expected start dates by 2030. *For other industries pipeline includes also use of ammonia and methanol as e-fuel (for aviation and maritime sector) and other chemical industry with use of hydrogen as feedstock.

REFINERIES: Hydrogen use in refineries is the leading end-use among FID projects, with 1.4 Mt/year of announced projects covering more than half of current replaceable demand

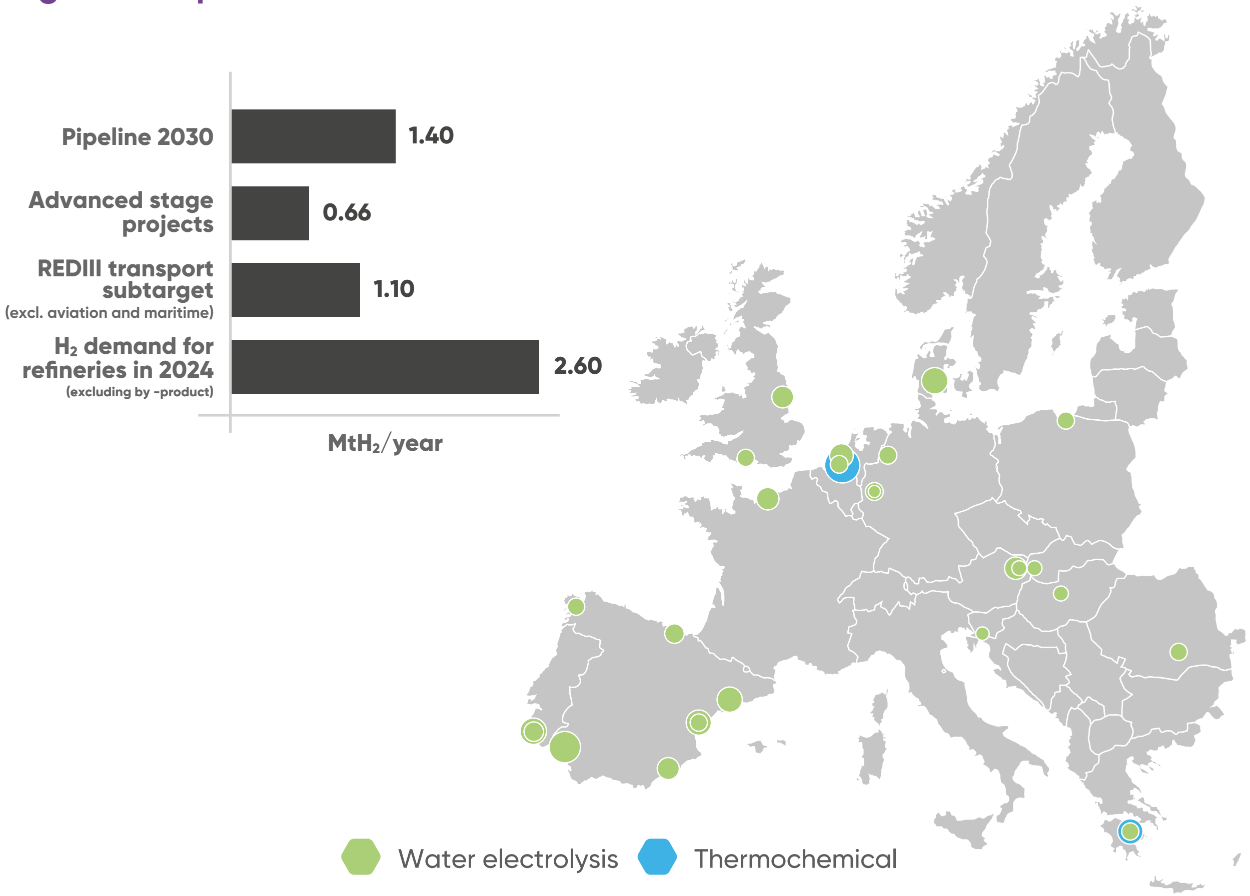
The refining sector plays a pivotal role in decarbonisation, **accounting for 58% of Europe's current hydrogen demand (4.5 Mt/year).** By 2030, RFNBOs must represent at least 1% of all fuels supplied to transport, and Member States are choosing more ambitious goals, which translate to 1.1 Mt of hydrogen. Under REDIII, RFNBOs used as intermediates to produce conventional fuels and biofuels count towards the transport target, thus boosting demand, market creation, and investment in clean hydrogen, while contributing to the decarbonisation of EU refineries.

In Europe there are around **1.4 Mt/year of announced clean hydrogen projects for refineries by 2030, including 0.7 Mt/year from electrolysis (~7.1 GW_{el}).** Of this, 0.66 Mt/year is at an advanced stage. Total announced volumes cover more than half of current replaceable hydrogen demand in the sector (hydrogen consumed in refineries excluding by-product).

Over half of all clean hydrogen projects under construction aim to supply refineries. In the second half of 2024 alone, over 500 MW_{el} of electrolysis for refinery use reached FID (e.g. GET H2 Nukleus (300 MW_{el}) and REFHYNE (100 MW_{el})). In 2025, progress continued with OMV's 10 MW_{el} in Schwechat, Austria, and MOL's first 10 MW_{el} in Százhalombatta, Hungary becoming operational. So far, in 2025 OMV's project in Petrobrazí's refinery in Romania and Motor Oil's Blue Med project in Greece reached FID. Unfortunately, there is still slow progress in Italy, which has 10 refineries, as well as in the Nordics and Baltic countries.

FIGURE 4.1

Selection of large-scale clean hydrogen production projects in advanced stage in Europe with refineries as intended end use



Notes: Hydrogen demand estimated for 2024 in Europe including United Kingdom, Norway, Switzerland and Iceland. Pipeline 2030 refers to the total number of announced projects with expected start dates by 2030 and intended end use of hydrogen to refining. Advanced projects on the map encompass those that are operational, under construction, or in the preparatory stages and larger than 500 tonnes/year.

ROAD MOBILITY: Hydrogen can decarbonise hard to electrify road mobility, REDIII could drive around 1.1 Mt/year of hydrogen demand, but aligned policies are key to scaling up

Decarbonising road mobility is essential to meet Europe's climate goals, particularly for heavy-duty and high-usage vehicles where battery electric solutions face limitations. **Clean hydrogen offers a complementary path, enabling longer ranges, faster refuelling, and greater operational flexibility.**

Key EU policies are driving this shift. The revised CO_2 emission standards for light and heavy-duty vehicles and the upcoming Greening of Corporate Fleets initiative will push the uptake of zero-emission vehicles. The Alternative Fuels Infrastructure Regulation (AFIR) sets binding targets for the deployment of hydrogen refuelling stations (HRS), requiring stations every 200 km on core TEN-T and in all major urban nodes by 2030. Hydrogen Europe estimates that at least 400–500 HRS will be needed to meet these targets, while industry groups suggest 1,000–2,000 HRS are required to support fleet deployment[1].

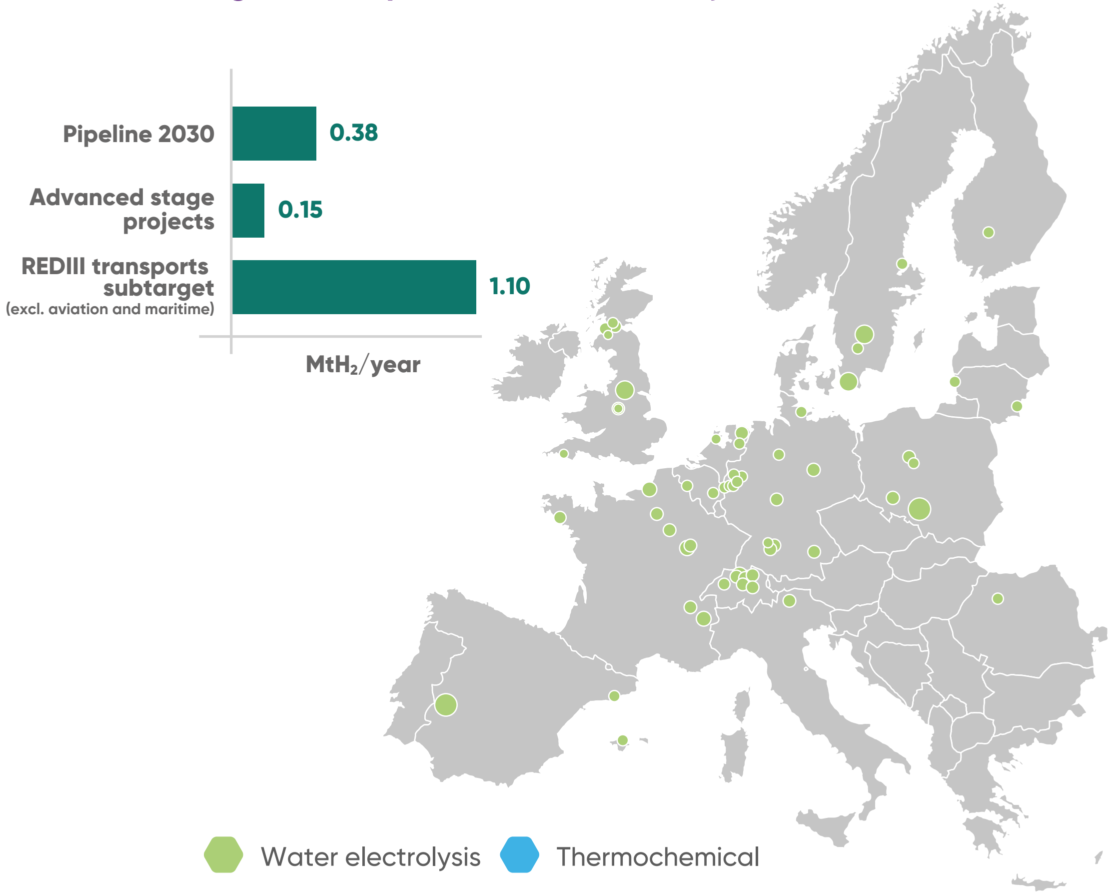
Excluding the aviation and maritime sectors, the transposition of **REDIII will drive demand for RFNBO use in road transport, estimated at around 1.1 Mt by 2030.** This could be met either through the direct use of hydrogen as fuel or indirectly via hydrogen use in refineries.

Several small-scale projects are already operational or under development, especially in Germany (H2 MOBILITY, GP Joule), Switzerland (Axpo), and France (Lhyfe), laying the foundation for scale-up.

To enable hydrogen road mobility at scale, clear long-term targets, coordinated investment support (e.g., infrastructure and vehicle purchasing simultaneously) and technology openness are essential, backed by a coherent and aligned policy framework across countries.

FIGURE 4.2

Selection of large-scale clean hydrogen production projects in advanced stage in Europe with road mobility as intended end use



Notes: Advanced projects on the map encompass those that are operational, under construction, or in the preparatory stages and larger than 200 tonnes/year or 2 MW_{el}.

REFINERIES AND ROAD TRANSPORT: As renewable hydrogen costs remain above the break-even point, the potential penalty for fuel suppliers set by Member States will be an important market reference point

The RFNBO hydrogen cost, needed to match the costs of using the fossil alternative as intermediate in production of fuels in the EU in 2024 was around 2.5-3.5 €/kg[2]. This is significantly above current renewable hydrogen production costs (see page 26). Therefore, one of the key elements that MS need to decide on when transposing REDIII obligations is an enforcement mechanism. The most common approach is a financial penalty on fuel suppliers that fail to meet their minimum RFNBO quota. **As long as production costs for renewable hydrogen remain high, the penalty will be an important price setting reference point.**

Getting the level of the penalty right is challenging. Given the different renewable hydrogen production costs across the EU, **there is not a single penalty level that makes sense for every Member State.** Finland, where costs of producing RFNBO are among the lowest in Europe, opted for a relatively low penalty, equivalent to around 6.6 €/kg of hydrogen. In contrast, Czechia implemented a much higher penalty, equivalent to almost 10 €/kg of hydrogen,– driven by higher hydrogen production costs in the country. Romania is an especially interesting case. The penalty of around 6 €/kg of hydrogen is low. However, in this case the penalty payment is not a buyout mechanism and the missed RFNBO amount rolls over to the following year, ensuring that the penalty will fulfill its role in creating willingness to pay.

FIGURE 4.3

Adopted and proposed penalties for fuel suppliers for non-compliance with REDIII obligations in transport

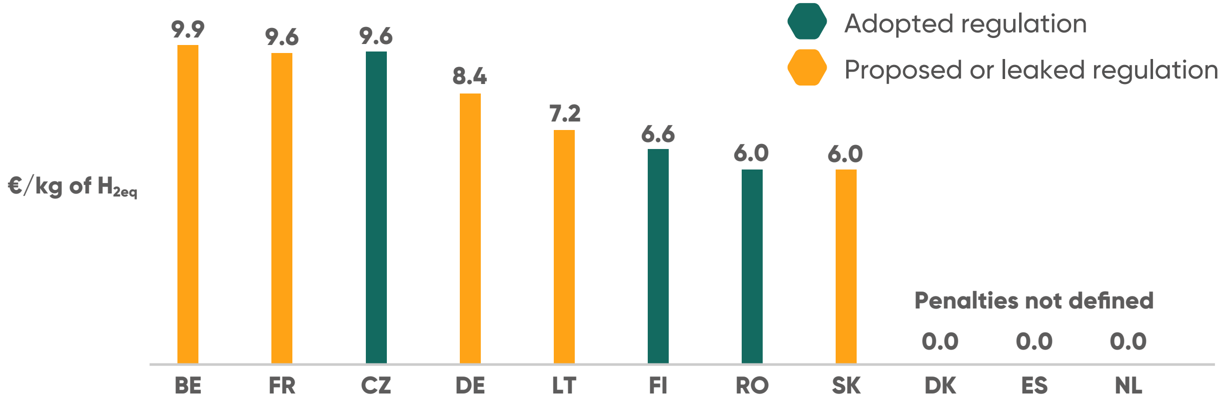
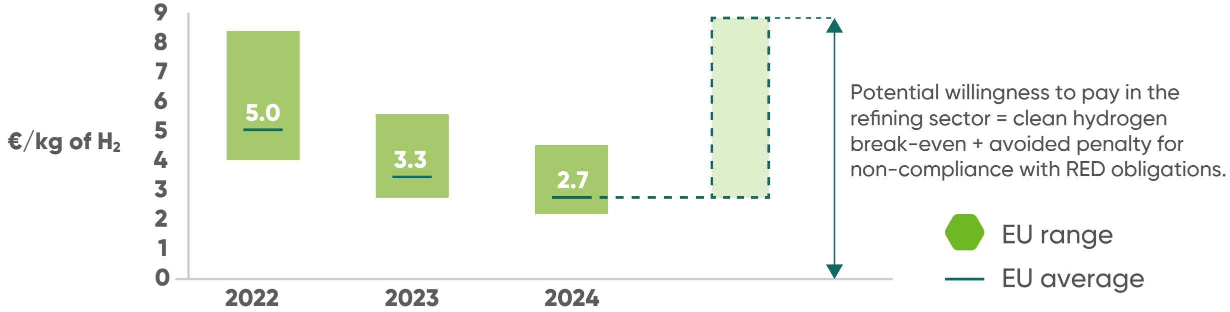


FIGURE 4.4

Hydrogen break-even-point for refining and impact of the REDIII penalty on potential willingness-to-pay



Notes: Break-even point refers to the cost of hydrogen at delivery point (including costs of transportation and storage) needed to match the cost of the fossil alternative plus any additional cost on CO_2 emissions either through ETS or other regulations. Data for figure 4.4 from the European Hydrogen Observatory.

AMMONIA: Emerging as a lead market for clean hydrogen in Europe, with around 0.93 Mt/year in advanced stage

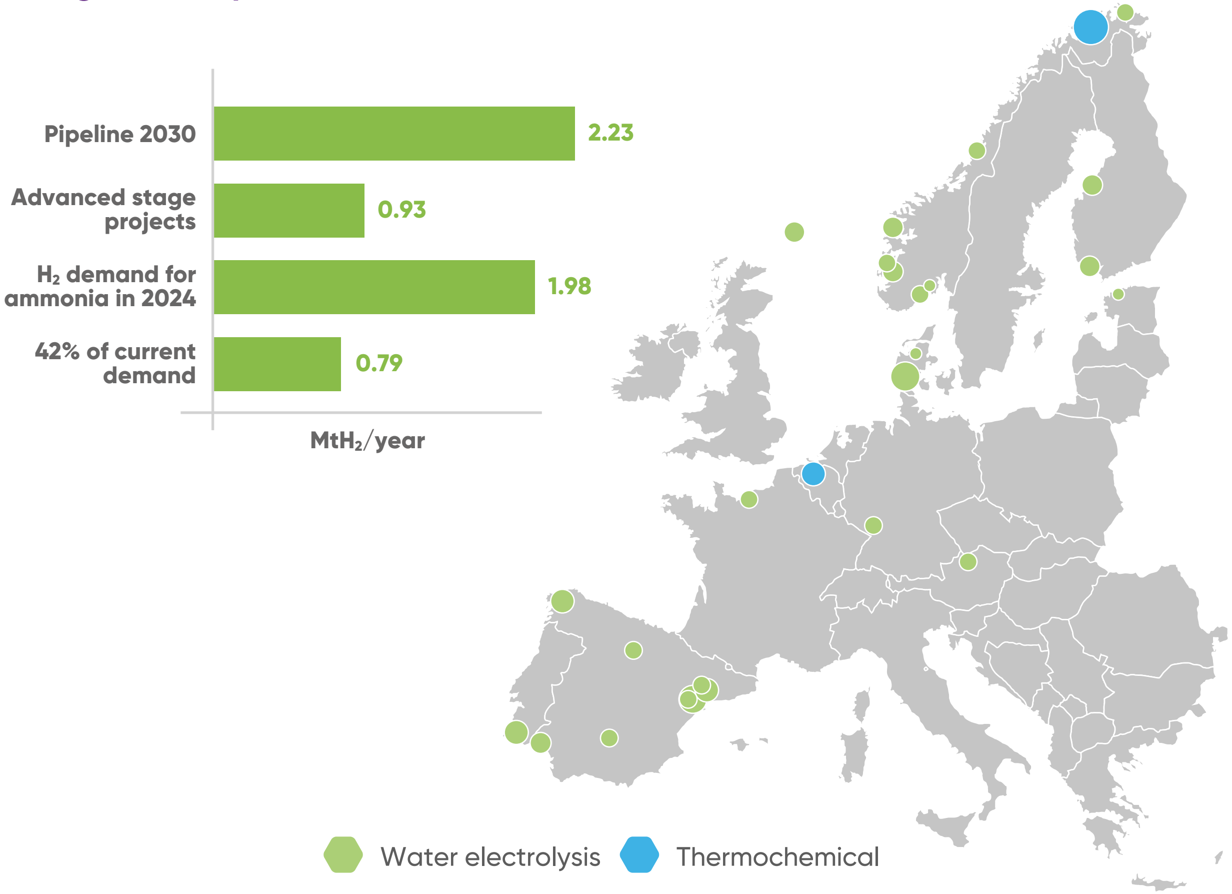
Europe has around 35 ammonia production facilities, generating ~11 $MtNH_3$/year, and consuming **~2 Mt/year of hydrogen, roughly 25% of Europe's hydrogen demand.** An additional 2–2.5 $MtNH_3$/year is imported. While ammonia is primarily used in fertilisers and as a chemical feedstock, its potential as a hydrogen carrier and maritime fuel is expected to drive significant additional demand post-2030. As an established industrial offtaker, ammonia can serve as a lead market for clean hydrogen, supporting the early scale-up and cost reductions.

Decarbonising the sector is reinforced by REDIII industry targets, which could result in up to 0.8 Mt/year of RFNBOs demand by 2030. Although current production is concentrated in the Netherlands, Germany, and Poland, cheaper renewables are attracting developers to the Nordics and Iberia, while other countries may rely on imports. However, REDIII implementation remains uncertain, with some Member States (e.g., NL) aiming to exclude ammonia from the targets or avoid company obligations due to strong competitiveness risks (and relocation to outside of Europe).

Announced clean ammonia projects could consume about 2.2 Mt/year (~16GW_{el}) of hydrogen by 2030, with 0.9 Mt/year at advanced stages. Operational projects include BASF's HyChem (54 MW_{el}), H2F Fertiberia (20 MW_{el}), and Yara SKREI (24 MW_{el}). Other notable projects are the winners of the first Hydrogen Bank auction (Catalina, Skiga, Hysencia, and Madoquoa), and Ignis' projects from the second auction. More FIDs are expected soon in Iberia and the Nordics, supported by these funding schemes.

FIGURE 4.5

Selection of large-scale clean hydrogen production projects in advanced stage in Europe with ammonia as intended end use



Notes: Hydrogen demand estimated for 2024 in Europe including United Kingdom, Norway, Switzerland and Iceland. REDIII targets are estimated based on EU-27 2024 consumption. Pipeline 2030 refers to the total number of announced projects with expected start dates by 2030 with intended end use of hydrogen to ammonia. Advanced projects on the map encompass those that are operational, under construction, or in the preparatory stages and larger than 500 tonnes/year.

METHANOL: A growing clean hydrogen end use, driven by maritime decarbonisation needs

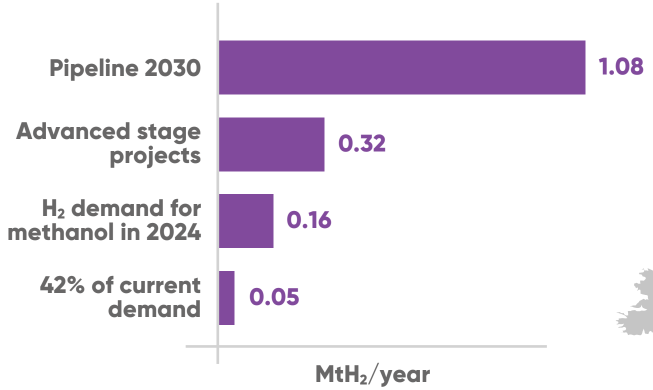
Methanol is primarily used in the chemical sector with 88% of Europe's supply covered by imports. **Domestic production accounts for around 2% of Europe's hydrogen demand, approximately 0.16 Mt/year in 2024.** Given the current hydrogen consumption, the EU's REDIII industry target could drive the demand for around 0.05 Mt/year of hydrogen by 2030.

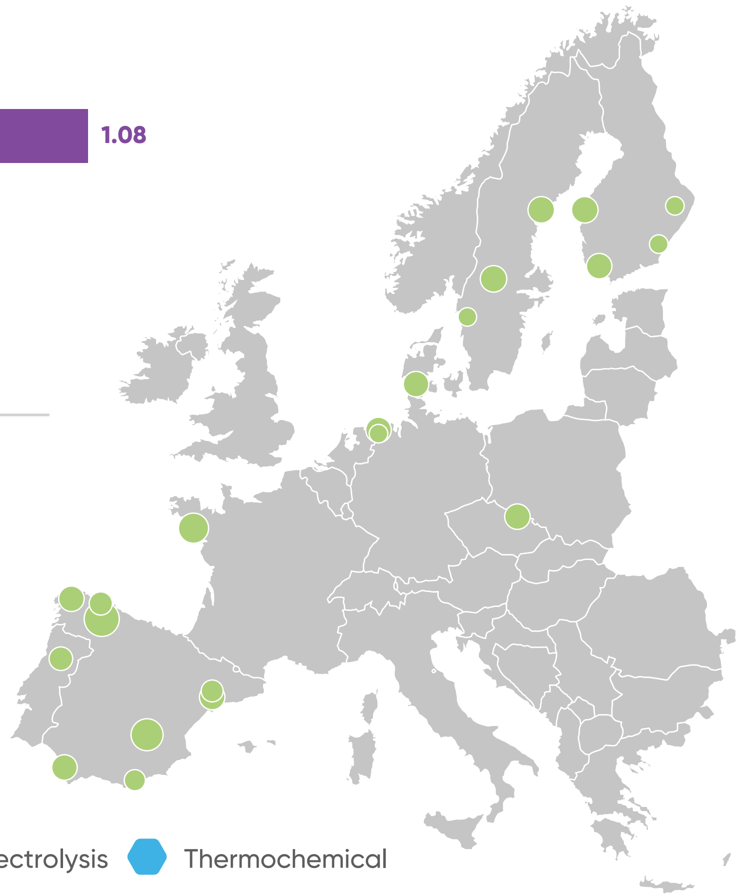
Announced e-methanol projects could produce up to 1.1 Mt/year (~9.6GW$_{el}$) of hydrogen by 2030, with 0.3 Mt/year in advanced stages, equal to twice the total current demand and significantly more than the REDIII obligations would indicate. This discrepancy is explained by the strong influence of maritime decarbonisation, with methanol demand expected to grow under the FuelEU Maritime regulation and potential reinforcement from the IMO's net-zero framework. Production of e-SAF via the methanol-to-jet route further boosts future demand. This additional demand could shift Europe's methanol trade balance, offering an opportunity to strengthen domestic supply and reduce imports reliance. However, market potential is limited by the availability of sustainable CO_2 sources, as biogenic CO_2 as well as CO_2 from direct air capture remain expensive.

Notable projects include European Energy's Kasso plant (52.5 MW$_{el}$) in Denmark, which began operations in May 2025 and is now the largest e-methanol plant in Europe. Among the projects under development include Liquid Wind's initiatives and Koppo Energia's e-methanol plant in Finland, H2Ossa's Albacete project from ET-Fuels in Spain, and ENGIE's HyNetherlands plant, which is supported by Innovation Fund.

FIGURE 4.6

Selection of large-scale clean hydrogen production projects in advanced stage in Europe with methanol as intended end use





Notes: Industrial demand estimated for 2024 in Europe including the UK, Norway, Switzerland and Iceland. REDIII targets are estimated based on EU-27 2024 consumption. Pipeline 2030 refers to the total number of announced projects with expected start dates by 2030 with intended use of hydrogen to methanol. Advanced projects encompass those that are operational, under construction, or in the preparatory stages and larger than 500 tonnes/year.

AMMONIA AND METHANOL: Replacing conventional hydrogen with RFNBO in existing industrial applications is among the most financially challenging and requires strong MS support

Industrial applications, like the production of ammonia or methanol, represent a major market for clean hydrogen (2.8 Mt/year), but are among the most challenging to decarbonise. For ammonia, a switch to renewable hydrogen requires securing a new nitrogen source and if urea is produced downstream, it also requires an alternative source of CO_2 . For methanol production further complexity and costs arise due to the need for sustainable CO_2 and a higher hydrogen input than the conventional syngas route, making it one of the most difficult markets for clean hydrogen, with the break-even point up to 1.4 €/kg lower than in oil refining.

Therefore, **achieving the REDIII objective of 42% RFNBO share in industry by 2030 is unlikely without strong regulatory or financial incentives.** So far only Romania has put in place a regulatory framework enabling the switch to RFNBO in industry, including a binding obligation and a high financial penalty for non-compliance. Czechia has proposed a binding obligation but the proposed penalty is insufficient (<3 €/kg), given high RFNBO production costs in the region. Still, these penalties should bring the willingness-to-pay close to 6.5-5.5 €/kg. However, these two countries represent only 4% of the EU's industrial use of hydrogen. In the rest of Europe willingness to pay in industry remains linked to costs of fossil fuel-based alternatives. And while the apparent willingness-to-pay could increase, re-locating production or moving to imports remains a considerable risk.

FIGURE 4.7

Hydrogen break-even point for conventional industrial application

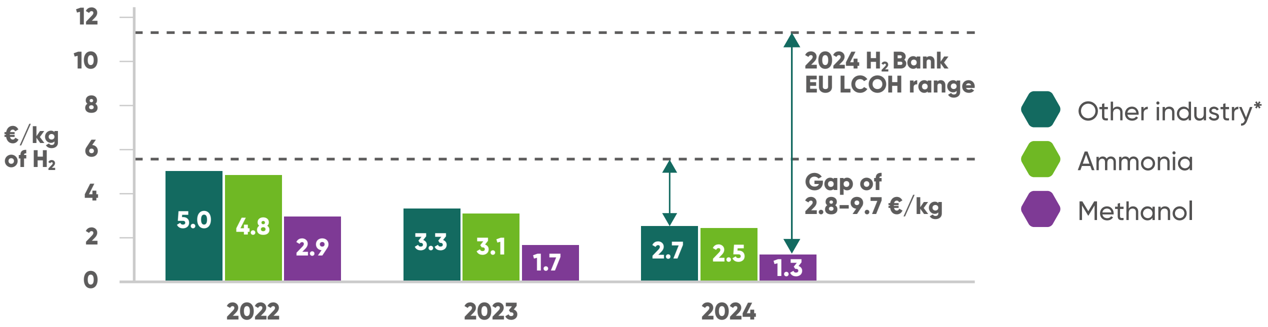
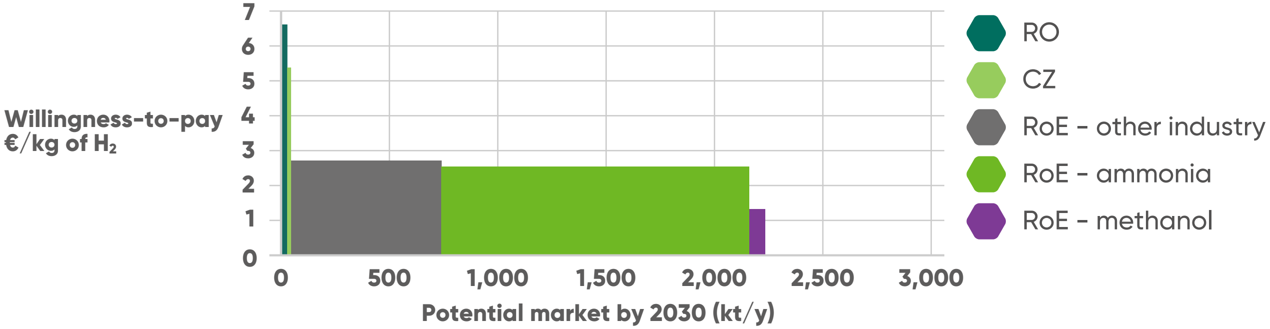


FIGURE 4.8

Potential market size by 2030 (in kt/y) and willingness-to-pay price (in €/kg) for conventional industrial applications for hydrogen



Indicated break-even points refer to the cost of hydrogen at delivery point (incl. costs of transportation and storage) needed to match the cost of the fossil alternative plus any additional cost on CO_2 emissions either through ETS or other regulations.

Notes: * Other industry includes other uses of hydrogen in the chemical sector (e.g., hydrogen peroxide) or merchant hydrogen production. In those cases it is assumed that the reference for calculating the break-even is conventional hydrogen production, similar to refineries described on page 65. RoE is rest of Europe.

AMMONIA AND METHANOL: Given the challenges in industrial applications, the most immediate market opportunities lie in the maritime sector

The current break-even point (BEP) for many maritime applications is as challenging as in industry, with the **2024 BEP estimated at around 2.2 €/kg for ferries operating on short routes and 1.1 €/kg for large ocean-going vessels[3].** The EU ETS price of around 70 €/t falls well below the estimated CO_2 abatement cost of around 500-600 €/t CO_2.

The FuelEU Maritime regulation with a penalty of €2,400 per tonne of conventional maritime fuel consumed above the GHG limit would close the cost gap. Even though the regulation is technology-neutral, the GHG reduction ambitions in the first years are modest and have a loophole treating all onshore power use as zero-emission. As a result, LNG remains the most attractive compliance option for many shipowners in the short to medium term, **highlighting the need for a maritime-specific approach in REDIII implementation.**

The IMO net zero framework could improve the competitive position of RFNBO. If approved, the measure could enter into force in 2027 and would be the world's first legally binding framework to cut GHG emissions in shipping. The two-tiered CO_2 pricing system is closer to what is needed to bridge the cost gap, with the high tier CO_2 price at 380 \$/tCO_2 . Furthermore, **hydrogen-derived e-fuels with a near zero GHG intensity are positioned as compliance winners and are allowed to generate compliance Surplus Units that could be traded on the market for additional revenues.**

FIGURE 4.9

Development of hydrogen break-even point in maritime sector in 2022-2024

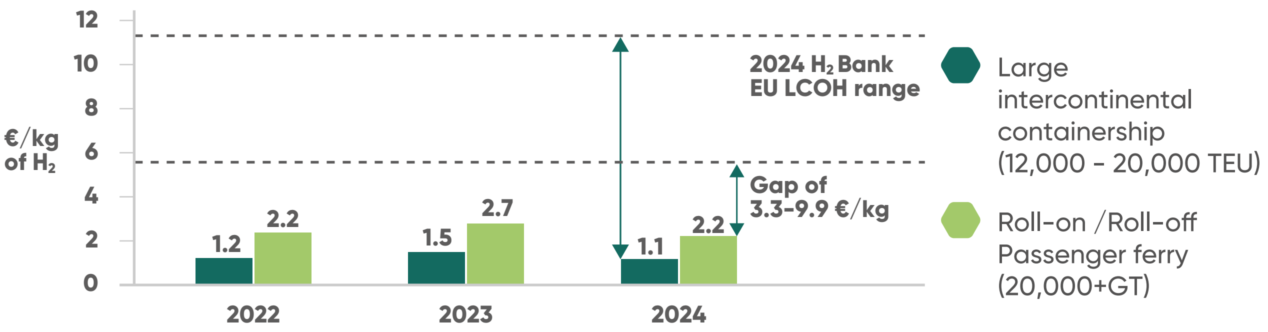
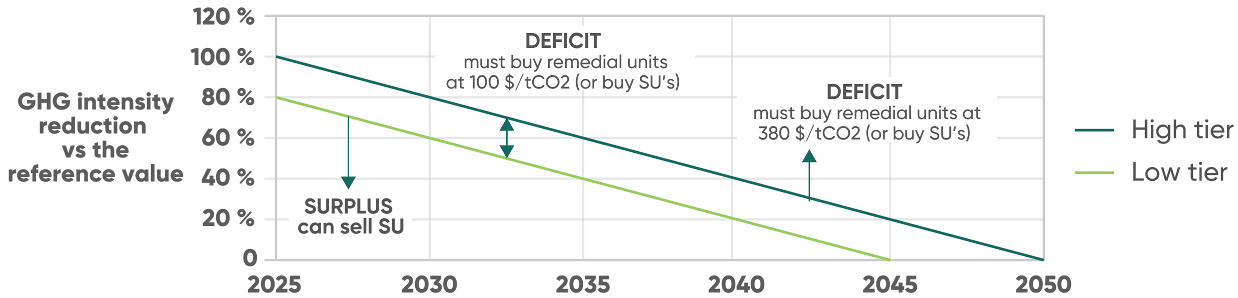


FIGURE 4.10

Simplified illustration of the proposed IMO Net Zero Framwork approach to CO_2 emissions pricing



Notes: Indicated break-even points refer to the cost of hydrogen at delivery point (including costs of transportation and storage) needed to match the cost of the fossil alternative plus any additional cost on CO_2 emissions either through ETS or other regulations. Data source for BEP: European Hydrogen Observatory[4].

E-SAF projects amount to ~1 MtH_2 /year, enough to reach the ReFuelEU Aviation 2030 goals, but securing long term offtakers remains challenging

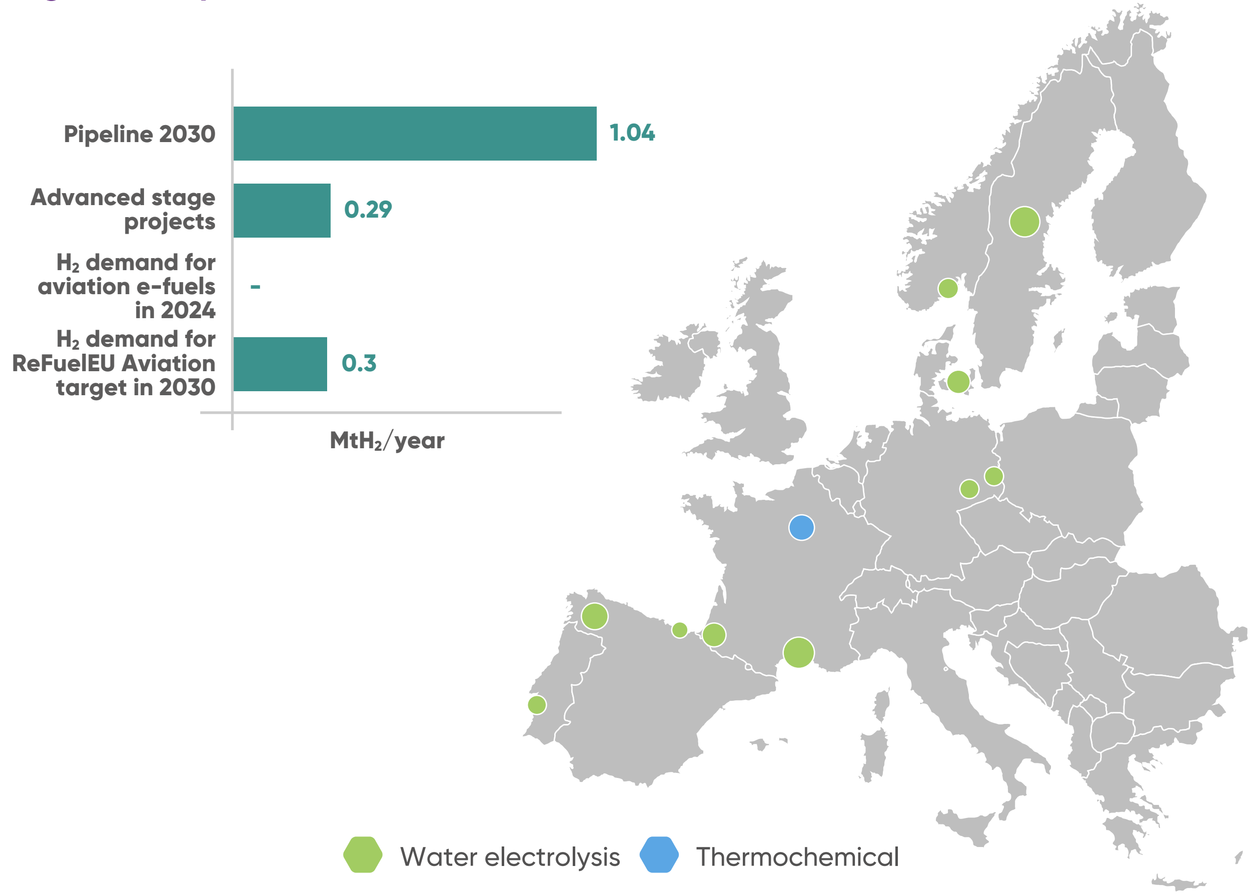
E-fuels will play a crucial role in decarbonising the aviation sector. The industry is pursuing emissions reductions through Sustainable Aviation Fuels (SAF), supported by regulatory targets. **Under ReFuelEU Aviation, at least 6% of aviation fuel at EU airports must be SAF by 2030, including 1.2% for synthetic fuels, equivalent to ~0.3 Mt/year of electrolytic hydrogen.** Demand will rise significantly post-2030, with synthetic fuels required to reach 35% market share by 2050. The UK is also supporting SAF through a £63 million funding programme and a national mandate requiring 2% of jet fuel to be SAF in 2025, rising to 10% in 2030 and 22% in 2040. A sub-mandate for e-fuels, produced using clean hydrogen, will apply from 2028, starting at 0.2% and rising to 3.5% by 2040.

Renewable hydrogen projects rely heavily on early offtake commitments to reduce investment risks. E-SAF producers face added challenges, as airlines usually sign fuel contracts only a year in advance. Policy measures encouraging early airline participation and co-investment will be crucial to accelerate projects.

Currently, around **1.0 Mt/year (~8.2 GW_{el}) of clean hydrogen production has been announced for aviation e-fuels by 2030, with 0.3 Mt/year in advanced stages.** Key projects include the Petronor/Repsol e-fuel plant (10 MW_{el}) in Bilbao, already under construction, as well as the Alby PtX (500 MW_{el}) in Sweden and Arcadia Endor's projects (280 MW_{el}) in Denmark, both nearing start of construction, with permits received in the past year.

FIGURE 4.11

Selection of large-scale clean hydrogen production projects in advanced stage in Europe with e-SAF as intended end use



Notes: Industrial demand estimated for 2024 in Europe including United Kingdom, Norway, Switzerland and Iceland. Pipeline 2030 refers to the total number of announced projects with expected start dates by 2030 with intended end use to e-fuels for aviation. Advanced projects encompass those that are operational, under construction, or in the preparatory stages and larger than 500 tonnes/year. H_2 demand for ReFuelEU estimated to meet the 1.2% of synthetic fuels by 2030 and assuming aviation fuel demand in the EU of 43 million tonnes, based on EU COM forecast.

E-SAF: Strong penalties make aviation potentially a highly attractive market for first movers

According to EASA estimates, **current e-SAF production costs are well above the market prices of conventional aviation fuel (734 €/t) both for e-SAF qualifying as RFNBO (7,520 €/t) as well as low carbon synthetic aviation fuel (5,525 €/t)[4].** However, as the ReFuelEU Aviation regulation defines the penalty for fuel suppliers who fail to reach the required minimum e-SAF quota (1.2% from 1st January 2030), to be twice the price difference between conventional and synthetic aviation fuels, even with such a high-cost gap, the aviation sector is proving to be an attractive opportunity for investors. In the case of Germany, the penalty proposed by the government of 17,000 €/t_{SAF} would be more than sufficient to ensure compliance with the minimum quotas, estimated to require at least 71 kt/y of clean hydrogen in Germany and around 310 kt/y in the entire EU.

The potential size of the market for clean hydrogen as feedstock to produce synthetic aviation fuels could be increased 5-fold, to a total of 1.55 Mt/y, if synthetic aviation fuels could be produced at a cost competitive with advanced aviation biofuels. However, with advanced aviation biofuels estimated at 2,715 €/t, clean hydrogen would have to be produced and delivered to e-fuel plants for no more than 3.5 €/kg. If more expensive CO_2 from DAC would be used (at 200 €/tCO_2), the break-even-point would fall to below 2 €/kg.

FIGURE 4.12

2024 aviation fuels reference prices for ReFuelEU Aviation and potential penalties (in €/t) based on EASA

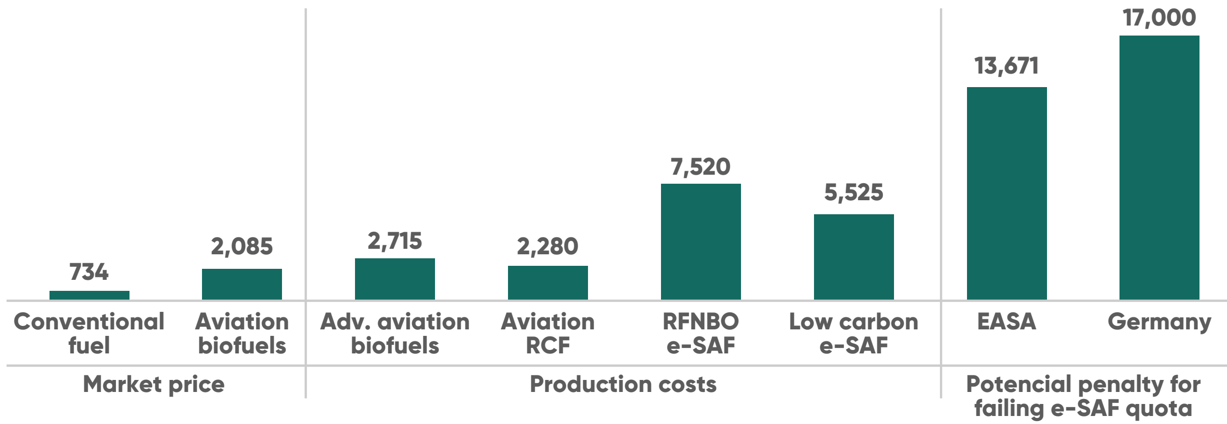
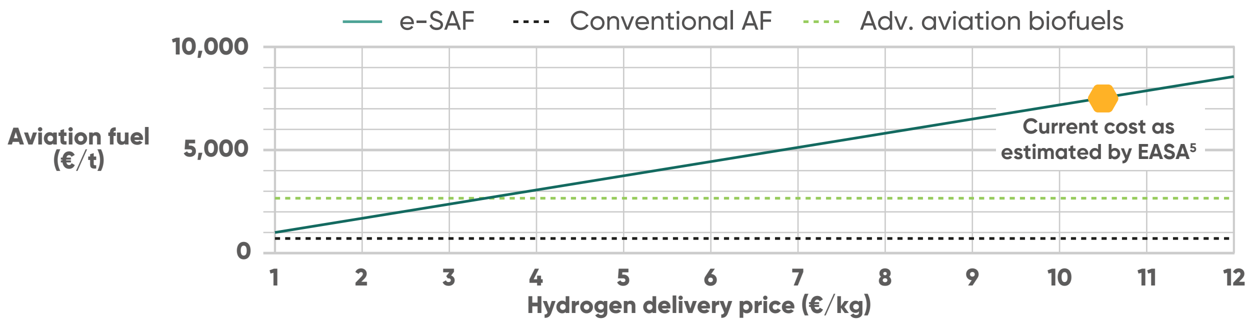


FIGURE 4.13

Production costs of synthetic aviation fuels depending on clean hydrogen feedstock costs



Notes: Source for 2024 aviation fuels reference prices: EASA. Production costs of synthetic aviation fuel estimated using assumptions from a 2024 report by Concawe and Aramco6, for e-kerosene production via Fisher-Tropsch, with key assumptions of CAPEX: 1,098 €/kW_fuel, fixed O&M costs of 3% CAPEX, variable O&M costs 1.5 €/GJ, 30 year lifetime, hydrogen input 1.404 MJ/MJ_fuel, electricity consumption of 0.044 MJ/MJ_fuel, CO_2 input of 0.09 tCO_2/GJ_fuel, CO_2 cost for point capture in industry at 20 €/t.

CLEAN STEEL: Production could drive a potential 4 Mt/year of clean hydrogen, cutting CO_2 emissions and positioning the sector as a hydrogen lead market

The EU-27 produced ~130 Mt of steel in 2024, including ~72 Mt of primary steel[7], accounting for about 5% of the EU's CO_2 emissions. **Transitioning to hydrogen-based Direct Reduced Iron (DRI) and Electric Arc Furnace (EAF) technologies could cut up to 144 Mt of CO_2 annually, requiring 4.0 Mt/year of clean hydrogen.**

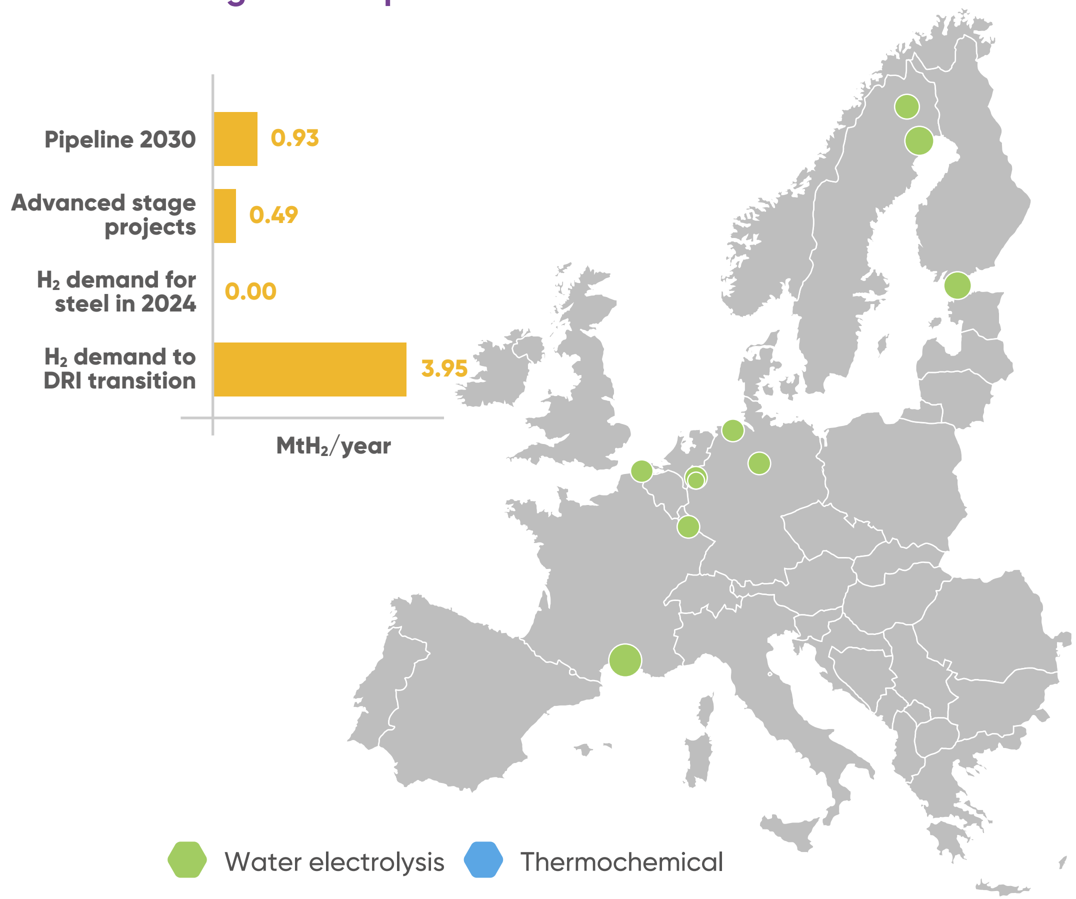
Steel is emerging as a key market for clean hydrogen, offering large-scale, predictable demand that can support renewable hydrogen uptake. Automotive manufacturers, major steel consumers, are helping drive this transition, often investing directly in clean steel projects, as the limited impact on vehicle prices allows to absorb the green premium.

Announced clean steel projects in Europe **require around 0.9 Mt/year (~7.6 GW_{el}) of hydrogen by 2030, with 0.5 Mt/year in advanced stages.** If all succeed, they could decarbonise roughly 24% of current primary steel production. While some companies are decarbonising existing plants, new players are building greenfield projects, particularly in the Nordics.

Projects under construction include Stegra's plant in Sweden (~740 MW_{el}) and Germany's SALCOS project (100 MW_{el}). Other advanced projects include GravitHy in France (500 MW_{el}) and Hybrit in Sweden (500 MW_{el}). However, uncertainty remains, ArcelorMittal recently cancelled their projects, citing high electricity prices and a weak business case for green steelmaking. Thyssenkrupp Steel and Saarstahl in Germany are investing in DRI and electric cars with state support, but it remains unclear when clean hydrogen demand through the core grid will materialise.

FIGURE 4.14

Selection of large-scale clean hydrogen production projects in advanced stage in Europe with steel as intended end use



Notes: Industrial demand estimated for 2024 in Europe including United Kingdom, Norway, Switzerland and Iceland. Pipeline 2030 refers to the total number of announced projects with expected start dates by 2030 and intended end use to steel. Advanced projects encompass those that are operational, under construction, or in the preparatory stages and larger than 500 tonnes/year. Hydrogen demand estimated based on current annual primary steel production in Europe and the assumption of 55kg of hydrogen per 1 ton of steel. CO_2 emissions is estimated based on a 1.6-2 tons of CO_2 per tonne of crude steel produced.

CLEAN STEEL: Renewable hydrogen in primary steelmaking is economically challenging, however even a small market premium for green steel can make a difference

Following a drop in coal and coke prices and a reduction of the ETS CO_2 price from 83 €/t to 65 €/t, **conventional steel production costs in the EU decreased, lowering the break-even hydrogen delivery price from around 4.7 €/kg in 2023 to only 2 €/kg in 2024[5].** Such a level is currently unachievable for renewable hydrogen producers, especially considering that storage and transportation costs need to be included.

However, unlike many other industrial applications such as ammonia or methanol production, where hydrogen dominates the cost structure, in the case of steel, other costs such as iron ore as well as electricity for EAF are equally impactful. Consequently, when the costs of the conventional production route (BF-BOF) are low, the pressure on hydrogen prices increases. However, even a modest market premium for green steel could greatly improve the economics of hydrogen-based steelmaking. **A 25% market premium for green steel would increase the hydrogen break-even price to around 5.0 €/kg, within the cost range reported in the recent Hydrogen Bank auction.**

In the case of the automotive sector, a similar cost premium would increase the cost of a vehicle for final consumer by ~€200, i.e. only around 0.5% for a vehicle of €40k. Stegra has reportedly signed agreements with several automotive OEMs at a premium steel price of 20% to 30%. It should be noted however that not all steel consuming sectors could absorb the extra costs so easily.

FIGURE 4.15

Development of hydrogen break-even point in steel production in 2022-2024 compared to the LCOH reported in 2024 Hydrogen Bank auction (in €/kg)

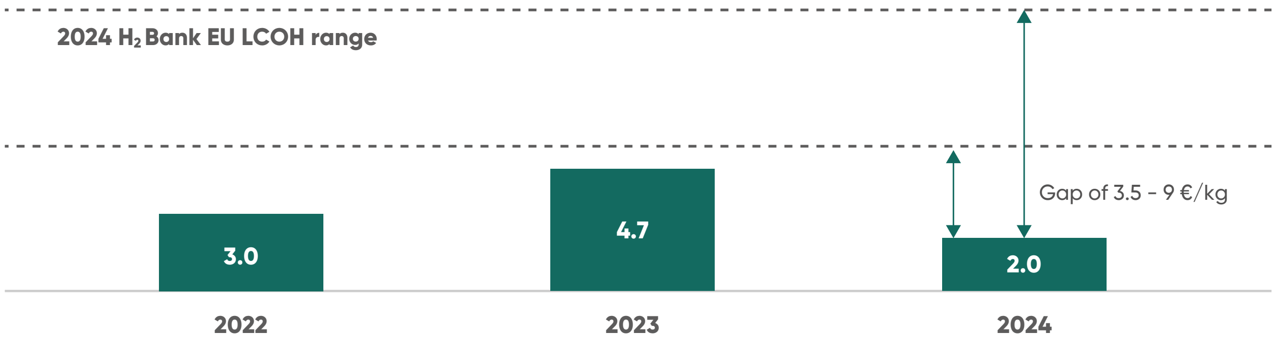
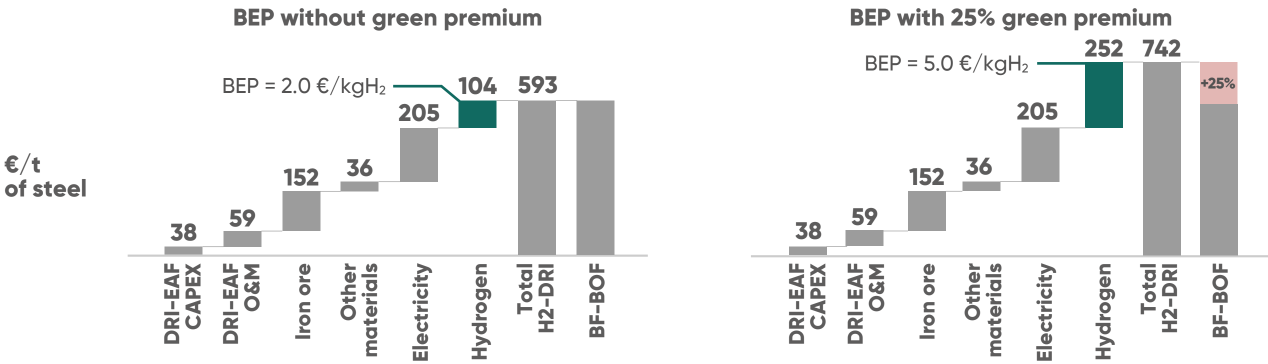


FIGURE 4.16

Hydrogen break-even point in steel production depending on market premium for green steel



Notes: Indicated break-even points refer to the cost of hydrogen at delivery point (including costs of transportation and storage) needed to match the cost of the fossil alternative plus any additional cost on CO_2 emissions either through ETS or other regulations. Data source for BEP: European Hydrogen Observatory[4].

Power generation and data centres could benefit from hydrogen's potential for long-duration clean energy storage, flexibility and backup

Clean hydrogen is emerging as a key enabler of dispatchable, flexible, and seasonal power in a renewable dominated grid. While current power-to-hydrogen-to-power efficiency remains below 40% and costs are still higher than fossil gas or batteries, its capacity for long-duration storage offers unique value in system balancing.

To date, hydrogen use in power generation remains limited to pilot projects such as the Centrale Électrique de l'Ouest Guyanais, H2H Saltend and the Reference Power Plant Lausitz. Developers like HDF Energy are among those testing the technological and economic viability of these solutions.

Growing power demand from data centres (DCs), driven by artificial intelligence, is adding pressure to already congested grids. As of 2024, DCs consumed 96 TWh[6] (3.1% of Europe's electricity), which could rise to 150–200[7] TWh by 2030. These facilities require firm, uninterrupted power and are currently heavily concentrated in FLAPD markets, where their electricity demand is disproportionately high. In 2023, DCs accounted for 33–42% of electricity in London, Frankfurt, and Amsterdam, and nearly 80% in Dublin[8]. **Hydrogen can support this need through backup generation and long-duration storage within integrated energy hubs.** Projects like Microsoft's hydrogen fuel cell pilot in Dublin reflect growing interest in these applications.

The future of hydrogen in power generation and data centres will depend on the evolution of policies, access to low-cost clean hydrogen, and recognition of its value in delivering firm capacity, flexibility and storage within a fully renewable electricity system.

FIGURE 4.17

Example of pilot projects in power generation

Power generation

PARTNERS: Equinor
STATUS: Waiting for FID
PROJECT: H2H Saltend, led by Equinor near Hull, UK, is a 600 MW low-carbon hydrogen project partially supplying power generation.

PARTNERS: HDF Energy
STATUS: Under development
PROJECT: The Centrale Électrique de l'Ouest Guyanais in French Guiana is a 16 MW solar-hydrogen plant supplying clean electricity.

PARTNERS: EnBW
STATUS: Operational since 2025
PROJECT: EnBW's Stuttgart-Münster commissioned hydrogen-ready gas turbines (124 MW electric), designed to eventually run on 100% hydrogen.

Data Centres

PARTNERS: Microsoft, ESB
STATUS: Pilot running since 2024
PROJECT: Pilot to use of green hydrogen fuel cells to power (250kW) a building at its Dublin data centre campus.

PARTNERS: NorthC
STATUS: Operational since 2022
PROJECT: In 2022, NorthC installed hydrogen fuel cells (500kW) at a Groningen data centre facility to replace diesel backup generators.

Notes: FLAPD markets refer to the biggest data centre markets in the EMEA region and are currently Frankfurt, London, Amsterdam, Paris, and Dublin.

Next steps for developing the European clean hydrogen market

Area	Issue	Next steps
EU regulatory framework	**ISSUE:** COMPLICATED OR MISSING REGULATORY FRAMEWORK FOR CLEAN HYDROGEN PRODUCTION	Developers continue to delay or cancel projects due to regulatory uncertainty or regulatory compliance costs for producing renewable or low-carbon hydrogen. • **Regulatory framework** – Create an investment-friendly regulatory framework for all clean hydrogen production technologies that are aligned with the 2050 climate targets. • **Renewable fuels of non-biological origin (RFNBO) DA** – Review the definition of RFNBO by 2026 latest, making it a lot more pragmatic to spur deployment and scale-up the industry. In the meantime, clarify all legal uncertainties and questions posed by certification voluntary schemes.
National implementation	LACKING NATIONAL REGULATORY FRAMEWORKS	Slow and often insufficient national transposition of REDIII and Hydrogen and Decarbonised Gas Markets package creates uncertainty. Developers and offtakers are unsure whether and how the targets should be met, whether there will be obligations and penalties, which incentives are available and whether hydrogen infrastructure will be in place to help deliver clean hydrogen. • **Target structure** – All Member States to provide visibility on how and when the industry and transport targets will be transposed. • **Penalties** – The Commission to clarify what the penalties are for non-compliant Member States and encourage penalty uniformity if targets are implemented at company level. • **Book and claim** – Get clarity on transferability of RFNBO credits and creation of a book and claim system for REDIII compliance (like for ReFuelEU Aviation).
Lead markets	LACK OF MARKET DEMAND FOR CLEAN HYDROGEN-BASED PRODUCTS HAMPERS SCALE-UP	Existing regulatory frameworks, while creating compliance-based demand in transport and industry, don't activate demand for green products like clean steel or fertilisers. Without a strong demand-side strategy and fair distribution of the green premium, first movers face disadvantages and uptake remains fragmented. • **Lead markets** – Establish Green Lead Markets with product-specific targets and sustainability criteria under the Industrial Decarbonisation Accelerator Act (IDAA) to provide predictable demand signals and support first movers. • **Labelling** – Develop robust, EU-wide carbon footprint labelling at product level using adaptable certification schemes. • **Demand mandates** – Introduce mandatory quotas in public procurement and apply downstream obligations or incentives to private buyers to accelerate market uptake across key sectors.
Infrastructure	SLOW DEVELOPMENT OF HYDROGEN TRANSPORT, STORAGE, AND IMPORT INFRASTRUCTURE PREVENTING CONNECTION BETWEEN CLEAN HYDROGEN SUPPLIERS AND INDUSTRIAL CONSUMERS	• **Implementation** – Rapidly implement the Hydrogen and Decarbonised Gas Markets package at national level, designating a hydrogen network operator, clarifying the framework for third party access to infrastructure, and design a funding framework for infrastructure roll out. • **Planning and modelling** – Incorporate energy storage into network development and strengthen cross-sectoral system planning via better scenarios and improved modelling tools. • **Strategy** – Develop a European hydrogen grid and storage strategy that forms a fundamental pillar of the EU grid action plan.
Funding	INADEQUATE FUNDING MECHANISMS AT EU AND NATIONAL LEVEL	EU funding is limited and complex (Innovation Fund calls, EU Hydrogen Bank) while national level funding can be dispersed and not effectively support market uptake. Some countries still lack a clear funding scheme for clean hydrogen deployment. • **European funding** – The EU Hydrogen Bank should evolve to further support offtaker risks and to include imports. Rules on accumulation need to be addressed to facilitate the funding of projects. • **National funding** – Member States should develop mechanisms to address the cost gap between clean and conventional hydrogen. Mechanism to support production can be complemented with offtaker support in the form of CCfD. It is important to continue supporting innovation and industrialisation, with a reinforced focus on deployment through OPEX base schemes.

Methodological note

BREAK-EVEN-POINT: Estimated as the cost of clean hydrogen at delivery point necessary to reach cost parity with the incumbent, conventional technology. As the BEP is estimated at delivery point it schould cover not only clean hydrogen production costs but also costs of storage and transportation to end consumers. Conventional technology costs include both full operating costs (not only marginal costs) and CO2 costs, based on average 2024 EUA price and the amount of free allowances estimated based on current ETS benchmarks. The costs of clean hydrogen include not only the cost of fuel itself but also (if applicable) other costs necesarry to switch to clean hydrogen. For example, in case of ammonia production, this would include also costs of an alternative nitrogen source (via ASU).

For most cases the BEP data is coming from the European Hydrogen Observatory (https://observatory.clean-hydrogen.europa.eu/)

Willingness-to-pay: Estimated as the potential price for clean hydrogen, the end consumer would be willing to pay at delivery point, that be equal to the costs of alternative conventional solution together with the impact of any additional policy or regulatory incentives put in place to promote decarbonisation (other than ETS). In case no such incentives exist, the willingness to pay = BEP.

COST GAP: Cost gap is estimated as the difference between the current levelised cost of hydrogen (based on the results of the Hydrogen Bank auction) and the estimated willingness-to-pay.

Endnotes

1 / ACEA, 2024
2 / European Hydrogen Observatory, 2025
3 / EASA, 2025
4 / Concawe, 2024
5 / Eurofer, 2025
6 / ICIS, 2024
7 / McKinsey, 2024 (The role of power in unlocking the European AI revolution)
8 / Greenpeace, 2025 (ENVIRONMENTAL IMPACTS OF ARTIFICIAL INTELLIGENCE)

Terminology

CLEAN HYDROGEN refers to hydrogen produced using production methods that have the potential to reduce emissions compared to conventional (non-abated fossil-fuel based hydrogen production). When referring to clean hydrogen, this report refers to hydrogen produced by electrolytic (water electrolysis) and thermochemical production methods. The thermochemical in this report refers to clean thermochemical production methods (reforming with carbon capture projects, methane splitting, biowaste-to-hydrogen, non-biological waste-to-hydrogen). The developers using these production pathways want to produce abated hydrogen and thus the assumption is that the emissions will be maximum 3.38 $kgCO_2/kgH_2$.

RENEWABLE HYDROGEN is used interchangeably with RFNBO hydrogen (Renewable Fuel of Non–Biological Origin) in this report and refers to hydrogen produced from renewable electricity and satisfying the conditions outlined in delegated acts of the Renewable Energy Directive.

WATER ELECTROLYSIS/POWER–TO–HYDROGEN/ELECTROLYTIC – This report uses the terms water electrolysis and power–to–hydrogen interchangeably. Water electrolysis or power–to–hydrogen (PtH) refers to electrolysers splitting water with electricity with hydrogen being the main product. This excludes brine electrolysis.

THERMOCHEMICAL refers to clean thermochemical hydrogen production. This includes the following hydrogen production pathways reforming, gasification, or partial oxidation of fossil fuels coupled with carbon capture of the emissions, methane splitting, biowaste-to-hydrogen, non-biological waste-to-hydrogen. The developers using these production pathways want to produce abated hydrogen and thus the assumption is that the emissions will be maximum 3.38 $kgCO_2/kgH_2$.

There are also installations being built right now that are retrofitting carbon capture on existing steam methane reformers and plan to store the captured CO_2. While that reduces the emission intensity of the produced hydrogen, depending on the technical solution, it can but doesn't have to produce hydrogen below 3.38 $kgCO_2/kgH_2$. These installations are included in this outlook and labelled as thermochemical.

In new future installations, most developers are aiming at using auto-thermal reforming technology and achieving high, ~95%, CO_2 capture rates which can under certain conditions and depending on upstream emissions achieve producing hydrogen below 3.38 $kgCO_2/kgH_2$.

CONVENTIONAL/NON-ABATED FOSSIL-FUEL BASED HYDROGEN refers to hydrogen produced by steam reforming, partial oxidation, gasification, and autothermal reforming of fossil fuels without any CO_2 abatement. Popularly referred to as "grey" hydrogen.

THERMOCHEMICAL WITH LIMITED CO_2 ABATEMENT it is important to note that most existing hydrogen production installations that capture CO_2 subsequently sell it rather than storing it. So while the carbon capture technology is being used, it does not make the produced hydrogen have lower emission intensity. Such example is Air Liquide's Port Jerome installation in France or Shell's heavy residue gasification unit in Pernis in the Netherlands.

REFORMING refers to hydrogen production from steam reforming, partial oxidation, gasification, and autothermal reforming of fossil fuels. These processes account for the largest hydrogen production capacity.

REFORMING REFINERY OFF-GAS/REFORMING BY-PRODUCT refers to hydrogen produced in refineries as a by–product, e.g., during catalytic reforming.

BY–PRODUCT (ETHYLENE, STYRENE) refers to the hydrogen production capacity as a by–product of ethylene and styrene production.

BY–PRODUCT (ELECTROLYSIS) refers to by–product hydrogen production capacity from electrolytic chlorine and sodium chlorate production.

NECP/H2 STRATEGIES refers to National Energy Climate Plans and National Hydrogen Strategies available by July 2025. For the purpose of this report the most recent publication of the two was chosen in relation to electrolyser targets.

END-USES: The supply volumes for various end-uses for both scenarios is a result of the above-mentioned supply outlook methodology applied to every single project and its announced end-use (or N/A when no specific end-use has been announced).

"Refining" refers to hydrogen's use in the refining process for conventional fuels.

"Ammonia" refers to the consumption of hydrogen for ammonia production.

"Methanol" refers to the consumption of hydrogen for methanol production.

"Steel" as an end-use refers to hydrogen used as a reducing agent in the H-DRI production process.

"E-fuels" as an end-use includes all synthetic fuels produced using clean hydrogen as a feedstock, excluding methanol and ammonia. This includes mostly e-methane and e-kerosene/e-SAF production projects.

"Mobility" as an end-use refers to the direct use of hydrogen in fuel cell electric vehicles.

"Other and N/A" as end use is used for industrial heat, residential heat, power generation, blending, unidentified industrial uses, and when no specific end-use has been announced.

In case a project has announced multiple end-uses for its produced hydrogen, only the largest end-use is taken into account. Authors realise this methodological limitation and will seek to remedy it in future publications.

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