European Hydrogen Index 2025

Bridging the gap between ambition and action

Review of the European hydrogen industry
January 2025

The better the question.
The better the answer.
The better the world works.

Hyvolution

EY
Shape the future with confidence

Contents

List of abbreviations

AEM	Anion-exchange membrane
ALK	Alkaline
AFIF	Alternative Fuels Infrastructure Facility
CCS	Carbon Capture and Storage
CCUS	Carbon Capture Usage and Storage
CEF-E	Connecting Europe Facility-Energy
CEF-T	Connecting Europe Facility-Transport
CfD	Contract for Difference
EEA	European Economic Area
EHB	European Hydrogen Bank
ENTSOG	European Network of Transmission System Operators for Gas
ERDF	European Regional Development Fund
ETS	Emissions Trading Scheme
EU	European Union
FID	Final Investment Decision
GHG	Green House Gases
H2	Hydrogen
IEA	International Energy Agency
IPCEI	Important Projects of Common European Interest
LCOH	Levelised Cost of Hydrogen
MFF	Multiannual Financial Framework
NECP	National Energy and Climate Plan
NGEU	Next-Generation EU
NZIA	Net-Zero Industry Act
PEM	Proton-exchange membrane
PPA	Power Purchase Agreement
PPP	Public Private Partnership
REACT-EU	Recovery Assistance for Cohesion and the Territories of Europe
RFF	Recovery and Resilience Facility
RFNBO	Renewable Fuels of non-Biological Origin
SOEC	Solid oxide electrolyser cells
TRL	Technology Readiness Level

Executive Summary

The purpose of the European Hydrogen Index is to analyse the state of play of the hydrogen sector in Europe. It proposes a comprehensive framework to assess the maturity of the European hydrogen industry and provides priority actions to implement in 2025. The analysis focuses on low-carbon hydrogen, although the quantitative analyses are centered on renewable hydrogen. Renewable hydrogen is defined by the European Commission in the Delegated Act on the methodology for renewable fuels of non-biological origin (RFNBO). This analysis covers 1) policy frameworks and incentive schemes, 2) industrial developments and 3) demand and investment perspectives.

On the policy level, the EU has launched extensive strategies and support mechanisms for the hydrogen sector, but further action is needed for full deployment.

- The European hydrogen strategy and RePowerEU have set the targets of 10 Mt of renewable hydrogen production and 10 Mt of imports by 2030. The regulatory framework includes several targets and definitions regarding renewable hydrogen, such as the RFNBOs Delegated Acts. The stringent conditions on temporal and geographical correlation can lead to additional storage capacities and ultimately higher development costs.
- Achieving these objectives will require robust financing tools to support project developers and industry stakeholders, an acceleration of the development of transport and distribution infrastructure, and the buildup of necessary competencies.
- The EU has structured a wide panel of subsidies, incentives and financial instruments. However, the approval process for granting these funds is long (12 to 24 months) and complex, which slows down the implementation of projects and jeopardises the achievement of EU objectives.
- As of December 2024, 60% of the European ambition on renewable hydrogen production capacity is covered by national targets. EU Member States need to coordinate their policy objectives and to align their targets with the EU's overall goals, particularly regarding the pace of production ramp-up by 2030.

The complexity of European and national funding mechanisms calls for improved accessibility and clarity of existing instruments. Long-term visibility for investors will also be crucial, in particular by ensuring the long-term stability of support schemes.

- While the EU hydrogen sector is evolving, it does not have the supply chain to meet its ambitious goals. Technological solutions are available and industrial scale-up is underway: up to 1.2 GW of additional electrolyser manufacturing capacity will be operational by the end of 2025.
- Manufacturers need support to overcome the "valley of death" due to potential delays in the uptake of the market.
- To achieve the REPowerEU targets, at least 100GW of installed electrolyser capacity in Europe would be required by 2030, equivalent to a CAGR for new electrolyser capacity of 150% between 2025 and 2030, far exceeding the CAGR of 45% from 2020 to 2024.

Project developers and investors remain cautious about the sector.

- 98% of the 142 GW project pipeline remains at the concept or feasibility stage, requiring rapid operationalization and financing to move to final investment decision.
- Effective implementation of hydrogen projects demands strong confidence in long-term demand perspectives and improved coordination between technology providers, energy suppliers, operators, and end-users to address transportation challenges and the complexity of large-scale industrial development. Securing long-term off-take contracts may be an example of this type of collaboration between upstream and downstream stakeholders.
- Clear and consistent signals need to be sent to market players to reduce unpredictability on subsidy programs and to reduce the risk of stop-and-go policy support to this still developing market.

The EU hydrogen sector shows promising developments; however, it still requires significant efforts to meet its ambitious goals, especially given the uncertainties of the energy market. Enhanced collaboration, clear regulatory frameworks, and stable support mechanisms are essential to accelerate progress and ensure the sector's long-term viability.

Introduction

Low carbon hydrogen is a pivotal element in reducing emissions within the industrial and transportation sectors. The European Union is committed to boosting its hydrogen production capabilities by expanding electrolysis capacity and renewable energy resources. The overall objectives are to improve energy security via a sustainable hydrogen supply and to meet climate targets.

The hydrogen sector has seen fluctuating progress due to varying support announcements and project realisations. The European Hydrogen Index, developed by EY & Associés (hereafter referred to as "EY") in collaboration with Hyvolution, aims to evaluate the current state of hydrogen sector deployment. It includes evaluation criteria for various stakeholders in the sector, facilitating comparisons with other regions.

The criteria selected for the European Hydrogen Index assessment address critical levers of the hydrogen industry, including EU and national policy targets, the deployment of funding programs, electrolysis technology readiness, production and manufacturing project trends, and the commitment of developers, off-takers and investors. The report evaluates these criteria and provides recommendations for action in 2025.

The quantitative analysis focuses on the development and potential of renewable hydrogen, as defined by the European Commission in its Delegated Act on the methodology for renewable fuels of non-biological origin (RFNBO). Low-carbon hydrogen also covers hydrogen produced from non-renewable sources with at least 70% fewer greenhouse gas emissions than fossil fuels across its lifecycle and includes technologies such as hydrogen produced using nuclear electricity for electrolysis or derived from natural gas with carbon capture and storage (CCS) via steam methane reforming.

Under Article 22b of the RED III[1], a Member State may reduce its 2030 target for RFNBOs by up to 20%, provided two conditions are met. The Member State must be on track to meet its national contribution to the EU's overall binding renewable energy target, as calculated under Regulation (EU) 2018/1999, and the share of hydrogen or hydrogen derivatives produced from fossil fuels consumed within the Member State must not exceed 23% by 2030 and 20% by 2035.

This analysis considers projects within the European Economic Area. Analyses are based on the IEA Hydrogen Projects databases[2]. These databases will be referred to in the report as the 2022, 2023, or 2024 IEA database.

1 European Parliament (2023), Directive (EU) 2023/2413

2 IEA (2022) (2023) (2024), *IEA Hydrogen Production Projects Database*

1.

European framework and support mechanisms are in place, but clarity and operationalization are required

1a. The European Union has demonstrated a consistent ambition and developed a regulatory framework that still needs to be completed

The EU's initial ambition for renewable hydrogen development was set out in the Commission's official strategy published in July 2020[3] setting the following targets: 40 GW of domestic electrolysers and 40 GW in neighboring countries[4] by 2030, with applications in hard-to-abate sectors. This ambition has been strengthened to address the industrial value chain needs, with the REPowerEU Plan[5] in 2022. This plan sets the target of producing 10 Mt of domestic renewable hydrogen and importing an additional 10 Mt by 2030. The imports include 6 Mt of renewable hydrogen and approximately 4 Mt of ammonia. However, it is unclear whether this refers to 4 Mt of hydrogen within the ammonia (equivalent to about 25 Mt of ammonia) or 4 Mt of ammonia itself (equivalent to 0.6 Mt of hydrogen[6]. This roadmap has been further enhanced with the Net-Zero Industry Act (NZIA), adopted in June 2024,[7] which is the first legislative framework addressing hydrogen development comprehensively across the EU. The NZIA expects that electrolyser manufacturers will scale up production in order to enable an installed capacity of 100 GW for the production of renewable hydrogen by 2030.

The EU has therefore established a policy framework to promote renewable hydrogen and its derivatives (e.g. e-fuels, e-ammonia), committing to renewable hydrogen production, publishing the RFNBOs Delegated Acts and recognizing electrolysers as key net-zero technologies. Key policies, including RED II[8] and RED III[9], as well as RefuelEU Aviation, set targets for RFNBOs and mandate SAFs, with a 6% SAF blending requirement by 2030. Among these, e-fuels are mandated to comprise 1 to 2% during the 2030-2034 period in the transport[10] sector. FuelEU Maritime[11] does not set specific RFNBO incorporation targets but establishes a GHG intensity reduction trajectory for maritime fuels, indirectly encouraging their use. However, the efforts made for the transport sector now need to be extended to other energy-intensive sectors such as steel, cement, fertilizer industries, and refineries. The current lack of clarity delays the adoption of hydrogen in these markets, slowing progress. Furthermore, there remains a significant need for work on standardization and certification.

Regarding low-carbon hydrogen, a clear consensus on its definition remains elusive, fueling ongoing debate about the criteria that should be included. On 27 September 2024, the European Commission launched a public consultation[12] on its draft proposal for a methodology to assess the greenhouse gas emissions savings from low-carbon fuels, including low-carbon hydrogen. The draft proposal allows nuclear-derived hydrogen to be classified as low-carbon under specific conditions, further intensifying discussions among Member States and industry stakeholders. It refers however to nuclear as a complex topic that requires further impact assessment that should take place over a period of four years. This has generated reactions, some of which by major industrial players, while the United States supporting scheme for clean hydrogen production (IRA - 45V) had just been adjusted to take into account nuclear based hydrogen Inflation Reduction Act (45V).[13]

3 European Commission (2020), A hydrogen strategy for a climate-neutral Europe, source

4 The Commission recognizes the following list of countries: Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Israel, Jordan, Kyrgyz Republic, Lebanon, Libya, Moldova, Morocco, North Macedonia, Palestine, Syria, Tunisia, Ukraine (European Commission, 2024).

5 European Commission (2022), RepowerEU plan, source

6 European Court of Auditors (2024), The EU's industrial policy on renewable hydrogen, source

7 The European parliament (2024), NZIA, source

8 The European parliament (2018), RED II, source

9 The European parliament (2023), RED III, source

10 The European parliament (2023), RefuelEU Aviation, source

11 The European parliament (2023), FuelEU Maritime, source

12 European Commission (2024), Commission launches consultation on draft methodology for low-carbon hydrogen, source

13 U.S. Department of the Treasury, 2025 Release of Final Rules for Clean Hydrogen Production Tax Credit, source

1b. Member States are responsible for the translation of the EU targets into national objectives and implementation frameworks

The success of renewable hydrogen deployment depends on the effective transposition of EU legislation into national frameworks. Additionally, most Member States include hydrogen production goals in their National Energy and Climate Plans (NECPs). **Figure 1** illustrates the gap between the EU's 2030 hydrogen objectives and the sum of national objectives.

The French political context has further added to existing delays in establishing a clear strategy and support framework for low-carbon hydrogen projects. In Germany, although there is significant communication about the importance of future hydrogen imports, substantial efforts are being made to increase domestic production capacity, through national incentive schemes and the H2Global initiative.

Discrepancies also exist between different EU initiatives: the NZIA sets a goal of 100 GW of electrolyser capacity by 2030, but achieving the production target of 10 Mt of renewable hydrogen could require up to 140 GW[14]. The European Court of Auditors stressed the need to reassess these targets to ensure consistency and feasibility[15].

Overall, the Commission's renewable hydrogen production targets have faced criticism for being overly ambitious and potentially unattainable. This raises questions about the feasibility of achieving the proposed production levels in a timely manner, particularly given the challenges of scaling up demand and infrastructure, securing investments, and ensuring alignment across Member States.

14 The Commission assesses that producing 10 Mt of renewable hydrogen in the EU would require an installed electrolyser capacity of 90-100 GW if measured in hydrogen output, further precising that this could go up to 140 GW if measured in terms of electricity input (European Clean Hydrogen Alliance, 2022)

15 European Court of Auditors (2024), The EU's industrial policy on renewable hydrogen, source

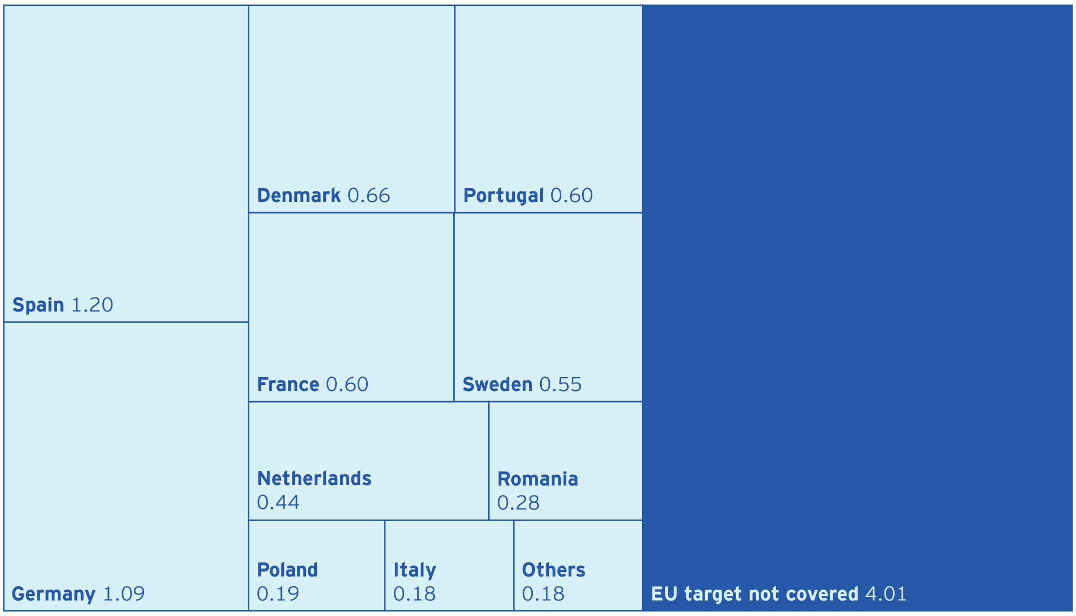

Figure 1 European renewable hydrogen production target for 2030 compared to goals set by Member States (Mt)

Source: EY analysis based on European Union Agency for the Cooperation of Energy Regulators, 2024, p. 20)

1c. Various financing mechanisms exist but they are considered long and complex to implement

To achieve its objectives, the EU has structured a panel of financing tools to support Research and Development (R&D), as well as project development and implementation from 2021 onwards (see **Table 1**: Allocated budgets and granted amounts by European hydrogen-dedicated subsidy programmes).

Funding programmes	Climate/clean tech dedicated budget relevant for H2 (in billion €)	Amount granted for H2 since 2021 (in billion €)
European Hydrogen Bank (under Innovation Fund)	2.0	**1.9**
Clean Hydrogen Partnership – under Horizon Europe (2021-2027)	1.2	**0.7**
ETS Innovation Fund (2020-2030)	40.0	**2.8**
CEF-T (2021-2027)	15.5	**0.4**
AFIF -included in CEF-T (2021-2023)	1.5	**0.2**
Modernisation Fund	33.6	**0.4**
LIFE (2021-2027)	1.9	0.02
ERDF	57.3	NC
Horizon Europe (2021-2027)	33.4	NC
Breakthrough Catalyst	0.4	NC
CEF-E (2021-2027)	3.5	NC
InvestEU	9.9	NC
Cohesion Fund	15.9	NC

Table 1 Allocated budgets and granted amounts by European hydrogen-dedicated subsidy programmes

Source: Hydrogen Europe, 2023, p. 120, 2024, p. 46

Between 2021 and 2027, the EU has allocated approximately €50-75 billion for additional electrolyser capacities in Europe and €200-340 billion for additional electricity production. The European Commission estimates these investments as the total costs required for renewable hydrogen by 2030[16]. These funds should foster sufficient private investments, providing that investors feel comfortable in the possible offtake and the economic viability of projects under the current regulatory framework. The competition with other regulatory frameworks and geographic conditions may allow non EU countries to produce a more competitive hydrogen. Currently, the financing mechanisms in place mainly target the supply side. However, greater efforts could be directed towards supporting the demand side[17].

The first auction of the European Hydrogen Bank (EHB) held in 2023 awarded €720 million to 7 renewable hydrogen projects, 6 of which signed their respective grant agreements[18]. The selected projects for this first auction are striking for their very low bid prices, between 0.37 €/kg and 0.48 €/kg. This could

16 European Commission (2022), Implementing the repower EU action plan: investment needs, hydrogen accelerator and achieving the bio-methane targets, source

17 BNEF (2023), Hydrogen Subsidies Skyrocket to $280 Billion With US in the Lead

18 European Commission (2024), IF23 Auction for renewable hydrogen production, source

be attributed to several factors, including electricity costs and the origin of the equipment. Based on the results of the first auction, the 2024 edition will offer awards of up to €1.2 billion. Besides, the new Terms and Conditions[19] for this edition are more restrictive than those of the previous edition. For example, projects must ensure that no more than 25% (in MWe) of electrolysis stacks, including surface treatment, cell unit production, or stack assembly, are sourced from China.

A second example of European financing instruments is the Important Project of Common European Interest (IPCEI) scheme for hydrogen, which has been extended since December 2020. This scheme allows state aid to be authorized for projects selected by the Commission, covering various hydrogen sector scopes: generation technologies (Hy2Tech), support for the adoption of hydrogen by the industry (Hy2Use), the development of infrastructure (Hy2Infra), as well as support for adoption by the transport sector (Hy2Move).

Nevertheless, EU funding schemes remain criticized due to their lack of clarity, their complexity and time-consuming processes. The multitude of European and national funding schemes presents a challenge, and even more for smaller projects and stakeholders. Out of the 337 proposals submitted under the fourth Innovation Fund call (IF23), 52 – which had mainly been submitted by Small, Medium, and Pilot categories – were considered ineligible. In other words, the complexity of the application processes favors larger companies which are able to leverage in-house or external experts.

Following submission, it usually takes several months for a project to get notified. The average time between the opening date of a call and the Commission's final decision is 13 to 14 months for the Innovation Fund[20] and 9 to 12 months[21] for the Horizon Europe call for proposals. Delays vary between schemes, with IPCEIs taking the longest – up to 2 years between the call's announcement and final approval – due to the involvement of multiple Member States in each project[22]. Several European utilities have scaled back their green hydrogen ambition due to delays in obtaining European subsidies.

19 European Commission (2024), Second renewable hydrogen auction: European Commission publishes Terms and Conditions, source

20 European Court of Auditors (2024), The EU's industrial policy on renewable hydrogen, source

21 Horizon Europe (European Commission), source

22 European Court of Auditors (2024), The EU's industrial policy on renewable hydrogen

2.

A structured industry and supply chain is a key of success for the development of large scale projects

2a. While the pipeline of hydrogen production projects for 2030 is significant, a number of expected projects have been pushed back to 2030 and beyond

A significant number of hydrogen production projects have been announced, with various timelines extending up to 2050, as shown in **Figure 2**. To date, the announced capacity in Europe for 2030 reaches approximately 141 GW[23]. Comparing the pipeline of projects year on year since 2022 indicates that several projects have been postponed or are experiencing delays.

23 IEA, project database, 2024

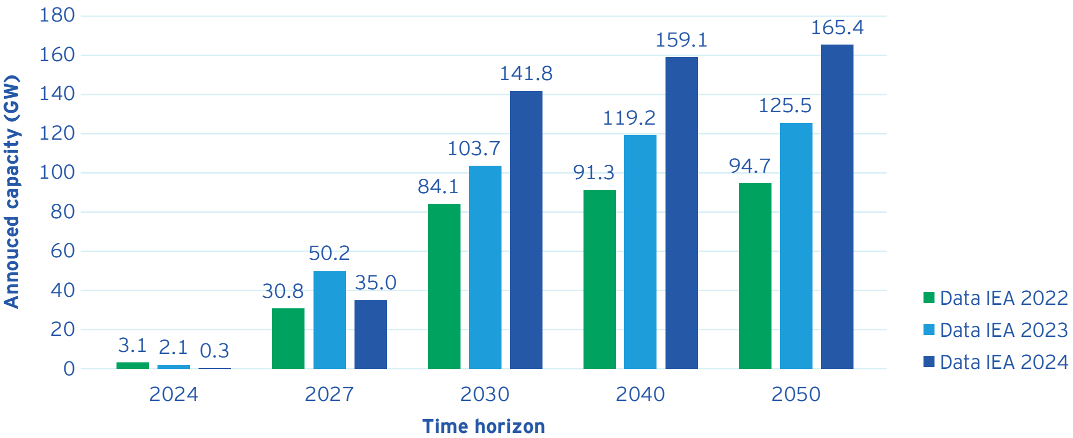

Figure 2 European renewable hydrogen production capacity announced

Source: IEA project databases, 2022, 2023, and 2024

Figure 3 shows all the European renewable hydrogen production projects in the IEA database that are expected to be operational by 2030. Most of the announced projects are mid-sized, whereas the majority of operational projects are small (<10 MW). The large projects (above 1 GW) are at an early stage of development. These large projects are critical to reach the EU targets, representing represent 65% of the announced production capacity for 2030 (92 GW out of 141 GW).

Clear and pragmatic rules for both renewable and low carbon hydrogen would allow for building on energy sources available in Europe, to mitigate the risk to have an uneven and uncompetitive development of its hydrogen production base.

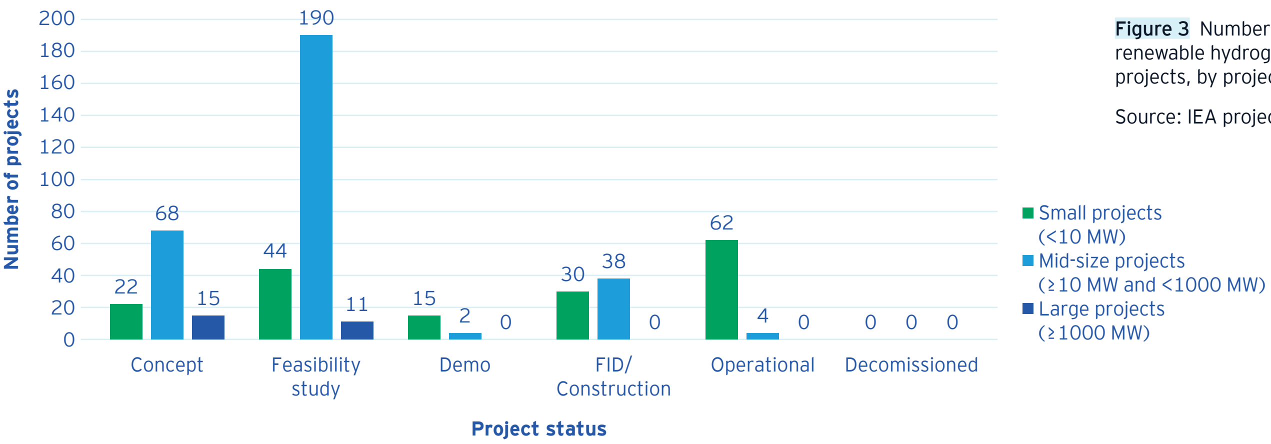

Figure 3 Number of European renewable hydrogen production projects, by project size and status

Source: IEA project database, 2024

2b. The European production capacity is progressing, yet industrialization needs to keep up

The different known electrolyser technologies continue to progress through various Technology Readiness Levels (TRL)[24]. In its 2023 Global Hydrogen Review, the IEA rated the readiness levels of different electrolysis technologies:

- Alkaline and Proton-exchange membrane (PEM) electrolysis technologies are at TRL 9, the highest deployment readiness level before full maturity,
- Solid oxide electrolyser cells (SOECs) are at the early market maturity stage, at TRL 8,
- Anion-exchange membrane (AEM) is at the demonstration phase and recently moved to TRL 7,according to the 2024 Global Hydrogen Outlook.

The EU supports innovation in this sector via diverse instruments. For example, Members States account for nearly a quarter of global patents for SOECs technology[25].

The progress towards commercial maturity is also indicated by the evolution of the Levelized Cost of Hydrogen (LCOH). In 2023, the LCOH across European countries ranged from 4.13 €/kg in Ireland to 9.30 €/kg in Luxembourg, with an average of 6.61 €/kg.[26] The lowest being observed in regions benefiting from favorable baseload renewable electricity prices. In particular, projects benefit significantly from surplus baseload electricity in areas with high renewable generation. For instance, the Nordic countries take advantage of abundant hydroelectric power, which is cheap and dispatchable. In contrast, regions like Spain face challenges due to an electricity grid already saturated with variable photovoltaic power, making it more difficult to secure the stable, low-cost supply needed for competitive hydrogen production. By 2030, the LCOH is expected to be under 3 €/kg if electricity prices decrease below 50 €/MWh[27], which remains a challenge in numerous countries in Europe. It is indeed essential to load sufficiently electrolysers to amortize them and with a stable supply to avoid technical challenges and degradations – especially alkaline ones.

While progress has been made in electrolyser technologies, industrial scale-up for electrolyser manufacturing is still a work in progress. Indeed the fundamental technology bricks are mature but assembling them and running large electrolyser units in front of renewable loads that can vary are challenges new to the entire industry worldwide. Certain companies are developing systems typically ranging from 1 to 5 MW, while larger pre-commercial units, such as 10-20 MW electrolysers, are being gradually deployed. Notable examples include the 24 MW system commissioned at Yara's site in Norway, currently the largest in Europe. However, these sizes remain modest compared to China's large-scale electrolysis projects, where systems exceeding 100 MW are being deployed. In addition, electrolyser technologies do not yet benefit from long-lasting feedbacks. The industry still needs to consolidate feedback on technical performance, reliability, and operational viability on the long run.

The rapid push to scale up installed capacity has stretched the capabilities of the supply chain, with bottlenecks observed for critical components like membranes, electrodes, and compressors due to limited manufacturing capacity and reliance on a very limited number of specialized suppliers. This slows European manufacturers' ability to meet demand for larger systems, delaying industrial deployment[28].

24 (TRL 6) the technology is tested in the conditions it which it will be deployed (TRL 7) it moves to the demonstration phase, (TRL 8) it undergoes first commercial testing, and (TRL 9) it advances toward full commercial operation in the relevant environment.

25 European Hydrogen Observatory (2024), The hydrogen education and research landscape, source

26 European Hydrogen Observatory (2024), Cost hydrogen production, source

27 Hydrogen Tech World (2023), Electrolysis technologies and LCOH: current state and prospects for 2030, source

28 European Clean Hydrogen Alliance (2022), joint declaration, source

2c. The European Union has supported the establishment of industrial assets, which now are to be further developed

The cost of electrolyser manufacturing, along with its projected evolution, represents a key factor influencing the scalability and adoption of hydrogen technologies. The CAPEX of electrolysers is unlikely to benefit from the same cost reduction curve as solar or batteries, as most of its components are already common in the market. However, scale effects are expected in the manufacturing process of electrolysers by 2030 and should contribute to cost decreases. Currently, the concern of several manufacturers engaged in the construction of gigafactories is the risk of overcapacity if the demand does not take off as rapidly as expected. For these manufacturers, the question is how long will the "valley of death"[29] phase last, with potentially gigafactories coming online in the next years without having the right level of uptake from the market.

Simultaneously, China's electrolyser industry is highly competitive, offering lower prices due to a robust domestic market and substantial state support, as well as less complex regulatory provisions. The choice of operating electrolysers, even at a reduced capacity and with grid electricity (with a high emission factor), has enabled industrial firms to gain experience in the manufacturing and operation of large-scale electrolysers, up to 100 MW.

In 2023, a total of 258 MW of electrolyser capacity was operational across 141 projects.[30] According to the 2024 IEA database, the installed capacity of renewable hydrogen production projects is largely dominated by Alkaline and PEM technologies.

Electrolysis technology	% of the operational electrolyser capacity		Trend	Comment
	Current capacity	2030 Forecast		
Alkaline	30%	51%	↗	Considered as a mature technology.
Proton-exchange membrane (PEM)	66%	49%	↗	Considered as a mature technology. Contains platinum, a critical raw material[31] listed in the European Critical Raw Materials Act[32].
Solid oxide electrolyser cells (SOEC)	3%	<0.1%	→	Considered as a promising technology as they share the flexibility for adjusting to load changes of PEM electrolysers, but do not require critical raw materials.
Anion-exchange membrane	1%	<0.1%	→	Could benefit from the fact that the higher temperatures increase the efficiency of the process and enable coupling with waste heat sources; Potential for efficient reverse operation may enhance flexibility and improve their development possibilities.

In 2022, the European Commission supported a pledge by European electrolyser manufacturers to scale production to 17.5 GW annually by 2025[33], doubling the estimated pace for 2024, projected at 8.8 GW/year[34]. Reaching the 100GW EU target of installed electrolyser capacity in 2030[35], it would result in a CAGR of 150%, far exceeding the current CAGR of 45% since 2020[36]. An acceleration of this magnitude represents a challenge, yet it remains a condition for maintaining the required pace to meet the long-term goal of achieving 100 GW of installed electrolyser capacity by 2030. One of the key challenges for Europe is to support the hydrogen sector in financing and securing large electrolyser units with European equipment, in order to stay in the race.

29 Development step within the TRLs between academic or upstream R&D and its commercialization in real environment.

30 European Hydrogen Observatory (2024),The European hydrogen market landscape, source

31 Materials with high economic importance and significant supply risks.

32 Annex I and Annex II of Regulation (EU) 2024/1252 provide the list of raw materials considered strategic and critical. European Parliament (2024), European Critical Raw Materials Act, source

33 European Clean Hydrogen Alliance (2022), source

34 European Hydrogen Observatory (2024), The European hydrogen market landscape, source

35 NZIA (2024), Regulation - EU - 2024/1735 - EN - EUR-Lex based on 2022 declaration of European Electrolyser Summit

36 Hydrogen Europe (2024), Clean Hydrogen Monitor, source

3.

Long-term commitments and securing investors are essential to overcome the recent slowdown period

3a. Long-term commitments from offtakers are key for hydrogen project developers

The final investment decision depends on securing demand from reliable offtakers and viable sectors. Securing offtake agreements for more than half of the production volume is a crucial threshold for investors when making funding decisions. The required rate of secured offtake agreements will depend on factors such as market maturity, policy support, and the presence of mechanisms like subsidies or Contracts for Difference (CfDs).

In 2023, renewable hydrogen demand in the European Union reached approximately 23 kt, 7 kt more than in 2022, accounting for 0.3% of the total hydrogen demand, broken down as shown in **Table 2**.

Industry	Share of hydrogen demand in 2023	Drivers
Industrial heat	21%	42% of hydrogen used by the industry (REDIII target)
Mobility	13%	70% sustainable aviation fuel (SAF) by 2050, with hydrogen-based e-kerosene playing a pivotal role in decarbonizing aviation (ReFuelEU Aviation)[37]. 80% reduction in maritime carbon intensity by 2050 (FuelEU Maritime).
Ammonia	11%	RFNBO rising demand - hydrogen-based fuels Fertilizer and chemical industries Energy carrier
Refining	11%	42% of hydrogen used by the industry (REDIII)
Blending in natural gas pipelines	10%	Decarbonisation goals of European countries
Methanol	7%	RFNBO rising demand – hydrogen-based fuels Chemical industry Energy carrier CO2 utilisation
E-fuels	5%	RFNBO rising demand – hydrogen-based fuels
Steel	3%	Hydrogen-based direct reduction of iron (DRI)
Power generation	2%	Stabilizing renewable-heavy grids and balancing electricity supply
Residential heat	1%	Renewable energy integration
Other (including other chemicals)	16%	Not described

Table 2 Distribution of green hydrogen demand in 2023 and regulatory drivers for future growth

Source: European Hydrogen Observatory (2023), Hydrogen demand

37 Institut Montaigne (2022), Decarbonizing aviation, source

Those most likely to be willing to pay a premium for low-carbon hydrogen are:

- Carbon reporting obligated entities and hard-to-abate sectors, encompassing actors subject to the EU ETS and CBAM (steel, cement, refineries, heavy transportation, energy producers or fertilizers);
- Industries that are facing higher costs of hydrogen due to a delivery of hydrogen model instead of on-site production (e.g. glassmaking, electronics);
- Price-adjustable product manufacturers or electricity price-insensitive sectors (e.g. luxury sector);
- Companies aiming to reduce their reliance on traditional gas suppliers.

Approximately half of the renewable hydrogen projects announced in Europe for 2030 are designed to serve multiple sectors, aiming to diversify offtake agreements and mitigate risks[38]. These approaches also contribute to respond to challenges related to fluctuating load levels at industrial sites by smoothing daily consumption patterns due the diverse profiles of offtakers.

38 25 GW of capacity, included in European projects planned by 2030 with no specified end-use sector, was excluded from this analysis.

3b. Uncertainties on business plan assumptions and infrastructure can lead to additional costs in the development of projects

In the last months, several developers have announced delays, postponements of FIDs, and even cancellations of their projects[39]. Several factors have contributed to the delays and slowdown in the hydrogen market from the developers' perspective. These include financing difficulties, infrastructure development challenges, and technical issues.

1. One of the primary challenges faced by developers is securing financing for hydrogen projects. These are CAPEX intensive projets, due to both infrastructure and technology costs, compounded by an inflationary context. They require substantial upfront investment and often necessitate debt leverage. Global supply chain disruptions due to the COVID-19 pandemic and the Russia-Ukraine conflict have also led to increased costs for raw materials, energy, and transportation, implying changes in business plan assumptions. These factors have increased green hydrogen production costs by up to 2 €/kg, requiring renewable hydrogen in Europe to be sold at a significant premium over fossil-based hydrogen[40].

2. Another challenge faced by developers is the development of transport infrastructure, such as hydrogen pipelines and storage sites, which can represent additional costs and takes longer than anticipated. Additional storage capacities can indeed be needed to match the geographical and temporal correlations. The Danish-German Hydrogen Pipeline Project has been delayed until 2031 – from 2028, due to increased project complexities, planning and permitting processes[41].

3. Further technical challenges also contribute to the slowdown in project development. As previously discussed (see Section 2.a.), the sector has not yet reached full industrial scale up, especially for high capacity, resulting in higher risks to invest.

To mitigate these risks and enhance project viability, consortia and hydrogen valleys have been established to connect hydrogen producers with end-users and to support the development of infrastructure. Hydrogen ecosystems are delivering promising results, with numerous projects under development across Europe. As of 2024, the IEA database identifies approximately 20 hydrogen valleys, 40 hydrogen hubs, and 30 hydrogen energy parks in Europe, representing a combined capacity of 22 GW, or 11% of Europe's announced capacity.

Some of these projects are already operational, such as the Farm project[42] in Northern Germany, which produces, stores, and delivers renewable hydrogen to public fuel cell buses and fuel cell cars. The Green Hysland project[43] aims at deploying a fully functioning Hydrogen ecosystem in Mallorca. In September 2024, it enabled the first-ever injection of green hydrogen into Spanish gas grid. These hubs drive the hydrogen economy by fostering collaboration, reducing risks, and lowering costs through pooled demand and shared infrastructure, such as pipelines and refueling stations. With financial support exceeding €1 billion from the Clean Hydrogen Partnership and objectives such as doubling their number by 2025, these initiatives are essential drivers to foster a sustainable hydrogen-based economy.

39 IEA (2024), Global Hydrogen Review 2024, source

40 S&P Global (Burgess, 2023)

41 Reuters (2024), Denmark postpones green hydrogen transmission roll-out to Germany to 2031, source

42 GP Joule (eFarm project), source

43 Green Hysland (About Green Hysland), source

3c. Investors need stability and long-term visibility

Hydrogen competes for financing with more established clean energy technologies, such as solar and wind, which offer lower risks and more predictable returns. Biofuels benefit from established infrastructure, lower costs, and faster deployment. As several green energy technologies appear as less risky and more attractive to investors in the short term, the flow of private capital into hydrogen projects remains limited.

Ensuring projects reach a FID stage with reduced uncertainties is critical. Public-private partnerships (PPPs) have proven effective in mobilizing private capital. Germany's H2Global program, for example, provides a competitive bidding mechanism that bridges the cost gap for green hydrogen. A €4 billion subsidy scheme utilizing Contracts for Difference (CfDs) supports industries like steel, glass, paper, and chemicals in transitioning to greener methods[44]. In December 2024, France launched the first phase of a support mechanism for the deployment of 200 MW of electrolysis, dedicated to projects ranging from 5 to 100 MW[45].

Direct financial support, such as subsidies for electrolyser installation or tax cuts for hydrogen infrastructure, can significantly lower upfront capital costs. The EU's Important Projects of Common European Interest (IPCEI) program has already showcased the potential of such mechanisms. The second IPCEI Hy2Use initiative represents €5.2 billion in public funding for 35 projects, aimed at constructing hydrogen-related infrastructure and fostering innovation for industrial decarbonization[46]. This program is expected to lead to additional €7 billion in private investments.

In order to mitigate policy risks, projects must demonstrate competitiveness without subsidies to attract investors. Transparent certification systems, such as guarantees of origin for green hydrogen, can enhance investor confidence by enabling premium pricing for renewable hydrogen products[47]. Financial de-risking mechanisms, such as guarantees for hydrogen projects provided by public entities like the European Investment Bank (EIB), can mitigate risks and make projects more appealing to private investors[48].

44 H2 Global (2022), Idea, instrument and intentions, source

45 France Hydrogène press release (2024), source

46 European Commission (2023), Approved IPCEIs in the Hydrogen value chain, source

47 Clean Hydrogen Partnership (CertifHy), source

48 EIB (2023), Replenishment of Green Hydrogen Fund: EIB and Germany [...] ramp-up of clean hydrogen, source

4.

Conclusion and priority actions for 2025

4a.

The European Union has established a comprehensive policy framework, yet to be clarified. This has been complemented with financial support through funding programmes accessible to hydrogen projects. This approach provides visibility to investors in the sector. However, European funding processes remains slow, taking up to two years to get disbursed, and the European funding landscape continues to pose challenges for project developers due to its complexity.

Complete and clarify the European regulatory framework

To give more visibility to the hydrogen industry and end-users, low-carbon hydrogen production could be expanded beyond electrolysis reliant solely on renewable electricity. It would foster creation and diversify hydrogen production pathways, allowing the industry to focus on addressing supply chain bottlenecks for critical components and ensuring scaling up and competitive costs by 2030.

Align EU and Member States objectives and legal frameworks

To ensure the successful adoption of hydrogen technologies, Member States should transpose the Directive (EU) 2023/2413 (RED III) and align their objectives to the Commission's. The EU must facilitate coordination between producer and consumer countries, as some countries will play a stronger role in producing green hydrogen than others. Coordination at the European level will enhance cross-border cooperation and optimize resource allocation.

Help navigate through the complexity of EU subsidies

Creating a clear and accessible resource center to help developers and investors to navigate through eligible EU subsidies will be a step forward. Providing detailed guidance on the application process, eligibility criteria, and available funding opportunities through hydrogen project development steps (R&D, development and financing, operationalization) can contribute to increasing the rate of disbursement of existing funding tools. More fundamentally, conditions for access to subsidies must be simplified in order to ease the process, while limiting competition between European projects and initiatives.

4b.

The EU has advantages for structuring a hydrogen supply chain. However, the push for the rapid development of complex projects requires support and the establishment of multi-stakeholder ecosystems, infrastructure, and large capacity production units. This context complicates the development of leading electrolyser manufacturers in Europe, compounded by increasing competition from other regions.

Accelerating the scale up of European electrolyser manufacturers

Developing a robust and resilient hydrogen supply chain requires to support existing electrolyser manufacturers in the scale up of their manufacturing activities, especially for large capacity units. This initiative should include targeted support for investment in advanced manufacturing facilities, leveraging existing regulations (e.g. RED III, EU ETS, CBAM) and supporting long-term offtake agreements with project developers. This should place EU eclectrolyser manufacturers in a better competing position.

Deployment of the Critical Raw Materials Act to guarantee EU sponsorship for critical raw materials

The deployment of the Critical Raw Materials Act[49] is also important to guarantee EU sponsorship for the production, processing, and recycling of critical raw materials, particularly the platinum group metals essential for hydrogen technologies. The EU identifies as "critical" raw materials that are characterized by high strategic importance and projected global supply/demand imbalances. This act should better include measures to secure a sustainable supply chain for these materials, reduce dependency on non-EU sources, and promote recycling and circular economy practices.

49 European Parliament (2024), Critical Raw Materials Act, source

4c.

The European hydrogen sector has faced delays in project deployments in 2024, reflecting broader challenges in the industry. Critical obstacles include securing financing for CAPEX intensive projects and long-term commitments from offtakers.

Visibility on the volume of financial support, at least for the upcoming years until 2030

It is essential to establish a long-term vision over the next five years, to ensure a stable investment environment. This vision should outline the anticipated funding levels and the strategic priorities for subsidy allocation. Investors and project developers need this visibility, both in terms of funding volumes and the frequency of project calls, for a sustainable hydrogen sector to emerge.

Adoption of long-term contract structures to secure electricity supply and prices

To provide confidence in the electricity supply for hydrogen production, it is essential to develop and promote the adoption of long-term contract structures such as Power Purchase Agreements (PPA) and Contracts for Difference (CfD) mechanisms. These contracts offer price stability, predictability and more reliable energy sources, which are critical for planning and investment in hydrogen projects. Similar to BPI France's initiatives on certain projects, providing guarantees for Power Purchase Agreements (PPAs) to secure renewable energy supply through European entities could be a key success factor in reducing risks for project developers and investors.

Collaboration with EU investors and joint response to enlarge the possibility of public/private fundings

Collaboration between the EU and investors is crucial to expanding the funding possibilities for hydrogen projects. By fostering strong partnerships between public and private sectors, a broader range of financial resources and expertise can be leveraged. Joint funding initiatives, co-investment schemes, and public-private partnerships (PPP) should be promoted to attract more long-term capital into the hydrogen sector.

References

BNEF. (2023). Hydrogen Subsidies Skyrocket to $280 Billion With US in the Lead. Retrieved from https://about.bnef.com/blog/hydrogen-subsidies-skyrocket-to-280-billion-with-us-in-the-lead/

Burgess, J. (2023, September 27). INTERVIEW: Inflation pushes Europe green hydrogen costs up by Eur2/kg. S&P Global Commodity Insights. Retrieved from S&P Global Commodity Insights: https://www.spglobal.com/commodity-insights/en/news-research/latest-news/electric-power/092723-interview-inflation-pushes-europe-green-hydrogen-costs-up-by-eur2kg

Clean Hydrogen Partnership. (n.d.). CertifHy. Retrieved from https://www.clean-hydrogen.europa.eu/document/download/4c5ada08-2a12-41f3-84bb-ebff84ad2048_en?filename=210617_CertifHy_Digital+brochures_EN_VF.pdf

EIB. (2023). Replenishment of Green Hydrogen Fund: EIB and Germany accelerate global ramp-up of clean hydrogen. Retrieved from https://www.eib.org/en/press/news/replenishment-of-green-hydrogen-fund-eib-and-germany-accelerate-global-ramp-up-of-clean-hydrogen

European Clean Hydrogen Alliance. (2022). Electrolyser Summit Joint declaration. Retrieved from https://ec.europa.eu/docsroom/documents/50014

European Commissionw. (2023). Approved IPCEIs in the Hydrogen value chain. Retrieved from https://competition-policy.ec.europa.eu/state-aid/ipcei/approved-ipceis/hydrogen-value-chain_en

European Commission. (2020). A hydrogen strategy for a climate-neutral Europe. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0301

European Commission. (2022). Implementing the repower EU action plan: investment needs, hydrogen accelerator and achieving the bio-methane targets. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A52022SC0230

European Commission. (2022). REPowerEU Plan. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483

European Commission. (2024). Commission launches consultation on draft methodology for low- carbon hydrogen. Retrieved from https://energy.ec.europa.eu/news/commission-launches-consultation-draft-methodology-low-carbon-hydrogen-2024-09-27_en

European Commission. (2024). IF23 Auction for renewable hydrogen production. Retrieved from https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/calls-proposals/if23-auction-renewable-hydrogen-production_en

European Commission. (2024). Neighbouring countries of the EU. Retrieved from https://economy-finance.ec.europa.eu/international-economic-relations/candidate-and-neighbouring-countries/neighbouring-countries-eu_en

European Commission. (2024). RFNBOs Delegated Act, COMMISSION DELEGATED REGULATION (EU) 2023/1184. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02023R1184-20240610

European Commission. (2024). Second renewable hydrogen auction: European Commission publishes Terms and Conditions. Retrieved from https://climate.ec.europa.eu/news-your-voice/news/second-renewable-hydrogen-auction-european-commission-publishes-terms-and-conditions-2024-09-27_en

European Commission. (n.d.). Horizon Europe. Retrieved from https://rea.ec.europa.eu/horizon-europe-how-apply_en

European Court of Auditors. (2024). The EU's industrial policy on renewable hydrogen. Retrieved from https://www.eca.europa.eu/en/publications?ref=SR-2024-11

European Hydrogen Observatory. (2024). Cost hydrogen production. Retrieved from https://observatory.clean-hydrogen.europa.eu/hydrogen-landscape/production-trade-and-cost/cost-hydrogen-production

European Hydrogen Observatory. (2024). The European hydrogen market landscape. Retrieved from https://observatory.clean-hydrogen.europa.eu/sites/default/files/2024-11/The%20European%20hydrogen%20market%20landscape_November%202024.pdf

European Hydrogen Observatory. (2024). Hydrogen Demand. Retrieved from https://observatory.clean-hydrogen.europa.eu/hydrogen-landscape/end-use/hydrogen-demand

European Hydrogen Observatory. (2024). The hydrogen education and research landscape. Retrieved from https://observatory.clean-hydrogen.europa.eu/sites/default/files/2024-10/Report%2003%20-%20The%20European%20hydrogen%20education%20and%20research%20landscape.pdf

European Parliament. (2018). RED II, DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Retrieved from https://eur-lex.europa.eu/eli/dir/2018/2001/oj

European Parliament. (2023). FuelEU Maritime, Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC. Retrieved from https://eur-lex.europa.eu/eli/reg/2023/1805/oj

European Parliament. (2023). RED III, DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Retrieved from https://eur-lex.europa.eu/eli/dir/2023/2413/oj?locale=fr

European Parliament. (2023). ReFuelEU Aviation, Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport. Retrieved from https://eur-lex.europa.eu/eli/reg/2023/2405/oj

European Parliament. (2024). European Critical Raw Materials Act, Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No . Retrieved from https://eur-lex.europa.eu/eli/reg/2024/1252/oj

European Parliament. (2024). NZIA, REGULATION (EU) 2024/1735 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401735

France Hydrogène. (2024). Press release. Lancement du dialogue concurrentiel pour le Mécanisme de soutien à la production d'hydrogène décarboné par électrolyse : un tournant pour la filière. Retrieved from https://www.france-hydrogene.org/press_release/lancement-du-dialogue-concurrentiel-pour-le-mecanisme-de-soutien-a-la-production-dhydrogene-decarbone-par-electrolyse%e2%80%af-un-tournant-pour-la-filiere/

GP Joule. (n.d.). eFarm project. Retrieved from https://www.gp-joule.com/en/references/hydrogen/efarm-1/

Green Hysland. (n.d.). About Green Hysland. Retrieved from https://greenhysland.eu/about-green-hysland/

H2 Global. (2022). Idea, instrument and intentions. Retrieved from https://files.h2-global.de/H2Global-Stiftung-Policy-Brief-01_2022-EN.pdf

Horizon Educational. (2024). The 10 Biggest Challenges Engineers Face with Hydrogen. Retrieved from https://www.horizoneducational.com/fr/the-10-biggest-challenges-engineers-face-with-hydrogen-and-how-to-solve-them/t1620?currency=usd.com

HyDeploy. (2021). Hydrogen blending begins on the public gas network in Winlaton. Retrieved from https://hydeploy.co.uk/about/news/green-light-for-first-hydrogen-blending-on-a-public-gas-network/

Hydrogen Europe. (2024). Clean Hydrogen Monitor 2024. Retrieved from https://hydrogeneurope.eu/wp-content/uploads/2024/11/Clean_Hydrogen_Monitor_11-2024_V2_DIGITAL_draft3-1.pdf

Hydrogen Insight. (2024). Engie delays 4GW green hydrogen target by five years, due to slower-than-expected industry progress. Retrieved fromhttps://www.hydrogeninsight.com/production/engie-delays-4gw-green-hydrogen-target-by-five-years-due-to-slower-than-expected-industry-progress/2-1-1605256

Hydrogen Tech World . (2023). Electrolysis technologies and LCOH: current state and prospects for 2030. Retrieved from https://hydrogentechworld.com/electrolysis-technologies-and-lcoh-current-state-and-prospects-for-2030

IEA. (2022). IEA Hydrogen Production Projects Database.

IEA. (2023). IEA Hydrogen Production Projects Database.

IEA. (2024). Global Hydrogen Review 2024. Retrieved from https://www.iea.org/reports/global-hydrogen-review-2024/executive-summary

IEA. (2024). IEA Hydrogen Production Projects Database. Retrieved from https://www.iea.org/data-and-statistics/data-product/hydrogen-production-and-infrastructure-projects-database#

Institut Montaigne. (2022). Decarbonizing aviation: all aboard. Retrieved from https://www.institutmontaigne.org/ressources/pdfs/publications/report-decarbonizing-aviation-all-aboard.pdf

Reuters. (2024). Denmark postpones green hydrogen transmission roll-out to Germany to 2031. Retrieved from https://www.reuters.com/business/energy/denmark-postpones-green-hydrogen-transmission-roll-out-germany-2031-2024-10-08/

RWE. (n.d.). NortH2. Retrieved from https://www.rwe.com/en/research-and-development/hydrogen-projects/north2/

Hyvolution (GL Events Exhibitions Operations)

EY | Building a better working world

EY is building a better working world by creating new value for clients, people, society and the planet, while building trust in capital markets.

Enabled by data, AI and advanced technology, EY teams help clients shape the future with confidence and develop answers for the most pressing issues of today and tomorrow.

EY teams work across a full spectrum of services in assurance, consulting, tax, strategy and transactions. Fueled by sector insights, a globally connected, multi-disciplinary network and diverse ecosystem partners, EY teams can provide services in more than 150 countries and territories.

All in to shape the future with confidence.

Studio BMC France – 2411BMC178.
SCORE № 2025-013.
ED None.

ey.com/fr

Contacts

Alexis Gazzo
Partner, EY & Associés
Climate & Sustainability Services
alexis.gazzo@fr.ey.com

Élodie Randrema
Senior Manager, EY & Associés
Climate & Sustainability Services
elodie.randrema@fr.ey.com

Jon Ducasse
Manager, EY & Associés
Climate & Sustainability Services
jon.ducasse@fr.ey.com

Raphaël Goerens
GL Events Exhibitions
Hyvolution Paris Director
raphael.goerens@gl-events.com

Pierre Buchou
GL Events Exhibitions
Hyvolution Development Director
pierre.buchou@gl-events.com

Acknowledgements

We thank the experts that have been consulted for their technical support and insightful feedback.