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European Hydrogen and Derivatives Index 2026

Review of European low-carbon hydrogen industry

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Contents

Glossary and definitions

Glossary

CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon Capture and Storage
DRI	Direct Reduced Iron
EHB	European Hydrogen Bank
ETS	Emissions Trading Scheme
EU	European Union
FID	Final Investment Decision
GHG	Greenhouse Gas
H2	Hydrogen
IEA	International Energy Agency
LCOH	Levelized Cost of Hydrogen
NZIA	Net-Zero Industry Act
PCI	Project of Common Interest
PMI	Project of Mutual Interest
PPA	Power Purchase Agreement
PV	Photovoltaic
RED III	Renewable Energy Directive III
RFNBO	Renewable Fuels of non-Biological Origin
T&C	Terms and Conditions

Definitions

Low-carbon hydrogen is defined as hydrogen that reaches a threshold of 70% greenhouse gas (GHG) emission savings compared to the use of unabated fossil fuels (the reference for fossil fuels being set at 94g CO_2eq/MJ).[1] This means that low-carbon hydrogen can be produced in various ways, for instance using natural gas with carbon capture, utilization and storage (CCUS), as well as from low-carbon electricity sources.

Renewable hydrogen qualifies as a "renewable fuel of non-biological origin" as defined in Article 2, second paragraph, point (36), of Directive (EU) 2018/2001[2] and which complies with the lifecycle emissions savings threshold referred to in Article 29a(1) of that Directive and is certified in compliance with Article 30 of that Directive.

The scope of the study, unless specified otherwise, is the 27 member states of the European Union (EU).

1 European parliament, 2023, RED III, source

2 European parliament, 2018, RED II, source

Executive summary

The industry is going through a consolidation phase, marked by fewer new project announcements in 2025 yet a continued growth in operational capacities, which rose by 17% year over year. Investment in European hydrogen supply reached US$1 billion in 2024, with US$800 million allocated to electrolysis production—more than double the previous year.

Medium-scale projects are driving growth, with the average size of European projects reaching Final Investment Decision (FID) at 23 MW in 2025 (up 37% from 2023), while Feasibility-stage projects average 132 MW. However, last year saw a slowdown in the Final Investment Decision (FID) pipeline, and 90% of the pipeline remains at the Feasibility stage.

As a consequence, European electrolysis manufacturing capacity exceeds projected deployment needs, and this situation is expected to persist if current trends continue. In 2030, the annual installation of new electrolyzers in Europe is projected to reach half of total manufacturing capacity.

On the regulatory front, **the EU adopted the Clean Industrial Deal and the Low-carbon Hydrogen Delegated Act in 2025, reinforcing its commitment to renewable hydrogen.** Yet, only Denmark met the May 2025 deadline for transposing the Renewable Energy Directive III (RED III) into national law. **From an incentive perspective, stakeholders are monitoring the third European Hydrogen Bank auction** with particular interest, especially after a significant share of the capacities awarded in the two previous auctions were canceled. **The European Commission acknowledges that aiming for 100% Renewable Fuels of Non-Biological Origin (RFNBO) compliance can impede industry development.**

Three critical factors are essential to secure firm purchase commitments for Power-to-X molecules:

- **Sector-specific decarbonization** mandates in hard-to-abate industries and long-range transport (e.g., REFuelEU Aviation e-SAF mandates);
- **Targeted subsidies** to incentivize early-adopters in these industries;
- **Public agency involvement** in mitigating counterparty risk, drawing lessons from the renewables sector.

In short, the European hydrogen industry is progressing, but it faces critical challenges in demand alignment, scaling up, and regulatory clarity. **The path forward requires coordinated action to implement existing policies, aimed at supporting scale-up on the production side and fostering demand from hard-to-abate heavy industries and long-range transport.**

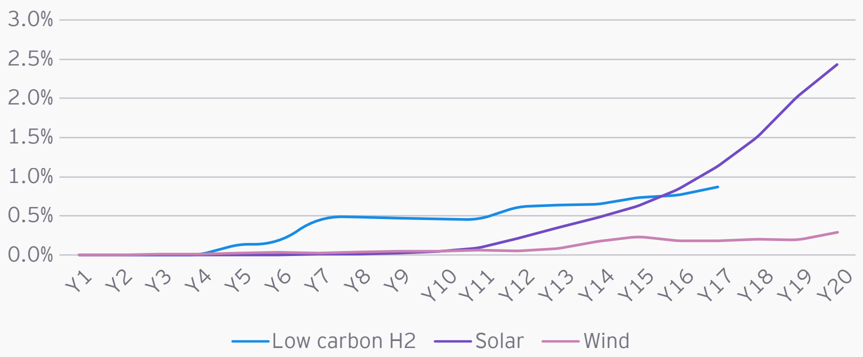
Introduction

The uptake of low-carbon hydrogen has not yet aligned with Europe's ambitious targets. Progress has been hampered by high costs, uncertain demand, regulatory challenges and slow infrastructure development. Nevertheless, there are signs of advancement. As of **September 2025, projects representing a total of 3.9 GW of low-carbon hydrogen capacity have reached FID, with approximately 10% of this capacity already operational (443 MW)**, marking a notable breakthrough compared to previous years.

To fully appreciate the development of hydrogen industry, it is essential to consider its progress alongside other low-carbon technologies, such as photovoltaic (PV) solar and wind energy. Analysing the development curves of these established industries provides valuable perspective on hydrogen's current progress and helps assess the maturity of the sector, particularly during this challenging period.

Both PV solar and wind energy faced initial challenges, including high costs and technological uncertainties, before achieving substantial growth and surpassing 1% market penetration in the global electricity mix. In comparison, the market penetration of low-carbon hydrogen, measured by comparing volumes of low-carbon hydrogen to conventional hydrogen, primarily produced through steam reforming, has already exceeded the early adoption rates of wind and solar. Figure 1 illustrates that low-carbon hydrogen reached the 0.5% threshold of the global hydrogen market in half the time it took PV solar to achieve the same milestone.

Figure 1 Evolution of global market penetration for low-carbon hydrogen, compared to wind and solar.



Source: IEA Project Database updated August 2025

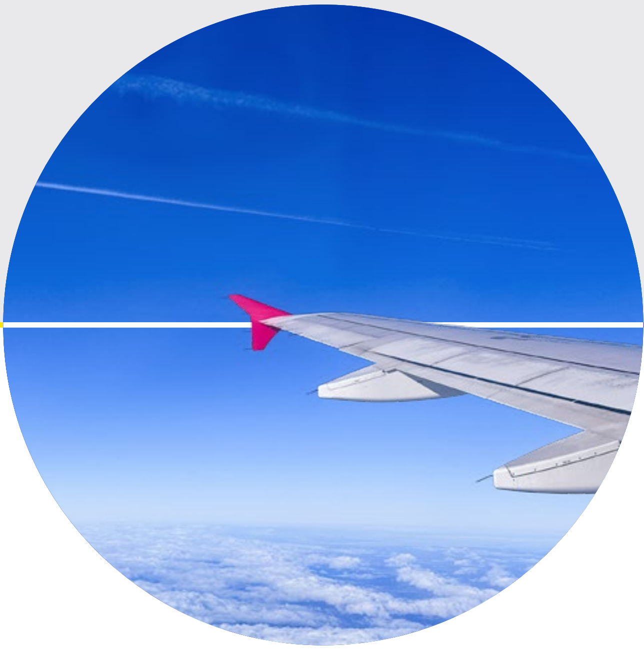
Note: Different years have been selected as the starting point (Year 0, Y0) for the development of these industries. These years only constitute a working assumption:

- For PV solar development: 1999, the year when worldwide photovoltaic capacity installed reached 1GW.[3]
- For wind: 1985, the year when worldwide wind capacity installed reached 1GW.[4]
- For low-carbon hydrogen: 2010, the year when low-carbon hydrogen production reached 1kt/H2. Low-carbon includes both low-carbon hydrogen per se and renewable hydrogen.

3 Earth Policy Institute, 2010, World on the Edge - Energy Data – Solar. Source

4 Earth Policy Institute, 2004, World Wind Energy Generating Capacity, 1980-2003. Source

Consolidation phase: Fewer announcements this year, but production capacity continues to grow



The European low-carbon hydrogen production landscape is currently shaped by **two contrasting trends**. One perspective suggests a self-regulating market dynamic, with continued investment flows and signs of resilience in capital deployment. In contrast, another view emphasizes that project development is entering a stagnation phase, characterized by declining momentum and reduced demand prospects.

Low-carbon hydrogen and derivatives production capacities that have come online in the past year are twice as important as those commissioned in the previous year in Europe

In 2024, **global investment in hydrogen supply jumped by 60%**, reaching a total annual volume of US$4.3 billion. This growth is expected to accelerate in 2025, as many recent FIDs involve large-scale projects; the total associated expenditure is estimated at almost US$8 billion in 2025, almost double the amount of 2024.[5]

In Europe, low-carbon hydrogen investments amounted to US$1 billion in 2024, with around US$800 million allocated to electrolysis production. This represents more than double the spending recorded in 2023.[6]

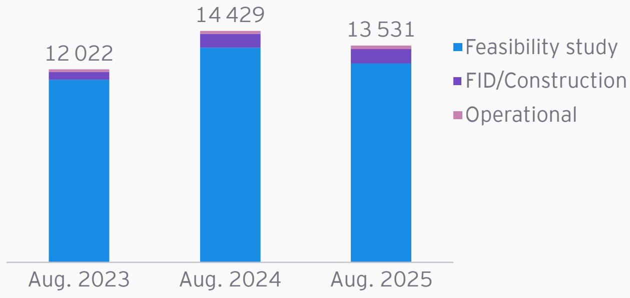
The International Energy Agency (IEA) Hydrogen Production Projects Database, which tracks more than 1,000 low-carbon hydrogen projects in Europe, provides a more detailed view of the sector's progress year after year.

Figure 2 shows that in Europe, as of August 2025, projects that have reached at least the Feasibility study phase represent a pipeline of over 13 million tonnes of annual hydrogen production capacity. This total capacity has reduced by 6.3% compared to August 2024, due to delays and cancelations affecting some projects. In fact, more than 92% of the pipeline capacity is at the Pre-FID (Feasibility study) stage, around 7% is in the post-FID/Construction stage, and 1% is already operational.

5 International Energy Agency, 2025, World Energy Investment 2025, p.72-73. Source

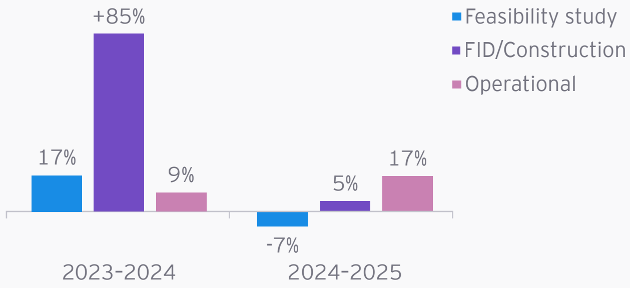
6 *Op. Cit.*

Figure 2 Europe low-carbon hydrogen pipeline, in terms of future production capacity (kt/y)



As illustrated on Figure 3, despite the slow-down of Feasibility study, the year-on-year evolution of the pipeline is insightful. From August 2024 to August 2025, the rate of capacity additions was 17% higher than in the previous 12 months, demonstrating that projects are being implemented at an increasing pace.

Figure 3 Evolution of Europe low-carbon hydrogen pipeline, in 2023-24 and 2024-25, in planned future production capacity (%) Source: EY analysis of IEA Hydrogen Projects Database, September 2025



Source: EY analysis of IEA Hydrogen Projects Database, September 2025
Note: As of 2025, the annual hydrogen production capacities in Europe by project status are as follows: operational capacity stands at c. 200 kt/y, projects at the FID or Construction stage represent c. 900 kt/y, and those at the Feasibility study stage account for c. 12 000 kt/y.

The trend is toward medium-scale projects

Economies of scale are expected as the average project size increases.

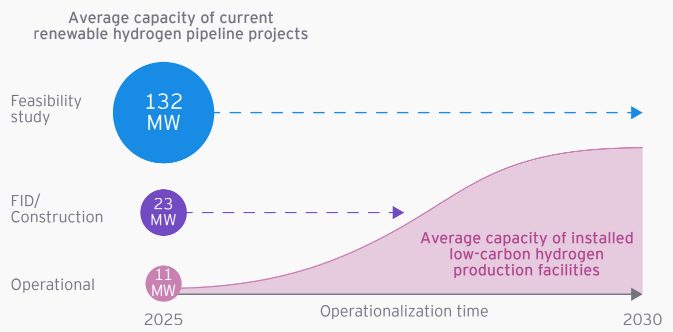
In terms of cost and technology, electrolyzer capacities are expected to become more mature and benefit from economies of scales. As the average size of electrolyzers quickly increases, doubling in 2023-24 compared to 2022-23, the capital expenditure (CAPEX) per megawatt installed is expected to decrease. Manufacturing firms therefore anticipate CAPEX savings of up to 30% as they progress from the current 1 MW stacks to 4 MW stacks in 2027. As a direct consequence of this reduction in CAPEX, the overall production cost of low-carbon hydrogen is also expected to fall. The scaling of electrolyzers' capacities is also reflected in the overall tendency to increasing the size of projects.

In 2025, the average size of European projects that reached FID/Construction was 23 MW (up 37% compared to 2023), reflecting the gradual industry ramp-up to supply heavy industries and long-range transport.

Indeed, the average size of projects that reached FID/Construction (23 MW) or Feasibility study (132 MW) stages in 2025 is much larger than that of projects that became operational during the same year (11 MW). Most of these pipeline projects are expected to become operational over the period 2026–2030, which would result in a significant increase in the average power of installed capacities.

This would constitute an acceleration of the current growth trend in operationalized capacities' size. Indeed, the average power of projects that came into operation in 2025 is over five-fold the power of projects that came into operation in 2024 (2 MW).

Figure 4 Average project size in MW, projects at the FID/ Construction phase



Source: IEA Hydrogen Projects Database, September 2025.
Potential evolution by 2030 is illustrative.
The average power of pipeline projects is calculated on a sample of 186 projects over the 3 different statuses: 18 Operational, 31 FID/Construction, 70 Feasibility study.

Although they tend to grow over time, European projects are generally smaller than those in other regions, regardless of their development phase. **Indeed, projects at FID/Construction phase have an average power of 72 MW at the global level, which is three times the size of European ones.**

Investment in the hydrogen industry can lose effectiveness when dispersed across numerous small, isolated projects. Greater efficiency may be achieved by channeling resources toward larger-scale initiatives that create industry-wide platforms. By supporting high-impact projects alongside regional integration, authorities can help reduce the cost of domestic low-carbon hydrogen, narrow the gap with imports and strengthen overall market competitiveness.

Key success factors
Medium-scale projects: a priority for industry development and supporting policies

Medium-scale projects, typically in the range of tens of megawatts, are the soft spot of many energy developers. These projects appear more feasible than large-scale projects and are more economically viable than small, localized initiatives. In emerging industries, it is common practice to scale progressively, starting with manageable projects and gradually increasing in size, rather than beginning with the largest and most complex ones.

Key success factors
Transnational initiatives enable pooling of knowledge

Transnational initiatives provide an excellent foundation for creating robust, integrated low-carbon hydrogen ecosystems and engaging a wide range of stakeholders simultaneously. A prime example is the Interreg H2Ignite project, which is focused on developing renewable hydrogen along the Seine-Nord Europe canal. This initiative brings together participants from France, Belgium, Luxembourg, the Netherlands, Germany, Denmark, and Sweden, fostering the sharing of best practices and collaborative learning.

Within the broader framework of such projects, national organizations can also benefit from knowledge exchange and capacity building. For example, Pôlénergie, an energy transition association, brings together multiple companies, thus contributing to advancing renewable energy deployment in the Hauts-de-France region as part of the wider Interreg H2Ignite initiative.

Key success factors
Vertical integration to secure electricity supply

Vertical integration is a key advantage for hydrogen developers, enabling control over energy sourcing and cost stability. By owning renewable assets, such as photovoltaic parks or wind farms, developers ensure reliable, traceable electricity for electrolyzers while retaining flexibility to buy competitively priced power from the market.

This approach reduces price volatility and builds confidence among lenders and hydrogen customers. An illustration is Power4Steel project, in the Land of Särr in Germany, where a planned 100 MW electrolyzer will produce hydrogen to a steel plant for Direct Iron Reduction (DRI). This electrolyzer will be fed by the company's own renewable supply to secure cost efficiency and reliability.

The success of production projects also relies on the ability to phase-in capacity over time.

Several hydrogen projects in Europe are adopting a phased-in strategy, gradually increasing production capacity over time. For instance, the HyVal project in Spain is currently constructing its first phase, which will deliver 25 MW of hydrogen production capacity by 2026. A second phase, currently in the Feasibility study stage, aims to scale up the capacity to 2 GW by 2030, marking a significant expansion.

Similarly, in Denmark, the project from European Energy (venture fund) has already delivered a first electrolyzer in 2024 which is operational with a capacity of 6 MW. The second phase which includes two additional electrolyzers scheduled for 2025–2026, targets a scale-up 12 MW and is under construction. This project in two phases enabled the company to capture valuable learnings by designing, constructing and commissioning the first plant, thereby reducing both cost and time for the second phase.

Key success factors
Phased in capacities are to de-risk investment

The Power4Steel project includes a Direct Reduction Iron (DRI) unit that initially operates primarily on natural gas, with a progressive integration of renewable hydrogen over time. Early-stage discussions considered higher volumes of hydrogen, but the current strategy favors a more gradual ramp-up with a minimum projected capacity of 6,000 tonnes per year.[7] This phased approach is a key driver of project competitiveness and helps mitigate financial and industrial risks.

However, the growth in the FID pipeline has significantly slowed down

Previous year's growth in new projects and FID/Construction announcements slowed down.

A divergence is clearly reflected in the maturity profile of hydrogen production projects. Indeed, the same projects database reveals **a sharp slowdown in pipeline growth** at early maturity stages. Between 2023 and 2024, projects at FID and at Feasibility study status increased by +46% and +15%, respectively. However, from 2024 to 2025, the growth rate of FID/Construction projects dropped to just a few percents, signaling that projects are facing commercial, financial and technical challenges. The pipeline of projects at Feasibility status has also reduced in absolute terms.

Consequently, 40 projects totaling a projected capacity of 1.9 GW have been recorded as experiencing delays, and for a minority of them, cancelations. Depending on their size,

7 Dillinger, SHS, Saarstahl, Rosega & Verso Energy, 2025, *La décarbonation de l'acier franchit une nouvelle étape : Le groupe SHS et Verso Energy signent un contrat pionnier de fourniture d'hydrogène*. Source

production type and offtake sector, some projects appear to be at higher risk of such delays or cancelation. Synthetic fuel production projects (maritime and eSAF), hydrogen projects aimed at producing fertilizers, and projects in the chemical sector have advanced more than average.

Lack of firm demand and willingness to pay a premium for low-carbon molecules.

The delays and cancelation of certain projects emphasize the current misalignment between projected low-carbon hydrogen supply and actual demand. As part of the Sisyphe study, the French Alternative Energies and Atomic Energy Commission (CEA) surveyed around 70 European industrial firms about their roadmap to purchase low-carbon hydrogen produced via electrolysis up to 2040. Based on their responses, demand was estimated at 2.5 million tonnes in 2030, which is more than 80% below the official EU low-carbon hydrogen targets for the same year (20 million tonnes).[8] This issue, along with key success factors to address offtake challenges, is further discussed in the section three key factors drive firm Power-to-X purchase agreements.

In addition, cost reduction achievements may be more limited for the low-carbon hydrogen sector compared to other renewable technologies that answer the same offtake needs. The Levelized Cost of Hydrogen (LCOH) for electrolyzers is driven by operational expenditure and mostly determined by electricity prices.

Furthermore, risk mitigation across the value chain remains insufficient. For some stakeholders interviewed, most low-carbon hydrogen projects in Europe are large-scale initiatives with significant risks, often managed by startups. The most frequently cited risks include the financial stability of original equipment manufacturers (OEMs), uncertainties regarding electrolyzer performance, the inherent complexity of these industrial projects, and the tendency of some developers to fragment contracts among multiple engineering, procurement, and construction (EPC) firms to reduce CAPEX.

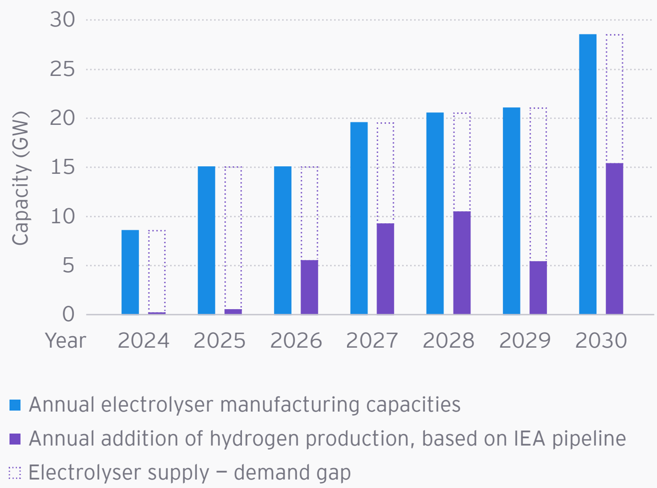
Consequently, European electrolysis-manufacturing capacities are oversized, amounting to twice the European needs

The gap between announcements and actual achievements has created a significant disparity between electrolyzer manufacturing capacity and hydrogen production forecasts.

In the early 2020s, the combination of initial announcements of hydrogen projects and EU and national policy objectives announcements led European industrials to invest heavily in electrolyzer manufacturing. For example, in 2021, global announcements regarding manufacturing capacity for 2030 amounted to a total of 90 GW.[9] The disparity between these announcements and actual achievements has led to a mismatch between industrial capacities and projected activities through 2030. The electrolysis-related ecosystem therefore appears at risk.

By 2029, Europe's annual electrolyzer manufacturing capacity is expected to reach 21 GW. However, the commissioning of new hydrogen production projects is projected to remain well below this level, with 2030 seeing manufacturing capacity significantly surpasses demand for electrolyzers (derived from project at Feasibility study stage).

Figure 5 Comparison of forecasted electrolyzer manufacturing capacity and pipeline of H2 production capacities for projects which maturity is at least Feasibility study (Feasibility study, FID/Construction, Operational) as of August 2025[10]



Therefore, before 2030, a critical question arises: How will European manufacturers utilize their production lines over the next five years, given that domestic demand is not yet sufficient to absorb the investments made in industrial infrastructure? The fall of McPhy, which went bankrupt in the second quarter of 2025, is a compelling example of this challenge.

China, which is also experiencing surplus capacity despite the more dynamic domestic demand, is actively seeking export opportunities in the European market, and may compete with European electrolyzer manufacturers by offering lower prices, adding to the above-described challenge.

8 CEA, 2025, Sisyphe Study. Source

9 IEA, 2021, Global Hydrogen Review, p.7. Source

10 Reading: in 2027, EU factories are projected with a maximum manufacturing capacity of 19 GW of electrolyzers. Based on the IEA pipeline of projects that have reached at least Feasibility study, however, only 9 GW of new low-carbon hydrogen facilities are likely to be commissioned that year.

Priority:
Focus on fully implementing existing regulations rather than introducing new ones

The EU has established a comprehensive policy framework to support low-carbon hydrogen and its derivatives by committing to renewable hydrogen production, publishing the RFNBO and Low-Carbon Delegated Act,[11] and designating electrolyzers as key net-zero technologies.

The EU's initial ambition for renewable hydrogen was outlined in the Commission's strategy published in July 2020. These goals were reinforced in 2022 through the REPowerEU Plan, which aims to produce 10 million tonnes of renewable hydrogen domestically and import a further 10 million tonnes by 2030. This roadmap was further strengthened by the adoption of the Net-Zero Industry Act (NZIA) in June 2024, calling for a significant scale-up in electrolyzer manufacturing to enable 100 GW of installed capacity for renewable hydrogen production by 2030.

New regulations were adopted in 2025: the Clean Industrial Deal and the Low-carbon Hydrogen Delegated Act

Last February, the Commission published the Clean Industrial Deal. This new legislation is designed to mobilize investment, foster lead markets for clean technologies, and create an enabling environment for companies to scale up and compete. These objectives are equally critical for accelerating the renewable hydrogen market. A particularly important component is the Clean Industrial Deal State Aid Framework (CISAF).[12] Under CISAF, state aid can cover up to 50% of the costs for hydrogen use in industrial applications and 45% for the deployment of renewable energy.

11 European Commission, 2025, Clarity to hydrogen sector with new EU methodology for low-carbon hydrogen and fuels. Source

12 European Commission, 2025, Clean Industrial Deal State Aid Framework. Source

Another long-awaited regulation, the Low-carbon Hydrogen Delegated Act, finally entered into force in November 2025. Producers must show at least a 70% emissions reduction compared to fossil fuels, equating 28.2g CO_2eq/MJ, using a full lifecycle emissions method. The act allows the use of biomass or biofuels to reduce the greenhouse gas intensity of low-carbon fuels, provided they are used as process fuels rather than feedstock. Nevertheless, the Commission does not allow the use of low-carbon electricity sourced through power purchase agreements (PPAs), and there has been no change in policy regarding hydrogen produced from nuclear energy.[13] A dedicated methodology will be released for public consultation in 2026, with July 2028 still set as the official deadline for revising the regulation.

In 2025, the focus will be on implementing existing regulations rather than revising them. The deadline for transposing the Renewable Energy Directive III (RED III) was set for May 2025,[14] but only Denmark has notified its full transposition to the Commission on time. Following the Commission's letter of formal notice to the remaining 26 member states in July 2025, transposition of the measures into national law has commenced, though the process is expected to be lengthy. RED III sets binding targets requiring that at least 42% of hydrogen used in industry, and 29% in transport, must be renewable by 2030. The Commission initiated infringement proceedings in July 2025 against all other member states. Transposition is a crucial stake as delays in incorporating the RED III requirements into national law are already hindering investment decisions and undermining market confidence. Without clear national regulations, project developers are unable to assess business viability, secure financing, or plan cross-border projects.[15]

The European commission's forthcoming **Sustainable Transport Investment Plan (STIP)** aims to accelerate the development of e-fuels and helps address persistent investment barriers and market failures. To meet the REFuelEU and FuelEU mandates, it is estimated that €100 billion in investments are needed. The STIP program is expected to mobilize at least €2.9 billion in 2027, and to provide pricing certainty for both suppliers and buyers.

Key updates at national level

- In September 2024, Spain significantly raised its ambitions for installed electrolyzer capacity from 4 GW to 12 GW by 2030. Furthermore, the country set an objective for the industrial sector, aiming for 74% of the hydrogen consumed by industry to be renewable hydrogen by the end of the decade.[16]
- France updated its national hydrogen strategy in April 2025 and set a new target of 4.5 GW of electrolysis by 2030, down from the 6.5 GW established in 2020.[17]
- Italy has recently redirected over €600 million of its post-pandemic funding, shifting the allocation from hydrogen projects to biomethane initiatives.[18]
- In Germany, the economy ministry stated it intends to revise its hydrogen support schemes and increase its focus on imports in order to reduce costs.[19]
- The Dutch government awarded more than €1.3 billion in subsidies funding through its OWE second tender (11 projects, 602 MW capacity)[20] and the SDE++ scheme (2 projects, 120 MW). This funding will cover both capital and operating expenditure, such as the difference between production costs and hydrogen market price.
- The Romanian Government has approved the National Hydrogen Strategy 2025-2030. The country aims to produce 153,000 tonnes of renewable hydrogen annually by 2030, mainly for transport and industry, requiring over 2,100 MW of electrolyzers and 4,200 MW of dedicated solar and wind power.[21]

13 Hydrogen Europe, 2025, Low-carbon Hydrogen Delegated Act a first step to closing the hydrogen production regulatory gap. source

14 European parliament, 2023, RED III, source

15 Wood Mackenzie, 2025, Enforcement and investment: how RED III is shaping the hydrogen market in the EU, source

16 Government of Spain, 2024, Integrated National Energy and Climate Plan. source

17 French Economy Ministry, 2025, *Stratégie nationale hydrogène (SNH II): le Gouvernement publie sa mise à jour*. source

18 Reuters Plus, 2025, Realizing the ambition of decarbonizing manufacturing, source

19 Clean Energy Wire, 2025, Germany to revise hydrogen subsidies, increase focus on imports, source

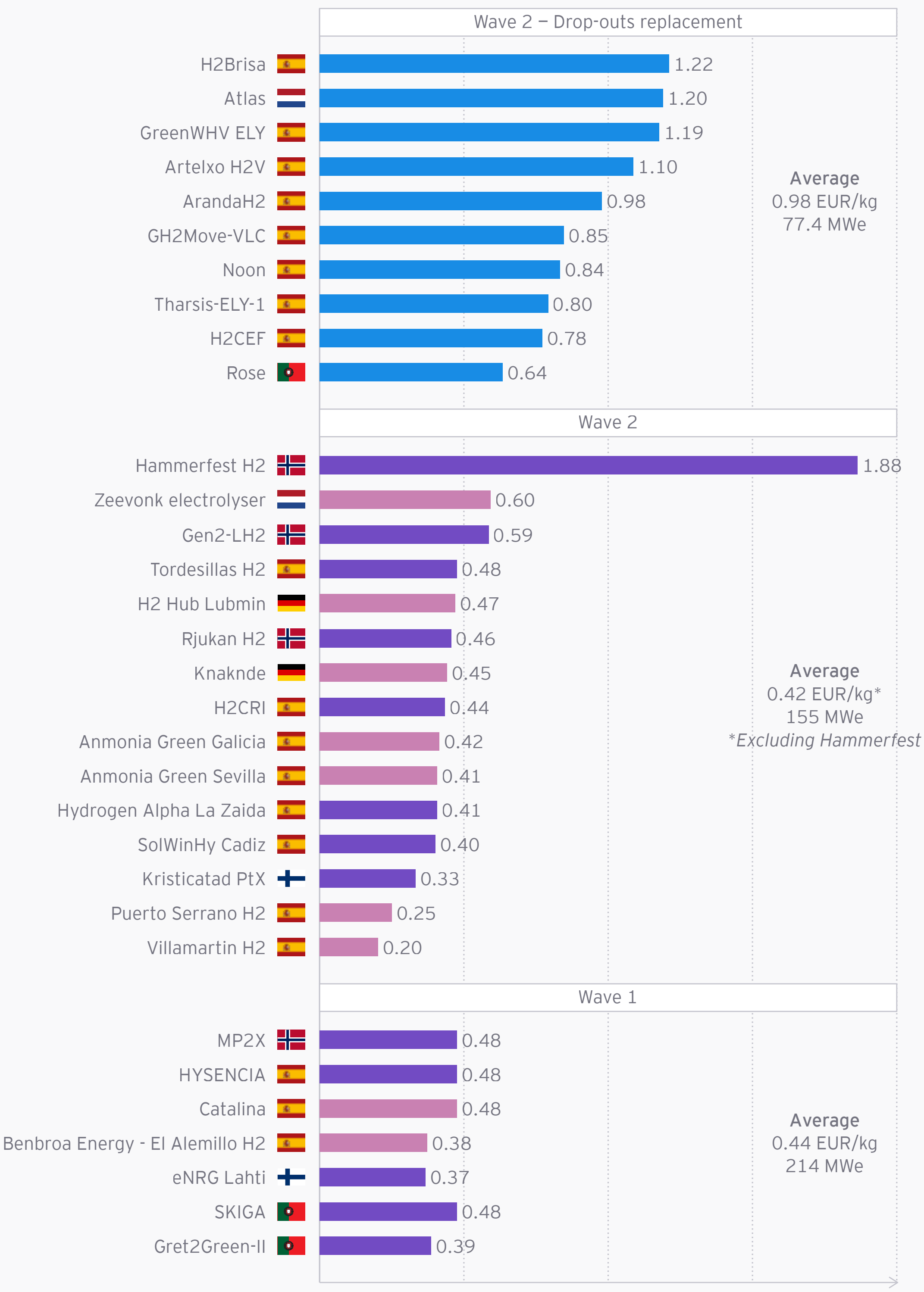
20 RE Global, 2025, Dutch Government awards subsidy to eleven green hydrogen projects, source

21 Hydrogen Europe, 2025, Developing Clean H2 Industry in Romania: National Strategy and Action Plan 2025–2030. source

Expectations for the third European Hydrogen Bank auction are high, as 80% of first auctions' capacities were canceled

Of the 15 projects selected under the second auction of the European Hydrogen Bank, seven have withdrawn from discussions with the Commission regarding production support. These have now been replaced by 10 reserve projects: eight located in Spain, one in Portugal, and one in the Netherlands. As a result, the total capacity of round 2 decreased from 2.33 GW to 1.23 GW. This shift has led to an overall increase in the level of financial support required, as the newly admitted projects are requesting higher premiums for their hydrogen. The highest premium requested among the withdrawn projects was €0.60/kg, whereas the most demanding of the new entrants is seeking €1.22/kg. As a result, the total budget allocated has risen from €991 million to €1.14 billion, out of a maximum available envelope of €1.2 billion.[22]

Figure 7 Bid price of EHB winning projects



To re-allocate de funds, 10 projects from de reserve list were invited to negociate a grant agreement

5 projects from Wave 1 signed their grant agreement, 8 projects from Wave 2 are negociating their grant agreement

9 projects dropped out of grant agreement negociations

Source: European Commission

22 Green Univers, 2025, La Banque de l'Hydrogène perd sept potentiels bénéficiaires, source

Developers of the Catalina and Zeevonk projects cited the strictness of the Commission's deadlines, specifically the requirement for commercial operation by 2030[23], as the reason for their withdrawal. Both projects rely on the commissioning of two important hydrogen pipelines: the Spanish Hydrogen Backbone and the Delta Rhine Corridor, each of which have been delayed. On the other hand, H2-Hub Lubmin withdrawal was attributed to the regulatory uncertainty in Germany, where the RED III directive has not been transposed into national law.[24]

Yet, it is worth noting that low-carbon hydrogen continues to receive funds in other European funding schemes. On 3 November 2025, the Commission unveiled the list of laureates[25] from the Innovation Fund latest call. Among them, 15 projects focus on the development of hydrogen-based solutions, including five dedicated to synthetic fuels (e-fuels) for the decarbonization of air transport. Additionally, on 1 December 2025, the Commission conferred the status of Projects of Common Interest (PCIs) and Projects of Mutual Interest (PMIs) on 235 cross-border energy initiatives, including 100 hydrogen and electrolyzer projects. These chosen projects are now eligible to seek EU funding through the Connecting Europe Facility.[26]

The European Commission acknowledges that aiming for 100% RFNBO compliance can impede industry development

In preparation for the third wave of auctions, the European Commission published draft Terms and Conditions (T&C) in July 2025.[27] In its third €1.1 billion European Hydrogen Bank (EHB) auction, the European Commission plans to subsidize clean hydrogen that does not fully comply with the strict Renewable Fuels of Non-Biological Origin (RFNBO) criteria. According to the draft T&C of the Innovation Fund auction, eligibility has been broadened to include both RFNBO-compliant hydrogen and electrolytic hydrogen produced from nonexclusive renewable electricity sources. All eligible hydrogen must comply with the EU's newly adopted definition of low-carbon hydrogen, which requires at least a 70% reduction in greenhouse gas emissions compared to fossil fuels. Out of the €1.1 billion budget, €700 million will be allocated to low-carbon hydrogen production.

Key success factors
Balancing RFNBO and low-carbon hydrogen production on low-carbon power grids

Producing exclusively renewable hydrogen (H2) is a challenge due to the substantial renewable energy capacity required under PPAs. The feasibility of achieving RFNBO certification is highly dependent on the production location. For instance, France's low-carbon electricity grid makes RFNBO compliance more accessible and cost effective than in Germany.

Adopting a hybrid strategy that combines RFNBO with low-carbon hydrogen is strategically advantageous. Oversizing the project is often necessary. For example, a 70 MW electrolyzer producing 10 kilotons of hydrogen annually to meet a 6-kilotons contract entails higher CAPEX but provides the flexibility to secure supply and manage variability.

Identifying off takers for low-carbon hydrogen gives flexibility for the plant to produce both RFNBO and low-carbon hydrogen, optimizing electricity supply OPEX.

23 *Op. Cit.*

24 ICIS, 2025, ICIS Whitepaper: Zero FIDs despite €3 billion investment – Why some European Hydrogen Bank-financed projects are struggling to progress, source

25 European Commission, 2025, General descriptions – Large Scale projects, source

26 European Commission, 2025, Commission boosts energy interconnectivity across Europe and beyond by supporting 235 cross-border projects. source

27 European Commission, 2025, Innovation Fund IF25 Hydrogen Auction – Draft Terms and Conditions, source

Commitments: Three key factors drive firm Power-to-X purchase agreements

At the global level, hydrogen capacities in development, covered by agreements, reached six million tonnes in 2024. 28% of these volumes, equivalent to 1.7 million tonnes, are firm offtake agreements, as opposed to those formalized solely by non-binding *letters of intent*. These firm agreements therefore cover 13% of the total current pipeline of projected capacities for 2030.[28]

Three success factors seem key to bridge the gap between market players' hard-to-abate decarbonization roadmaps and their actual low-carbon molecules purchase commitments.

Drawing from learnings in the renewables industry, public agencies can involve in counterparty risk mitigation

The demand for low-carbon hydrogen is driven by sectors that are frequently exposed to substantial economic challenges. A relevant example is the European steel industry, which is currently experiencing significant difficulties: EU steel output has declined from 160 million tonnes in 2017 to 126 million tonnes in 2023, with capacity utilization rates at just 65%. This sector is confronted with high energy costs, ineffective trade safeguards, and the potential for factory closures, all of which threaten its viability.[29] As a result, the solvency of steel firms becomes a critical concern for hydrogen developers and investors, highlighting the need for targeted interventions and support.

28 IEA, 2025, Global Hydrogen Review, p.34. Source

29 European Economic and Social Committee, 2025, EESC warns Europe could lose its steel industry without urgent action. Source

Key success factors
Mitigating risk in steel decarbonization

In the steel industry, the solvency of off-takers is a key concern. To mitigate counterparty risk, several mechanisms can be leveraged to help de-risk projects:

- Local public agencies involvement: Public entities may participate as shareholders in strategic projects.
- Access to subsidies: Offtakers may be eligible for various support schemes.
- To go further the introduction of public guarantees for offtakers, similar to those provided by BPI France (French Public Investment Bank) for PPAs, are often cited as efficient tools.

Tackling the structural challenges of the steel industry requires robust policy tools. The Carbon Border Adjustment Mechanism (CBAM) is essential not only for protecting the industry and mitigating counterparty risks but also for maintaining pressure and encourage decarbonization strategies.

Key success factors
Supply risk mitigation and strategic partnerships

In the emerging bio-SAF and e-SAF markets, project bankability depends on securing renewable hydrogen supply and ensuring downstream offtake.

Developers are adopting multi-layered strategies to mitigate counterparty risk and strengthen commercial viability:

- Contingency planning for hydrogen supply: to address potential delays or failure of external H2 suppliers, developers prepare backup solutions such as building their own electrolyzers and engaging early with technology providers;
- Upstream and downstream agreements: securing feedstock inputs (such as CO2) through Memoranda of Understanding (MOUs) and pursuing binding agreements with airlines and fuel distributors ensures resilience across the value chain;
- Leveraging strategic shareholders: Partnerships with aviation services leaders or fuel distributors provide privileged access to networks and markets, reinforcing credibility and accelerating offtake commitments.

This integrated approach reduces supply chain risk and enhances confidence among lenders and customers, positioning developers for success in the SAF market.

A viable business case can only occur in the context of sector-specific decarbonization and incorporation mandates

The low-carbon hydrogen market would have difficulties taking off if it was only supported by public subsidies. For this reason, in addition to such mechanisms, the European Commission came up with incentive measures and mandates to drive some industries to adopt renewable and low-carbon hydrogen. Core policies like RED II[30] and RED III,[31] along with RefuelEU Aviation,[32] set binding targets for RFNBOs and mandate the use of sustainable aviation fuels (SAFs), including e-fuels, with a 6% SAF blending requirement by 2030 and a 1%–2% share for e-fuels between 2030 and 2034. While FuelEU Maritime[33] does not impose specific RFNBO quotas, it introduces a Greenhouse Gases (GHG) intensity reduction trajectory for maritime fuels, indirectly promoting clean fuels adoption.

However, the momentum seen in the transport sector must now be extended to other energy intensive industries, such as steel, cement, fertilizers, and refineries. A lack of regulatory clarity continues to delay hydrogen uptake in these sectors, impeding progress. Additionally, significant work remains to be done on standardization and certification of low-carbon hydrogen.

Key success factors
Targeted mandates to foster low-carbon hydrogen adoption in heavy industries

It is essential to identify sectors where cost pass-through is feasible, where the increase in the cost of raw materials and intrants has a limited impact on the final selling price. Relatively low materials cost combined with high GHG footprint, results in low GHG abatement cost.

For example:
- In the automotive sector, steel accounts for only a minor component of the vehicle's final price (typically in a 2%–5% range).
- In agriculture, fertilizers may constitute a significant share of operating costs, yet their influence on the final product price remains marginal.

30 European parliament, 2018, RED II, source

31 European parliament, 2023, RED III, source

32 European parliament, 2023, RefuelEU Aviation, source

33 European parliament, 2023, FuelEU Maritime, source

Subsidies on hard-to-abate sectors are often required to trigger investment decisions

Given the high costs and uncertainties around low-carbon hydrogen adoption, public subsidies appear as a securing tool that can leverage private investment although care is to be taken to mitigate inflation as well as the risk of supporting non viable projects.

The recently announced Sustainable Transport Investment Plan[34] from the European Commission is a first step to a more structural investment approach. In that regard, the idea of creating an Industrial Decarbonisation Bank, presented in the European Commission's Industrial Deal and supported by several stakeholders of the industry, could fulfil that role. Similarly to the EHB, the Industrial Decarbonisation Bank is planned with a funding target of €100 billion, drawing from available resources in the Innovation Fund, additional revenues from certain parts of the Emissions Trading Scheme (ETS), and revisions to InvestEU.[35] On 10 October 2025, the European Commission published the first Terms and Conditions to launch an auction to decarbonize industrial process heat, "paving the way for the future Industrial Decarbonisation Bank."[36]

Key success factors
Securing offtaker support through public intervention

Most projects lack support for offtakers, even though demand for hydrogen from offtakers is primarily driven by subsidies.

In some cases, public authorities provide substantial financial assistance, with packages covering up to half of the client's CAPEX and reaching up to billions euros.

34 European Commission

35 European Commission, 2025, Clean Industrial Deal. source

36 European Commission, 2025, Commission publishes Terms and Conditions for the first pilot auction for industrial heat decarbonisation with a budget of €1 billion. source

Read more
The potential of emerging low-carbon hydrogen technologies

Biomass and waste to hydrogen

Waste-to-H_2 solutions, particularly pyrogasification, are emerging as attractive options to combine decarbonization with circular economy benefits. **Pyrogasification converts local, non-recyclable waste streams (e.g., wood residues, sorting residues, digestate fractions, dried sludge) into syngas, methane or hydrogen**, reducing landfill while producing a low-carbon, dispatchable energy carrier. By leveraging local waste streams, **it enhances regional resilience and reduces exposure to volatile electricity markets.**

Despite this potential, the technology remains at a pre-industrial stage (TRL 7–8), with performance highly sensitive to feedstock variability and gas-cleaning efficiency. **Economic viability depends on long-term, stable input supply contracts (10–12 years), consistent input quality, and the ability to monetize co-products such as biochar, waste heat, and biogenic CO_2.**

Some projects offer profitability prospects with an H selling price below €8/kg. Achieving such profitability depends on effectively monetizing co-products generated (CO_2, heat).

Natural hydrogen

Beyond low-carbon hydrogen produced via electrolysis, carbon capture and storage (CCS), or biomass pathways, another emerging option is natural hydrogen.

Natural hydrogen holds significant promise for decarbonization, yet major uncertainties remain. The global resource potential is vast, but the amount that can be economically recovered is highly uncertain. **Cost competitiveness (estimated at US$0.5–1.5/kg) would only be achievable under strict conditions: high purity, shallow wells, and proximity to end-users.** Its greenhouse gas footprint is not negligible, with emissions ranging from 0.37 to 1.5 kg CO_2 per kg of hydrogen depending on extraction conditions and gas composition.

The sector remains at **an early technological stage (TRL = 3), facing technical, regulatory, and social acceptance challenges** before large-scale deployment. If successfully developed, natural hydrogen could complement planned low-carbon production pathways and play a meaningful role in meeting the growing demand for clean hydrogen across industrial sectors.

Our team recently studied business models for pyrogasification-based hydrogen production and natural hydrogen extraction. Contact us to learn more.

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