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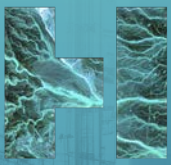
Overcoming Industry Barriers



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Intelligence Report

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Introduction

With so many projects being announced daily, the clean hydrogen era is upon us. The ambition is certainly there, and actions are being taken to support it, but progress has not been achieved as quickly as needed to fulfil the world's climate objectives.

In its report Hydrogen Insights 2023, the Hydrogen Council says that the clean hydrogen project pipeline is indeed maturing, but about 75% of the projects included in it are still at the announced and planning stages, and just 7% have passed the final investment decision (FID) milestone. The industry body also gives some figures – 1,418 clean hydrogen projects have been announced as of October 2023, representing direct investments of more than USD 570 billion through 2030. In terms of electrolysis capacity in megawatts, deployments worldwide have now passed the 1 GW mark, whilst some 12 GW have passed FID and represent a total of USD 39 billion in direct investments. China accounts for about 55% of those 12 GW, followed by the Middle East and Europe with roughly 15% each, and North America with about 5%.

Europe is the region with the largest amount of projects (540), and while it also accounts for the total investment volumes committed, only about 4% of the announced investments have passed FID. For comparison, the share of investments past FID stands at 35% in China and 15% in North America. Latin America and Oceania are associated with the lowest project pipeline maturity, with less than 1% passed FID.

Of the 305 GW of projects announced for execution through 2030, around 150 GW have progressed past the 'announced only' stage, and almost 140 GW are conducting feasibility or FEED studies.

The Hydrogen Council estimates that the current 1.1 GW of installed electrolysis capacity needs to grow by a factor of more than 250 by the end of the decade so that the entire 305-GW pipeline is realised. It also notes that the developers would need to achieve financial close for their projects in the next 1-2 years so that they can become operational in the coming 3-5 years, which puts pressure not only on themselves, but on original equipment manufacturers (OEMs) as well.

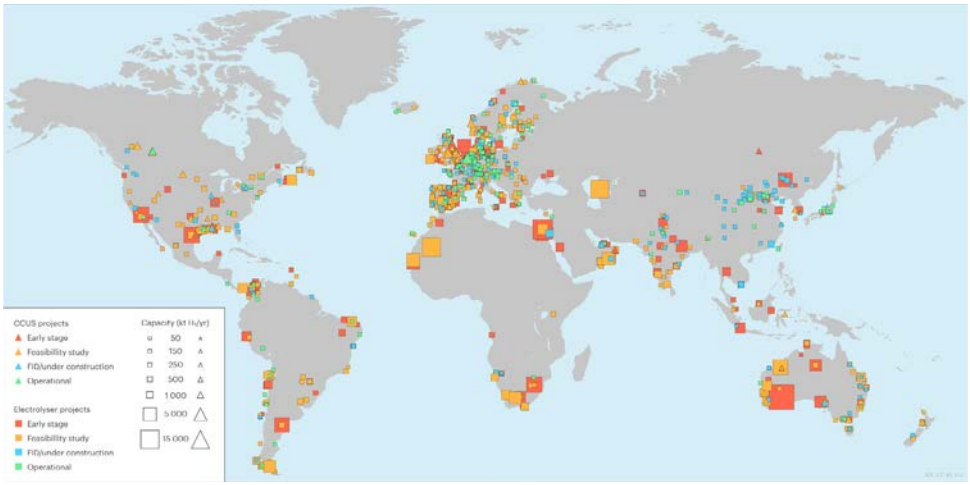

Figure 1:
Map of announced low-emission hydrogen production projects. Source: IEA.

Meanwhile, a look at the International Energy Agency's (IEA) Hydrogen Production and Infrastructure Projects Database (last updated on October 31, 2023) indicates that just one-fourth of the world's hydrogen projects are operational, with FID in place or under construction.

IEA says its dataset covers all projects worldwide that have been commissioned since 2000 to produce hydrogen for energy or climate change mitigation purposes. It also includes projects in planning or under construction. It is important to note that in addition to the various electrolysis technologies, the database also considers the plants producing hydrogen using coal gasification, natural gas reforming and oil-based processes, all with carbon, capture, utilisation and storage (CCUS), and biomass-based technologies.

IEA's database shows that out of roughly 2,000 projects, about 275 are operational, and less than 230 are in the "FID/construction" phase. The rest are labelled with the statuses **concept, decommissioned, DEMO** and f**easibility study**. The demonstration projects are a bit over 200.

When it comes to just European markets, ENTSOG's EU-wide, open-source, comprehensive database for Hydrogen Projects indicates that there are 98 integrated hydrogen projects covering everything from production, transport and

end-use, 86 projects to retrofit or repurposing existing infrastructure, 75 hydrogen production projects, 73 hydrogen at end-user level projects, 36 hydrogen storage projects, and 12 new-built hydrogen infrastructure projects. There are a total of 18 host countries. Unfortunately, ENTSOG's platform does not give information about how close to construction these projects are.

The global interest in clean hydrogen is evident, but some additional steps are still needed so that countries around the world can move towards establishing their hydrogen economies. **This report explores the industry barriers to clean hydrogen projects proceeding to the FID phase and what needs to change for more projects to advance past that stage.**

The Experts Speak

So, what exactly is hindering the progress of so many clean hydrogen projects around the world? We interviewed several industry experts who gave their opinions on the matter.

When we draw the line, we see that the main challenges include the lack of supportive **regulations**, the **tedious permitting** procedures, the **volatility in the market** when it comes to the price of electricity, the **high inflation** at this point, the **uncertainty about what qualifies as green hydrogen** both in the US and in Europe, and, most importantly, the **difficulty in securing offtake** agreements for the output.

Emma Woodward
European Hydrogen Market Lead at Aurora Energy Research

Our conversation with Emma Woodward, European Hydrogen Market Lead at Aurora Energy Research, started with the need for offtake agreements. She called this "a major blocker at present" and added that having a contract with a creditworthy counterpart is critical when there is no liquid market for hydrogen. Woodward noted that investors are still learning to manage the risks associated with this type of project. Then, she mentioned one pretty obvious factor – the current high cost of hydrogen production.

Woodward also sees the regulatory uncertainty and the lack of policy support as significant roadblocks. There is hope as things in this area are changing, albeit slowly. When asked about what needs to change to turn the tide, Woodward said there needs to be regulatory certainty and certainty on support that might be available.

Source: Plug Power Inc.

Andrew Marsh
CEO of Plug Power

Andy Marsh is the CEO of Plug Power Inc., one of the big hydrogen players worldwide, creating its own hydrogen network while supplying the equipment needed to produce and use hydrogen. According to him, the biggest challenges to reaching FID include:

- volatility in the market, which affects future hydrogen price visibility;
- the definition for "green" hydrogen;
- slow permitting.

Marsh started the discussion by noting that smaller projects are much easier to advance and reach FID than larger ones.

Volatility

"I think when you look at the large projects, one of the biggest challenges is found both on the supply side of electricity and on the demand side for hydrogen. Because of all the volatility in the market, who knows what the price of hydrogen is going to be in three-four years. That makes the customers buying hydrogen concerned. And on the supply side, because electricity is such a big factor in the pricing, you need to make sure you have a business model that's good for 10 to 15 years. And so volatility really makes it very, very challenging. Less of a challenge for Plug in the US because, especially in the US, we have our own demand. So, that kind of balances out the demand side. And electricity prices in the US are not as volatile as they are in Europe."

What is "green."

Marsh went on to talk about the definition of green hydrogen at home in the US and Europe.

"On both sides of the ocean, we got to find what green hydrogen is. Nobody knows for certain and you can't do a green hydrogen project unless you know what green hydrogen is. I would suggest people work on that so it's easy for people to build their business plans."

"Here in the States, we're waiting for the regulations for the Production Tax Credit (PTC) to be written. I know it is hard to write that and deal with all the issues of regionality, time-matching and additionality… issues that Europe has struggled with also.

Slow permitting

In addition to the uncertainty of what is going to qualify as "green" in the end, Marsh also spoke about "the huge, huge challenge" of permitting large projects. He gave as an example Plug's New York project, which needed at least 30 permits to deploy.

"I think that government rules on both sides of the Atlantic are either Ill-defined or not defined, which creates challenges when you're trying to raise funds to build a project. The way the permitting structure is just way, way too problematic."

The executive does not think that current regulations make it easier to develop across the entire US compared to the European Union, just in portions of the US.

"If you go into the southeast of the US and in Texas, where people are used to doing large chemical and gas projects, the restrictions and regulations are not as challenging as you'll find in [other] portions of the US and portions of Europe," he said.

Another factor Marsh discussed briefly is inflation. "Hydrogen, even though it's going to be a large portion of the world's energy, is not immune to the fact that we've been in inflationary times, interest rates have been extremely high."

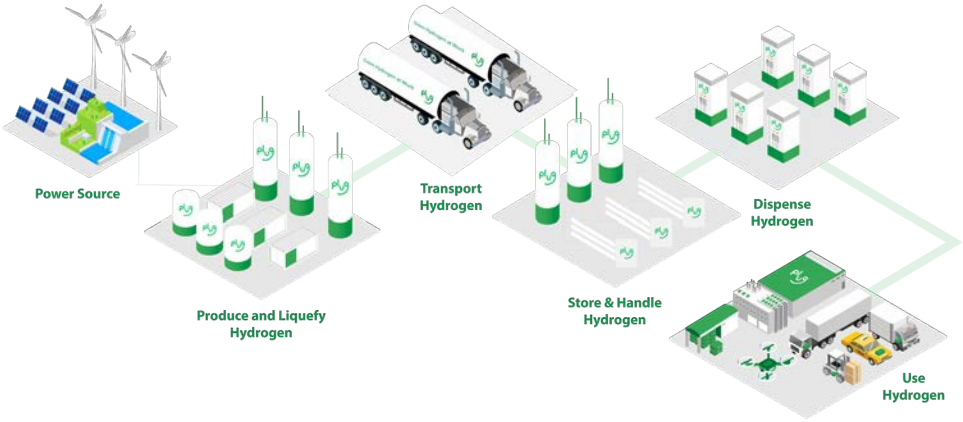

Figure 2:
A scheme for Plug's master ecosystem. Source: Plug Power Inc.

Marsh concluded by mentioning one last thing governments around the world could do:

> I just think that the government has to help across the board, maybe with project guarantees. I saw that Germany's government stood behind Siemens Energy yesterday [November 14] to kind of provide guarantees for some of their work. I think that's really beneficial. I don't think the government has to put its own money in place. I think it needs to help take the risk and I think that will help accelerate projects."

Source: Hydrogenera.

Dimiter Banov
CFO of Hydrogenera

Hydrogenera, formerly Green Innovation AD, is a Bulgarian hydrogen solutions company that covers the entire supply chain. It is headed by chief executive Dragomir Ivanov and chief financial officer Dimiter Banov. They see two main obstacles to projects reaching FID faster – offtake and standardisation.

> What I see as a problem from an investment point of view is exactly the hydrogen offtake. It leads to the Chicken or the Egg conundrum. Presently, I am noticing a growing interest in hydrogen as a fuel. However, this interest has not yet translated into the mass production and consumption of hydrogen. In order for you to create an investment project, you have to have a way to realise the product, which is currently a bit uncertain. On the other hand, car manufacturers are unable to implement hydrogen-powered vehicles as a product on the market because, in Bulgaria for example, even if you buy such a vehicle, you won't be able to find where to refuel it. There are EU regulations in place, but local governments are slow to implement them," Banov commented.

The CFO also emphasised on the difficulty of convincing potential clients to invest in hydrogen. They are reluctant because it is a big investment, and they lack experience dealing with hydrogen. However, as soon as there is an adequate green bond programme or a direct subsidy scheme for electrolysers, he said such an investment becomes a "no-brainer" for them. Furthermore, it is difficult to convince customers who are already using hydrogen to make the shift away from steam-methane-reformed grey hydrogen toward the pricier renewables-powered electrolysis.

Source: Hydrogenera.

Dragomir Ivanov
CEO of Hydrogenera

Ivanov sees **standardisation**, the regulatory frame for developing such projects, as a big issue. Still, the good news is that obstacles are being eliminated gradually. He pointed at the so-called German-Danish Offtake Declaration on green hydrogen signed in November 2023 by 32 stakeholders, including Danish producers and suppliers of green hydrogen and German offtakers. Another positive development underscored by him is the establishment of a bourse for green hydrogen trading.

While this was not explicitly mentioned as an obstacle to the development process, apparently, mistakes in equipment selection also happen even when it comes to big projects. Ivanov described one such mistake – when project sponsors with little experience decide to go with cheaper electrolysers without determining first whether those devices can operate under the conditions present.

The Reality

To summarise, field experts say that the sector will benefit hugely from a stable regulatory framework, faster permitting, a clear definition of what green hydrogen is, certainty regarding project financing support, and the availability of project guarantees, green bond programmes or direct subsidies.

US rules on hydrogen tax credits

The industry praised the Biden-Harris Administration's signing into law the Inflation Reduction Act (IRA) of 2022 in the US, but more than a year later, sector players are still desperately waiting for the Treasury to set the rules for how the hydrogen PTC included in the IRA will be implemented.

On several occasions, it has been noted that those rules should be announced by the end of 2023, but according to a Reuters report from mid-November, the release of the guidelines could be pushed into next year, as late as March 2024. Informed sources have told the news agency that Treasury officials find resolving ongoing disputes between environmentalists and the industry difficult. This uncertainty hurts the industry, and its resolution will be a significant milestone.

Two media reports emerged in December, discussing a leaked draft of the Treasury's hydrogen tax credit rules. According to the reports (from Politico and Bloomberg), the draft indicates that the USD-3-per-kilogramme credit would be limited to hydrogen production running on wind, solar or other clean-power projects executed within the last three years. Furthermore, it envisages that electrolysers must be matched with new clean power annually from 2027 and hourly from 2028, making the rules stricter than those in the European Union.

The EU steps

In the EU, the European Commission set out rules to define what constitutes renewable hydrogen in February 2023. The final texts were published in the Official Journal in June without any changes to the draft acts initially adopted by the Commission. Just like in the US, determining the rules in the EU resulted in disputes between certain Member States.

"We share the view that the production and use of low-carbon hydrogen and low-carbon fuels should not be incentivised through a directive on the promotion of renewable energy," reads a letter dated March 16, 2023, and signed by Austria, Denmark, Germany, Ireland, Luxembourg, Portugal, and Spain. Another group, led by France and comprising Bulgaria, Croatia, Czechia, Hungary, Poland, Romania, Slovakia, and Slovenia, pushed for the inclusion of low-carbon hydrogen produced from nuclear power in the EU's renewable hydrogen targets.

France secured its win in June 2023 when a declaration including the following statement was made: "The Commission acknowledges that other sources of fossil-free energy than renewable energy contribute to reaching climate neutrality by 2050 for Member States who decide to rely on such sources of energy."

Another big step in the EU was made with the launch in November 2023 of the first auction under the European Hydrogen Bank, offering EUR 800 million of support for producing renewable hydrogen. Under this first call, producers of renewable hydrogen will be able to bid for subsidies in the form of a fixed premium per kilogram of hydrogen produced, up to a cap of EUR 4.5 per kg. The deadline for bids is February 8, 2024, with evaluation results expected as early as April 2024.

Standards and certification

Certification

Certification has long been considered one of the main barriers to creating the market. In a report released in January 2023, the International Renewable Energy Agency (IRENA) notes that, at the time, none of the existing hydrogen certification systems were suitable for cross-border trade. It found gaps in design, standards and ecolabelling, among other aspects.

According to the IEA, seven national and supranational governments have introduced regulatory frameworks, while a further six countries have announced forthcoming regulations. The table below gives an overview of the existing and planned regulatory frameworks and certification systems for hydrogen and hydrogen-based fuels, as presented by the agency in its Global Hydrogen Review 2023 report.

Country	Name	Purpose	Product	Status	Criteria
Australia	Guarantee of Origin certificate scheme	Voluntary	Hydrogen, hydrogen carriers	Under development	No eligibility criteria. The only requirement is to implement an emissions accounting methodology for the hydrogen produced.
Canada	Clean Hydrogen Investment Tax Credit	Regulatory, access to tax credits	Hydrogen, ammonia	Under development	Production below certain emissions intensity levels (<0.75, 0.75-2, 2-4 g CO2-eq/g H2). For ammonia, only one emissions intensity level is defined (<4 g CO2-eq/g H2-eq).
Denmark	Guarantee of Origin certificate scheme	Voluntary	Hydrogen, hydrogen-based fuels	Operational	Production from renewable electricity.
EU	Renewable Energy Directive II	Regulatory, count against renewable energy targets	Hydrogen, hydrogen-based fuels	Operational (certification under development)	Production from renewable electricity (or grid electricity with <65 g CO2-eq/kWh) meeting criteria on temporal and geographical correlation and additionality of renewable generation.
France	France Ordinance No. 2021-167	Regulatory, access to public support programmes	Hydrogen	Under development	"Low-carbon hydrogen": production with emissions intensity <3.38 g CO2-eq/g H2. "Renewable hydrogen": production with emissions intensity <3.38 g CO2-eq/g H2 and renewable sources.

Japan	Basic Hydrogen Strategy	Regulatory, access to public support	Hydrogen, hydrogen-based fuels	Under development	Production with emissions intensity <3.4 g CO2-eq/g H2.
South Korea	Clean Hydrogen Certification Mechanism	Regulatory, access to public support	Hydrogen	Under development	Production with emissions intensity <4 g CO2-eq/g H2.
India	Green Hydrogen Standard for India	Regulatory, access to public support	Hydrogen	Under development	Production from renewable energy with emissions intensity <2 g CO2-eq/g H2.
Italy	Guarantee of Origin certificate scheme	Voluntary	Electricity and renewable gases (incl. hydrogen)	Operational	Production from renewable sources.
Netherlands	Guarantee of Origin certificate scheme	Voluntary	Hydrogen	Operational	Production from renewable electricity.
Spain	Guarantee of Origin certificate scheme	Voluntary	Renewable gases (incl. hydrogen)	Operational	Production from renewable electricity.
UK	Low Carbon Hydrogen Standard; Certification Scheme	Regulatory, access to public support	Hydrogen	Operational (certification under development)	Production with emissions intensity <2.4 g CO2-eq/g H2.
UK	Renewable Transport Fuel Obligation	Regulatory, access to public support	Hydrogen (use in transport)	Under development	Production from renewable energy (excluding bioenergy) with emissions intensity <4.0 g CO2-eq/g H2.
USA	Clean Hydrogen Production Standard; Tax Credit	Regulatory, access to public support	Hydrogen	Under development	Production below certain emissions intensity levels (<0.45, 0.45-1.5, 1.5-2.5, 2.5-4 g CO2-eq/g H2) eligible for different levels of investment tax credits support.

Green Hydrogen Standard. The Swiss non-profit foundation created this scheme to license project developers to use the "GH2 Green Hydrogen" label and thus become eligible to obtain and trade GH2 certificates of origin for green hydrogen and derivatives such as green ammonia. Projects are to undergo full certification once they start production.

"Around the world the vast majority of green hydrogen projects are yet to reach FID. Pre-qualification under the Green Hydrogen Standard will help early-stage projects attract funding and demonstrate to investors and other stakeholders that these projects are genuinely low carbon and designed sustainably," stated GH2's chief executive Jonas Moberg.

At the launch of the pre-qualification phase, Fortescue Future Industries' CEO Mark Hutchinson said that the company plans to implement the Green Hydrogen Standard across its global portfolio of green hydrogen projects.

Version 2.0 of the Green Hydrogen Standard was launched on December 3, 2023, at Dubai's 28th Conference of the Parties (COP28).

COP28 was also the stage for a new initiative where 36 nations endorsed a declaration for mutual recognition of certification schemes for renewable and low-carbon hydrogen and its derivates. The declaration was launched by Germany, Japan, and Namibia and was joined by other countries such as Canada, the US, Australia, South Africa, India, Brazil, and other European nations.

"This initiative will make a decisive contribution to global decarbonisation and at the same time pave the way for sustainable industrial value creation in the global south. The hydrogen market needs clarity and security from the start. Reliable and transparent norms and standards are essential for this. That's why it's so important that we align our processes with international cooperation, because the hydrogen market will be a global market," Germany's parliamentary state secretary for economy, Stefan Wenzel, stated.

Standardisation

International standards also need to be established to ensure the safety and compatibility of certain technologies and to establish how to handle operational issues.

In March 2023, the European Clean Hydrogen Alliance published a roadmap on hydrogen standardisation that lists more than 400 topics "clustered" along all hydrogen value-chain segments. In this roadmap, the alliance notes that the responsibility for designing or developing standards falls on European standardisation bodies CEN, CENELEC, and/or their international counterparts ISO (the International Standardisation Organisation) and IEC (the International Electrotechnical Commission).

The following figure shows how complex the hydrogen standardisation process really is.

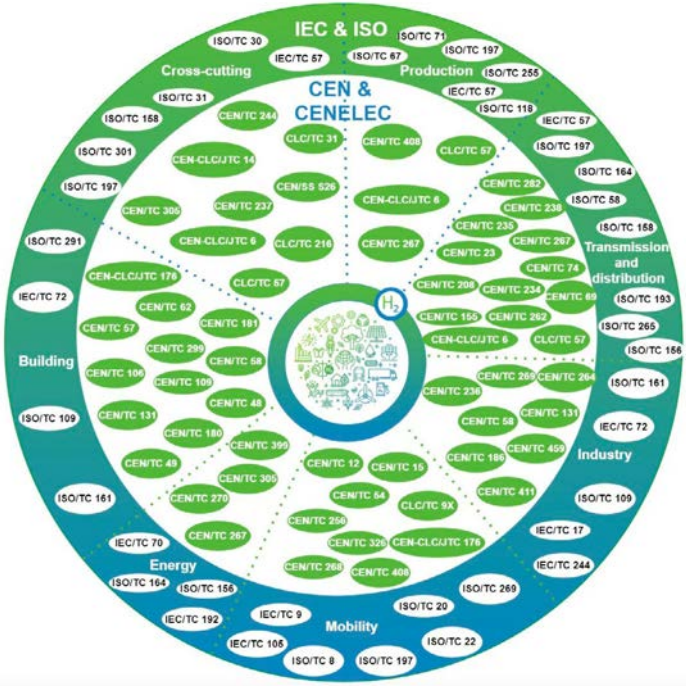

Figure 3:
European and international standardisation landscape for hydrogen topics. Source: European Hydrogen Alliance, Roadmap on Hydrogen Standardisation, March 2023.

Latest additions to the FID club

Even in the current environment associated with uncertainty, some projects reach FID, some are under construction, and some are near completion.

FlagshipONE

Danish energy company Ørsted A/S took the FID on its 70-MW FlagshipONE e-methanol project in December 2022, when it announced the acquisition of the 55% interest in the project it did not already own. The seller was the original developer, namely Liquid Wind AB.

FlagshipONE will be built in Ornskoldsvik in Northern Sweden with the capacity to produce some 50,000 tonnes of e-methanol a year. It will be situated on the grounds of the Horneborgsverket biomass-fired combined heat and power (CHP) plant. E-methanol will be produced using renewable power and biogenic CO2 captured from the CHP facility.

The company said that this would be its first commercial-scale Power-to-X facility and, at the time, Europe's largest green e-methanol project to reach FID. It is expected to become operational in 2025.

Figure 4:
An artist's rendition of the FlagshipONE facility. Source: Ørsted A/S

"Our first offshore wind projects came with significant risk, but we saw a route to leveraging our capabilities to deliver that technology as a cornerstone in the green transformation. Today, Power-to-X is at a similar inflexion point - and at Ørsted, we're once again ready to assume risk and lead the maturation of this crucial technology. However, the Power-to-X industry urgently needs supportive frameworks that enable the transition away from fossil fuels, and we call on policymakers to take action to match the climate ambitions of developers and shipping companies," Olivia Breese, CEO of Ørsted Power-to-X, said in December 2022.

Bad Lauchstadt Energy Park

In June 2023, energy company Uniper SE announced the FID for the Bad Lauchstadt Energy Park project in Central Germany, which is described as "a production-scale regulatory sandbox or real-life laboratory for the intelligent production of green hydrogen and its storage, transport, marketing and use." The scheme calls for the construction of a 30-MW electrolysis plant, which will run on wind power from a nearby park. The produced hydrogen will be temporarily stored in a salt cavern storage facility designed for this purpose before being fed into the network via a converted gas pipeline.

While commenting on the FID, project lead Cornelia Mueller-Pagel said this milestone was reached "against the backdrop of still considerable regulatory and framework-condition uncertainties in the project environment." Moreover, it is unveiled that the total project cost has surged from about EUR 140 million at first to EUR 210 million when reaching FID.

Picture 5:
Groundbreaking ceremony for the Bad Lauchstaedt Energy Park. Source: ENERGIEPARK BAD LAUCHSTÄDT.

Uniper is developing the project as part of a consortium which also includes renewables developer Terrawatt Planungsgesellschaft mbH, energy group VNG AG, natural gas supplier VNG Handel & Vertrieb, gas storage company VNG Gasspeicher GmbH and gas pipeline network operator ONTRAS Gastransport GmbH, with the support of the independent research institute of the DVGW e.V. (German Association of Gas and Water Industries). Sunfire GmbH is the supplier of the electrolyser.

Construction work started the same day the FID was announced and is expected to last several years. From the third quarter of 2025, the pipeline associated with the project is planned to begin transporting green hydrogen from the Bad Lauchstadt Energy Park for use in the TotalEnergies Refinery Central Germany.

In late November 2023, TotalEnergies formally signed Germany's first supply contract for green hydrogen with Mitteldeutschland GmbH, a joint venture between Uniper and VNG Handel & Vertriebs.

HySynergy Phase I

Meanwhile, Danish sector player Everfuel A/S is getting ready for the completion of Phase I of its flagship HySynergy project in the first quarter of 2024, according to information released by the company in November 2023.

Picture 6:
The Queen of Denmark visits the HySynergy site. Source: Everfuel.

HySynergy 1 is a PtX facility in Fredericia, Denmark, comprising a 20-MW electrolyser. Everfuel is the project owner and operator, while Crossbridge Energy will be the offtaker of some green hydrogen. The rest of the partners are Aktive Energi Anlaeg (AEA), Trefor Elnet, Energinet, TVIS, and EWII.

In Phase II and III, HySynergy is expected to reach 300 MW in 2025 and 1 GW in 2030, respectively.

Gasunie's national hydrogen network

In June 2023, Gasunie took FID for the first portion of its national hydrogen network, authorising subsidiary Hynetwork Services to invest more than EUR 100 million in the project to be developed in Rotterdam. This section will stretch for more than 30 km, from the Tweede Maasvlakte to Pernis. Construction work is expected to be completed by 2025.

The overall network will be 1,200 km long and, from 2030 onwards, will connect large industrial end-users in the Netherlands with neighbouring countries such as Germany and Belgium. About 85% of the network will reuse existing natural gas pipelines, which, Gasunie estimates, is 75% cheaper than building new infrastructure.

COP28

To confirm the statement made by Hydrogenera's chief executive that the obstacles to hydrogen development are being dealt with one by one and will be eliminated gradually, the COP28 summit in Dubai became the stage for several hydrogen-related announcements that demonstrate governments' commitment to supporting the industry.

At the High-Level Roundtable on Hydrogen, a few initiatives were launched, as outlined by the Hydrogen Council, including an intergovernmental declaration of intent on mutual recognition of certification schemes for hydrogen and hydrogen derivatives, an ISO methodology providing a global benchmark for greenhouse gas (GHG) emissions assessment of hydrogen pathways on a life-cycle analysis basis, and a public-private action statement on cross-border trade corridors in hydrogen and derivatives.

The ISO unveiled its new technical specification on December 5. The following comments were made regarding that move.

"The new ISO standard fits seamlessly into our ongoing efforts in Germany to develop and implement a detailed roadmap for future hydrogen standardisation. We systematically analyse the existing standards catalogue and supplement it with technical rules that will accelerate the ramp-up of hydrogen technologies," said Christoph Winterhalter, CEO of the German Institute for Standardization (DIN) and ISO Vice President of Policy.

"The new ISO/TS 19870 provides a truly international methodology for assessing the GHG footprint of hydrogen as a product from well to consumption gate, including every delivery gate on a life cycle analysis basis. It helps us create a common international language around hydrogen and allows the least carbon-intensive solutions to shine. This is crucial for facilitating international trade, which is vital to realising the decarbonisation potential of hydrogen," said Ulrika Francke, ISO President.

References:

1. https://hydrogencouncil.com/wp-content/uploads/2023/12/Hydrogen-Insights-Dec-2023-Update.pdf, "Hydrogen Insights 2023," report by the Hydrogen Council, last accessed on December 13, 2023.
2. https://iea.blob.core.windows.net/assets/8d434960-a85c-4c02-ad96-77794aaa175d/GlobalHydrogenReview2023.pdf, "Global Hydrogen Review 2023," report by IEA, last accessed on December 4, 2023.
3. https://iea.blob.core.windows.net/assets/ac-c7a642-e42b-4972-8893-2f03bf0bfa03/Towardshydrogendefinitions-basedontheiremissionsintensity.pdf, "Towards hydrogen definitions based on their emissions intensity," report by IEA, last accessed on December 4, 2023.
4. https://www.iea.org/data-and-statistics/data-product/hydrogen-production-and-infrastructure-projects-database#, IEA's Hydrogen Production and Infrastructure Projects Database, last accessed on December 4, 2023.
5. https://h2-project-visualisation-platform.entsog.eu/, ENTSOG's Hydrogen Project Visualisation Platform, last accessed on December 4, 2023.
6. https://app.powerbi.com/view?r=eyJrIjoiODQ3NGE2ZjAtMzYwYi00ZD-ViLThmYzMtMzUyMzAwZmM5ZjNlIiwidCI6IjgxMDU4NGZkLTY5ZjktN-DEzNy1hNmExLWMwZTMzMjgwYjE1YyIsImMiOjh9&pageName=ReportSection2586994ace7414e26b62, ENTSOG's Hydrogen Project Visualisation Platform, last accessed on December 4, 2023.
7. https://www.danskindustri.dk/siteassets/di-energi/the-german-danish-offtake-declaration-on-green-hydrogen_november-27th-2023.pdf, "Joint statement on the industry cooperation between Danish producers and suppliers of green hydrogen, and the German industrial offtake market," press release, last accessed on December 1, 2023.
8. https://www.reuters.com/business/energy/us-hydrogen-tax-credit-rule-could-slip-into-2024-amid-debate-over-its-design-2023-11-16/, "US hydrogen tax credit rule could slip into 2024 amid debate over its design -sources," news article by Reuters, last accessed on December 4, 2023.
9. https://www.bloomberg.com/news/articles/2023-12-05/hydrogen-industry-raises-alarm-over-leaked-us-tax-credit-rules?leadSource=uverify%20wall, "Hydrogen Industry Signals Alarm Over Proposed US Tax Credits," news article by Bloomberg, last accessed on December 7, 2023.

10. https://energy.ec.europa.eu/news/renewable-hydrogen-production-new-rules-formally-adopted-2023-06-20_en, "Renewable hydrogen production: new rules formally adopted," press release by the European Commission, last accessed on December 4, 2023.
11. https://www.euractiv.com/section/energy-environment/news/seven-countries-reject-nuclear-derived-hydrogen-from-eu-renewables-law/, "Seven countries reject nuclear-derived hydrogen from EU renewables law," news article by Euractiv, last accessed on December 4, 2023.
12. https://www.euractiv.com/section/energy-environment/news/nine-eu-members-want-low-carbon-hydrogen-included-in-blocs-renewables-goals/, "Nine EU countries want low-carbon hydrogen included in bloc's renewables goals," news article by Euractiv, last accessed on December 4, 2023.
13. https://www.euractiv.com/section/energy-environment/news/france-finally-satisfied-with-eu-deal-on-renewables-directive/, "France finally satisfied with EU deal on renewables directive," news article by Euractiv, last accessed on December 4, 2023.
14. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5982, "Commission launches first European Hydrogen Bank auction with €800 million of subsidies for renewable hydrogen production," press release by the European Commission, last accessed on December 4, 2023.
15. https://gh2.org/article/pre-qualification-launches-under-green-hydrogen-standard, "Pre-qualification launches under the Green Hydrogen Standard," article by Green Hydrogen Organisation, last accessed on December 4, 2023.
16. https://www.bmwk.de/Redaktion/DE/Pressemitteilungen/2023/12/20231205-wasserstoffhochlauf-erreicht-neue-phase.html, "Wasserstoffhochlauf erreicht neue Phase: Deutschland unterstützt gegenseitige Anerkennung von Normen für Wasserstoff," press release by the German government, last accessed on December 6, 2023.
17. https://ec.europa.eu/docsroom/documents/53721, "European Clean Hydrogen Alliance roadmap on standardization," document, last accessed on December 6, 2023.
18. https://orsted.com/en/media/newsroom/news/2022/12/20221220609311, "Ørsted assumes full ownership and takes final investment decision on FlagshipONE, the largest green e-methanol project in Europe," press release by Ørsted, last accessed on December 4, 2023.

19. https://www.uniper.energy/news/bad-lauchstaedt-energy-park-now-in-implementation-phase, “Bad Lauchstädt Energy Park now in implementation phase,” press release by Uniper, last accessed on December 4, 2023.

20. https://energiepark-bad-lauchstaedt.de/aktuelles-downloads/aktuelles/vertrag-total/, “REPRESENTATIVES OF ENERGIEPARK BAD LAUCHSTÄDT AND TOTALENERGIES RAFFINERIE MITTELDEUTSCHLAND GMBH SIGN GERMANY'S FIRST SUPPLY CONTRACT FOR GREEN HYDROGEN,” press release by Bad Lauchstaedt Energy Park, last accessed on December 4, 2023.

21. https://news.cision.com/everfuel-a-s/r/everfuel---q3-2023--executing-strategy-realignment-and-progressing-hysynergy-1-towards-start-up-,c3880327, “Everfuel – Q3 2023: Executing strategy realignment and progressing HySynergy 1 towards start-up,” press release by Everfuel, last accessed on December 4, 2023.

22. https://www.everfuel.com/projects/hysynergy/, the HySynergy project page on Everfuel’s website, last accessed on December 4, 2023.

23. https://www.gasunie.nl/en/news/dutch-national-hydrogen-network-launches-in-rotterdam, “Dutch national hydrogen network launches in Rotterdam,” press release by Gasunie, last accessed on December 4, 2023.

24. https://hydrogencouncil.com/en/cop28-presidency-marks-the-launch-of-flagship-initiatives-to-unlock-the-climate-and-socio-economic-benefits-of-hydrogen/, “COP28 Presidency marks the launch of flagship initiatives to unlock the climate and socio-economic benefits of hydrogen,” news release by the Hydrogen Council, last accessed on December 14, 2023.

25. https://hydrogeneurope.eu/new-iso-standard-on-hydrogen-unveiled-at-cop28/, “New ISO standard on hydrogen unveiled at COP28,“ news release by Hydrogen Europe, last accessed on December 14, 2023.

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