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ENERGY INSIGHTS

HYDROGEN: A realistic plan to deliver on Europe's ambitious strategy

After a few false starts, the current momentum for hydrogen is unprecedented in the technology's lifetime. Over the past few months alone, governments around the world have come forward with ambitious strategies worth billions, analysts have converged in anticipation of significantly falling costs, and broader business and stakeholder interest has surged – especially in the context of economic rebuild post-COVID-19 and hydrogen's potential to support the decarbonisation of traditionally hard to abate sectors.

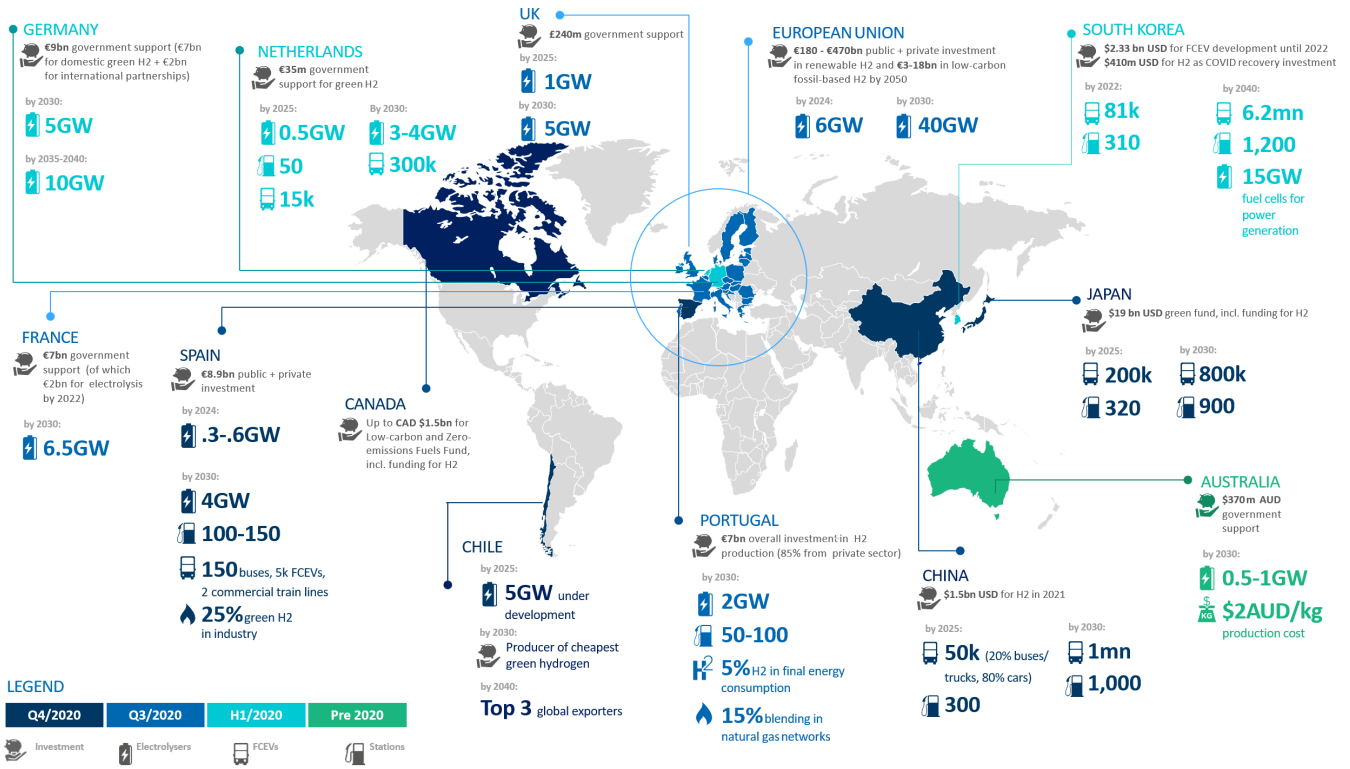
In particular, the bold vision published in the EU's "A hydrogen strategy for a climate neutral Europe" (the EU Hydrogen Strategy) has reframed the global discussion. Hydrogen has firmly entered the next stage of its journey to scale market. The question is no longer "*if*" hydrogen has a role to play in the energy transition; focus has firmly shifted to exactly "*how*" its potential can be realised, scaled and rolled out.

While these dynamics are excellent news for the sector, they also raise a new set of critical questions:

- Cutting through the noise and looking at the EU's Hydrogen Strategy with a cool head, what's the gap between the master plan and the realities on the ground? What needs to be done to achieve the EU's objectives?
- Considering the EU Member States' individual plans, is the sum of the parts enough to unleash the full potential of hydrogen at scale and build a robust European marketplace?
- How might similar plans from other major international markets (or lack thereof) impact the rapid establishment of a global hydrogen market?

As the sector defines its path forward, the forthcoming 12-18 months will be vital. Work is already underway to translate the EU Strategy into a specific set of actions and deliver on its first (2024) set of goals whilst further countries examine what a hydrogen economy might mean for them and confirm their own plans. Europe's speed of progress and results will be watched closely around the world. If this is to be hydrogen's "*now or never*" moment, what are the key challenges ahead and how can they be addressed?

FIGURE 1: EUROPE IN CONTEXT OF PLEDGED HYDROGEN AMBITION BY COUNTRY



Source: FTI Consulting, December 2020 * *Expected shortly: Italy*

EU Hydrogen Strategy: Plans versus reality

Since its announcement in July 2020, the EU Hydrogen Strategy has garnered international attention for simultaneously proposing an ambitious decarbonisation strategy and a means to stimulate economic recovery in the wake of COVID-19. The document is one of the most comprehensive hydrogen strategies to date, addressing the need for investment, development, and collaboration between the public and private sectors across the entire hydrogen value chain.

At face value, the Strategy has the potential to be a pivotal step in defining Europe's path towards decarbonisation. However, policy alone, no matter how ambitious, isn't enough. While it confirms high-level support for the buildout of a European hydrogen economy, effective realisation won't happen without considerable work. The Strategy gives a timeline of just ten years - challenging for any technology - to scale up from a series of sizeable but disjointed pilot projects to a fully integrated pan-European hydrogen network capable of supporting international trade. Any attempt to meet this ambition will require targeted support and investment from the public and private sectors alike to achieve the massive ramp up in production, infrastructure, and demand necessary to establish a competitive market.

FIGURE 2: EU HYDROGEN STRATEGY – KEY HIGHLIGHTS

1.	Acknowledges hydrogen's role in the future integrated energy system and the COVID-19 recovery.
2.	Clearly indicates the EU's priority in developing "green" (renewables-based) hydrogen to accelerate progress toward net-zero emissions targets.
3.	Sets clear and ambitious targets to scale up green hydrogen to 6 GW of electrolyser capacity quickly - by 2024 - and thereafter, 40 GW by 2030.
4.	Formalises the vision of building out an international hydrogen economy where hydrogen can be efficiently traded between regions to meet supply and demand.
5.	Acknowledges the need for a strong investment agenda to build up a clear pipeline of viable investment projects, to be coordinated by the European Clean Hydrogen Alliance.
6.	Recognises the critical role of industry in scaling up hydrogen production, infrastructure, and demand and the need for a supportive policy framework for building out an open and competitive hydrogen market.

1. Scaling up production capacity

One of the most notable aspects of the EU Hydrogen Strategy is its concrete and ambitious targets to ramp up electrolyser capacity to 6 GW by 2024 and 40 GW by 2030. Reaching these targets will require immediate and targeted action to promote electrolyser development, manufacturing, and deployment to improve economies of scale and increase production capacity.

WHAT DOES THAT MEAN IN REALITY?

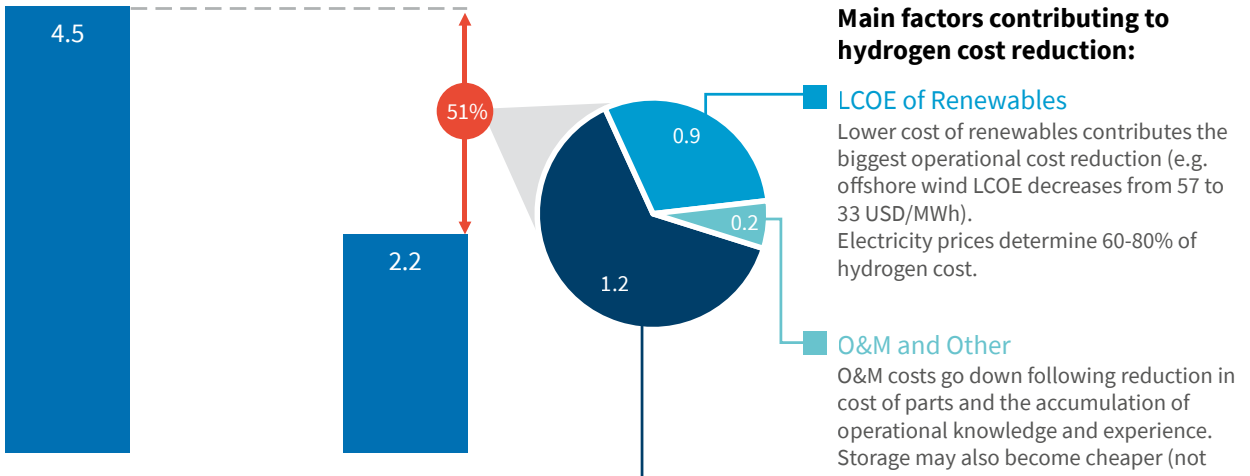
— There is currently a significant gap between the scale of existing hydrogen production and the EU Strategy targets, both in terms of individual projects and country-level ambition. There is currently only 4.7 GW of planned electrolyser capacity and EU countries have only pledged a combined ~21.5 GW electrolyser capacity by 2030 (Fig.1), just over half of the overall European goal. A substantial scale up in both individual project investment and public sector support will be required to reach 40 GW.

— Despite the high rate of new project announcements, it will be a challenge to deliver both the short-term and medium-term target capacities within the timeframe provided. Most electrolyser projects are being developed in a series of phases such that a gigawatt scale project announced today is only likely reach the 100 MW scale by mid-2020s, with full completion closer to 2030 or beyond. It takes years to develop projects from initial feasibility studies and pilot phases to full scale commercial production, so private and public sector investment must be made now in attempt to rapidly scale up total electrolyser capacity within the decade. This will be further complicated by hydrogen's particular vulnerability to COVID-19 as an emerging sector, where the ongoing economic fallout will continue to threaten project financing and increase the risk of delays.

— Ramping up electrolyser manufacturing and installation will be critical to delivering planned project capacity. Electrolyser production capacity is currently well below 1 GW per year in Europe, which means the EU would still miss its 2030 target even if 40 GW of planned electrolyser capacity were announced today. As more hydrogen projects are announced and demand for electrolysers continues to increase, domestic suppliers will have to rapidly scale up manufacturing and installation or risk losing market share to non-EU companies (particularly as the cost of Chinese electrolysers continues to fall).

— Simultaneously, more R&D is required to enable electrolysers to become larger and more efficient. Electrolyser costs are anticipated to decrease by 50-60% by 2030 driven largely by improvements in efficiency, increased system size, and the industrialisation of electrolyser manufacturing to achieve economies of

FIGURE 3: COST REDUCTION FOR OFFSHORE WIND PRODUCED HYDROGEN IN EUROPE (SAMPLE CASE) EUR/KG HYDROGEN



Source: FTI Consulting Analysis

scale as production increases[1]. Analysis indicates that the associated decrease in CAPEX will be a key driver for continued cost reduction through to 2030 (-51%), ultimately enabling renewable hydrogen to become cost-competitive with fossil fuel-based hydrogen in optimal locations by 2030 (Fig. 3). Achieving cost-competitiveness will help spur investment and accelerate the build out of the hydrogen economy.

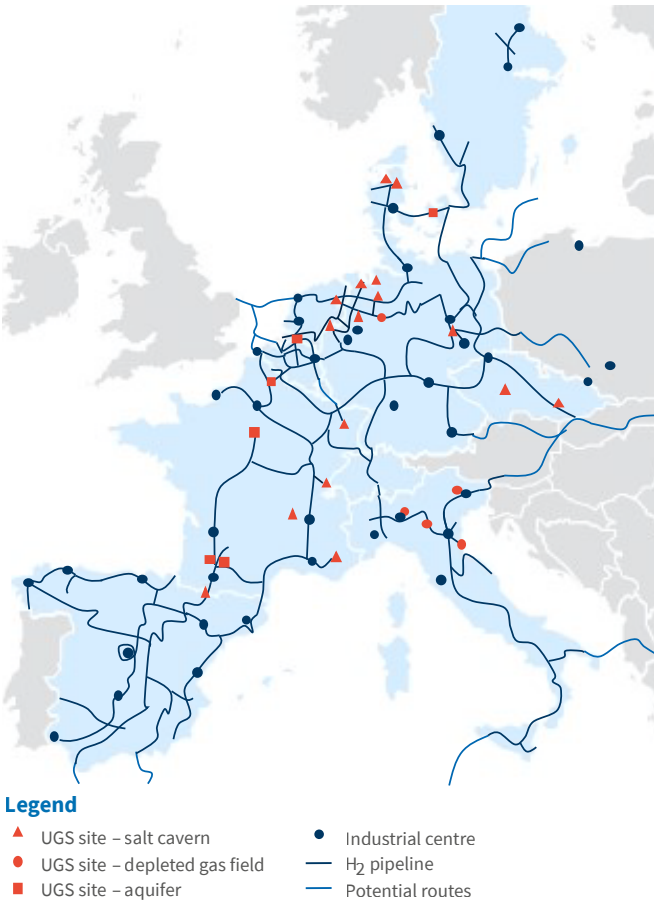
2. Scaling up infrastructure

In addition to scaling up electrolysers, the success of the hydrogen economy depends on the build out of critical infrastructure: (i) constructing additional renewable capacity dedicated to supplying electrolysers (or CCS for "blue hydrogen" although it has a lesser role in the EU Strategy overall); (ii) developing a storage solution for long-term industrial-scale hydrogen storage, and (iii) upgrading the existing gas infrastructure to be used for hydrogen transportation and distribution.

WHAT WILL THIS TAKE?

- The EU Strategy anticipates that early demand will be met by on-site or nearby production to create 'local hydrogen clusters,' or 'hydrogen valleys' in regions with large renewable potential. While hydrogen can initially be produced from the excess electricity created by variable renewable sources in these locations, additional capacity will eventually be required to directly supply the dramatic scale up in electrolysers[2]. The Strategy estimates that an additional 80-120 GW of dedicated solar and wind infrastructure will be needed explicitly for hydrogen production by 2030. For reference, this would require additional capacity equal to approximately one quarter or one third of all solar and wind capacity installed across the EU today, and would be roughly equivalent to doubling the entire current installed capacity of Germany in just ten years.
- Meeting this demand will be challenging as EU Member States already have high renewables targets even before considering the additional capacity needed for hydrogen. Early initiatives will need to demonstrate the additional system benefits of renewable hydrogen, including its ability to efficiently transport and store renewable energy over long distances and periods of time. Increasing the demand-side flexibility of renewables will enable a higher share of variable renewables in the generation mix and encourage the mutual build out of renewables and green hydrogen production infrastructure over time.

FIGURE 4: THE 'EUROPEAN HYDROGEN BACKBONE'



Source: European Hydrogen Backbone Report[3]

- The Strategy ultimately aims to connect these 'local hydrogen clusters' into a pan-European hydrogen backbone grid by 2030 (Fig. 4). The development of a robust and efficient hydrogen market will also require massive coordination at the EU-level to build out the necessary storage and transportation infrastructure. The ambitious timeline assumes the existing gas grid could be partially repurposed, referring to the conversion of natural gas pipelines and underground storage (UGS) facilities (salt caverns, depleted gas fields, and aquifers) for renewable hydrogen. However, the unique chemical properties of hydrogen pose specific technical challenges. Further innovation will be required to both prove the technical feasibility of converting existing gas infrastructure to hydrogen use and deliver these solutions at scale.

1 Hydrogen Council. "Path to Hydrogen Competitiveness." January 2020.

2 It is important to note that while the EU Strategy prioritises renewable ("green") hydrogen, using "blue" hydrogen poses its own infrastructure challenge as CCUS would also have to be developed at scale.

3 Enegás, Energinet, Fluxys Belgium, Gasunie, GRTgaz, NET4GAS, OGE, ONTRAS, Snam, Swedegas, Teréga. "European Hydrogen Backbone." July 2020.

— Alongside innovation, new standards will have to be agreed upon regarding gas quality, gas composition, injection rates, pressure, etc. to ensure the safety and interoperability of grid networks. Network planning and development will have to be organised at the EU-level, or at least between Member States, which will require coordination between industry, transmission system operators (TSOs), and policymakers.

— Europe also plans in the long run to be an importer of renewable hydrogen, and this brings additional infrastructure challenges. Comparisons with the development of the LNG market show that it will take considerable time and investment before hydrogen can become an internationally traded commodity.

3. Scaling up demand

Despite the growing momentum around clean hydrogen, the current market remains small. Today, hydrogen is mainly used in industrial processes and various pilot phase transportation projects, nearly all of which use hydrogen produced from fossil fuels ("grey hydrogen"). The long-term viability of a clean hydrogen market therefore depends on scaling up hydrogen demand by developing and expanding new end-use applications.

HOW CAN WE GET THERE?

— The fastest way to build up clean hydrogen demand in the short-term will be to decarbonise existing hydrogen applications by substituting low-carbon hydrogen for fossil fuel-based hydrogen feedstock for use in the chemical and industrial sectors. While this substitution will be relatively simple from a technical point of view, the current cost disparity between low-carbon hydrogen and conventional grey hydrogen will make this conversion costly and require a high level of demand side policy support.

— The development of a robust clean hydrogen market will ultimately require the creation of new end-use applications. Hydrogen has potential to be used in various applications in transportation, residential and industrial heating, power generation, and industry, all of which are mentioned at some point in the EU Strategy as possible sources for additional demand. Although this presents a politically palatable message of universally scaling up hydrogen demand in all sectors, it is unrealistic to universally push hydrogen adoption across all possible end-uses. Instead, emphasis should be placed on developing applications in hard-to-abate sectors where hydrogen is the most cost-competitive means of decarbonisation.

— In a recent study, the Hydrogen Council identified 22 end-use applications in which hydrogen has the potential to become the most cost-competitive low-carbon solution by 2030 (Fig. 5)[4]. After the industrial applications for which hydrogen is the only available feedstock (e.g. ammonia production, methanol production, and refining), the most cost-competitive applications are predominantly in heavy-duty and commercial transportation. Industry and the public sector should focus on developing these end-use applications first in order to secure initial hydrogen demand. Only once a hydrogen economy is established around the most competitive applications and the initial cost of hydrogen is brought down will it make sense to pursue less competitive end-uses to drive up demand.

— Developing new end-use applications for hydrogen will take time. Companies will initially be conservative when deploying new technologies and will be further constrained by both the up-front costs of fuel switching and the availability of supporting infrastructure. However, the bold vision presented in the EU Hydrogen Strategy will require scaling up demand before new applications reach commercial scale and cost-competitiveness. Substantial new policy incentives and public investment will be needed to accelerate the commercialisation of key end-use sectors and secure the demand needed to build a competitive hydrogen market by 2030.

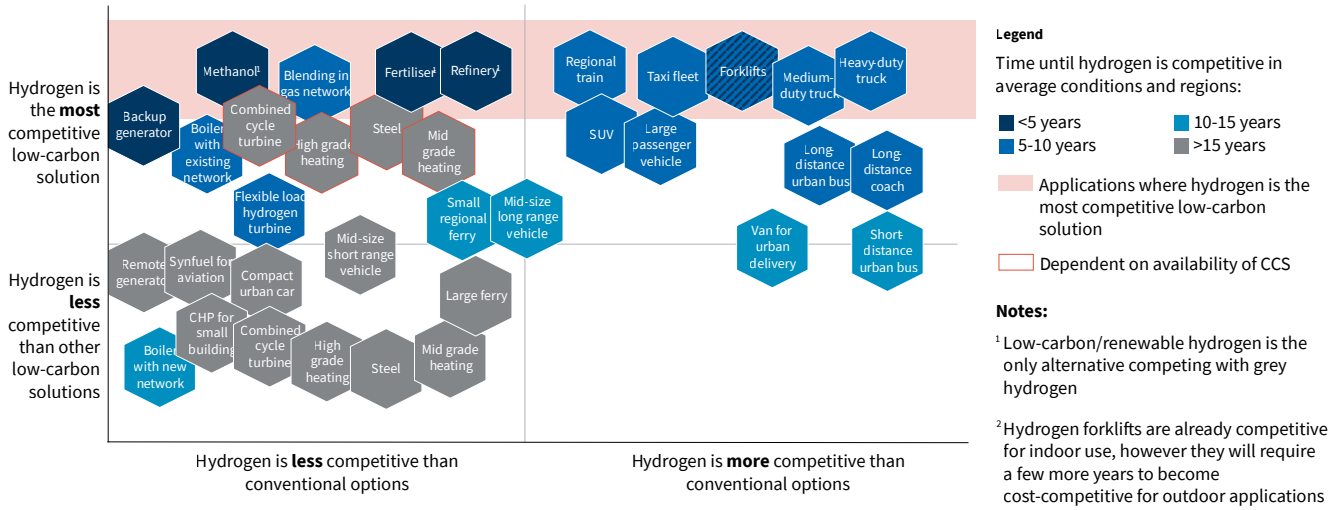
What next?

As we go through the long to-do-list, one thing is clear - the accelerated commercial scale-up of hydrogen is dependent on a raft of legislation that will need to be drafted, adopted and implemented to an aggressive timetable.

Both the European Union and its individual Member States have proposed a series of policy, regulatory and financing measures to support the industry through this fundamental but understandably challenging phase of development. Among other efforts, the EU's signature "European Clean Hydrogen Alliance" will convene topical CEO roundtables and a policy-makers' platform to build up a pipeline of viable investment projects. In addition, the EU foresees incentivising supply and demand in lead markets by *"bridging the cost gap between conventional solutions and renewable and low-carbon hydrogen and through appropriate State aid rules,"* and making

4 Hydrogen Council. "Path to Hydrogen Competitiveness." January 2020.

FIGURE 5: COMPETITIVENESS OF HYDROGEN APPLICATIONS VS. LOW-CARBON AND CONVENTIONAL ALTERNATIVES



Source: FTI Consulting Analysis; adapted from the Hydrogen Council's "Path to Hydrogen Competitiveness."[5]

available a wide variety of funding schemes to build up the foundations of the hydrogen economy. Industry and policymakers will need to work together to create an investment framework that will help projects become bankable and stimulate private sector finance.

It will be critical for the industry to engage with policymakers and other stakeholders at both the European and country level to ensure that the above tools are designed and deployed for maximum impact. Companies will need to pay close attention to the legislative timetable and assess business risks and opportunities on an individual basis. While there is plenty of distraction and noise in this newly popular space, success will be conditional on laser focus prioritisation and, most of all, conveying a realistic perspective on the opportunities and challenges at hand.

It is important not to get discouraged by the scale of the challenge or the perceived feasibility of meeting the explicit targets set forth in the EU Strategy, but instead use the ambition as momentum to drive targeted and progressive action towards establishing what is sure to be a critical sector in the global effort towards decarbonisation. Hydrogen's success in Europe is inextricably linked to its global success. If Europe shows decisive progress towards its goal, we are sure to see further movement in other markets, too - most notably in the U.S. and certain markets in Asia and Latin America.

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