OUTLOOK FOR THE DEVELOPMENT OF A GLOBAL HYDROGEN MARKET

IMPLICATIONS FOR THE BASQUE COUNTRY

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EXECUTIVE SUMMARY

*Hydrogen, a key bet of the European Union*

Hydrogen (H₂) has become a key instrument for the European Union (EU) to achieve energy and decarbonization goals and develop a sustainable and competitive industry on a global scale. The adoption of the European Hydrogen Strategy and the EU Strategy on Energy Sector Integration in 2020 as part of the European Green Deal, the focus of the European post-Covid 19 economic recovery strategy on the sustainability of the industrial sector and the development of hydrogen roadmaps in several EU Member States attest to this.

Along the same lines, H₂ is gaining great relevance in the Basque energy sector. At the time of writing this report, for example, the Basque Hydrogen Strategy is being drafted and an updated Basque Energy Strategy will be integrated into the new Strategic Plan for Energy Transition and Climate Change of the Basque Country, which will view H₂ as a key energy vector.

At the business level, the project for the development of a “Basque Hydrogen Corridor” has been launched. First announced in the autumn of 2020, this is a public-private initiative centered around activities where interests and capacities of the Basque energy sector converge. In parallel, several leading companies within the Basque industrial fabric are promoting other innovative initiatives related to H₂ inside and outside the Basque territory.

*A global hydrogen market will enhance the value of the hydrogen industry*

The development of a global H₂ market is an important driver of the value of the local hydrogen industry. H₂ trade between hubs in different parts of the world and between local, regional and national markets can facilitate the materialization of opportunities linked to technological and industrial developments in the Basque Country, including new H₂ production and storage technologies, new fuels (e.g., e-fuels or synthetic fuels) and new end-use solutions in the industry, building or transport sectors. The possibility of guaranteeing the supply of green H₂ at low cost in an international market also offers a great opportunity to advance in the decarbonization of the Basque industry.

*Evolution of hydrogen supply, demand and transport networks*

At present, almost all the hydrogen produced is "grey" hydrogen (from methane, the production of which generates CO₂ emissions). For "green" H₂ (from renewable energy, mainly electrolysis) to be competitive, the cost of renewable energy must continue to fall, and innovations will have to be made to produce efficient, large-scale electrolyzers (around 100 MW). The competitiveness of "blue" H₂ ("gray" H₂ with CO₂ capture) depends on the development of viable technologies for CO₂ capture, storage and use. All this implies that the replacement of gray hydrogen with renewable or low net-emission hydrogen will require substantial R&D investments and strong political and regulatory support.
significant growth in H₂ production capacity can be expected by 2030 (mainly grey and green), provided that the plans to support this sector and the required investments are implemented.

At present, most of the H₂ produced is consumed in industry (ammonia production, refining industry and as an input in other production processes). The growth of hydrogen demand in the coming years will depend on greater penetration in industry and, above all, on new uses in sectors such as transport, buildings and energy storage. However, the estimates of future H₂ demand growth are subject to great uncertainty, due to the lack of maturity of the renewable H₂ industry, the lack of infrastructure and the low level of efficiency in the energy conversion processes required to produce and use H₂.

While hydrogen is expected to be competitive in the medium term where electrification is more costly (long-distance heavy transport or high-temperature heat use in industry) or for seasonal or strategic energy storage in areas with high renewable energy density, its competitiveness in other uses in the medium to long term depends not only on innovation in the H₂ area, but also on how the costs and applications of alternative energy sources and carriers evolve, most notably electric power (e.g., major breakthroughs in electric batteries may hinder the penetration of H₂ in mobility). By 2030, significant growth in H₂ demand can be expected in industrial hubs, that may lead to the creation of so-called "hydrogen valleys".

Scenarios for the development of hydrogen transport networks

H₂ can be transported in various ways; for instance, in gaseous form (through dedicated infrastructures), as compressed gas (in tankers or trains) or in liquid form (in trucks or in ships similar to LNG carriers). Alternatively, H₂ can be injected into the natural gas networks (and then consumed as a mixture or H₂ can be separated at the destination) or transported via carriers such as ammonia (a promising alternative in terms of costs in long-distance transport) and other chemicals.

The development of transport and distribution networks to support the creation of H₂ markets will have to resolve challenges related to innovation in materials and equipment and the deployment and financing of infrastructure. By 2030 we should expect to see growth in hydrogen distribution by road (in liquid form or as compressed gas) and the development of some dedicated hydrogen networks (i.e., pure H₂) in local nodes where a significant volume of demand is concentrated (e.g., industrial hubs). An increase in the level of hydrogen injection into natural gas networks and the development of demonstration projects of natural gas networks adapted to transport H₂ can also be expected.

In the longer term, the gas industry seems to be betting on a transformation of the natural gas network into a hydrogen transport and distribution network, which will require not only investments, but also the development of an appropriate regulatory framework. It is estimated that the current cost of developing dedicated H₂ transport infrastructure is between 10% and 50% higher than that of adapting the existing natural gas infrastructure.
On the other hand, the creation of an interconnected global market will crucially depend on significant differences in green hydrogen production costs between regions to justify investments in maritime transport infrastructures (liquefaction and gasification plants, ships dedicated to H₂ transport, etc.), which is feasible due to differences in solar irradiation and average wind speed between countries and regions.

In addition to the development of supply and demand and of transport, distribution and storage infrastructures, the creation of local markets and of a global H₂ market will require the updating of commercial and trading uses and conventions. At present, there are no wholesale markets for H₂ and virtually all hydrogen trading takes place through bilateral contracts between producers and consumers. The development of secondary hydrogen markets will require the standardization of the hydrogen product (especially in aspects such as hydrogen purity) and the growth of demand to a minimum critical mass that supports the formation of a base of liquidity in the market.

Favorable prospects for the development of the hydrogen industry in the short-term

The outlook for the development of the hydrogen industry is favorable in the short term, with high growth rates in the total value of the H₂ market (and especially the renewable H₂ market) over the next ten years and increased penetration in the industrial sectors and some niches in other sectors. Drivers of this growth include decarbonization policies and strategies, falling costs of renewables (wind and PV), the adoption of national and supranational (e.g., European Union) H₂ roadmaps, and industry alliances to position themselves in this market (e.g., HyDeal initiative in Europe).

On the 2030 horizon, an optimistic scenario for the development of the global hydrogen market could be characterized by the following elements:

- There is international trading (OTC) of liquid H₂ via tankers between 4 or 5 hubs.
- In Europe, the mixture of natural gas and H₂ is incorporated into international trade through the large natural gas transport networks.
- The European H₂ market becomes more integrated gradually through the adaptation of natural gas networks and the existence of a few liquid local H₂ hubs.
- The distribution of H₂ within the national markets takes place either via the natural gas network or via pure liquid H₂ or compressed gas (in trucks and trains).
- Some (new) dedicated networks are developed for the transport of pure H₂ in geographic areas with high H₂ demand (in the industrial sector).
- Some trials and pilots are carried out to use natural gas transport networks to transport pure H₂ in specific areas with dedicated networks.
- The Iberian Peninsula is competing with Italy for the development of a reference H₂ hub in Southern Europe, integrating the infrastructures of North Africa.
In the longer term (year 2040), the transformation of natural gas transport and distribution networks into 100% hydrogen networks is generalized as a key element to consolidate hydrogen as the main energy vector to decarbonize sectors such as building or industry.

**Uncertainty about the development of a global hydrogen market**

However, there are some unanswered questions about the role that H₂ will play in the future energy matrix and sources of uncertainty that may condition or limit the development of the global hydrogen market, preventing the materialization of the optimistic scenario described above. These factors include the following:

- The development of the H₂ industry depends crucially on regulatory support and heavy investment in the coming years.
- H₂ should significantly increase its competitiveness in end-uses such as industry or transportation vis-à-vis other energy sources. In particular, the total cost of hydrogen (including all cost items) should fall between 35% and 50% for it to be competitive in uses such as heavy transport, ammonia production or in boilers and turbines.
- The cost reductions of green hydrogen production should be very significant by 2030 (from 2.5-5 €/kg today to the vicinity of 1 €/kg).
- Production of large volumes of green H₂ will require significant amounts of dedicated renewable power generation capacity.
- It is unclear whether the industry will commit to the development of facilities dedicated exclusively to hydrogen production.
- Developments and innovation in the use of other energy sources as decarbonization tools and forms of storage (e.g., electrification of industry and transportation) may induce a loss of momentum to the current boom in the H₂ sector.
- The development of international hydrogen transport routes will require consensus around global agreements to combat climate change and international alliances granting stability to their development.

**Implications for the Basque Country**

The implications for the Basque industry will depend on the scenario of the evolution of the global H₂ market. The scenario considered in this analysis for 2030 is conservative: the use of hydrogen in industrial applications increases and some pure H₂ transport networks are being developed, but an integrated European H₂ market does not exist and trading volumes on a global scale are limited.

Despite this, in this scenario, and independently of the development of the global H₂ market, it is interesting for agents in the Basque Country to commit to allocating
resources to R&D activities and to the financing of strategic H₂ infrastructure (such as those associated with the “Basque Hydrogen Corridor”). This positioning is justified for several reasons:

- A specialized hydrogen value chain will generate enough added value to justify the bet on infrastructures and R&D, since industrial energy consumption (electricity and, above all, heat) in the Basque Country acts as a partial “natural hedge” of the positioning in the H₂ industry.
- The use of renewable H₂ can make a decisive contribution to the decarbonization of certain industrial sectors (e.g. metals, steel, basic chemicals, refining, etc.), heavy road transport and maritime transport, where electrification and other decarbonization processes (e.g., CO₂ capture, storage and use) are more costly or technologically complex. Greenhouse gas emissions in industry account for 30% of global emissions, while those from heavy road transport and international maritime shipping account for 7% and 2%, respectively.
- The strengths and techno-industrial capabilities of the Basque knowledge and research ecosystem can contribute to materialize R&D opportunities and the generation of economic value in different industrial sectors (mobility and automotive components, power electronics, energy storage, renewable energies, energy efficiency or ICT-based services).
- A potential source of additional value for the Basque economy is the reutilization of the existing natural gas infrastructure in the Basque Country and other physical infrastructures (e.g. ports and airports).

At the regulatory level, it will be interesting for the nascent Basque H₂ industry to (a) promote short-term reforms aligned with the Basque Hydrogen Strategy and the roadmap for the energy transition, and (b) work, in the medium and long term, in favor of the development of a specific, complete and detailed regulatory framework for H₂. In the short term, it is particularly relevant that the regulatory framework be modified in order to:

1. distinguish between H₂ production methods (e.g., steam reforming vs. electrolysis);
2. facilitate the deployment of local production, storage and stationary distribution infrastructure (refueling stations) through simplified administrative and environmental procedures; and
3. develop specific technical standards and norms adapted to different forms of H₂ production and use (on quality, safety in operation, etc.).

In short, hydrogen is a bet for the Basque economy that can generate economic value and environmental benefits and boost innovation and the growth of the territory's techno-industrial base regardless of the speed at which the national and global markets for this energy vector develop.