Orkestra
BASQUE INSTITUTE OF COMPETITIVENESS
DEUSTO FOUNDATION

EXECUTIVE SUMMARY
CUADERNOS ORKESTRA
03/2021
ISSN 2340-7638

OUTLOOK FOR THE DEVELOPMENT OF A GLOBAL HYDROGEN MARKET

IMPLICATIONS FOR THE BASQUE COUNTRY

Jorge Fernández Gómez
Roberto Álvaro Hermana
Jaime Menéndez Sánchez

2021

Executive Summary. Cuadernos Orkestra 03/2021

www.orkestra.deusto.es

The arguments, analysis, opinions and comments included in this document reflect the authors' views and do not necessarily coincide with the views of the institution to which they belong. All mistakes in this document are attributable exclusively to the authors.

EXECUTIVE SUMMARY

Hydrogen, a key bet of the European Union

Hydrogen (H_2) 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, **H_2 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 H_2 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 H_2 inside and outside the Basque territory.

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

The development of a global H_2 market is an **important driver of the value of the local hydrogen industry**. H_2 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 H_2 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 H_2 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 CO_2 emissions). For "green" H_2 (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" H_2 ("gray" H_2 with CO_2 capture) depends on the development of viable technologies for CO_2 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**. A very

significant growth in H_2 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 H_2 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 H_2 demand growth are subject to great uncertainty, due to the lack of maturity of the renewable H_2 industry, the lack of infrastructure and the low level of efficiency in the energy conversion processes required to produce and use H_2.

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 H_2 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 H_2 in mobility). By 2030, significant growth in H_2 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

H_2 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, **H_2 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 H_2 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 H_2) 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 H_2 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 H_2 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 H_2 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 H_2 market will require the updating of commercial and trading uses and conventions. At present, there are no wholesale markets for H_2 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 H_2 market (and especially the renewable H_2 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) H_2 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 H_2 via tankers between 4 or 5 hubs.
- In Europe, the mixture of natural gas and H_2 is incorporated into international trade through the large natural gas transport networks.
- The European H_2 market becomes more integrated gradually through the adaptation of natural gas networks and the existence of a few liquid local H_2 hubs.
- The distribution of H_2 within the national markets takes place either via the natural gas network or via pure liquid H_2 or compressed gas (in trucks and trains).
- Some (new) dedicated networks are developed for the transport of pure H_2 in geographic areas with high H_2 demand (in the industrial sector).
- Some trials and pilots are carried out to use natural gas transport networks to transport pure H_2 in specific areas with dedicated networks.
- The Iberian Peninsula is competing with Italy for the development of a reference H_2 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 H_2 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 H_2 industry depends crucially on **regulatory support and heavy investment** in the coming years.
- H_2 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 H_2 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 H_2 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 H_2 market. The scenario considered in this analysis for 2030 is conservative: the **use of hydrogen in industrial applications increases** and some pure H_2 transport networks are being developed, but **an integrated European H_2 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 H_2 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 H_2 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 H_2 industry.
- The use of renewable H_2 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., CO_2 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 H_2 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 H_2. In the short term, it is particularly relevant that the regulatory framework be modified in order to:

(1) **distinguish between H_2 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 H_2 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.

www.orkestra.deusto.es