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THE POTENTIAL OF THE PORT OF BILBAO IN HYDROGEN TRANSPORT

EXECUTIVE SUMMARY
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Executive summary

The energy transition involves a shift towards a decarbonised energy *mix*, where fossil fuel-based energy generation must be limited in favour of an increased share of renewables. However, the intermittent and seasonal nature of these energy sources poses challenges for their implementation in all sectors. In this context, hydrogen (H_2) can play a crucial role in energy-intensive sectors, as well as in certain areas of transportation that are difficult to electrify.

Challenges in hydrogen transport: the role of hydrogen carriers

Given the scale of the energy-intensive sectors' needs, the absence of a hydrogen pipeline network, and the potential limitations of hydrogen transport by gas pipelines, ports can play a crucial role in hydrogen transport, as has been the case with natural gas.

However, the transport of hydrogen faces significant complexities due to its physico-chemical characteristics. Therefore, its transport and storage through hydrogen carriers is proposed. Generally speaking, a hydrogen *carrier* is a material that stores hydrogen and requires it in its production process, regardless of its final use.

Today's hydrogen carriers exhibit varying characteristics, and there is currently no single hydrogen carrier that is the optimal choice. In any case, it is essential to know the end use of the hydrogen to choose the most suitable carrier.

Developmental state of some hydrogen carriers vs. liquid hydrogen

	Liquid hydrogen (LH_2)	Ammonia (NH_3)	*E-fuels*	Metal hydrides	Methanol	Liquid organic hydrogen carriers (LOHC)
Economic feasibility						
Technical feasibility						
Environmental sustainability ((current) / future)						
Future perspectives						
Regulation						

Note 1: The colours indicate the level of cost, the degree of technological development, the environmental impact, the prospects for growth and whether or not there is ad-hoc regulation. Dark green represents the most favourable situation in each indicator, and dark orange the least favourable situation.
Note 2: Under environmental sustainability, the upper left triangle shows the current situation, and the right triangle shows prospects. The current environmental sustainability of synthetic fuels is shown in white, as it is assumed that they will only be produced from green hydrogen.
Note 3: Economic viability relates to production cost and selling price levels. Technical feasibility relates to the transport and storage of each carrier.
Note 4: Regulation refers to the degree of support in existing regulations and the need to develop new rules related to the role of each hydrogen carrier beyond the usual regulations addressing practical usage issues, such as environmental impact or safety.
Note 5: Both ammonia and methanol are valued as hydrogen carriers and not as feedstock for other uses.

Source: own elaboration.

Hydrogen in the environment of the Port of Bilbao

The main hydrogen-consuming sectors are refining (an activity developed around the Port of Bilbao and which has an *ad-hoc* infrastructure there) and, in the chemical industry, the production of ammonia (for fertilisers) and methanol. The production of hydrogen from the electrolysis of water using renewable energies would enable a reduction in greenhouse gas emissions in these sectors, as well as in others that are difficult to decarbonise, such as the iron and steel, foundry, or cement industries, thereby supporting the decarbonization of the Basque Autonomous Community's economy.

However, as green hydrogen production faces numerous challenges (production cost, transport, increasing electrification and other technological changes), doubts are arising as to its role in the decarbonisation of some sectors. Moreover, due to the high uncertainty surrounding green hydrogen projects, both worldwide and in Spain, many of them have been slowed down and even halted *sine die in* recent times. Also in the Basque Autonomous Community, investment in the largest planned 100 kW electrolyser was halted in 2024. Despite this, the project was reactivated in February 2025.

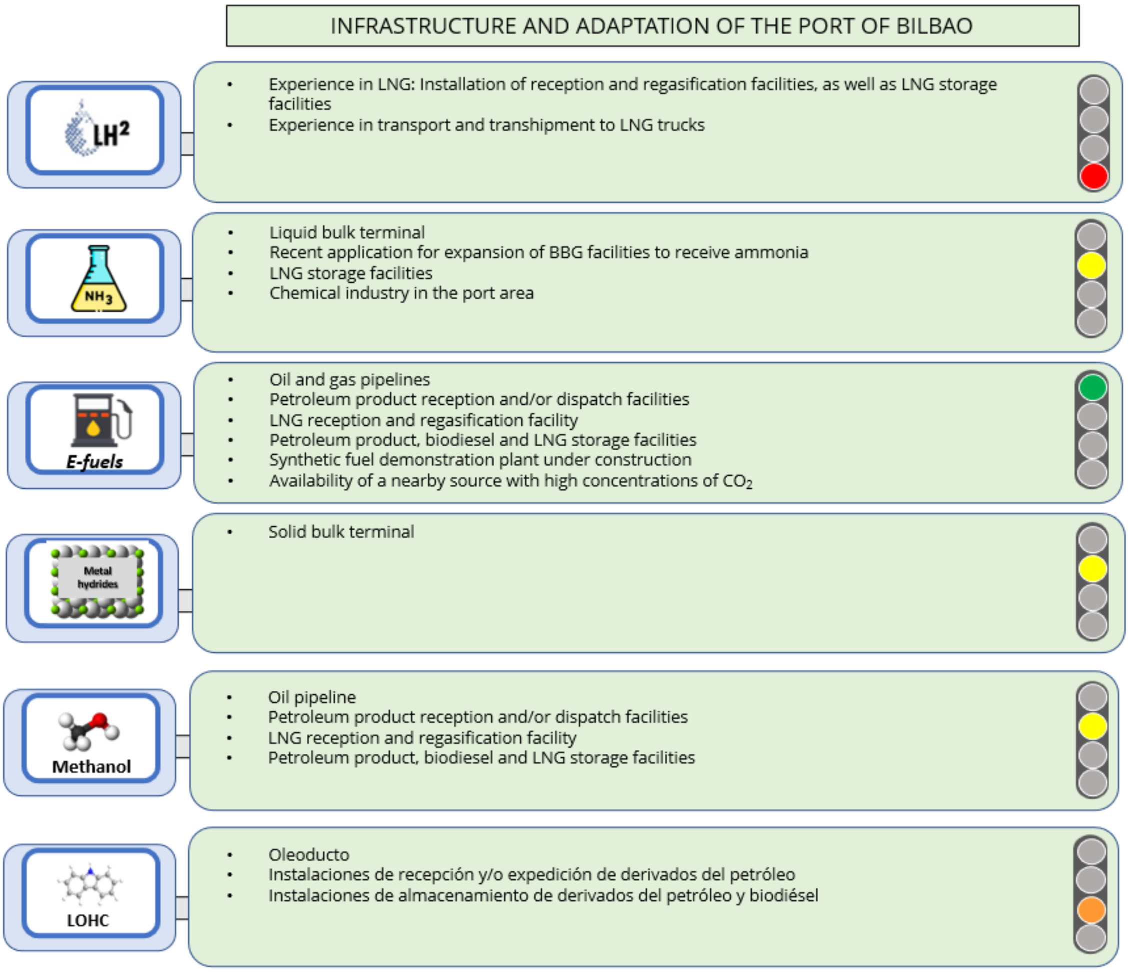
In this context, in the first phase of deployment of green hydrogen consumption, the option should be to develop projects in the vicinity (i.e. without major transport needs) or to import (in order not to assume the risks of investment projects in green hydrogen generation), taking advantage of the transport and storage infrastructure for certain H_2carriers currently available in the Port of Bilbao or its surroundings. If, in the future, surplus production were to be obtained, exporting H_2 would also be an option for positioning the port, following the current agreements between the Port of Bilbao and the Port of Amsterdam and Duisburg.

The potential of the Port of Bilbao as a hydrogen logistics hub

In this context, the Port of Bilbao can become a hydrogen *hub* for two main reasons:

- It is sufficiently connected or expected to be sufficiently connected to potential hydrogen supply and demand points by land (road and/or pipeline-H2med), as well as by sea due to its advantageous geographical position on the trade routes and number of ports it accesses; and
- Currently existing infrastructure (pipelines, solid, liquid, or LNG bulk terminals, and storage) and experience available for different carriers analysed can be leveraged.

Available infrastructure and adaptation of the Port of Bilbao



Source: own elaboration.

With which carrier?

Currently, transporting liquid hydrogen, despite its advantages (greater purity and no need for dehydrogenation), is not a feasible solution due to the lack of infrastructure and the high cost of implementation. Nor should the port of Bilbao opt for this option for import or export, because the challenges of evaporation have not yet been overcome, and there is not a sufficient fleet to transport it.

However, although it is difficult to predict the future of H_2, it is necessary to reflect on the challenges faced by the different carriers and to assess potential scenarios for the case of the Port of Bilbao.

- **Synthetic fuels**: Currently, there is a production plant under construction and infrastructure available for the operation, transport and storage of conventional fuels (which can be used for synthetic fuels). They are a future option with two limitations: (i) the uncertainty around demand due to their high price; and (ii) that they are not used as a hydrogen carrier because their use as an alternative fuel to conventional fuels takes up all the expected production.
- **Methanol** and **LOHC:** They can also benefit from port facilities for conventional fuels. However, LOHCs still present significant uncertainties.

- **Ammonia** and **methanol**: Together, they represent the leading international carriers, due to the potential demand as hydrogen carriers, the expected increase in demand for other end uses, and the fact that the processes for obtaining, transporting, and storing them are standardised. In both cases, one could opt for port shipping and reception facilities, where infrastructure already exists, or consider developing new infrastructure on port land for the production of the carrier or the recovery of hydrogen (depending on whether it is imported or exported). The latter would be complex in the Port of Bilbao due to current space limitations. In the case of ammonia, the new infrastructure will require greater investment and, therefore, a higher level of certainty to be undertaken.
- **Metal hydrides:** Their main limitation is their weight, which is a barrier on land, but they can find in the sea an essential means of transport that promotes the movement of hydrogen over long distances. The availability of a solid bulk terminal in the Port of Bilbao could be a way to leverage the existing infrastructure and make progress in the international hydrogen trade. Again, in this case, hydride production and hydrogen recovery facilities would need to be available, depending on whether the hydrogen is exported or imported. However, these facilities would not necessarily have to be located in the port.

Recommendations

Despite the doubts regarding the future role of hydrogen, some elements encourage us not to rule it out. An alert attitude must be maintained in the face of possible changes due to technological advances, among others, and bearing in mind that Basque technology centres and companies are participating in projects at different levels of development and that the Basque Government is, in Spain, the autonomous government that provides the highest level of financing. Three key recommendations emerge from the analysis of the different alternatives for hydrogen transport in the specific case of the port of Bilbao:

1. **Exploiting strengths and opportunities:** In the first phase of deploying the green hydrogen and hydrogen-derived products value chains, it is recommended to capitalise on the strengths and opportunities associated with a supply and demand for hydrogen at points geographically close to the Port of Bilbao.
2. **Leveraging existing infrastructures to experiment with new value chains:** The Port of Bilbao currently has infrastructure that various green hydrogen carriers can utilise. This infrastructure can serve as a starting point and, in parallel, play a crucial role in the social acceptance of hydrogen deployment or its carriers. This exploitation can be seen as the starting point of an infrastructure deployment strategy for green hydrogen and its carriers.
3. **Transforming itself into a *living lab*:** The Port of Bilbao should reflect on its potential, beyond becoming a logistics *hub*, to transform itself into a *living lab* for green hydrogen demonstration projects or carriers. This could take into account, among others, the current synthetic fuels project, the electrolyser projects being developed in the area and the international agreements reached for the development of a European renewable hydrogen corridor connecting different ports (Bilbao-Amsterdam).

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