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What role in the transition for a Trans-European hydrogen network?

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The year 2020 has seen the announcement of significant investment flows for the development of hydrogen in the European Union. These plans raise the question of transport and storage hydrogen infrastructure. Such infrastructure is sized and located depending on hydrogen demand and production modes, for which estimates are highly debated for the moment. In order to plan hydrogen infrastructure, it is crucial to better evaluate the conditions for hydrogen end uses and supply to materialise. Otherwise, there is a risk that substantial financial resources be spent on developing an unnecessary and unsustainable network, which could result in significant stranded assets.

The development of a hydrogen industry in Europe naturally raises the question of a transport and distribution infrastructure. Planning it requires a proper estimate of future demand, its location, and possible production sites depending on the mode, i.e. based on natural gas in a transitional period or electricity by electrolysis (see [here](#) for production processes). However, existing studies propose estimates of hydrogen demand in 2050 that vary up to eightfold between studies (see table), depending on whether they favour electricity or hydrogen use. On the supply side, much uncertainty remains regarding the role of blue (low-carbon) hydrogen, of cross-border hydrogen trade and the location of renewable electricity production. Therefore, iterative trade-offs must be carried out between transporting and storing electricity and hydrogen, based on techno-economic criteria as well as acceptability of infrastructure projects by residents, for which further analysis would be useful. While exploring varied outcomes is useful, engaging investments based on the most ambitious demand estimates could run the risk of constituting stranded assets, but also pre-empt the development of hydrogen uses, and thus [favour uses](#) for which there are more efficient, and therefore more economical, low-carbon alternatives. Poor planning could also lead to lock-ins in uses or supply routes that are not sustainable in the long term (the lifetime of transport infrastructure lies between 30 and 60 years). It is therefore essential to adopt a "no-regret" approach that minimises lock-in risks.

<i>Study</i>	Estimates of hydrogen demand by 2050 Europe
Agora Energiewende - No regret hydrogen	270 TWh
European Commission - 1.5°C Pathways 1.5LIFE et 1.5TECH	790-900 TWh
Bruegel- Navigating through hydrogen	295- 2 080 TWh
Gas for Climate - Accelerated Decarbonisation Pathway (used for the European Hydrogen Backbone)	1 710 TWh

Uncertainties about which hydrogen uses should be developed make it difficult to plan a potential hydrogen network at this stage. However, it is possible to identify "no-regret" hydrogen applications, where no low-carbon alternatives exist. In a [recent study](#), think tank Agora Energiewende quantifies this "no-regret" demand at the European level to around 270 TWh per year by 2030-2050, corresponding to uses as a feedstock in the industry, including hydrogen as a raw material (e.g. for the manufacture of ammonia) or as a reducing agent for steel production. These "no-regret" uses would be relatively concentrated geographically around industrial sites.

In the first phase, develop clusters

To deploy hydrogen in "no-regret" industrial uses, a large-scale Trans-European hydrogen transport infrastructure is not inescapable. The modular nature of electrolyzers makes it possible to locate hydrogen production near consumption sites: the electrolyzers can be small and [require an electrical connection and a modest water resource](#). It is therefore strategic to invest first in production capacity close to "no-regret" industrial uses. The use of hydrogen to decarbonise industrial uses could then be achieved without deploying cross-border infrastructure.

Concentrating production on demand sites allows for economies of scale and the deployment of a certain level of hydrogen consumption before potentially having to develop a hydrogen transport infrastructure. It is therefore strategic to invest first in production capacity close to "no-regret" industrial uses and in distribution and storage infrastructure to supply such regional clusters from production zones. The value of investing in clusters as a priority is reflected in European hydrogen strategies (see strategies by the [European Commission](#), [France](#), [Spain](#)).

Agora Energiewende identifies four such clusters: in the North of France through Belgium, the Netherlands and the West of Germany; between Poland and Lithuania; in Spain; between Romania, Bulgaria and Greece. Developing transport and storage corridors in these regions by converting part of the gas network (methane) and building some new hydrogen pipelines seems without risk even in the long term.

What terms for a European backbone?

A recent study by natural gas network operators considers a ["European hydrogen backbone"](#), "European hydrogen backbone", i.e. about 40,000 km of pipelines crossing 21 countries across Europe and numerous storage sites in salt caverns over the 2040 horizon. This network would be mainly made of methane pipes converted to carry hydrogen. The total cost would range between 43 and 81 billion euros.

Such a scenario relies on the realisation of some conditions which are as of today uncertain. First, the hypotheses for hydrogen demand lie at the higher end of existing estimates (see table). For example, the ["Accelerated Decarbonisation Pathway"](#) sees 1,710 TWh of pure hydrogen consumption by 2050, supplied with low-carbon hydrogen from electricity and methane. However, fossil-based hydrogen, even when supplemented with carbon capture and storage, raises the issue of methane leakage along the value chain. Furthermore, it assumes that some of the hydrogen demand would be supplied by countries outside Europe. However, there is no unified vision regarding the use of imports at the European level: for example, Germany plans to import most of its consumption, while France does not mention cross-border trade in its hydrogen strategy. Finally, importing low-carbon resources from countries with high-carbon energy supply [raises sustainability issues](#).

Considering the uncertainties around the level of hydrogen demand and production methods, an approach based on no-regret demand and storage sites should be preferred in order to avoid irreversibility of hydrogen demand. Developing a Trans-European infrastructure too quickly without ensuring the relevance of the uses and modes of production of low-carbon hydrogen entails risks, in particular reducing other financial support that is more relevant today for the development of a hydrogen sector for decarbonization, such as the deployment of electrolyzers to lower their cost or research and development on modes of production of decarbonized hydrogen. These are the areas that should now be at the heart of an enhanced European cooperation on hydrogen, which is already underway in the framework of the [Important Projects of Common European Interest \(IPCEI\)](#). Additionally, all energy sector stakeholders should take up the issue of long-term hydrogen infrastructure planning, within an integrated approach on energy infrastructure (electricity, methane, hydrogen).

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