Hydrogen transport

Factsheet

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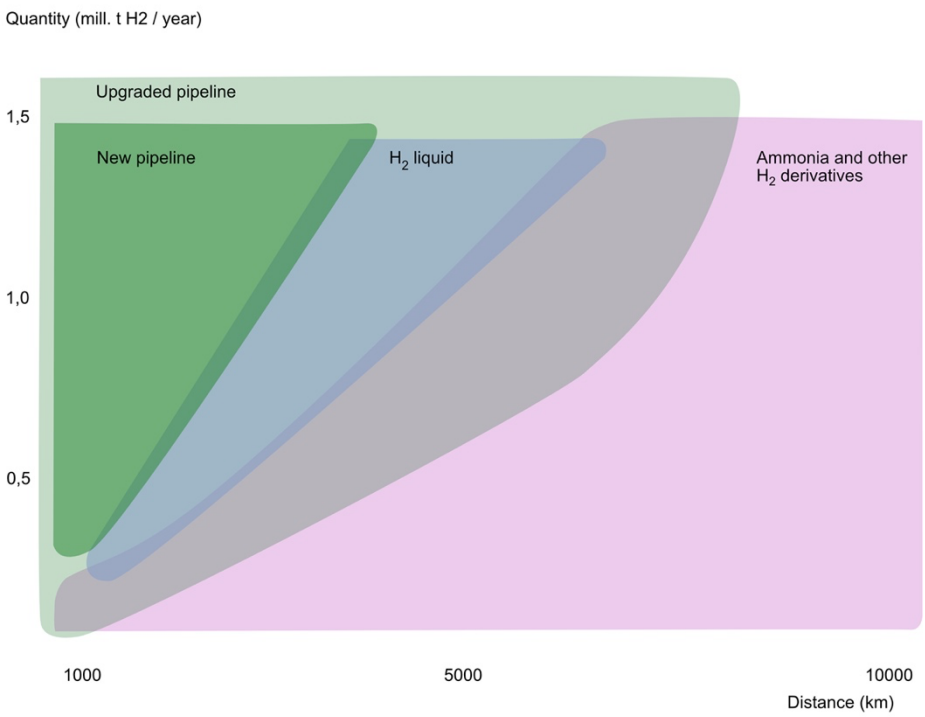
Costs of hydrogen transport



Source: IRENA *Graphics: GES*

According to experts, transporting hydrogen over shorter distances (up to 4000 km) is cheaper by pipeline than by ship. For very long distances, transport by ship with the carrier substance ammonia or other hydrogen derivatives, such as methanol is the best option.

Why transport?

Germany imports about 70 percent of its energy, and that is fossil. In Europe, this figure is around 60 per cent. In our latitudes, self-sufficiency in energy is hardly feasible and certainly not affordable. Therefore, Europe will continue to import energy on a large scale in the future - and as green as possible. This also applies to other industrialised countries. The import of hydrogen and its derivatives will be especially important for sectors that cannot be electrified, such as air traffic.

What transport options are available?

Hydrogen is the lightest chemical element. The energy density per weight share is high, but per volume share it is low. For transport by pipeline, hydrogen is therefore compressed. For transport by ship, the gas even has to be liquefied. These conversion processes cost energy. Finally, the gas can be transported with the help of chemical hydrogen storage (derivatives), for example as methanol or ammonia. These substances can even be moved using existing infrastructure (pipelines, ships, pipelines, filling stations). There are losses here, too, especially during the conversion back into pure hydrogen.

Transport per pipeline

There are currently natural gas pipelines with a length of 1.2 million kilometres. In contrast, there are hydrogen pipelines with 4,600 kilometres, which is only a fraction compared to gas. Networks that can transport hydrogen must be protected against corrosion. The operating pressure is between 70 and 100 bar. But there is also the possibility of upgrading existing gas pipelines to transport hydrogen. For this, for example, the compressors (for compression) have to be replaced. An increased admixture (2 to 10 percent) of hydrogen to natural gas in existing networks is also possible.

Transport by ship

To transport large quantities of hydrogen over long distances, ships with liquid hydrogen on board are the obvious choice. Liquid hydrogen must be stored at minus 246 degrees Celsius - compression and cooling cost energy. In addition, there is the so-called boil-off loss during ship transport. Hydrogen evaporates when heat gets into the tanks - which cannot be avoided. The longer the transport, the greater the losses. All this leads to considerable investment and operating costs.

Transport as a hydrogen derivative

First, ammonia is one of the most produced chemicals in the world, mainly for the fertiliser industry. The toxic substance is largely produced from nitrogen and hydrogen using the tried and tested Haber-Bosch process. Ammonia becomes liquid at minus 33 degrees C and can store a lot of hydrogen. If one wants to recover hydrogen from ammonia at its destination,

considerable costs are incurred. To avoid these, ammonia can also be used directly, for example as fuel for ships or turbines.

Secondly, methanol is also a common chemical. It is produced from the synthesis of hydrogen and CO_2. This process is also mature. However, the substance is only climate-neutral if no additional CO_2 is released into the atmosphere when it is consumed, or the CO_2 produced is compensated for elsewhere by negative emissions. The capacity to store hydrogen is lower than that of ammonia. On the other hand, methanol is available in liquid form under normal conditions, so there is no need for cooling. Methanol is a basic chemical substance, but can also be burned directly. Tankers are suitable for transport, as they are also used for transporting crude oil.

Thirdly, Liquid Organic Hydrogen Carriers (LOHC) are chemical substances that are properly loaded and unloaded for hydrogen transport. The energy input for this is relatively low. LOHC are also liquid at room temperature. However, unlike ammonia, they must be converted back. Some LOHC carrier substances are considered technically mature, but they are not yet traded internationally and are expensive. So far there are only pilot projects.

How high are transportation costs?

According to a scientific study, ammonia and methanol could be transported to Germany in 2030 for about 1.5 euros per litre, including production costs. Experts' opinions differ as to which of the chemical hydrogen carriers is more suitable. In any case, the total cost of transport, including conversion and loss costs, is decisive. For medium distances of 1000 to 4000 kilometres, pipelines are the preferred means of transport. Ship transports are more suitable for longer distances, from about 4000 kilometres and then rather by means of derivatives.

Conclusion

For the desired climate neutrality, Europe will also have to import considerable amounts of the required energy in future to come. For distances of a few thousand kilometres, converted or new pipelines will play an important role. Because of the very large energy demand, however, transport as a derivative will also become important - for example from Chile or Australia, where the conditions for the production of climate-friendly hydrogen are particularly favourable. Technology transfer to economically weaker export countries and access to finance are essential if hydrogen is to be sourced from there. From a European perspective, this applies above all to Africa.