Hydrogen production

Factsheet

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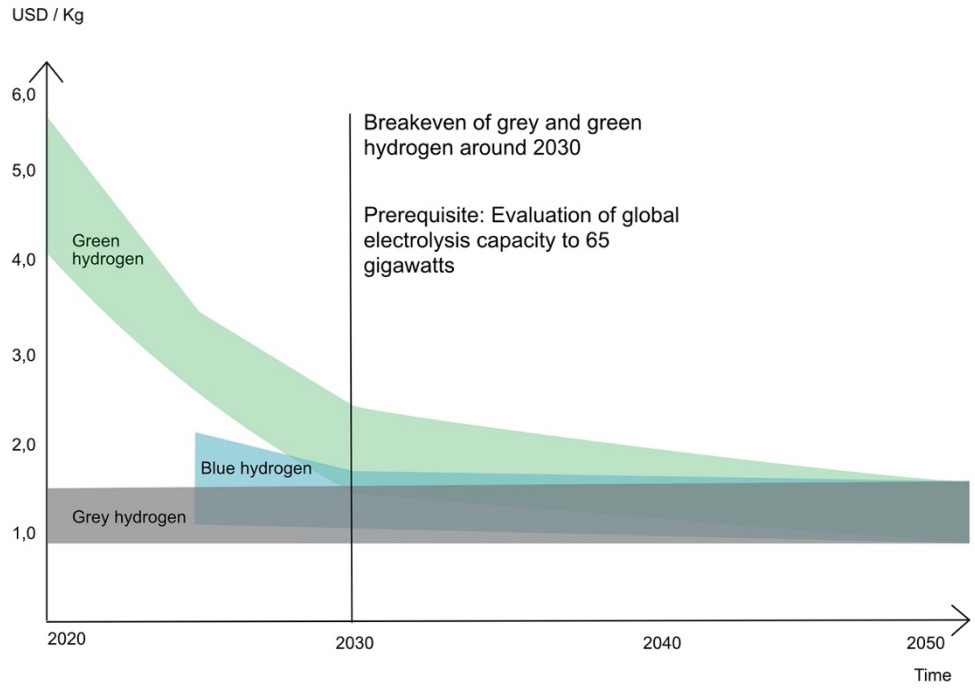
Expected price development of hydrogen



Source: Hydrogen Council und McKinsey *Grafik: GES*

The graph shows the price ranges of hydrogen of different origins. According to experts, green hydrogen could become competitive with grey hydrogen around 2030.

What is special about hydrogen?

Hydrogen (H_2) is the lightest element we know. The gas hardly occurs in our natural living environment. On earth, it is predominantly bound in water. Hydrogen has a high calorific value. Per kilogram, for example, the gas delivers more than twice as much energy as methane (gravimetric energy density). However, because hydrogen is so light, the energy yield per cubic metre at normal pressure is relatively low (volumetric energy density). During transport, the gas is therefore pressurised, liquefied or shipped by means of chemical hydrogen storage (derivatives).

How is hydrogen produced?

Up to now H_2 has been produced predominantly from natural gas. It is broken down into hydrogen and CO_2 by heat (steam reforming). In the process, a lot of CO_2 escapes into the atmosphere, around 10 tonnes per tonne of hydrogen produced. According to the common "colour theory", this is grey hydrogen. Green hydrogen, on the other hand, is produced by water electrolysis. Only electricity from renewable sources is used. Blue hydrogen is grey hydrogen, but the CO_2 produced is captured and stored (CCS). Turquoise hydrogen is produced by thermal cracking of methane (methane pyrolysis). Instead of CO_2, solid carbon is produced, which can easily be stored or used. This method is still under development. One speaks of pink hydrogen when the electricity for electrolysis is produced with nuclear energy. GES considers the prevailing colour theory to be problematic. What is important is the largely climate-neutral production of the hydrogen, not its colour.

Why electrolysis?

Water electrolysis is the predominant technology for producing green hydrogen. In simple terms, it is a process in which electrical energy is converted into chemical energy. A cost-effective and established technology is alkaline electrolysis. However, its efficiency is lower compared to other processes (PEM and high-temperature electrolysis). Currently, there is a real boom in the development of electrolysis projects internationally. Nevertheless, the proportion of green hydrogen produced compared to grey hydrogen is vanishingly small, less than one per thousand. Almost all electrolysers are still manufactured in the factory. Automation is a decisive step towards cost reduction. Experts agree: to increase the supply of low-CO_2 hydrogen, the electrolysis industry must develop into a globally networked gigawatt industry.

How expensive is hydrogen?

A kilogramme of grey hydrogen costs about 1.5 to 2 US dollars to produce - and the trend is rising because the price of gas is increasing as a result of the war in Ukraine. The price of electrolysis hydrogen is about three times as high, i.e. around 5 US dollars. This does not include the costs for storage and transport.

When will low-CO2 hydrogen be competitive?

That depends on many factors. For green hydrogen, the price of electricity is of central importance. In addition, there is the utilisation of the plants, investment and operating costs as well as the cost of water. The decisive factor will be the ramp-up of a global hydrogen economy. According to experts, this will require large quantities of low- CO_2 hydrogen (i.e. also blue and turquoise for a transitional period) to be produced quickly in order to develop the infrastructure for production, storage and transport. The market ramp-up of electrolysers is crucial for the cost development of green hydrogen. According to the Hydrogen Council and McKinsey, green hydrogen could become competitive with grey hydrogen around 2030. This only applies, however, to favourable production locations with corresponding electricity prices and if the global volume ramp-up for the production of electrolysers is successful.

Where are the obstacles?

A possible bottleneck for the expansion of PEM electrolysis is, for example, a shortage of raw materials such as iridium and platinum. Both precious metals are largely corrosion-resistant and therefore excellently suited for the technology. There are many obstacles to scaling up the production of hydrogen: high electricity prices, low utilisation factors, government regulations or transport costs. Only if it is possible to tackle these problems simultaneously can the ramp-up work.

Will there be enough low-CO2 hydrogen in the future?

Hydrogen is a rare commodity. The German hydrogen strategy, for example, currently envisages an expansion of electrolysis plants by 5 gigawatts by 2030 and a further 5 gigawatts by 2040. Demand, however, will be many times higher. Germany and also Europe will have to import large quantities of low- CO_2 hydrogen. In a global perspective, the Fraunhofer Institute has examined the potential for the production of electrolysis hydrogen. In the PTX Atlas, the institute calculates a possible production volume of 109,000 terrawatt hours outside Europe. Taking into account questions of investment security and infrastructure, the production potential is reduced to about 69,000 terrawatt hours of hydrogen. By way of comparison, global oil and gas production is currently equivalent to about 100,000 terrawatt hours.

Conclusion

Only when low- CO_2 hydrogen can be produced at comparable prices to grey hydrogen will business models emerge and the market ramp-up accelerate. Until then, state regulation and further investment in the development of this future technology are needed. An important player in the production of electrolysers is China, where production is massively subsidised. The global energy transition will not be achieved with electrolysis hydrogen alone. Blue and turquoise hydrogen will also be needed over the next few years. Other building blocks will also be needed, such as direct electricity generation, energy efficiency and nature-based solutions to compensate for unavoidable CO_2-emissions.