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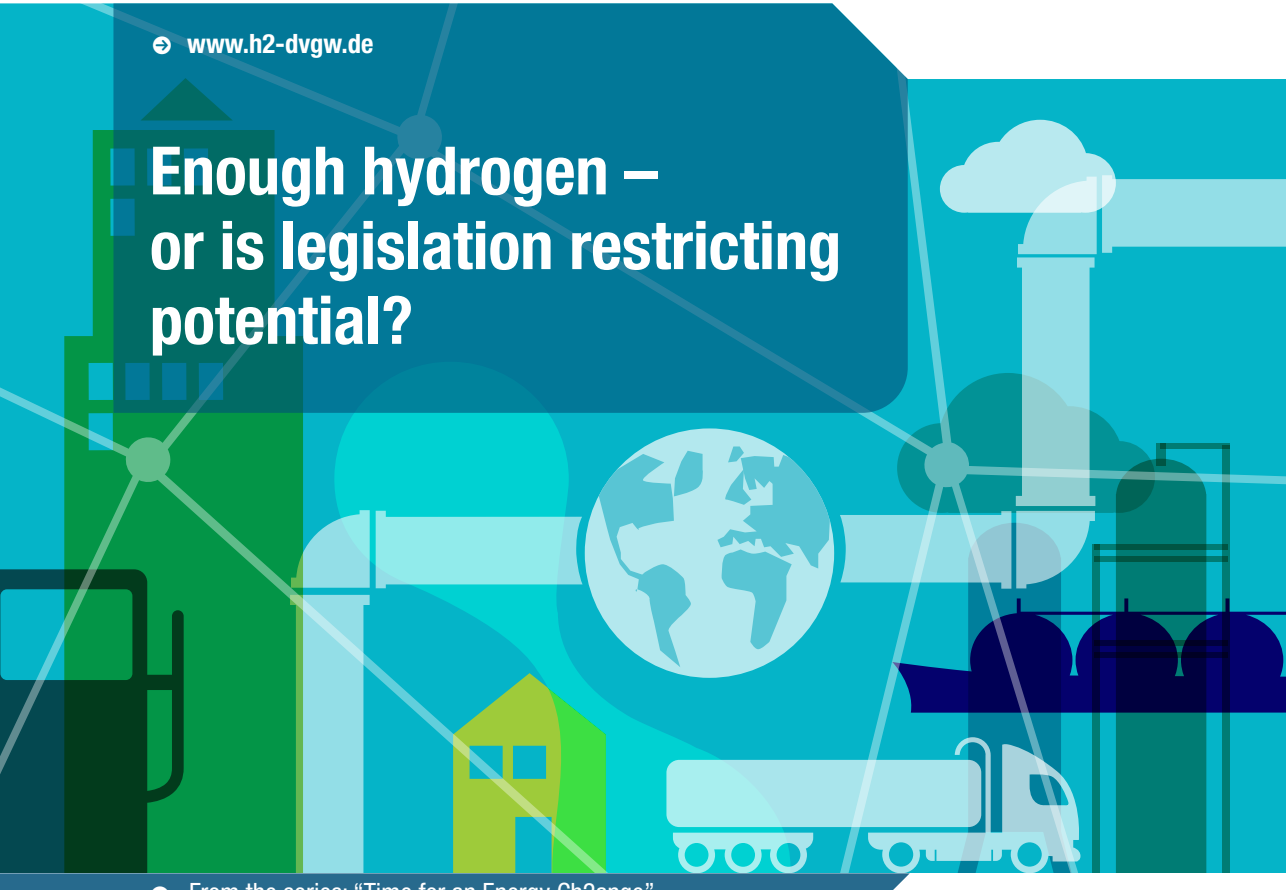
Enough hydrogen – or is legislation restricting potential?



From the series: “Time for an Energy Ch2ange”

It may become tight
for hydrogen.

The main points

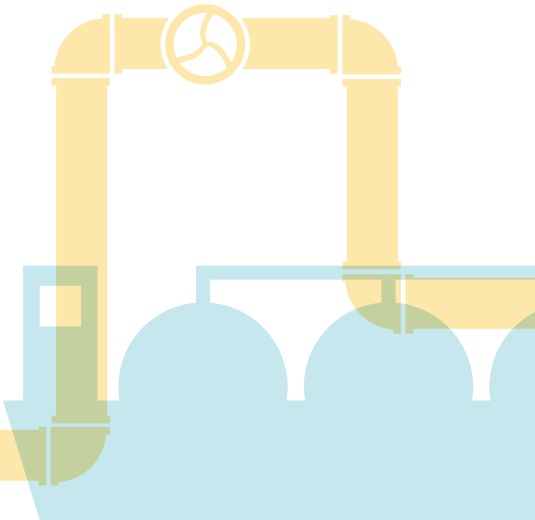
- As a general principle, enough hydrogen is available.
- Domestic production capacity will not be adequate – Germany will also need to import hydrogen.
- Production and infrastructure will need to be developed rapidly.
- The potential is restricted by regulatory requirements.
- Further restrictions would make it difficult to meet demand.

Enough hydrogen – possibly

Germany has set itself the goal of becoming climate-neutral by 2045. To achieve this goal, the rapid expansion of renewable energies, significant improvements in energy efficiency and increasing. electrification in a variety of sectors will be necessary. In this context, hydrogen will play a key role – at the transition between electrons and molecules.

To ensure that sufficient hydrogen is available, it will be necessary to develop production capacity and transport infrastructure and to create the right conditions. In the study. “Regulatory and technical conditions for the ramp-up and import of hydrogen”, Frontier Economics and DVGW consider the following questions: What quantities of hydrogen could be available in Germany? To what extent will these be restricted by regulatory requirements and technical conditions?

It has become clear that a combination of hydrogen produced in Germany and imported from other countries could just be about be sufficient to meet demand – **provided that** hydrogen production is expanded as planned **and** hydrogen is imported via marine **and** pipeline routes **and** appropriately sized infrastructure is created **and** the regulatory requirements faced by hydrogen are not made more stringent **and** demand does not increase faster than expected. It is clear that appropriate conditions will need to be established.

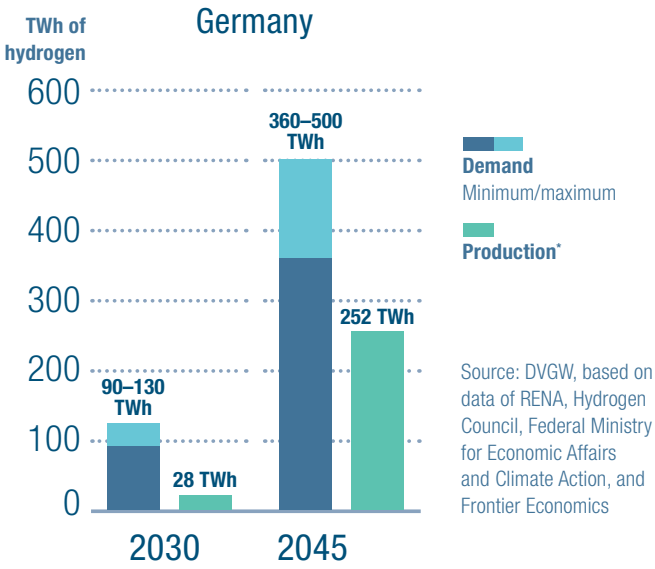


There is still a considerable gap between supply and demand

A target of at least 28 terawatt-hours (TWh) per year has been set for the production of green hydrogen in Germany by 2030. This is significantly lower than expected demand. By 2045, the Federal Ministry for Economic Affairs and Climate Action (BMWK) expects that electrolysis capacity in Germany could reach about 190 to 245 TWh of hydrogen. This would be sufficient to cover about half of national demand.

Germany will therefore be forced to import hydrogen from other countries in Europe and throughout the world. The Ministry expects that about 50 to 70 percent of German demand will need to be covered by imported hydrogen or hydrogen derivatives in 2030.

The gap between predicted demand and production potential



Source: DVGW, based on data of RENA, Hydrogen Council, Federal Ministry for Economic Affairs and Climate Action, and Frontier Economics

* The calculation of production potential is based on a target figure of 10 GW of electrolysis capacity in 2030 and an estimate of 90 GW for 2045 as well as 4000 full-load hours and an electrolysis efficiency of 70 percent.

Great potential – severe restrictions

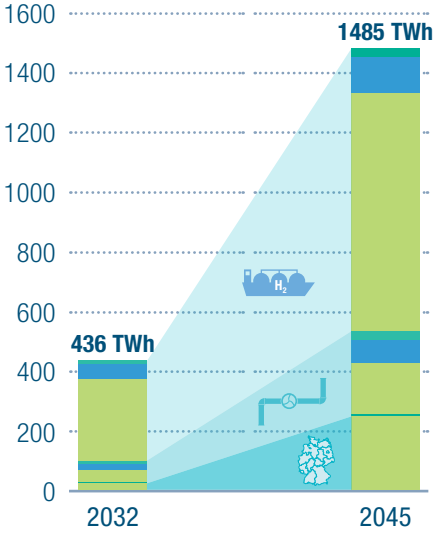
The study considers the quantity of hydrogen available for export in a global context and the share that could be imported by Germany.

Together with domestic production, hydrogen imports result in total potential of about 440 TWh of hydrogen in 2032 and almost 1,490 TWh by 2045. That corresponds to between two and three times the expected demand. However, this potential is reduced by regulatory and infrastructure conditions.

Import potentials
Hydrogen type
- Turquoise H_2*
- Blue H_2
- Green H_2

Import route
- Marine transport
- Pipeline transport

Domestic potential



The import potentials have been subdivided into hydrogen imported via marine and pipeline routes as this has an impact on the carbon footprint of the imported fuel. The figures have also been subdivided into green and low-carbon hydrogen. Low-carbon hydrogen is produced from natural gas by a variety of processes; this is important in the context of emission limits and the requirements for the criterion of "renewable". This type of hydrogen includes blue and turquoise hydrogen.*

* Methane pyrolysis for the production of turquoise hydrogen is currently in the test phase. The technical feasibility and economic viability of this potential are therefore uncertain and only small quantities should be assumed.

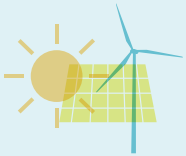
What factors reduce the import potential?

Emission limits:
The Renewable Energy Directive and the "gas package" of the European Union (EU) state that the carbon footprint of hydrogen must not exceed 100 grams of CO_2 equivalent per kWh. As a result, marine transportation would take blue hydrogen and in some cases even green hydrogen over the emission limit. This restriction will only cease to have an impact when climate-neutral propulsion systems are available for ships.

Infrastructure:
Technical restrictions of import and transport infrastructure may have a negative impact on the availability of hydrogen. The crucial factors are:

- The number and capacities of ships available to carry hydrogen and hydrogen derivatives
- The capacities of pipelines in Germany and other countries

The requirements of the EU Renewable Energy Directive will restrict the availability of green hydrogen



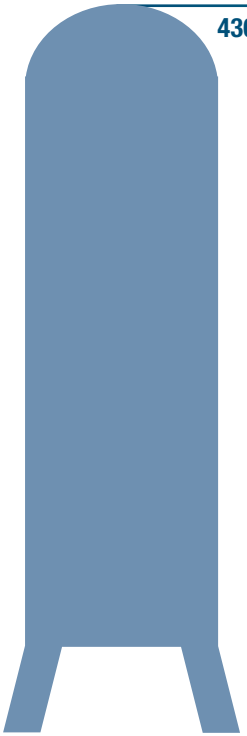
Additional renewable energy:
From January 2028 onwards, electrolysers may only be connected to wind or solar power facilities no later than three years after the commissioning of such facilities. Higher demand for hydrogen is to be linked to the creation of new capacities for power generation from renewable sources.

Geographical correlation:
Renewable hydrogen is only to be produced where sufficient power from renewable sources is available.

Time correlation:
Power is to be generated and used at the same time. The objective of this requirement is to ensure that sufficient renewable power is available for other applications. However, this will reduce the full-load hours of the electrolyser and increase the production costs for hydrogen.

The remaining potential will just about cover demand

In **2032,** the entire import and production potential in Germany will be about 440 TWh.



The availability of hydrogen will mainly be restricted by the EU requirements concerning **emission limits.** These requirements will reduce the quantity available by about 40 percent. Emissions will be driven by the use of fossil fuels for marine transport and power from non-renewable sources for conversion processes such as hydrogen liquefaction.

In addition, the **regulatory requirements for renewable hydrogen** will present obstacles to the ramp up. Especially the time correlation with the generation of green power will reduce the potential by a further 10 percent.

The **limited marine import capacities** in Germany will reduce the direct import potential by 60 TWh. In contrast, **pipelines** are adequately sized.

2032

The hydrogen supply in 2032 could be adequate, but with very little leeway for further requirements faced by hydrogen or short term demand increases. In addition, this would mean that Germany would have to take up a considerable share in the import potential of the EU.

All in all, the remaining hydrogen **supply** for Germany would be 144 TWh.

144 TWh

Supply

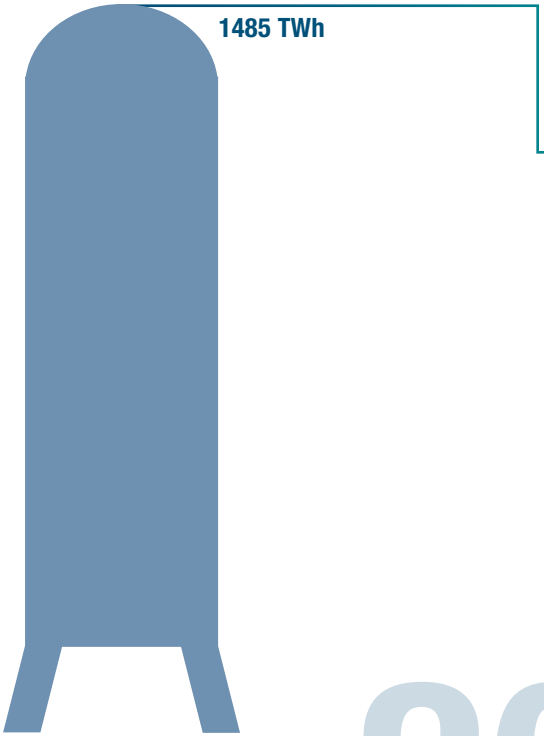
With a projected **demand** of 95 to 130 TWh, this quantity would probably be adequate.

90–130 TWh

Demand

Import infrastructure is the key

Calculations indicate that the hydrogen potential in Germany will be trebled to about 1,490 TWh by **2045.**



By then, the regulatory framework will be of secondary importance in view of the possibility of climate-neutral marine propulsion systems and the widespread use of power from renewable sources. **Emission limits, requirements for green hydrogen and CO_2 prices** will reduce the hydrogen supply by one-fifth.

The availability of hydrogen will mainly be restricted by the import infrastructure available. **Marine import capacities** will probably be limited to about 110 TWh, reducing import quantities from countries outside Europe by 426 TWh. However, terminals in other EU countries could compensate for this shortfall and the quantities concerned could then be carried to Germany via the European hydrogen pipeline system.

2045

In overall terms, hydrogen import and transport infrastructure in Germany seems to be adequately sized for the medium and long term.

Taking into account all the applicable factors, the **hydrogen supply** for Germany will be about 770 TWh in 2045.

768 TWh

Supply

With **demand** of 370 to 700 TWh, this will be adequate, provided that the hydrogen infrastructure plans are appropriately implemented.

370–700 TWh

Demand

Minimum implementation requirements

The analysis of hydrogen potentials for Germany in 2032 and 2045 indicates that hydrogen supply will be **just about adequate to meet demand** with the current assumptions concerning infrastructure and regulation. Hydrogen infrastructure, consisting of the core network and import terminals, will be adequately sized for the medium and long term. However, limited marine import capacities could restrict hydrogen availability

For the rapid ramp-up of the hydrogen market, it will be crucial for the hydrogen production and infrastructure projects that have been announced to be implemented as planned. There is **little leeway for additional requirements or short-term demand increases**, for example as a result of the use of hydrogen at power plants in Germany in dark, low wind conditions. There must therefore be no further cuts in the projects to be implemented.

Especially up to 2032, the EU requirements concerning emission limits will represent severe restrictions. Up to that date, ships will still be powered by fossil fuels, increasing the carbon footprint of hydrogen imported from countries outside Europe. A temporary increase or staged introduction of the emission limits could help in bridging the transitional period until zero-emission ship propulsion systems are available, and would **facilitate the import of hydrogen and hydrogen derivatives**. This would make the short-term ramp-up of hydrogen considerably easier.

The most cost-effective and climate-compatible import route is via pipelines. Germany should therefore give preference to pipeline transport. For this purpose, the development of the European Hydrogen Backbone must be accelerated.

So that the hydrogen imported can reach industrial, commercial and domestic customers, action must already be taken to design and construct **regional hydrogen distribution systems**. To a large extent, the existing natural gas grid can be converted and used.

The core hydrogen network and current plans for import capacities on the German coast represent minimum requirements for meeting future demand. There must be no further cuts to these projects.

DR. DIETRICH GERSTEIN

DVGW

Source: D. Gerstein

You will find information on the definition of the hydrogen types in our publication “Hydrogen reduces the carbon footprint – in many ways”.

“Time for an Energy Ch2ange” DVGW publications

Hydrogen is the fuel of the future and a key element in climate protection and the energy transition in Germany. DVGW has already been committed to this area for more than 10 years. Its research institutes are working on a large number of projects concerning the production, transport, distribution and utilization of hydrogen. In addition, the codes of practice of DVGW have been almost entirely adapted to hydrogen operation. Our series “Zeit für einen Stoffwech2el” (Time for an Energy Ch2ange) covers in a compact form the current status of research and the range of technical know-how collected during work on standards.

Already published:

Klimafreundliche Gase. Mehr als genug Potential (Climate-friendly gases. More than enough potential; in German only)

Das Gasnetz – Rückgrat der Wasserstoffwelt (The gas grid – backbone of the hydrogen world; in German only)

Hydrogen reduces the carbon footprint – in many ways

Largely H_2-ready now: networks, storage facilities, components

Wasserstoff vor Ort. Für Wärme und mehr (Hydrogen on site – for heat and more; in German only)

Hydrogen: demand and procurement paths

More information at:
www.h2-dvgw.de

Sources:
Regulatorische und technische Rahmenbedingungen für den Hochlauf und den Import von Wasserstoff; DVGW study conducted by Frontier Economics Limited (Regulatory and technical conditions for the ramp-up and import of hydrogen; DVGW study conducted by Frontier Economics; in German only)
www.dvgw.de/h2-angebot

DVGW Deutscher Verein des
Gas- und Wasserfaches e. V.
Josef-Wirmer-Straße 1-3,
53123 Bonn, Germany

Phone: +49 228 9188-5
Email: info@dvgw.de
Internet: www.dvgw.de

Design: waf.berlin

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