ready4H_2

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

From the “Time for an Energy Ch2ange” series.

Little levers make
big changes.

At a glance

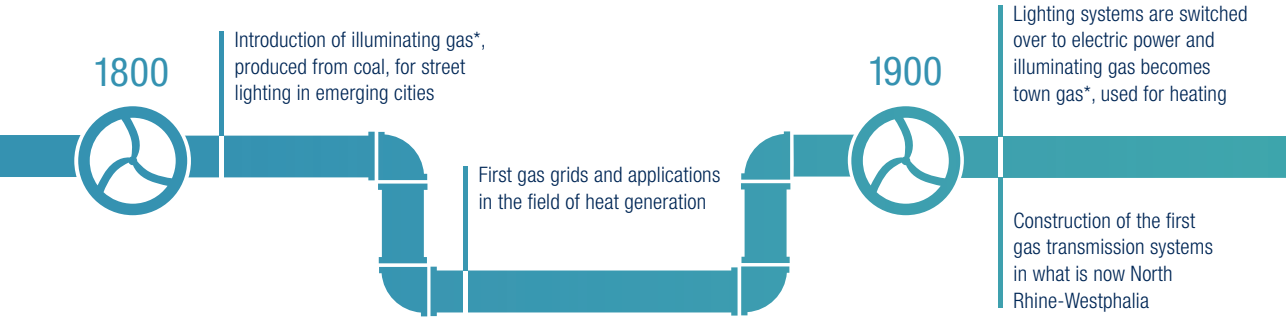
- New fuels such as hydrogen will replace natural gas.
- Gas grids are used to carrying hydrogen in the past.
- Gas pipelines are largely H_2-ready.
- Storage facilities can be modified.
- Individual components and plants are critical points.
- The groundwork for hydrogen transmission and distribution is being laid.

Out with natural gas – in with new gases

The climate targets are clear: Germany is to reduce its greenhouse gas emissions to zero by 2045. That will only be possible if not only the power sector, but also the energy sector as a whole, becomes climate-neutral.

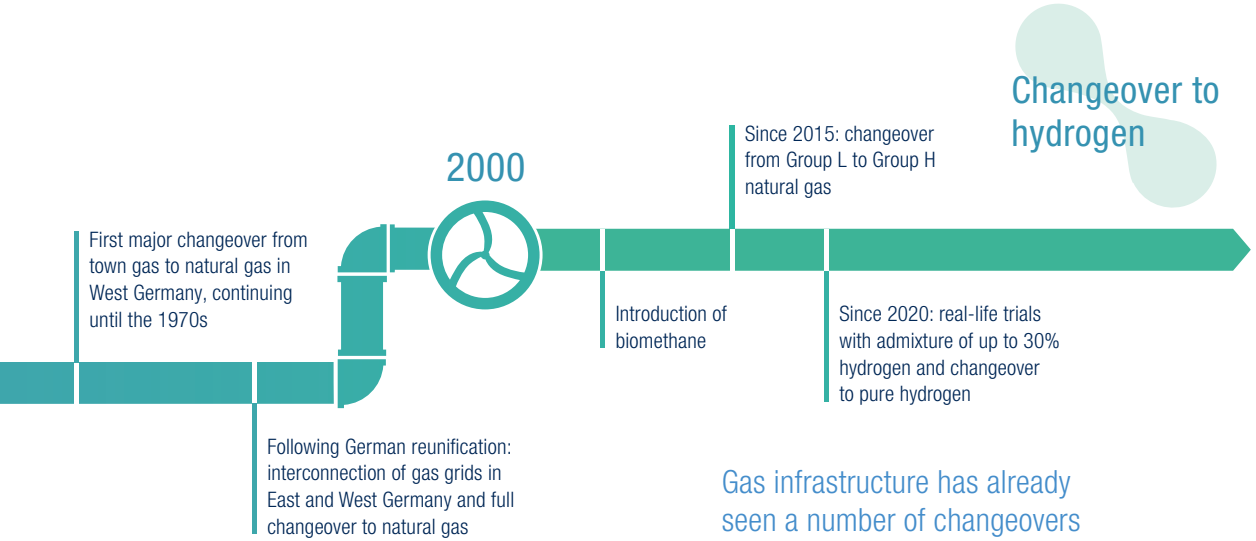
Hydrogen will be one of the keys to this transformation of the German energy market. Step-by-step, hydrogen will replace natural gas, which is currently predominant, and account for the lion's share of the planned climate-neutral gases.

The grids have already carried many different gases



*Illuminating gas, also known as town gas, was a mixture of hydrogen, representing about half the total volume, methane, nitrogen and carbon monoxide.

Hydrogen must be available on a nationwide basis in order to supply the 1.8 million companies and about 19 million households connected to the gas grid in Germany. Gas infrastructure must be fit for the transmission and distribution of hydrogen and will need to be modified and converted as necessary. This is why the research and standardization efforts of DVGW are currently focusing to a large extent on pipeline materials and individual components. Components are being tested to confirm their fitness for service with hydrogen in a large number of projects – this applies to the transport of hydrogen/methane mixtures as well as pure hydrogen.



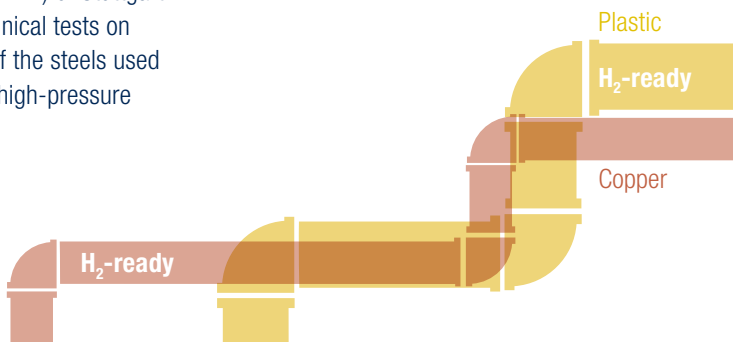
Gas infrastructure has already seen a number of changeovers in the course of its history

Hydrogen – no problem for steel pipes

In order to ensure the safe transport of hydrogen in technical terms, materials and components coming into contact with the gas must be gas-tight, sufficiently strong and safe. The materials used must not become brittle or otherwise deteriorate in contact with hydrogen. Components must function properly. For example, hydrogen should not escape through the wall of pipelines or at valves, flanges or other fittings. Gas meters must measure consumption accurately.

In order to ensure the technical safety of pipelines, the DVGW research project "Sample testing of steel materials for gas pipelines and plants for assessment of their suitability with hydrogen" was initiated. Within the framework of this project, the Material Testing Institute (MPA) of Stuttgart University carried out technical tests on a representative sample of the steels used in German and European high-pressure pipelines.

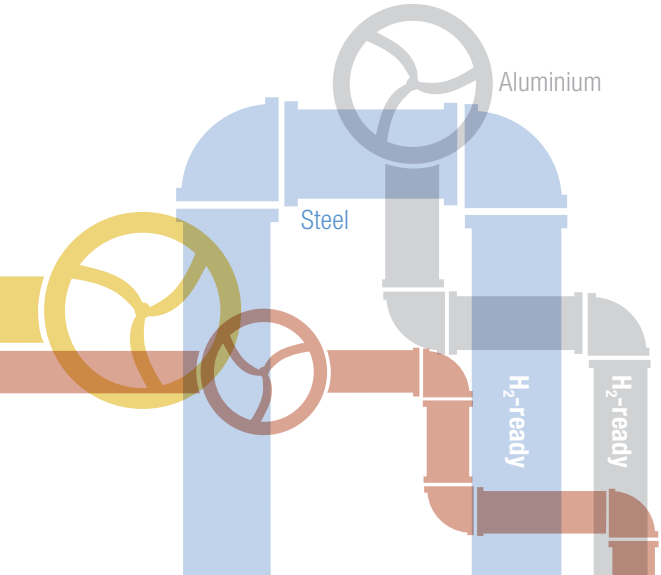
The fracture tests carried out showed that all the steels tested were fit for service with hydrogen. Both ageing behaviour under operating conditions and the fracture toughness determined were in accordance with expectations for decades of service with hydrogen. The Institute carried out comprehensive measurements to consider the effects of hydrogen pressure. The results can therefore also be applied to pipelines operated at lower pressures. The conclusion is: **steel pipelines are fit for hydrogen service in all types of transmission and distribution systems at all pressures.**



The distribution grid is almost H_2-ready

In addition to pipeline steels, many other materials, such as plastics, copper and aluminium alloys, are fit for service with hydrogen and therefore also "H_2-ready". This is confirmed by a survey of all materials and components used conducted by the Deutsches Brennstoff-Institut (DBI). As a general rule, if the plastics used in the gas distribution system are fit for service with natural gas, they are also fit for service with hydrogen.

On this basis, the pipelines in the German gas distribution grid are 96 percent H_2-ready. Statistics indicate that the remaining four percent consist of ductile or grey cast iron or other unknown materials. This small portion of the distribution grid will therefore need to be considered in greater detail if a section of the system is to be changed over to hydrogen. Before any changeover, the systems concerned need to be tested and assessed by independent experts.



What does "H_2-ready" mean?

If a gas system or a system component is technically "H_2-ready", this means that it can be changed over from natural gas to hydrogen without any operational restrictions. For example, almost all the pipelines in the gas grid are fit for service with hydrogen regarding the materials used.

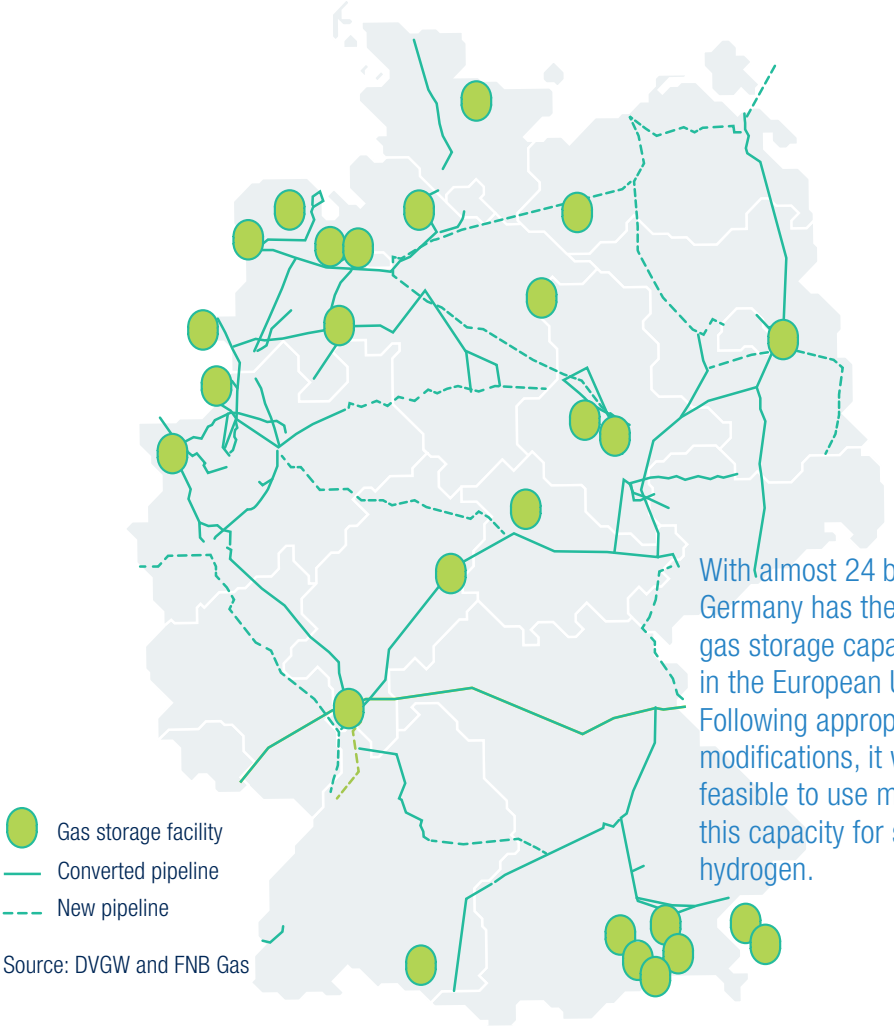
Hydrogen transport and storage is generally feasible – with some modifications

As a general principle, not only transmission pipelines, but also the natural gas storage facilities currently in operation, could be used for hydrogen storage. However, the storage facilities will need to be suitably equipped and certain modifications will need to be made to underground and aboveground facilities. A study entitled “Hydrogen storage – what is safe and sure?” conducted by DBI came to the conclusion that all the cavern storage facilities (i.e. facilities with artificially created caverns in salt formations) in Germany could be made available to store pure hydrogen, with certain modifications to plant components. The capacity of these storage facilities totals about 15 billion cubic metres.

In the case of porous rock storage facilities, individual investigations will be needed to verify whether they are fit for service with hydrogen. Currently, it is assumed that about four of the 16 porous rock storage facilities in Germany will be suitable for hydrogen storage. Provided that appropriate modifications are made, current gas storage facilities could store at least about 32 TWh of hydrogen.

To transport hydrogen produced in Germany, imported from other countries or stored in storage facilities, a gas transmission system which is 100 percent H_2-ready will be needed. In July 2023, the German gas transmission system operators presented the results of the first model study for a national hydrogen grid. This is to be created by 2032 from newly constructed and modified pipelines and will lay the foundation for the ramp-up of hydrogen use in Germany. The core hydrogen grid is also part of the new version of the national hydrogen strategy presented in July 2023.

The planned hydrogen grid and gas storage facilities in Germany



Source: DVGW and FNB Gas

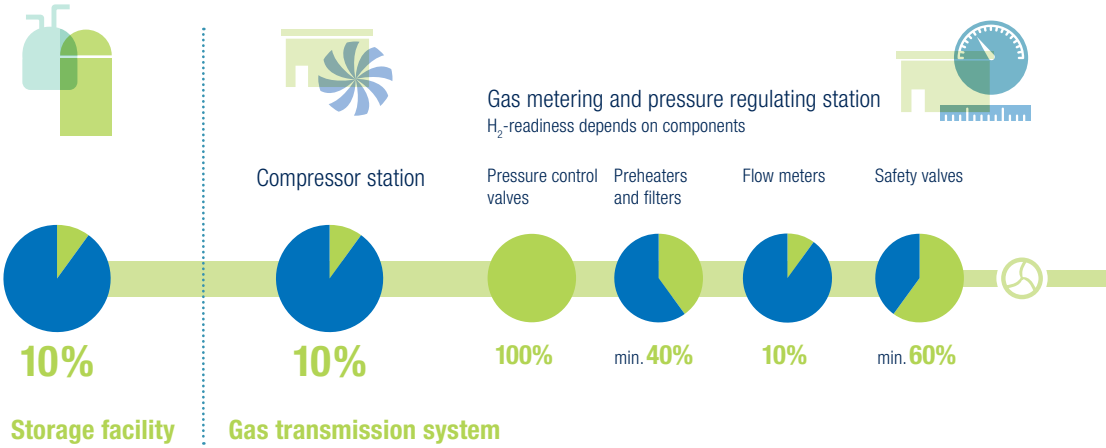
With almost 24 billion m^3, Germany has the largest gas storage capacity in the European Union. Following appropriate modifications, it will be feasible to use much of this capacity for storing hydrogen.

Critical points: individual components and plants

Whether a specific component of the gas grid, such as a compressor, pipeline or valve, can be operated with hydrogen without any problems, depends on the extent to which the gas composition affects material properties or functioning.

H_2-readiness within the system

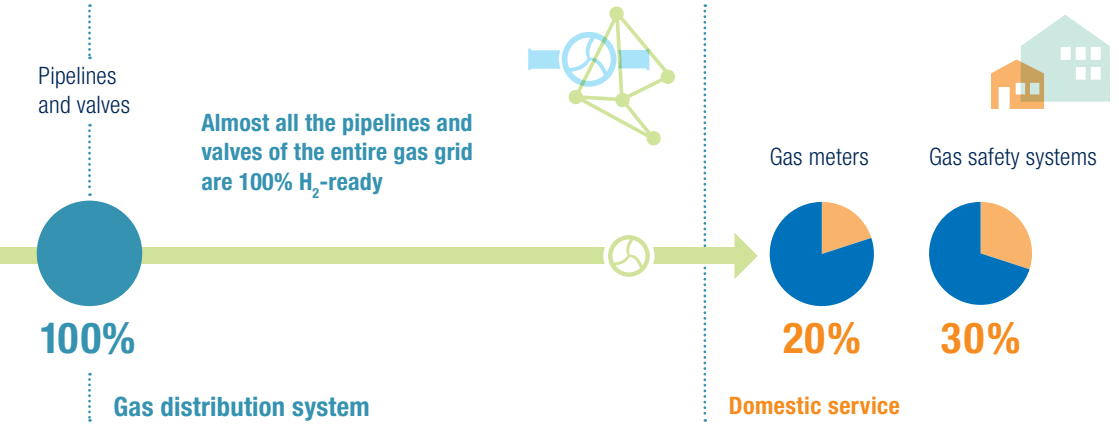
The percentages shown indicate the hydrogen readiness of the individual component – in other words, the percentage of hydrogen in the gas mixture at which safe operation is feasible with the information currently available.



Source: DVGW

Some individual components of the gas grid are not yet fit for service with hydrogen or do not offer the performance required. These include for example gas metering and pressure regulating stations and components. These will need to be checked to ensure that they are fit for hydrogen service and adapted if necessary.

Currently, the gas storage facilities, compressor stations and metering and pressure regulating stations in the German gas grid can carry gas with up to 10 percent hydrogen. In contrast to buried pipelines, which are almost H_2-ready, other facilities are installed above ground and are easily accessible. This means that modifications can be completed faster and at lower cost, and require less planning than in the case of buried pipelines.

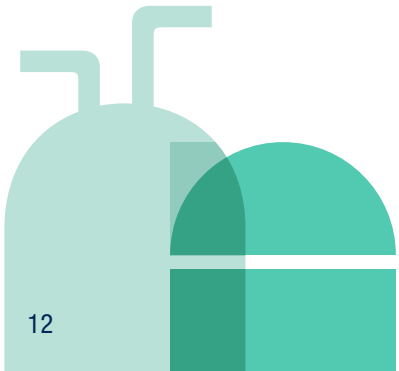


The groundwork for hydrogen is being laid

It is technically feasible to lay the groundwork for hydrogen and to upgrade the relevant infrastructure. In order to make the entire German gas grid and all its components completely H_2-ready, DBI estimates that a total investment of about €30 billion is required. Compared to the replacement value of the entire German gas grid, assessed at more than €300 billion, or the total cost of the energy transition, this is a relatively small amount.

While the pipelines are already almost completely H_2-ready, storage facilities, stations and individual components can be converted without considerable expenditure or major construction projects. DVGW has amended its code of practice and created new codes of practice for hydrogen. All the details of technical safety, right down to the last nut and bolt, are currently being investigated in a large number of research projects. To make the transition easier for the gas industry, DVGW has set up an online database (www.verifhy.de), allowing users to check at the touch of a button whether a specific component is fit for hydrogen service.

In order to fill the pipeline systems with hydrogen, it is necessary to ramp up production and imports now. At the same time, manufacturers and users need to make their equipment H_2-ready. This way, most of the companies and households in Germany will be able to obtain climate-neutral energy via their gas connection and to make a key contribution to climate protection.



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„European distribution operators are getting ready to transport hydrogen and contribute significantly to the decarbonisation of energy and help Europe meet its climate targets."

BARBARA JINKS

Director Ready4H2

„The latest results show: almost all the pipelines in the German gas grid can be used for hydrogen. Following the replacement or modification of individual components, gas infrastructure will become the backbone of climate-neutral energy supplies."

BJÖRN MUNKO

Head of Gas Technologies and Energy Systems, DVGW

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“Time for an Energy Ch2ange” DVGW publications

Hydrogen is the energy carrier of the future and a key element in climate protection and the energy transition in Germany, as in the rest of Europe. DVGW has 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 Potenzial (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)

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Hydrogen: Demand and Procurement Pathways

More information at:
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