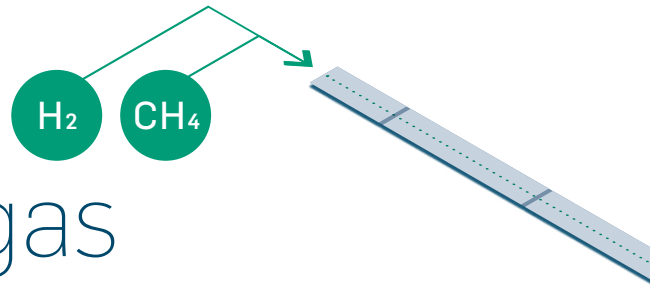
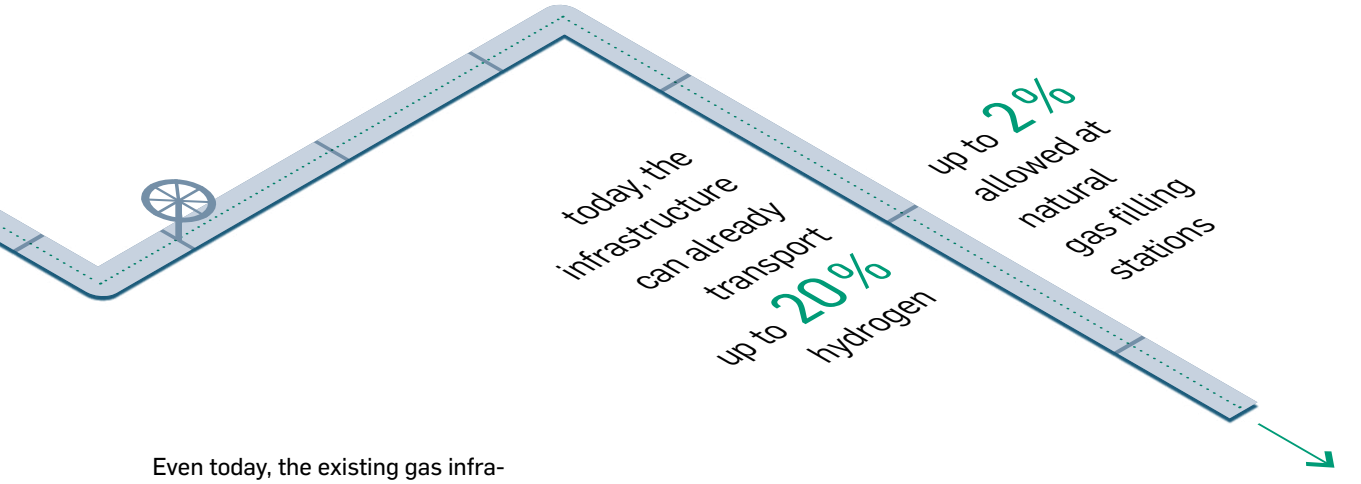
A new mix in the gas network



Hydrogen will play a decisive role in achieving the climate goals. A joint project initiated by the FVV with the German Association for Gas and Water (DVGW) investigates how the gas can be integrated in the existing natural gas infrastructure.

H_2 in the gas network // Whether in steel, chemicals or transport, hydrogen plays an important role in the future scenarios of a carbon-neutral industrial society. In the ›H_2 in the Gas Network‹ project initiated in early 2020, researchers have been investigating how a higher concentration of hydrogen in gas affects both the mobility sector and stationary gas engines, such as those used in combined heat and power plants. The starting point was the question as to how the existing gas network would need to be adapted to allow hydrogen to be mixed in. After all, hydrogen is corrosive and can damage seals and valves if they are not designed for high concentrations of H_2. While new pipelines are already ›H_2-ready‹, the existing gas infrastructure, such as compressors and reservoirs, needs to be modernised in a number of places. However, it is not only the technical side from the supplier's point of view that is relevant. »The customer will gain a completely new energy carrier – no longer methane, or natural gas, but a mixture containing hydrogen,« explains Dr. Dietrich Gerstein from the DVGW. A switchover would therefore have an impact on private households with gas heating, combined heat and power plants and the mobility sector.

As a first step, the experts want to determine the maximum possible hydrogen concentration in the gas network. Gerstein believes that the concentration will initially be increased in small increments without any significant modifications, to a 5, 8 or 10 % share of hydrogen in natural gas. In the future, however, it needs to be determined how far the hydrogen content can be raised in the network and for the consumers. In the project, the researchers assume that the H_2 level will fluctuate. »There can also be regional differences, such as if more hydrogen is produced in northern Germany through wind energy, which is then fed into the network,« explains Gerstein.



Even today, the existing gas infrastructure could transport up to 20 % H_2. However, not all natural gas engines are suitable for operation with hydrogen. In individual cases, compatibility with a hydrogen component of up to 100 % was demonstrated. »But the question is how to bring about compatibility for dynamically fluctuating hydrogen contents and for the entire fleet,« explains Georg Blesinger from the Institute for Internal Combustion Engines (IFKM) at the Karlsruhe Institute of Technology (KIT). In collaboration with the Institute for Thermal Energy Technology and Safety at the KIT, Blesinger is performing a risk and status analysis within the scope of the project. After all, there are a number of challenges: hydrogen attacks rubber and plastic parts, and even high-alloy steels, as used in valve seats and elsewhere, are not suitable for this application. Moreover, the gas is extremely flammable and burns five times as quickly as methane. As a result, there is a particularly high risk of pre-ignition and knocking. Under certain conditions, flashback into the intake area can even occur during gas exchange. However, IKFM head Prof. Dr. Thomas Koch is convinced that the challenges can be overcome.

In the future, vehicles running on natural gas could be filled with the H_2 / CH_4 mixture at natural gas filling stations. The proportion of hydrogen there currently cannot exceed 2 %, as the tanks of natural gas vehicles are not approved for higher concentrations. If necessary, the hydrogen could be separated from the natural gas again at the filling station if it is to be stored and not burned as a mixture. »If the gas network is suitable for transporting hydrogen in the future, there will also be sufficient storage options,« comments a convinced Gerstein.

The DVGW expert believes that a considerable hydrogen production infrastructure could be established in Germany within five to ten years. Above all, this requires the political will and the right framework conditions. Gerstein feels that the recently published hydrogen strategy is a big step in the right direction. Indeed, the technology is already available:

there are already pilot power-to-gas plants in which electrolysis is used to convert wind and solar energy into ›green‹ hydrogen, which is then fed into the network. However, these smaller plants are not sufficient to supply the gas nationwide. Therefore, the German federal government plans to import hydrogen from North Africa, where, with solar energy and low electricity costs, the gas can be produced much more cheaply than in Germany.

It is not only the technical aspects that determine long-term success: an economic perspective is also important. The switch to a higher share of hydrogen would likely be profitable in spite of the high costs, reports Gerstein: »If we had to build power lines to transport the same amount of energy, it would be much more expensive. Also, far more energy can be stored in the gas network than in power stores.«

The project has a planned duration of two years and focusses on Germany. However, scenarios for Europe are also being considered. Although vehicles with gas engines are very much a niche in Germany, a glance at the rest of Europe reveals the potential they hold: in Italy, ten times as many natural gas vehicles are registered as in Germany. //

3 months
storage duration in gas reservoirs at a maximum load of 85 GW

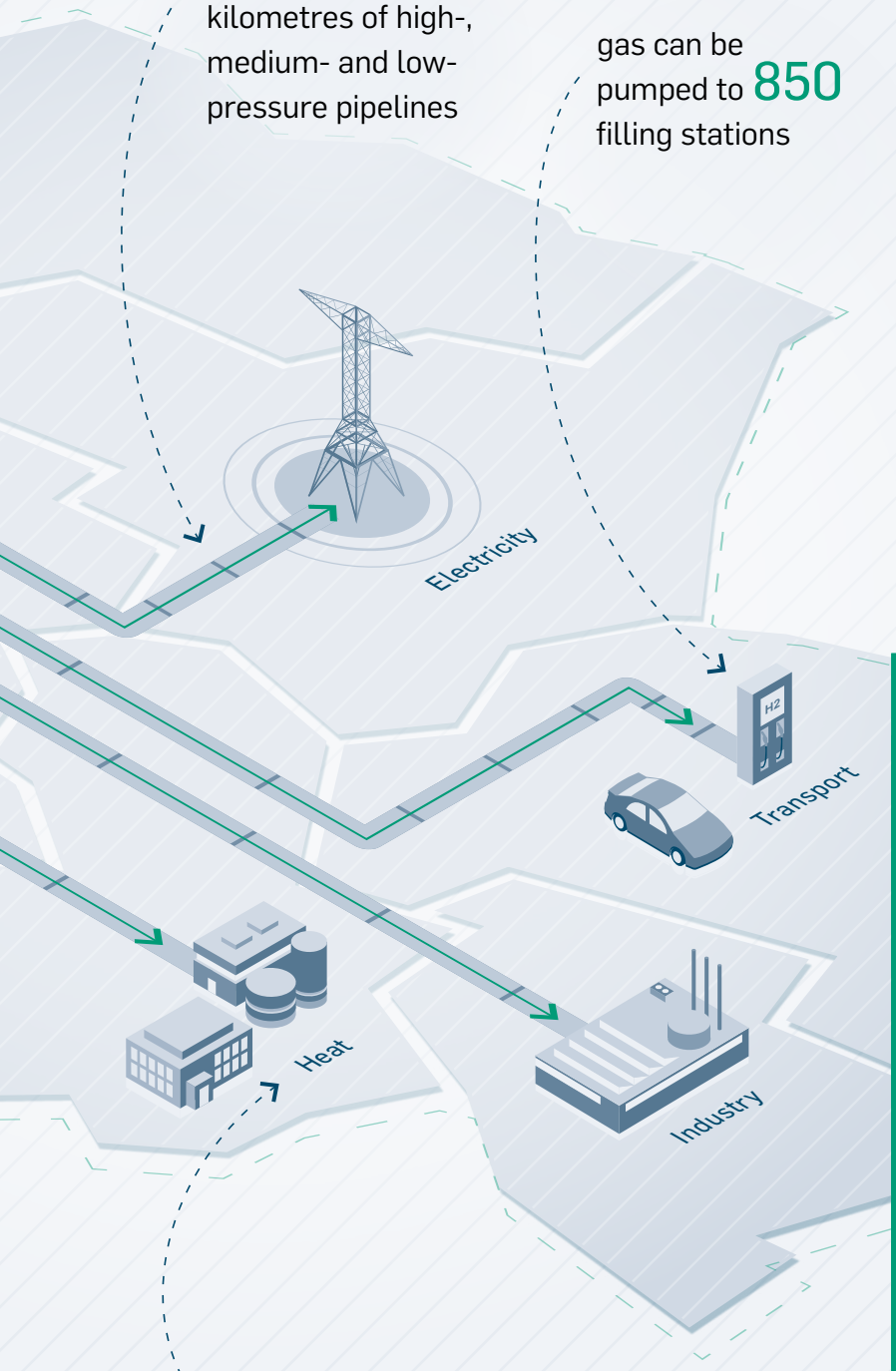
→ only 36 minutes in power stores

220 TWh
storage capacity in gas network and infrastructure

→ only 0.04 TWh in all power stores

510,000
kilometres of high-, medium- and low-pressure pipelines

gas can be pumped to **850** filling stations



Every **2nd** household in Germany uses natural gas for heating

Potential of the gas infrastructure in Germany

→ In power-to-gas plants, electricity from renewable sources is used to generate hydrogen or methane – which can then be stored and transported.

→ The **›green gases‹** can be used via the existing infrastructure.

Project data

→ »H_2 in the Gas Network [1384]: Development of a market ramp-up for increasing the hydrogen concentration in the gas network // Description of solution approaches in the gas and automotive industries for preserving the integrity of CNG engines and their economic assessment«

→ **PROJECT FUNDING**
€ 560,000 // DVGW, FVV

→ **PLANNING GROUP**
PG 1 ›System‹

→ **PROJECT MANAGEMENT**
Dr. Dietrich Gerstein, DVGW
Dr. Ulrich Kramer, Ford-Werke

→ **RTD PERFORMERS**
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