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# Converting Gas Networks to Hydrogen

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# Importance of hydrogen

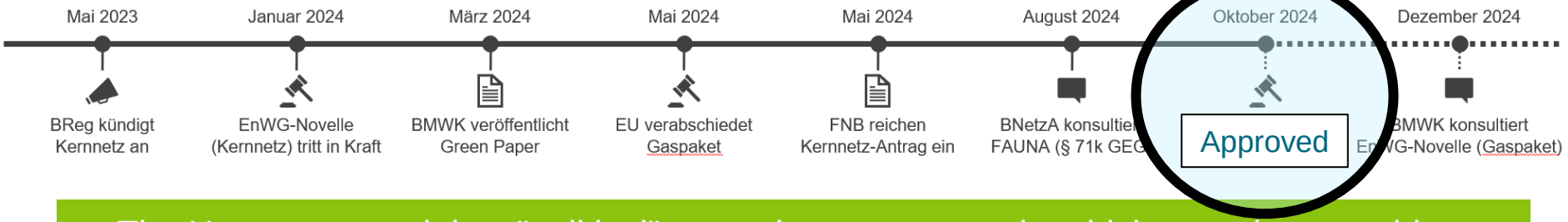
- Hydrogen is emerging as a crucial element in the global effort to combat climate change and achieve energy independence.
- As the most abundant element in the universe, hydrogen offers a clean and versatile alternative to fossil fuels.

# Germany decission to built the core network for $H_2$


- Germany is advancing rapidly with its hydrogen core network, starting new pipeline sections this year.
- The core grid is laying  the foundateion for a new $H_2$-based energy system. It is considered to be a starter grid which is to be expanded further.
- The development of the $H_2$ market is now a collective task.

# Germany decission to built the core network for $H_2$

## History of the hydrogen core network




## The $H_2$ core network is a "political" network to overcome the chicken-and-egg problem

Parameters:

- Length: 9,040 km
- High pressure network
- Entry/exit capacity: 100GW/87GW
- Operation: 2032
- Responsible for implementation: 15 TSO and 20 interconnected companies

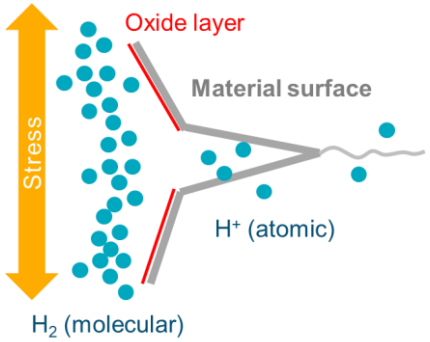
- New construction/conversion ratio: 44/56
- Compressor capacity: 291 MW
- Invest: € 18.9 billion

This is a "starter network" that needs to be expanded further.

# Investigating the hydrogen suitability of natural gas pipelines (Part 1)

## The problem:

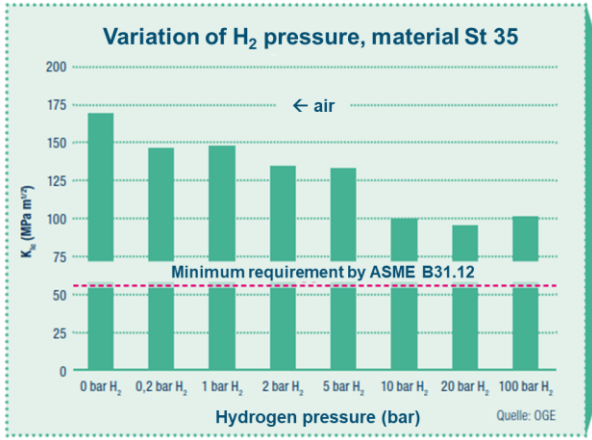
- Hydrogen is known to lead to faster crack growth in pipework damage.
- Can natural gas pipelines therefore be safely converted to hydrogen?




**First set of results**
(here using an example of the material ST35):

➲ **All samples met the stability criteria (ASME limit value) even at up to 100% $H_2$**

**Studying the influence of the partial $H_2$ pressure**




Increasing partial $H_2$ pressure lowers the facture toughness $K_{Io}$ till saturation

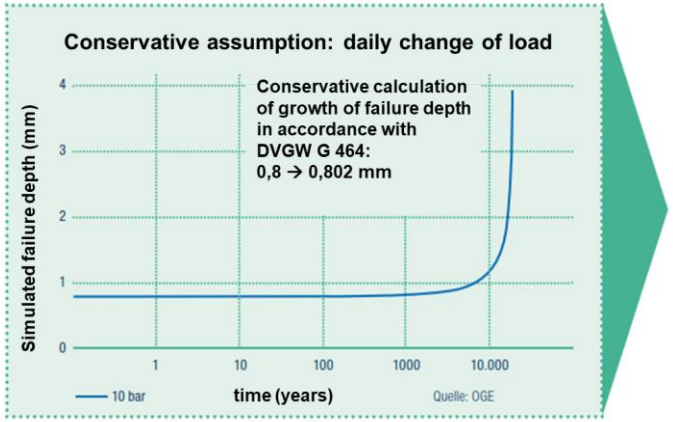
All results are significantly higher than the requested threshold of 55 MPa m ½ (ASME B31.12)

# Investigating the hydrogen suitability of natural gas pipelines (Part 2): Exposure to dynamic loads in accelerated lifetime testing

Example: Lifetime of a steel pipe (DN 600, DP 67,5, L 415, t = 8 mm) with artificial defect (l = 50 mm, d = 0,8 mm)

A natural gas pipeline (DN 600, DP 67.5 bar) would last approx. 10,000 years with daily, high load changes.

- All steels typically used in pipework in Germany (and Europe) are 100% $H_2$ -compatible.
- Normal operation of steel pipes with $H_2$ in accordance with DVGW G 464 is possible.
- Results are transferable to distribution grids and $H_2$ admixtures.




Even under a daily load variation of 10 bar the crack (defect) would remain stable for > **10.000 years** before growing rapidly leading to a failure

**Alternative interpretation:**
The defect depth would grow within the first 100 years by **0,002 mm**

**Details on the service life of each individual steel under selectable load cycles can be found in the "SyWeSt" project report**

# Highlights and major findings so far: Readiness of other materials

The "Hydrogen research projects 2024" edition summarises the results of around 80 R&D projects



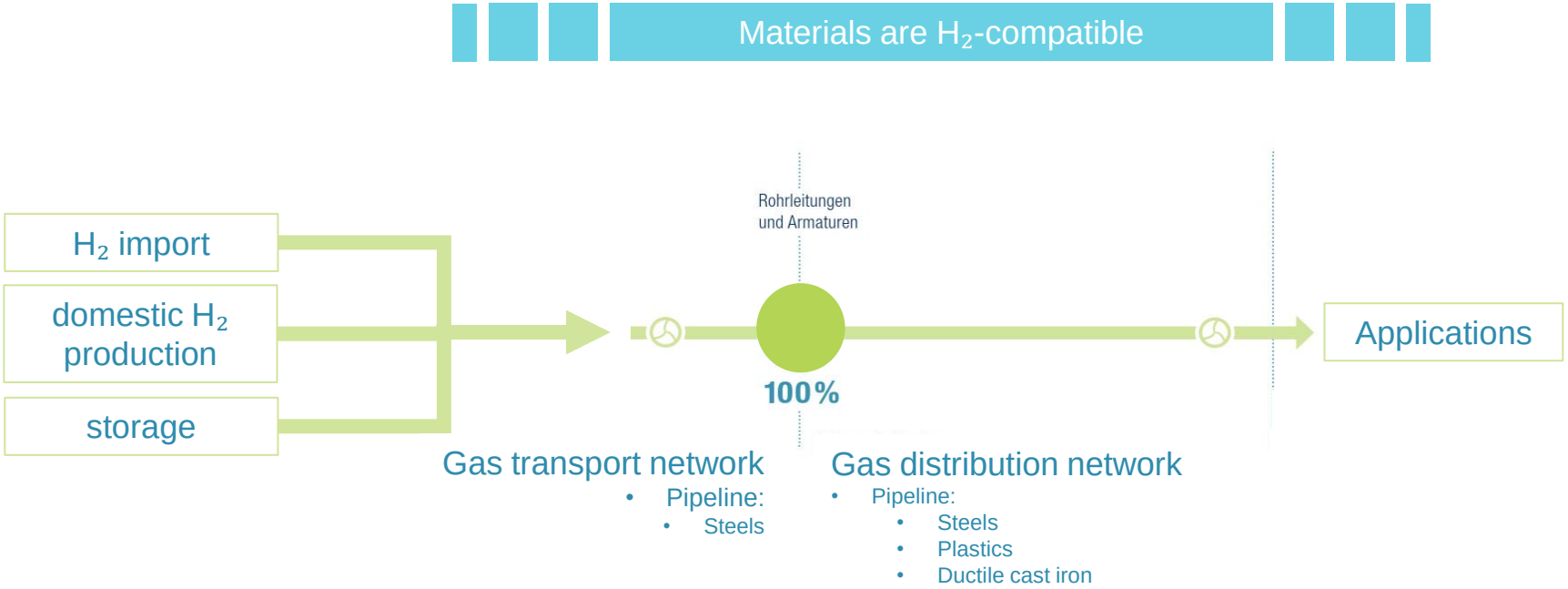

**Steel pipes are $H_2$-ready**. Nevertheless, a integrity assessment must be carried out for the conversion (due to possible previous loads and previous damage).
The remaining service life is determined conservatively using **fracture mechanics models.**



Pipes and moulded parts made of PE63, PE80, PE100, PE100-RC, PA-U12 and PVC are generally suitable for use with $H_2$ (see also R&D project G 202222).

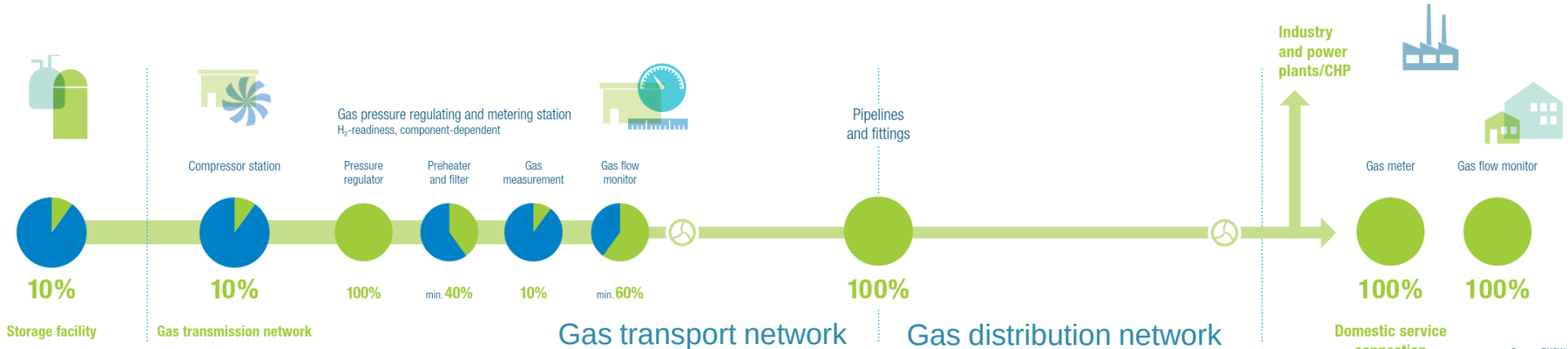
DSO systems: in accordance with the R&D project G 202333, no fracture mechanics assessment will generally be necessary in the gas **distribution** network due to the high design reserves.

# Overview of the $H_2$ readiness of the supply assets: (simplified representation and reduction to essential installations)



# Overview of the $H_2$ readiness of the supply assets:
## (simplified representation and reduction to essential installations)

However, $H_2$-readiness also requires the functional suitability of the built-in parts

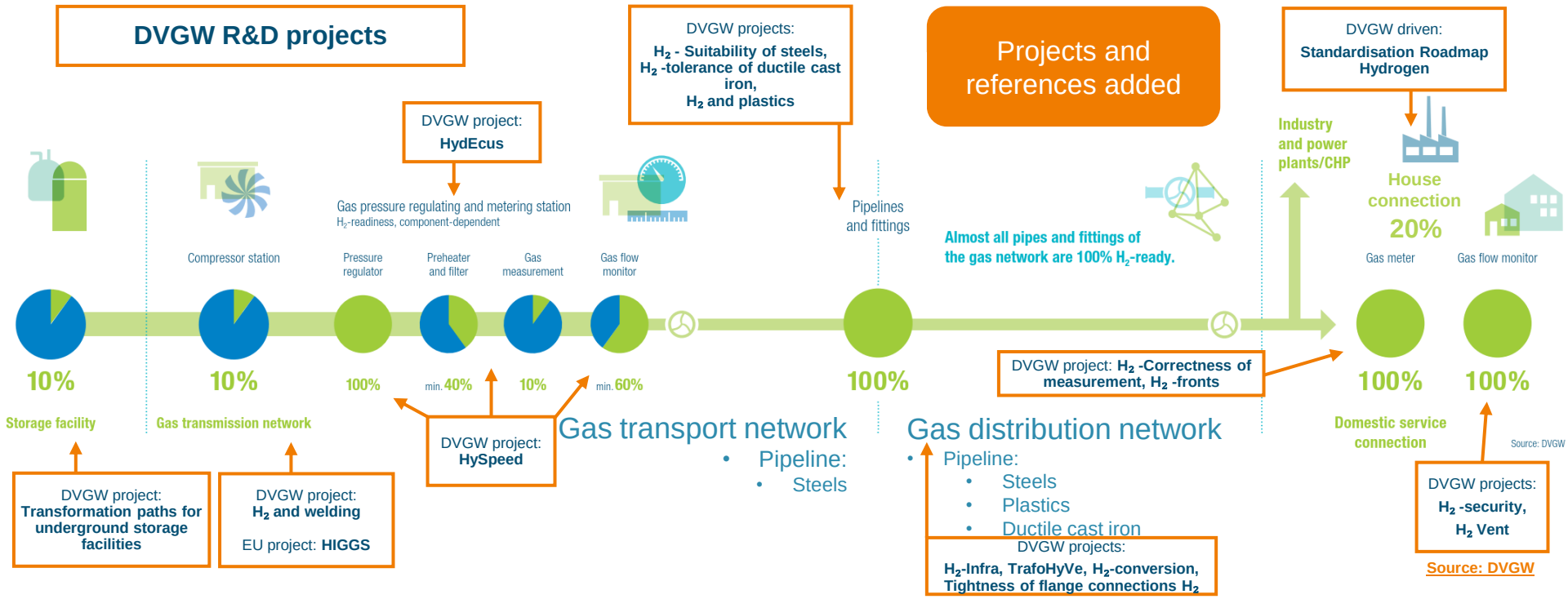



### Gas transport network
- Pipeline:
  - Steels

### Gas distribution network
- Pipeline:
  - Steels
  - Plastics
  - Ductile cast iron

➲ Compressor stations, preheaters and gas measuring stations must be adapted

# Overview of the $H_2$ readiness of the supply assets:
## (simplified representation and reduction to essential installations)




The $H_2$ readiness test is not just about material suitability, but also about full functionality.
Statements on readiness are underpinned by dedicated DVGW R&D projects and define the requirements for the changeover.

# All results of years of R&D on material and functional suitability of grid components are systematically stored in the database verifHy®

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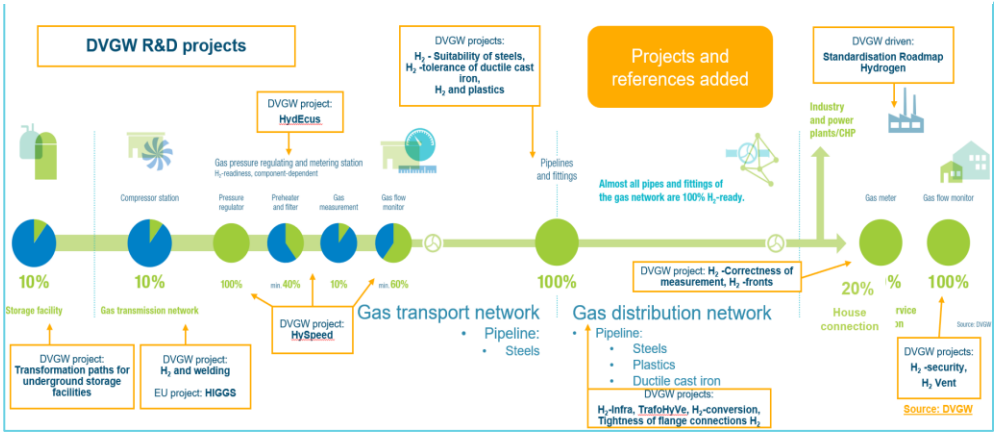
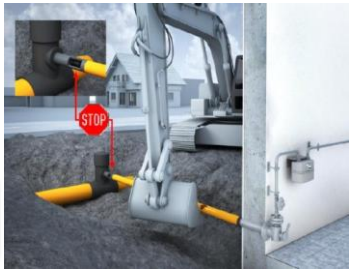
## Material and functional tests of all components along the

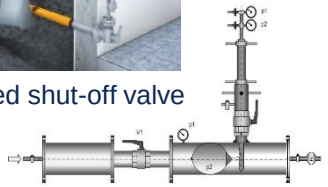



## Tightness and functional tests - passed successfully

DBI GEPRÜFT / TESTED




Flow-controlled shut-off valve

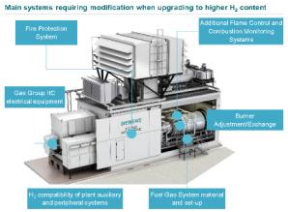


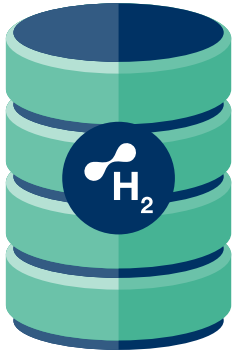
shut-off bubbles

## e-drives for compressors are $H_2$-ready

Chromato-graphs for up to 20% $H_2$ are available

## Turbines can be up-graded or bought $H_2$-ready




verifHy HydrogenREADY Database

# verifHy – Hydrogen-READINESS Database: Automated evaluation of your gas grid

- Bundled info on $H_2$ suitability of products, components and materials of all gas grid operators
- Automated evaluation and assessment
- Enables grid operators to design their asset planning thoroughly
- Work can be embedded in target network planning processes

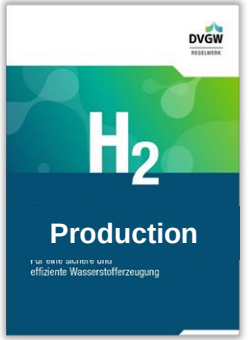

www.verifHy.de

# Germany has all standards to plan, build and operate a hydrogen infrastructure in place

- 171 hydrogen standards covering the entire gas grid value change
- Issued in three different sets
  - Complete set
  - Industry
  - Production
- **English version will be available for the Hydrogen Week in Brussels**
- As the German regulatory framework (by DVGW) is notified, all standards can be applied in every other European country


The entire set:
171 standards


Module Industrie:
61 DVGW + 4 DIN standards




Module Generation:
35 DVGW + 1 DIN standards

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