

# Plastic lines for Hydrogen Transport

How “ready” are plastic piping systems?



**Hydrogen (H<sub>2</sub>)**  
Use in infrastructure  
and industry

Stefan Griesheimer  
15.08.2022



# Synopsis

1. Introduction
2. Advantages of Hydrogen
3. Supply of hydrogen
4. Current situation in infrastructure
5. DBI “H2ready” pilot project
6. “Hydrogen Island” pilot project by Netze BW
7. Conclusion

# Introduction

## Energy transition in Germany is in full swing

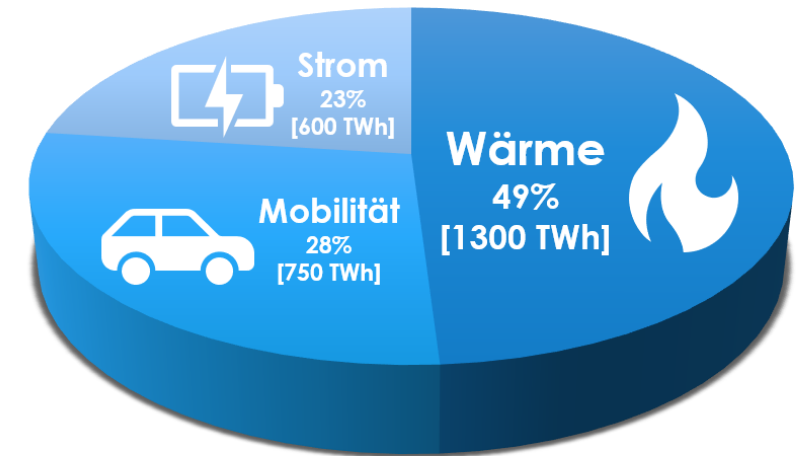
- CO2 savings of 65% by 2030 (previously 55%)
- 88% less CO2 by 2040
- Climate neutrality by 2045 (previously 2050)

## ■ Energy distribution in Germany

- Politics and public perception focused on electricity
- For the use of hydrogen [H<sub>2</sub>], mobility has been the focus so far

## ■ Transformation of the German gas network

- The existing gas network is to be made usable for hydrogen intake
  - Step 1: Add 20% (30%) of hydrogen [H<sub>2</sub>] to the natural gas
- Develop regulations for the use of 100% hydrogen [H<sub>2</sub>]
  - Step 2: Apply 100% hydrogen [H<sub>2</sub>] in planned networks



# Introduction

## Main European Hydrogen Network

- Biggest 23 utilities
- 21 countries are involved
- 11,600km are to be implemented by 2030
- 39,700km are to be implemented by 2040
- Further network development after 2040 will occur

### Total costs amount to 81 billion euros

- 69% on reusable gas pipelines
- 31% on new lines for expansion

- New Supply lines DN 600 – 900 mm
- Range of Pipelines DN 500 – 1200 mm
- Pressure Range 30 – 80 bar
- H<sub>2</sub> Production Costs 1 – 2 € per kg

- H<sub>2</sub> pipelines by conversion of existing natural gas pipelines (repurposed)
- Newly constructed H<sub>2</sub> pipelines
- - - Export/Import H<sub>2</sub> pipelines (repurposed)
- - - Subsea H<sub>2</sub> pipelines (repurposed or new)



# Benefits of hydrogen

## Three most important advantages

1. Simplified energy transport (one system)

2. Storage (finally possible)



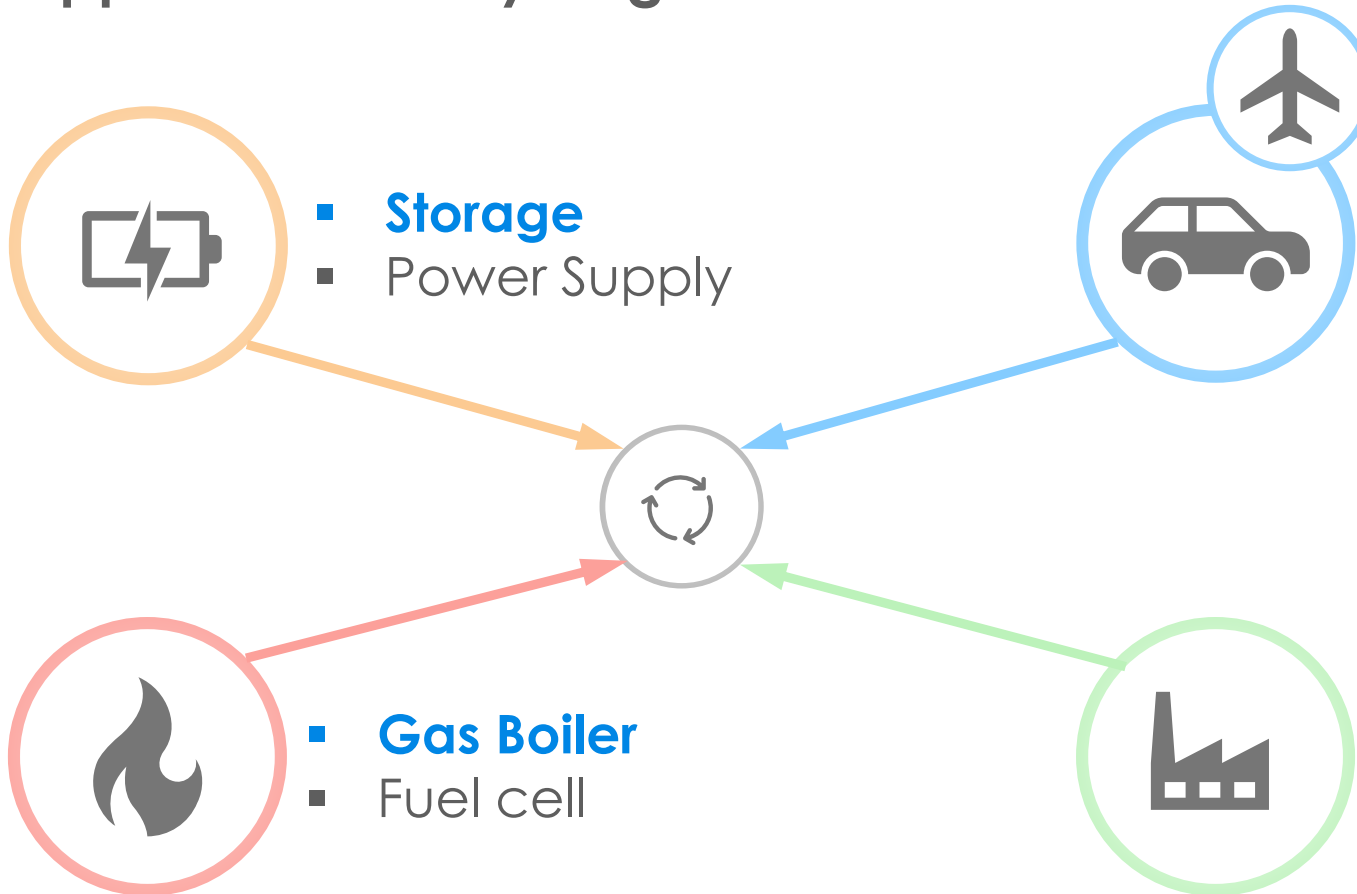
3. “Sector decoupling” (unrestricted use)

The **use** of hydrogen is almost **unlimited!**



# Benefits of hydrogen

- Applications of Hydrogen



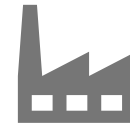
- **Storage**
- Power Supply



- **Methanol [CH<sub>4</sub>O], Petrol**  
by Power-to-X Method
- Car fuel cell



- **Gas Boiler**
- Fuel cell



- **Fuel cell**
- H<sub>2</sub> gas turbine



H<sub>2</sub> + CO<sub>2</sub>



# Benefits of hydrogen



- **German Initiative (State):**

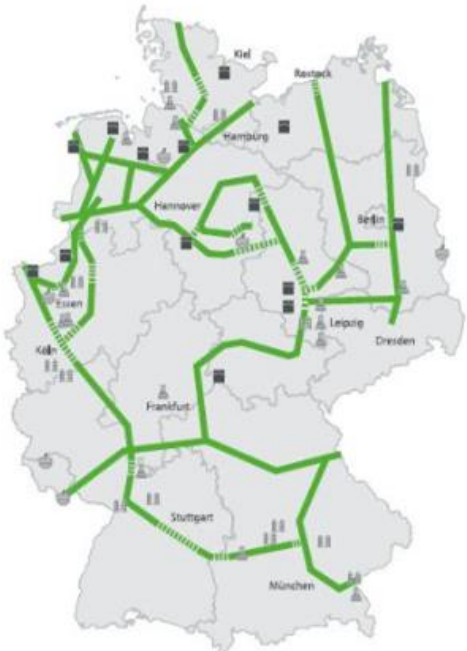
- The “National Hydrogen” Strategy was adopted in 2019
- The funds amount to €7 billion nationally and €2 billion internationally

Step 1: **1.11€ billion**

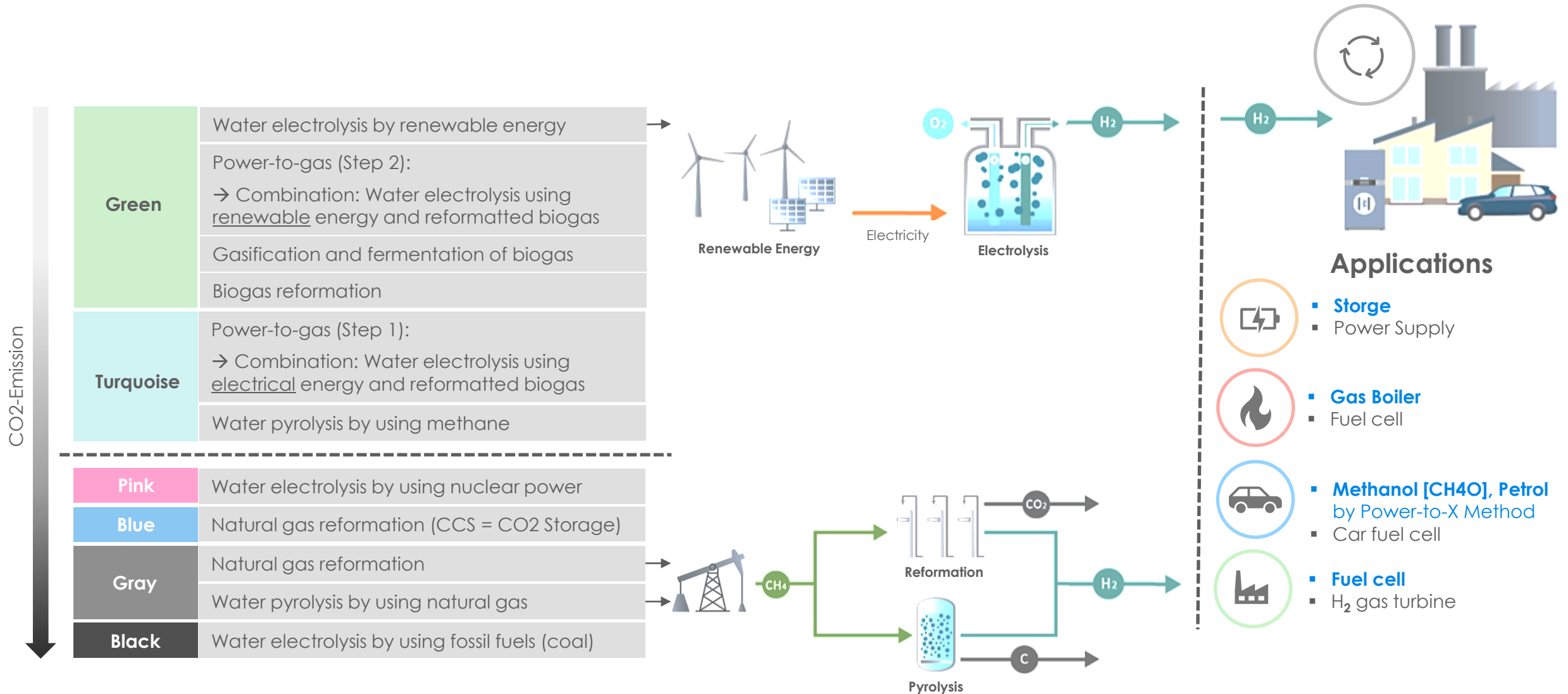
→ **300€ million in basic research**

→ **200€ million in application-oriented energy research**

→ **600€ million in pilot projects**



# Supply of hydrogen





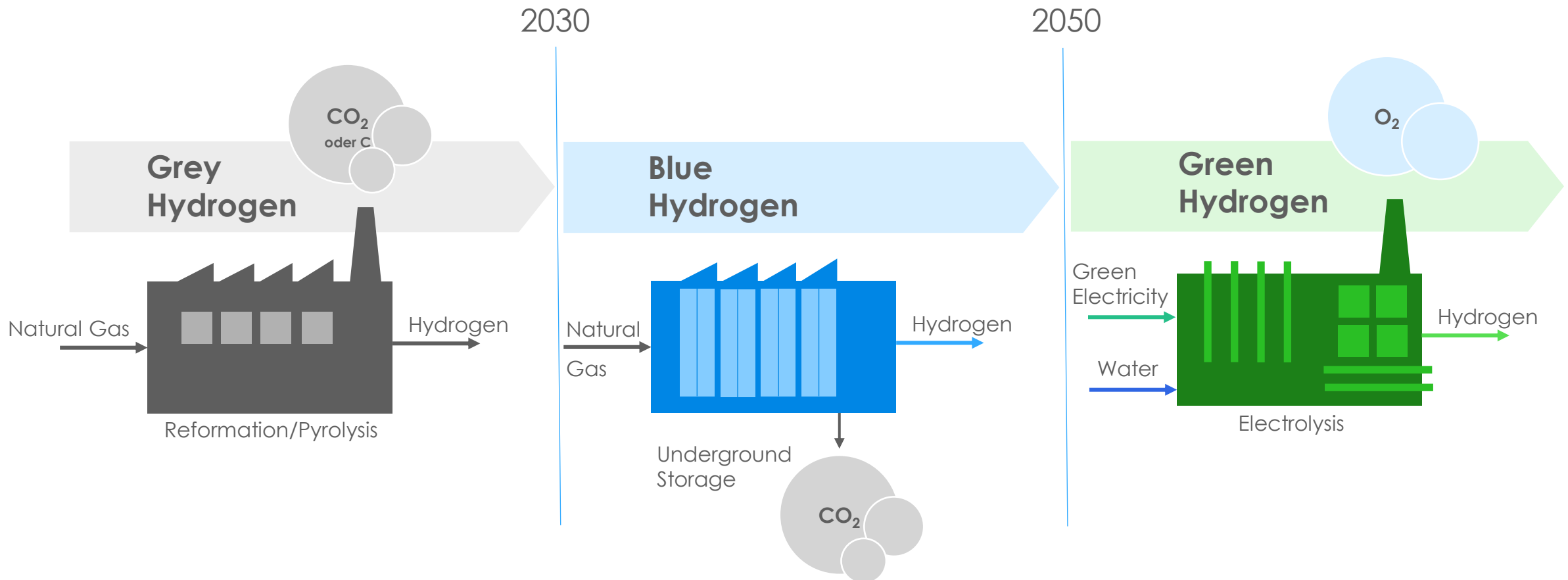
# Supply of hydrogen

Pink  
Hydrogen

Nuclear Power

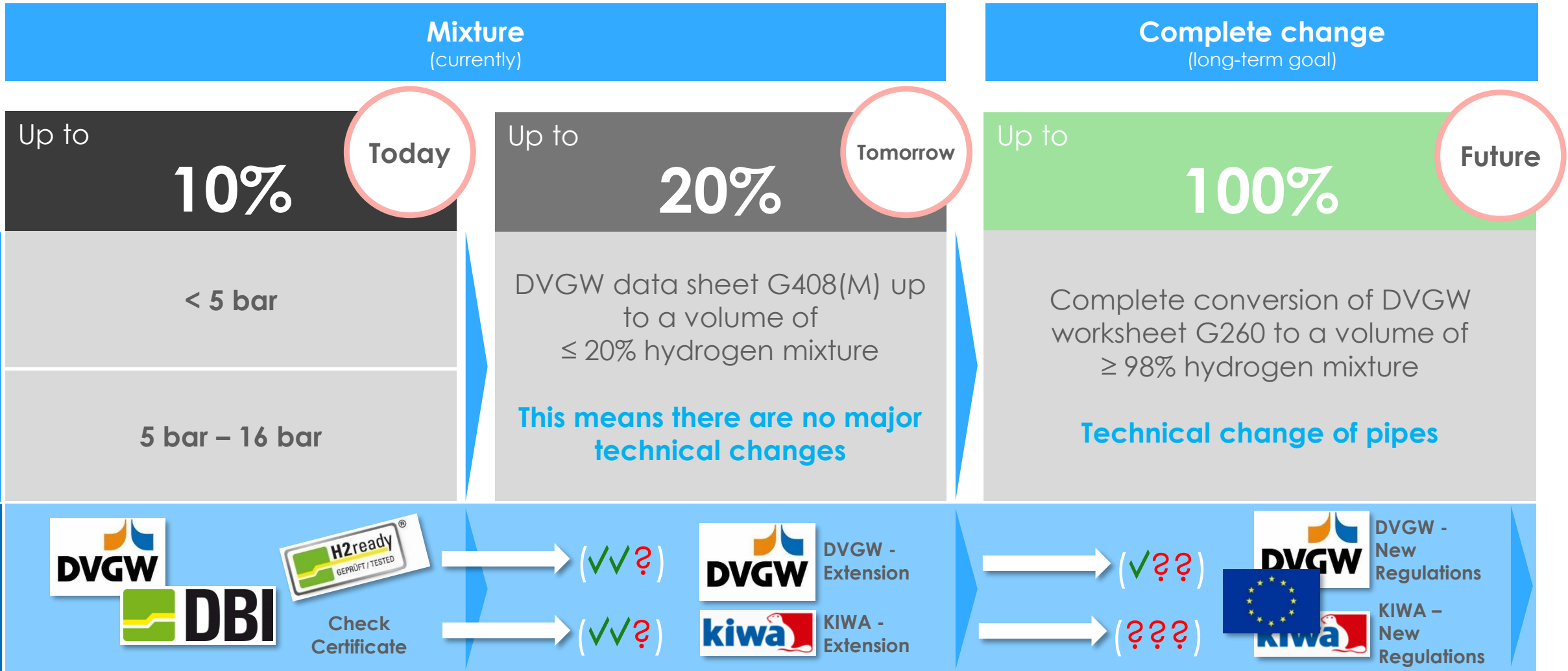


Production type leads to different effects on the carbon footprint



→ All types of hydrogen are chemically the same

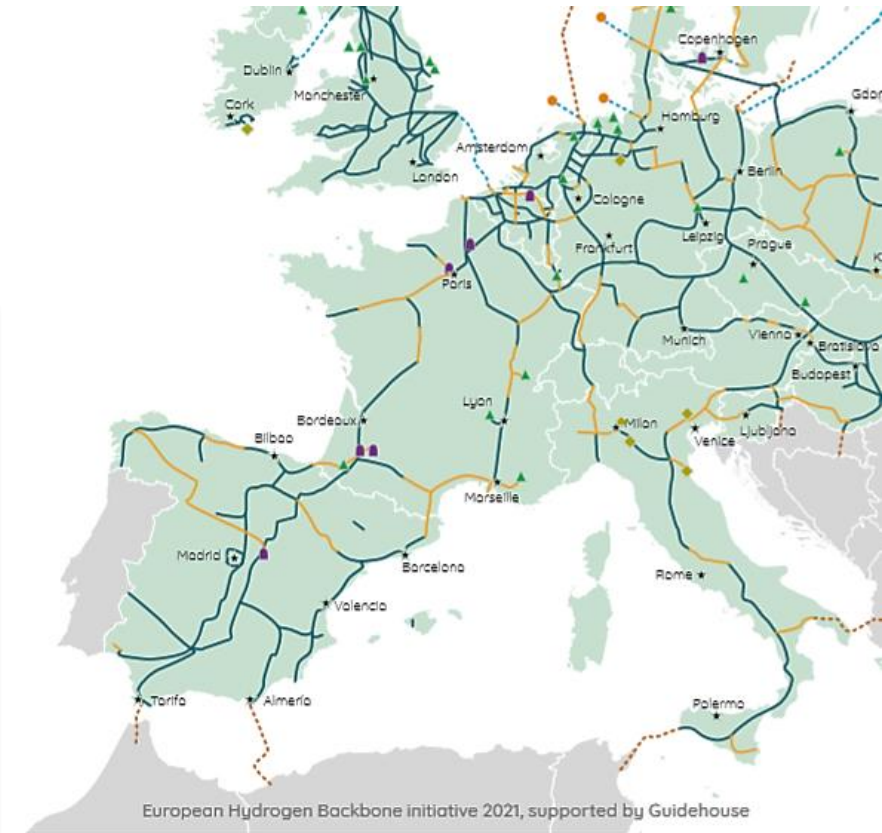
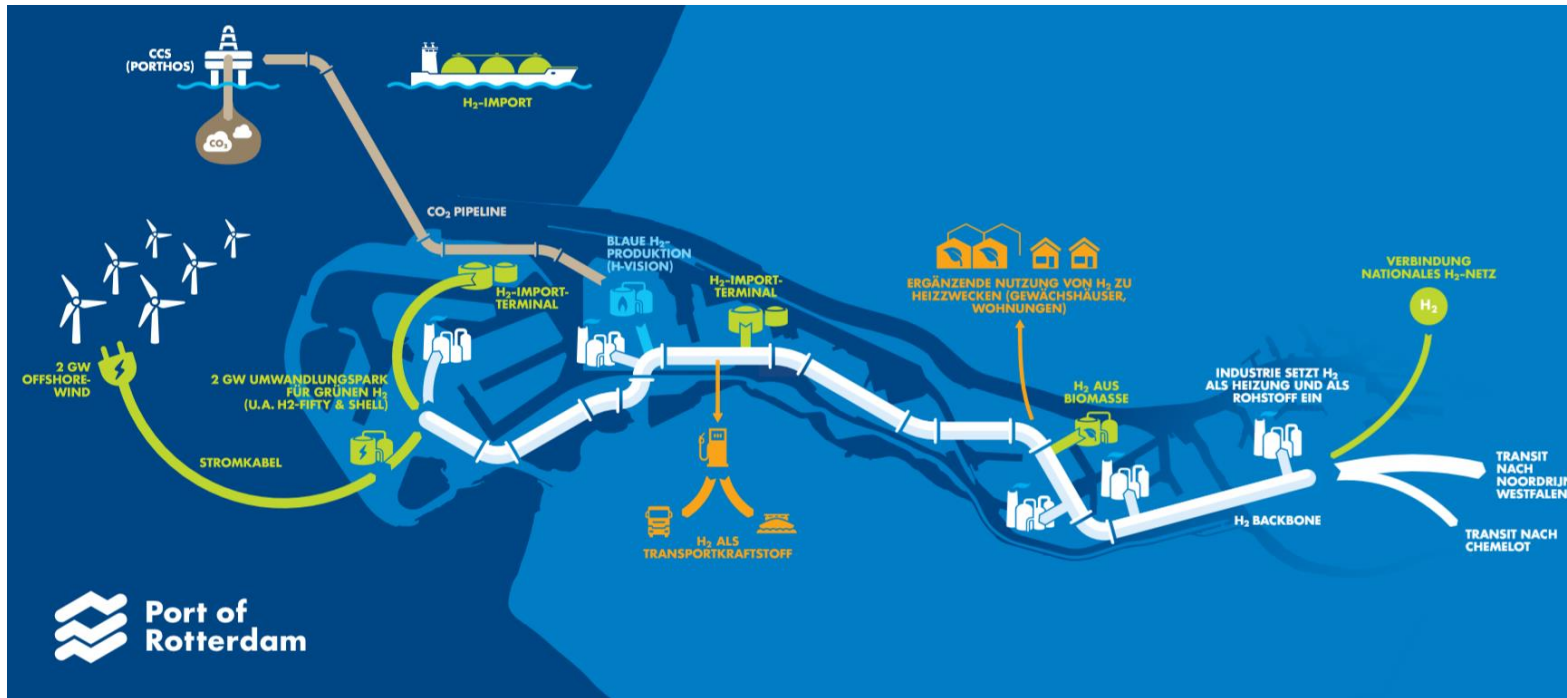
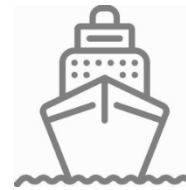
# Supply of hydrogen



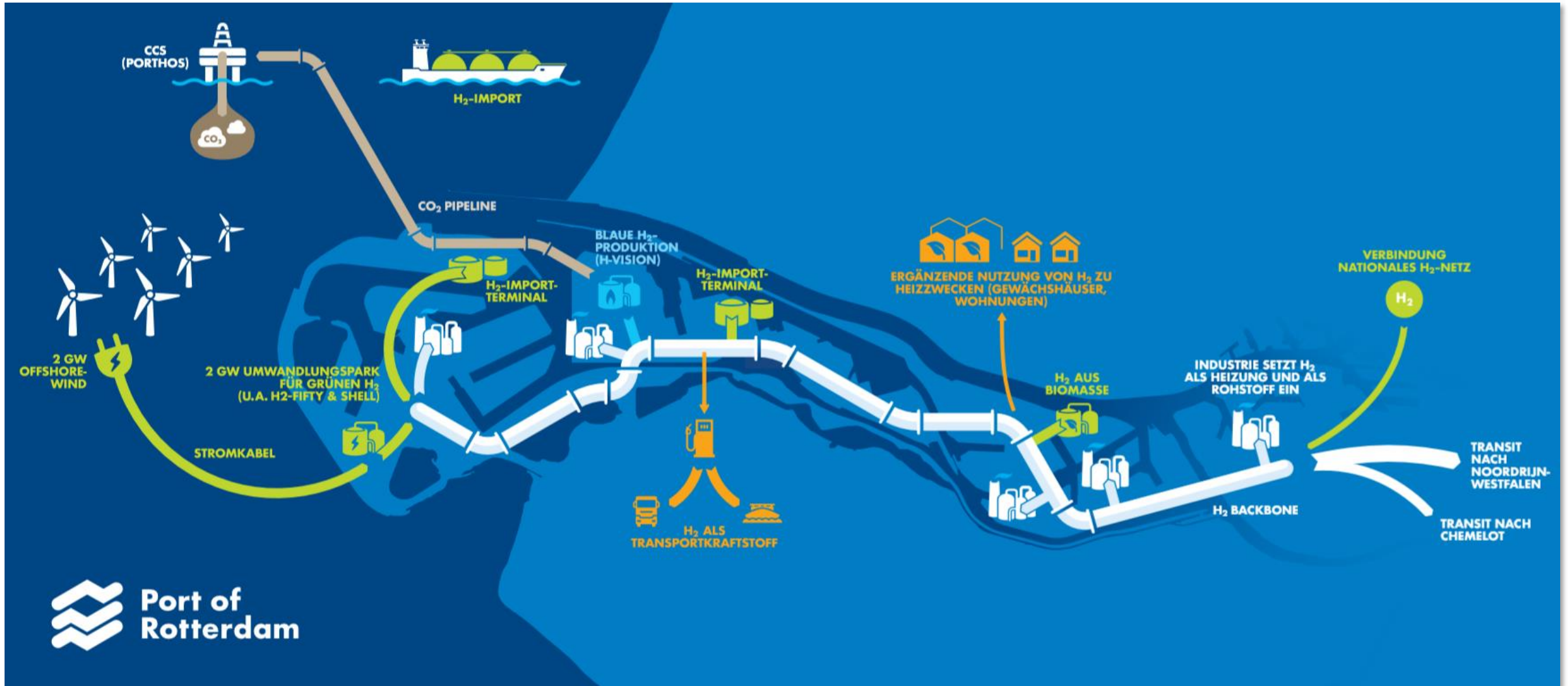
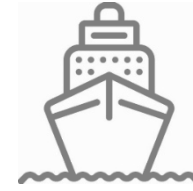
# Supply of hydrogen

- Procurement:
  - Hydrogen tankers
  - Hydrogen pipelines long-distance network
  - Hydrogen pipelines local network

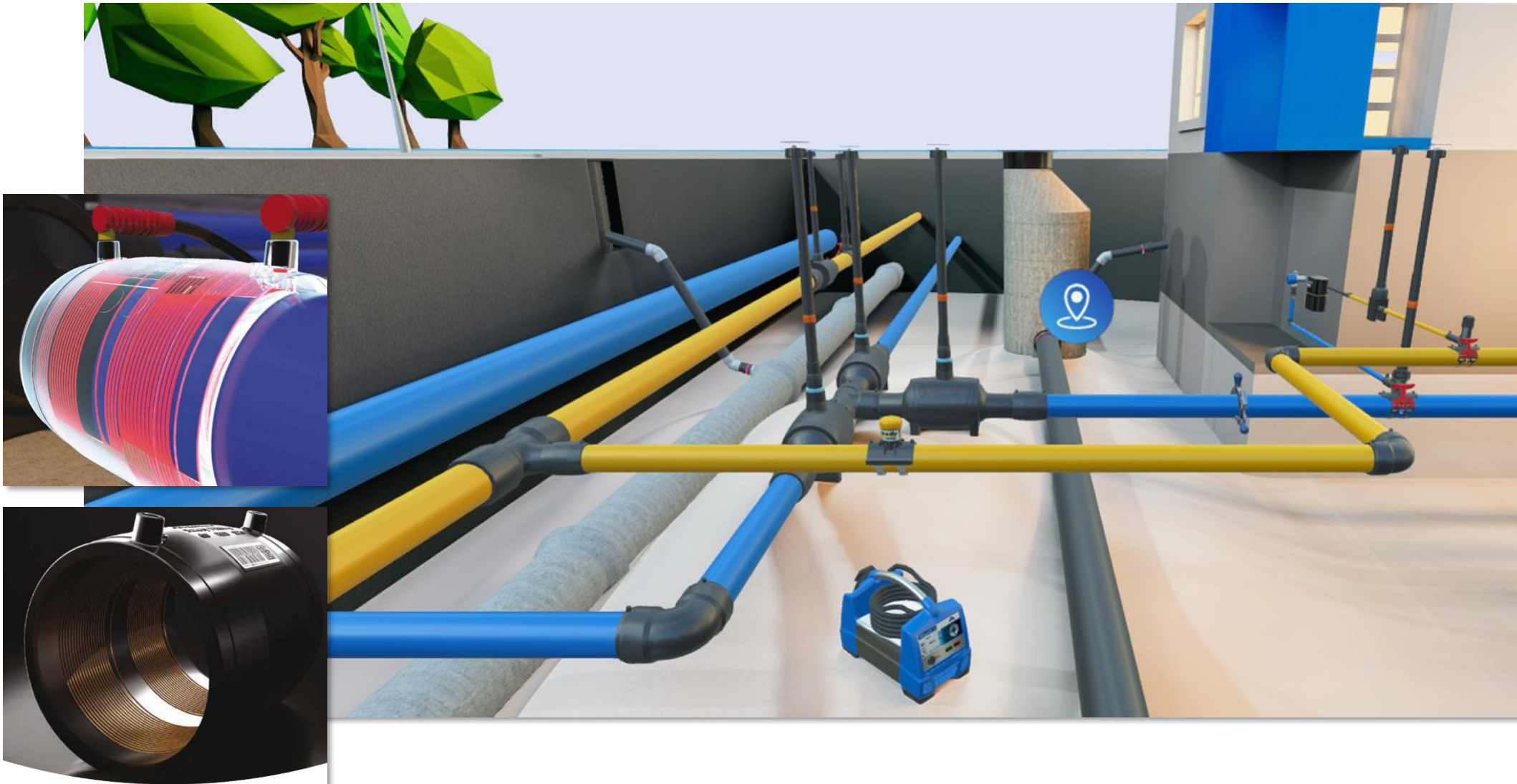
→ Initial input via ports is possible



# Supply of hydrogen



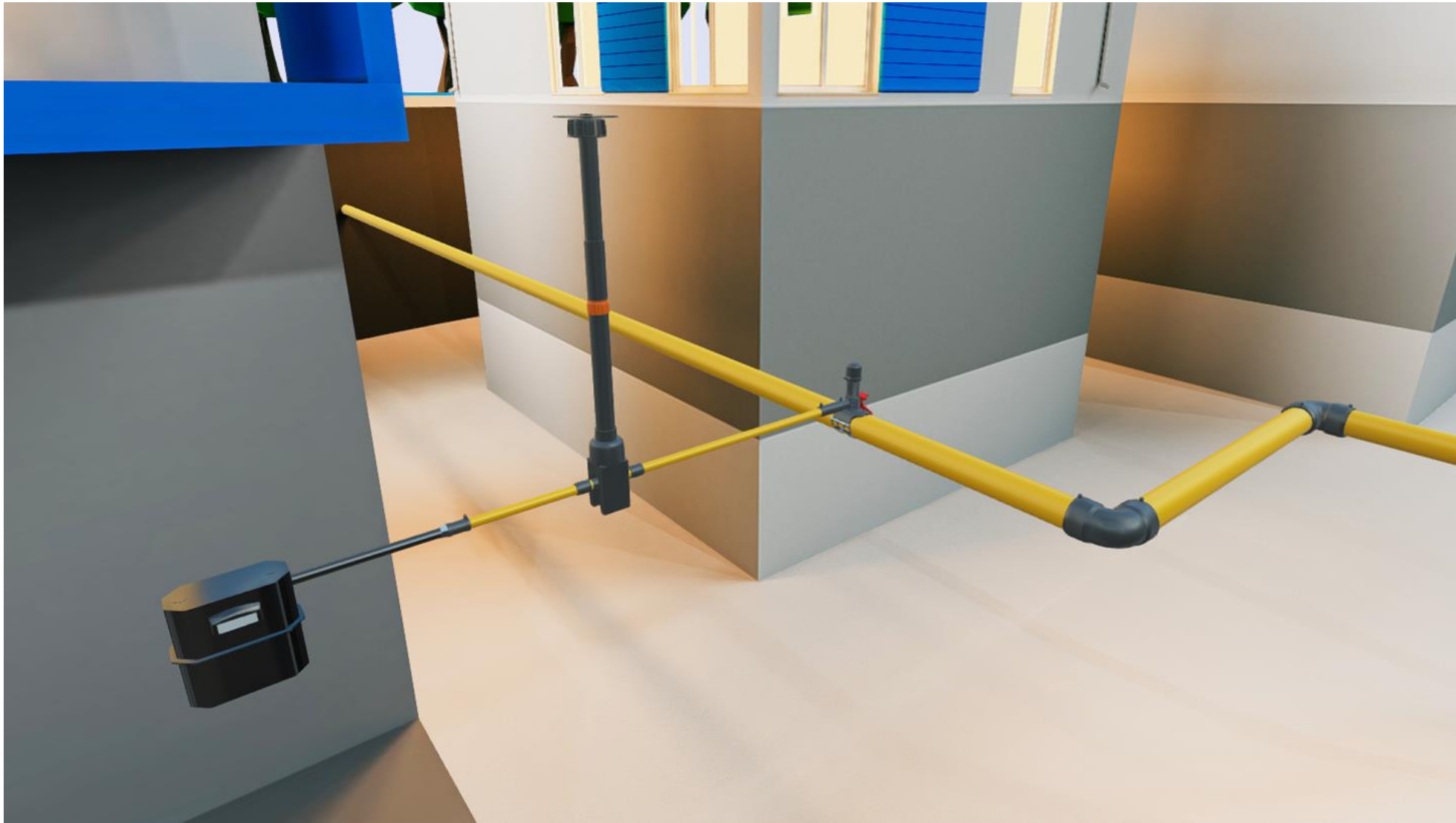
# Current infrastructure situation



# Current infrastructure situation



# Current infrastructure situation



# DBI “H2ready” pilot project



- DBI “Gut” Gas and Environmental Technology
  - DBI Gas and Environmental Technology GmbH emerged in 1991 from the gas technology departments of the German Fuel Institute Freiberg (DBI, Deutschen Brennstoffinstituts Freiberg) and is now based in Leipzig.



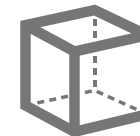
## ■ Terminology

- Permeation = describes the penetration of molecules through a solid medium (permeate)

- Calorific value: **Hydrogen**  
**Natural Gas**



120 MJ/kg  
39 MJ/kg



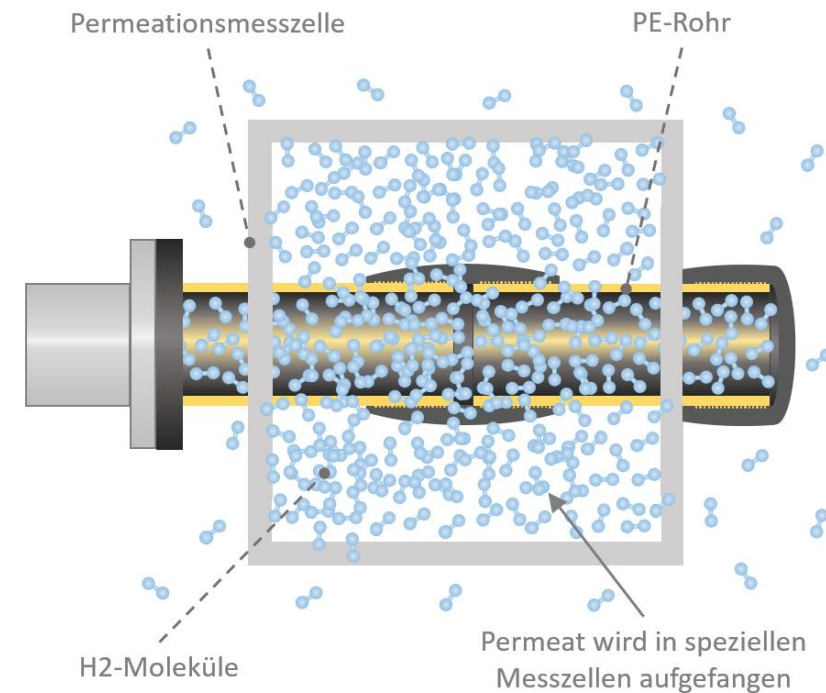
11 MJ/m<sup>3</sup>  
36 MJ/m<sup>3</sup>



# DBI "H2ready" pilot project



- Scope of testing
  - Leak test (permeation tests) of the FRIALEN components made of PE
  - 100% hydrogen
  - Up to MOP 10 bar
  - Hydrogen concentration measurements in permeation measuring cell



# DBI “H2ready” pilot project



- Tightness

- Tightness is based on VDI 2440. This provides for mass spectrometry with helium as a test method (later comparable with hydrogen).
- Additionally measured at temperatures from -20°C to +40°C
- In the H2ready test procedure, the test pressure of  $10^{-4}$  mbar /  $s^{-1}$  must not be exceeded. This applies to the total leakage rate at all points to be tested.



Coupler (type UB), Transition fittings PE/St, Ball valves and pressure tapping valves/fittings



# DBI "H2ready" pilot project

- Proof of the tests:

DBI-Gas- und Umwelttechnik GmbH  
DVGW - Prüflaboratorium Energie  
Koblenzer Straße 34, D-10269 Berlin

Prüfbericht Nr.: 8.200701010  
DVGW CERT - AZ.: 2V46.114.006  
Regulation Nr.:  
Datum: 11.01.2020

Art der Prüfung: Prüfung „H2ready“ des Systems PE Rühr mit PE-Nennweitenmaßstab

Zweck der Prüfung: Prüfung „H2ready“ zur Verifizierung der Dichtheitsprüfung von Systemen mit bis zu 100% Wasserstoff mit einem Prüfdruck bis 10 bar

Aufgaben: Allein durchgeführt durch: DBI-Gas- und Umwelttechnik GmbH  
Zweck: Nachweis der Dichtheitsprüfung von Systemen mit bis zu 100% Wasserstoff mit einem Prüfdruck bis 10 bar

Produktname: Allein durchgeführt durch: DBI-Gas- und Umwelttechnik GmbH  
Medium: Gas (H<sub>2</sub>)

Produkt: PE 100

Produktart: Gas- und Wasser-Abnehmerarmaturen für PE-AB-Zweckungen

Prüfbedingungen: Gas- und Wasser-Abnehmerarmaturen mit Betriebsdrücken bis 10 bar

Prüfverfahren: DBI-Gas- und Umwelttechnik GmbH  
DBI-Gas- und Umwelttechnik GmbH

Datum Auftrag: 11.01.2020

Prüftechniker: DBI-Gas- und Umwelttechnik GmbH

Prüfart: Prüfung

DVGW  
DVGW-Zentrum  
Leipzig

DBI-Gas- und Umwelttechnik GmbH  
Prüflaboratorium Energie

PRÜFZEICHENBESCHEINIGUNG  
zur Wasserstofftauglichkeit  
100 Vol.-% in Ergas

Das DVGW-Prüflaboratorium Energie der DBI - Gas- und Umwelttechnik GmbH bestätigt die erfolgreiche Prüfung von  
Kugelhähnen aus PE 100 (gemäß DVGW VP 302:2006),  
Typ FRIALEN Kugelhahn KH 0110

nach den Prüfbedingungen  
DBI-Gas- und Umwelttechnik GmbH  
Prüfungen an „H2ready“ für Abnehmerarmaturen aus PE 100

Die Ergebnisse der Prüfung sind in den nachfolgenden Prüfberichte dokumentiert.  
8.200701010 (10.01.2020)

Aufgrund dieser Prüfbescheinigung ist der Hersteller  
Allein durchgeführt durch:  
DBI-Gas- und Umwelttechnik GmbH  
(Übersengedelle 10, D-80339 München) (Deutschland)

berechtigt, die Druckbehälterprüfung (DBI) für die genannten Produkte in Übereinstimmung  
mit der Tabelle anzuwenden. Die Prüfbescheinigung ist gültig bis zum 05.05.2023.

H2ready  
GEPRÜFT / TESTED

DBI-Gas- und Umwelttechnik GmbH  
Leipzig

Prüfung am 14.01.2020

DBI - Gas- und Umwelttechnik GmbH  
Prüflaboratorium Energie

Allein durchgeführt durch:  
DBI-Gas- und Umwelttechnik GmbH  
(Übersengedelle 10, D-80339 München) (Deutschland)

Das Unternehmen bestätigt die Übereinstimmung der technischen Anforderungen an die genannten Prüfbedingungen mit den geltenden Vorschriften der DVGW-Regelwerke und der europäischen Normen. Die Einhaltung der technischen Anforderungen ist durch die erfolgreiche Durchführung der Druckbehälterprüfung bestätigt. Die Druckbehälterprüfung ist eine Prüfung der Druckbehälter nach der DVGW-Regelung VP 302:2006. Die Druckbehälterprüfung ist eine Prüfung der Druckbehälter nach der DVGW-Regelung VP 302:2006. Die Druckbehälterprüfung ist eine Prüfung der Druckbehälter nach der DVGW-Regelung VP 302:2006.

- ALIAXIS Hydrogen release:

- For FRIALEN fittings and valves, the scope of hydrogen [H<sub>2</sub>] has been extended.
- The FRIALEN products can be used for 100% hydrogen up to MOP 10 bar
- This is confirmed by "test certificates" from the DBI

**Note:** This is not a certificate, but an attestation for leak tightness. The regulations on the subject of hydrogen are only in the development phase through committees and working groups. There is currently no certification. The DBI is taking the lead here in cooperation with the DVGW and European regulations. The test certificates can be viewed on the website.

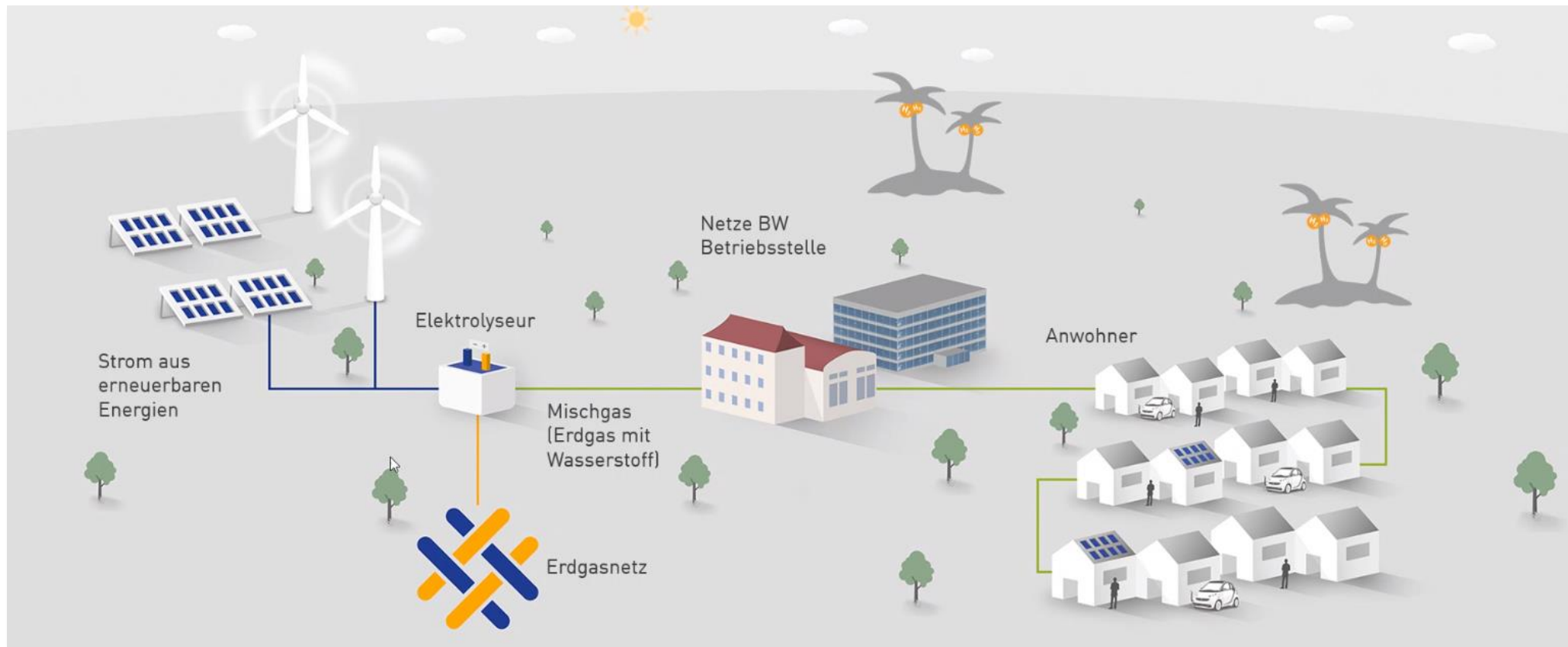


# “Hydrogen Island” pilot project by Netze BW



## Basic Information:

- Location: Öhringen close to Stuttgart
- Pilot project with 28 households from the 90s
- Supply with 30% hydrogen (mixed with natural gas)

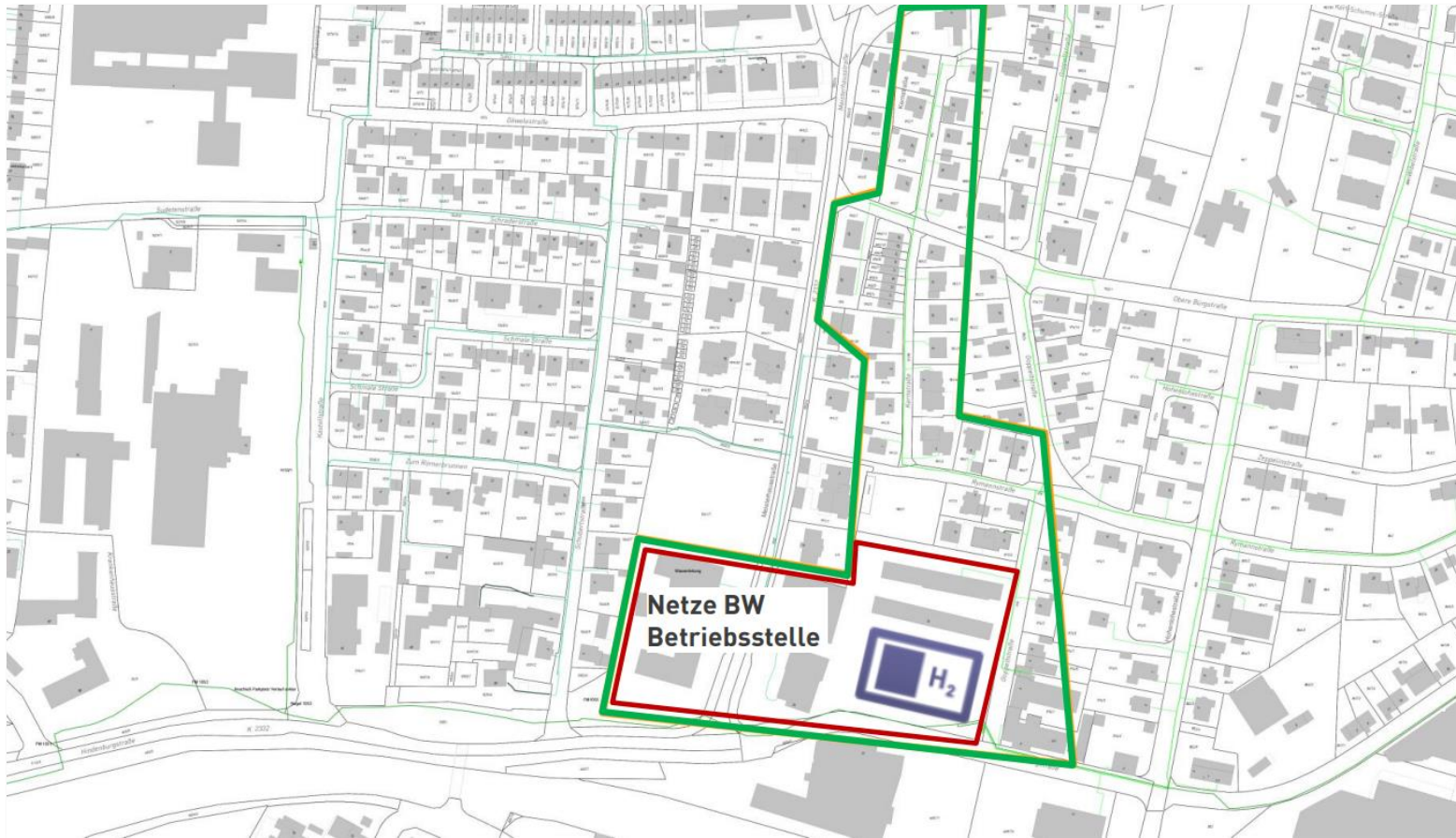


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# Conclusion



- Legal Requirements (✓)
  - DVGW
- Test Method (✓)
  - DBI
- Pilot project (✓)
  - Wasserstoff-Insel in Öhringen



## Aliaxis

We are "H<sub>2</sub>ready 100" and are available to position operators and planners with our expertise at any time!

- Statement of the plastic pipe association KRV:
  - Available publications show that pipes and fittings made of the materials **PE 80, PE 100, PE 100-RC and PA-12** are suitable for the transport of hydrogen.
  - No negative feedback with hydrogen contact is known for the suitability of elastomers and lubricants as used in fittings. However, scientific proof is still pending here.



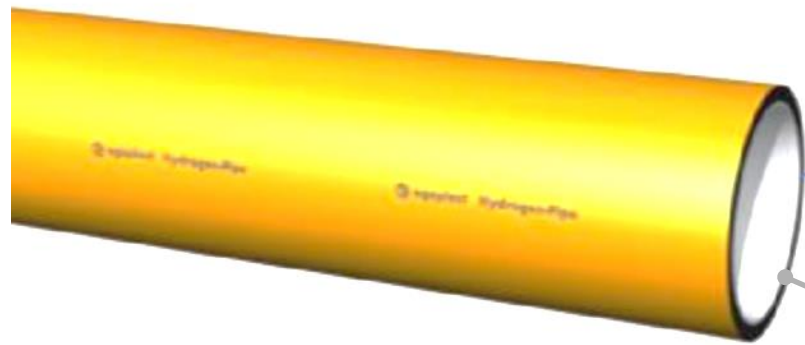
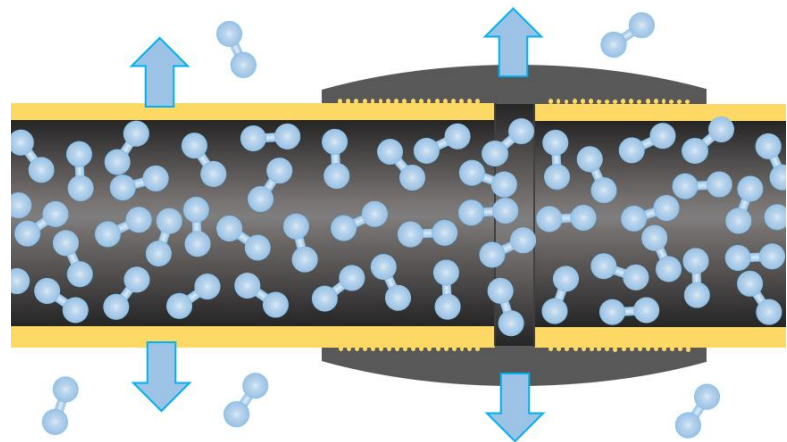
# Conclusion

Change

Towards  
**100%**



Visible steps of the pipe manufacturers and trends

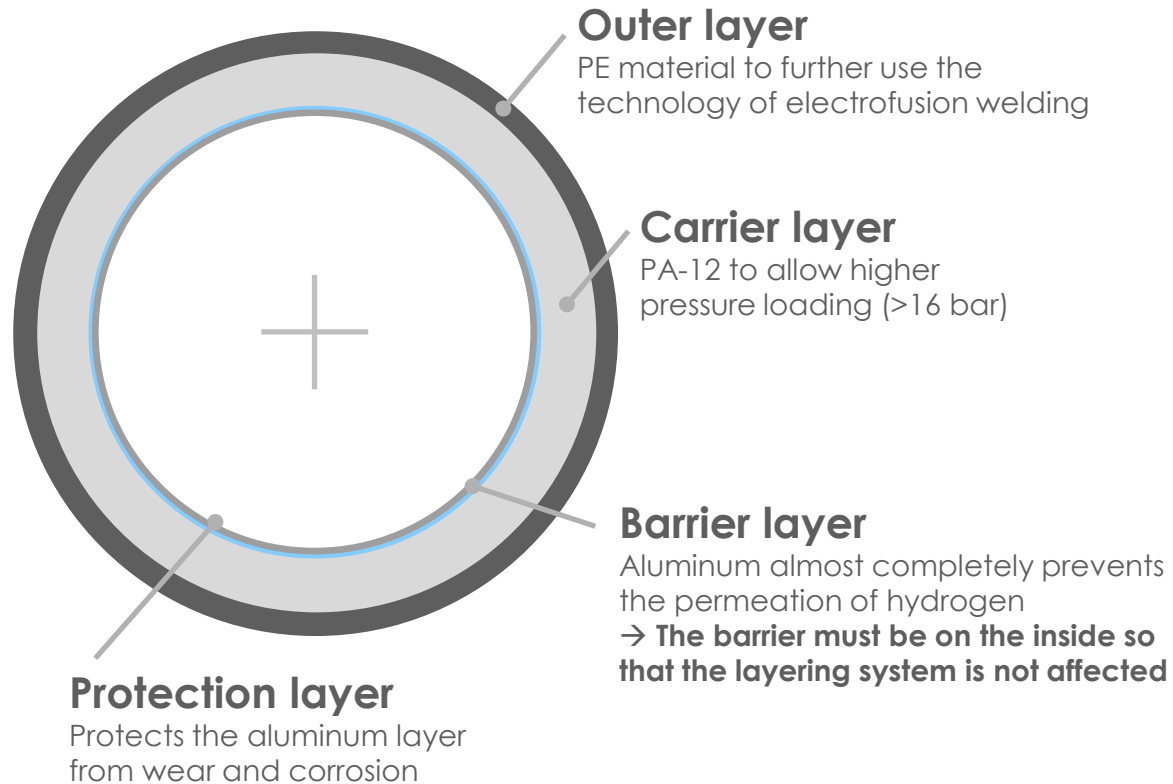


**Barrier layer**  
To reduce permeation  
(e.g. aluminum layer)

Material	Permeation coefficient CH <sub>4</sub> $\frac{cm^3 \cdot mm}{m^2 \cdot bar \cdot Tag}$	Permeation coefficient H <sub>2</sub> $\frac{cm^3 \cdot mm}{m^2 \cdot bar \cdot Tag}$	Ratio $\frac{P_{I, CH_4}}{P_{I, H_2}}$
PE100RC with PA 0.5mm	0.246	58.155	0.42%
PE100RC with PA 0.7mm	0.246	60.799	0.40%
PVC	0.417	119.483	0.35%
PE100RC with PA 0.2mm	0.892	61.491	1.45%
PE100	19.096	120.453	15.85%
PE100RC without PA	22.138	92.653	23.89%
PE100RC	22.928	107.624	21.30%
HexelOne	29.165	168.872	17.27%

# Conclusion

## Possible layered structure of pipes for H<sub>2</sub>:



Change

Towards  
**100%**



# Aliaxis

With Egeplast, we have a reliable pipe manufacturer as a partner who is taking the next step into the future of hydrogen together with us!

# Conclusion

Possible home solutions for H<sub>2</sub>  
Solar Hydrogen System



Change

Towards  
**100%**



**How much water is needed to produce one liter of hydrogen?**

- At least 9 kg of water!



**FRIALEN is**  
**“H<sub>2</sub>ready 100”**  
for the new age of  
energy with hydrogen

Dr.-Ing. Stefan Griesheimer  
Product Management Global

**ALIAxis Deutschland GmbH**  
Steinzeugstraße 50  
68229 Mannheim

Email: [stefan.griesheimer@alixis.com](mailto:stefan.griesheimer@alixis.com)





[aliaxis.com](http://aliaxis.com)