Molecules & Electrons in the Energy Transition – Role of the Natural Gas Infrastructure

New Dynamics in the natural gas sector in Europe

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The range of the challenge – Division of final energy consumption between electrons and molecules

2.5.4 Final Energy Consumption

BY FUEL

	2015						
Mtoe	Petroleum and Products	Gases	Electricity	Renewables	Derived Heat	Solid Fuels	Wastes, Non-Renewable
EU-28	429.6	236.3	235.7	86.8	45.9	46.3	3.5
Share (%)	39.6 %	21.8 %	21.7 %	8.0 %	4.2 %	4.3 %	0.3 %

- **Today: electrons about 20%, molecules above 70%** (International: ~80%)
- **In year 2050: ?**
  - **even in high electrification scenarios 40-60% still molecules**

Corresponding pairs of strengths and weaknesses

Pair 1: Balancing

- The electricity grid need constant balancing of production and consumption, that will increase over time as the shares of RES gets higher.
- Molecule distribution systems are inherently robust and is not effected in that instant way by differences in rate of production and consumption.

Pair 2: Storage

- Electricity have a lack of storage options in significant time frames, volumes, energy density and costs.
- Molecules are easy to store.

Pair 3: Renewable Energy

- Electrons are relatively easy and sheep to produce in a renewable manner.
- It requires more complex systems to produce renewable molecules and is limited to natural resources (if you do not consider Power-to-Gas)

Pair 4: Transport Capacities

- The infrastructure for electricity is encountering it limitations already at lower shares of RES in its 20% of the final energy consumption.
- The infrastructure for molecules is already fitting the current demand. As the requirements for renewables grows, capacity will be freed, that could potentially be used.

Gas – Clean, Low cost applications and Powerful existing infrastructure

Clean Burning + gradually greener

> Natural Gas is already low CO2

> Biomethane is state of the art technology

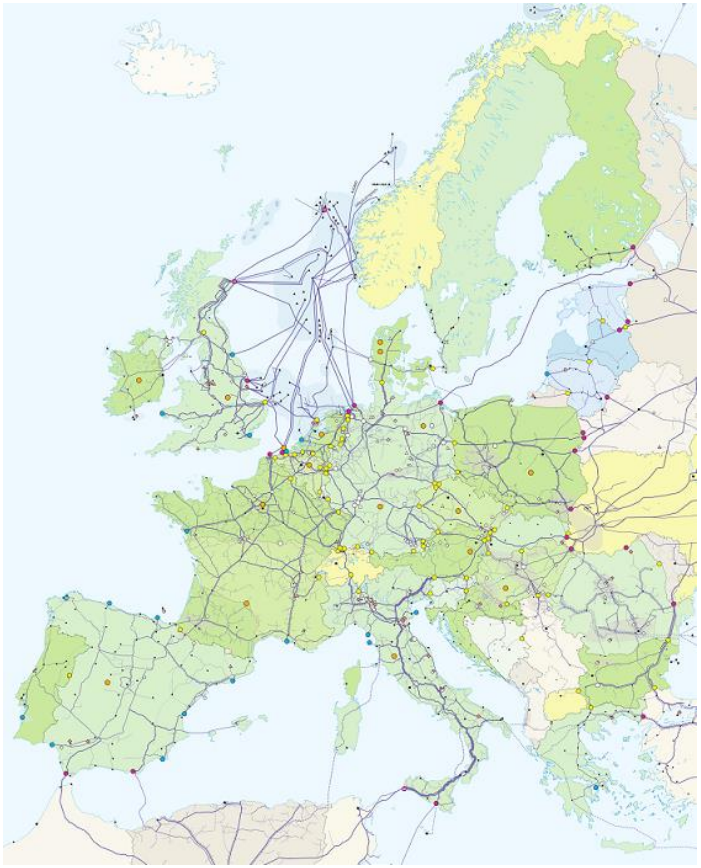
Transmission + distribution network EU

> 2.2 million km

Underground storage EU

~100 billion m^3

~25% EU annual consumption of about 4000 TWh worth of energy



Source: ENTSOG.EU

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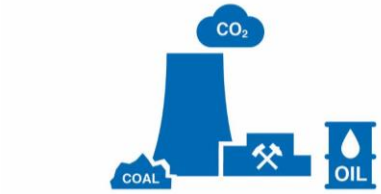
Natural Gas Sector in an integrated approach to the energy system according to “DVGW Energie Impuls”

	Power Sector	Heat Sector	Transport Sector
Fuel Switch			Replacement of CO_2 intensive energy sources like coal and oil by gas
Content Switch			Continuous increase of CO_2 neutral or CO_2 free gases
Modal Switch			Sectoral coupling of infrastructures; efficient integrated system

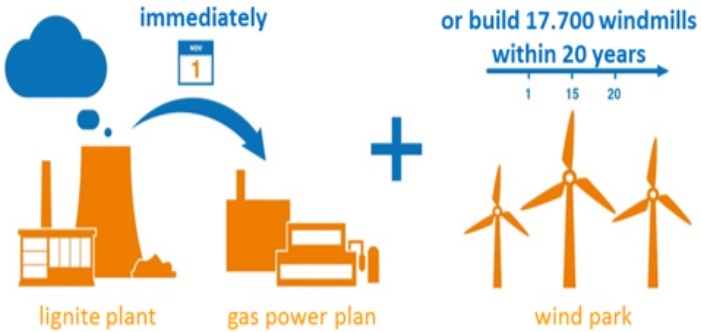
Source: DVGW

CO_2 reductions of the entire fuel switch in Germany – potential by natural gas alone

	Power Sector	Heat Sector	Transport Sector
Fuel Switch	lignite → gas: -70 coal → gas: -54 -124	oil → gas households: -14 industry: -16 -30	diesel → gas: -23

TOTAL
CO_2 reduction:
-177 Million t

Savings are 38% of the power emissions



Current German energy emissions: 795.5 Million t:		
Power: 326.5	Heat: 304.0	Transport: 165.0

DVGW

Source: DVGW

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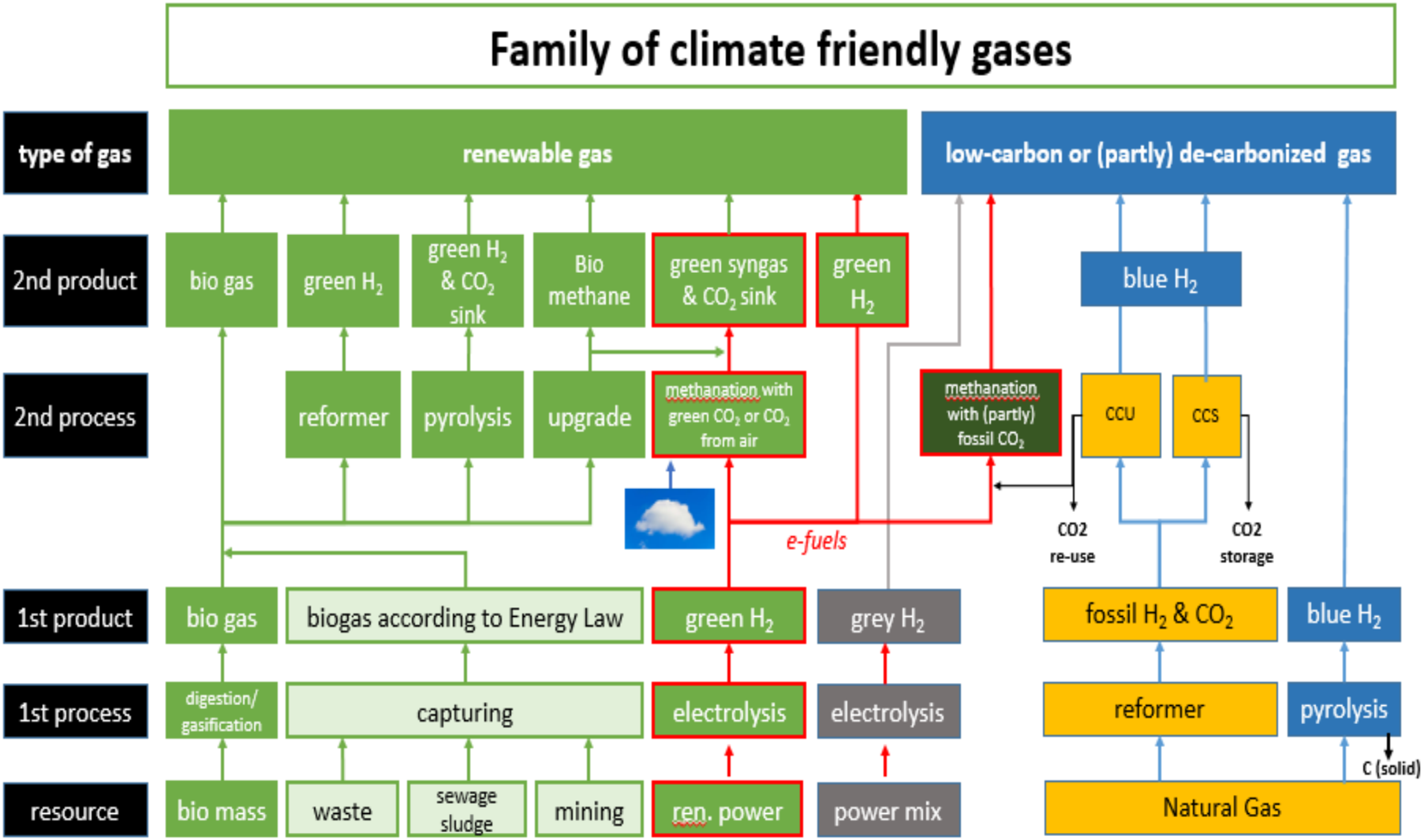
Content Switch: The future of gas is not „Mono Gas“ but „Multi Gas“



Source: DVGW

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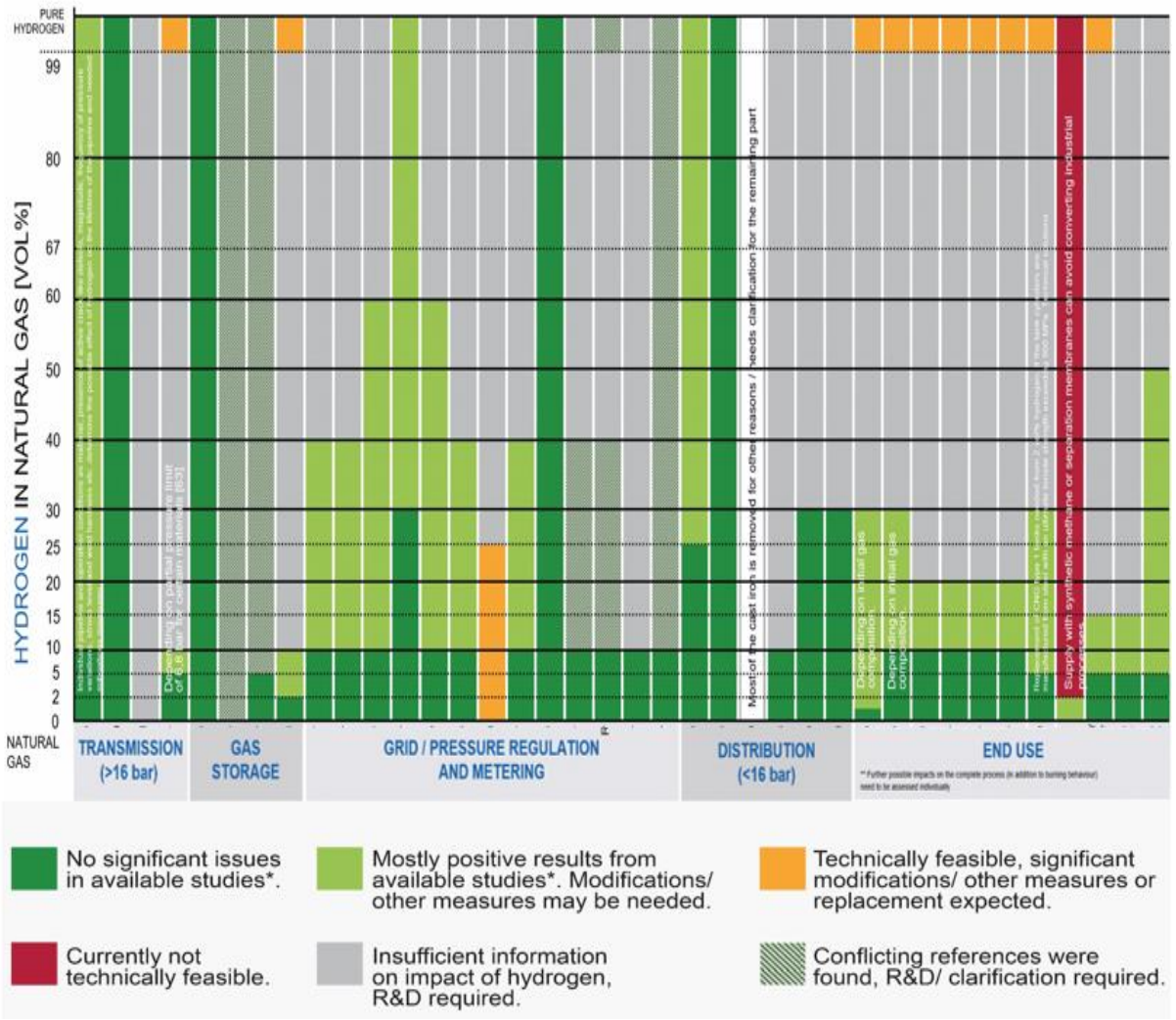
Current Status – Hydrogen Admission Levels in the Natural Gas infrastructure

- **Major elements** of the gas transmission, storage and distribution infrastructure and residential gas appliances are expected to be able to accept **10 vol.-% H2 without modification**
- **Some networks and residential appliances** are already being operated with **20 vol.-%** of hydrogen [62].
- **Major elements** of the infrastructure and residential appliances are **expected** to be able to accept **20 vol.-% H2 with modification***.
- **Higher concentrations** (> 20 vol.-% H2) can be reached **through R&D** by further measures or replacement.



Source: www.marcogaz.org/publications-1/documents/hydrogen-infographic/

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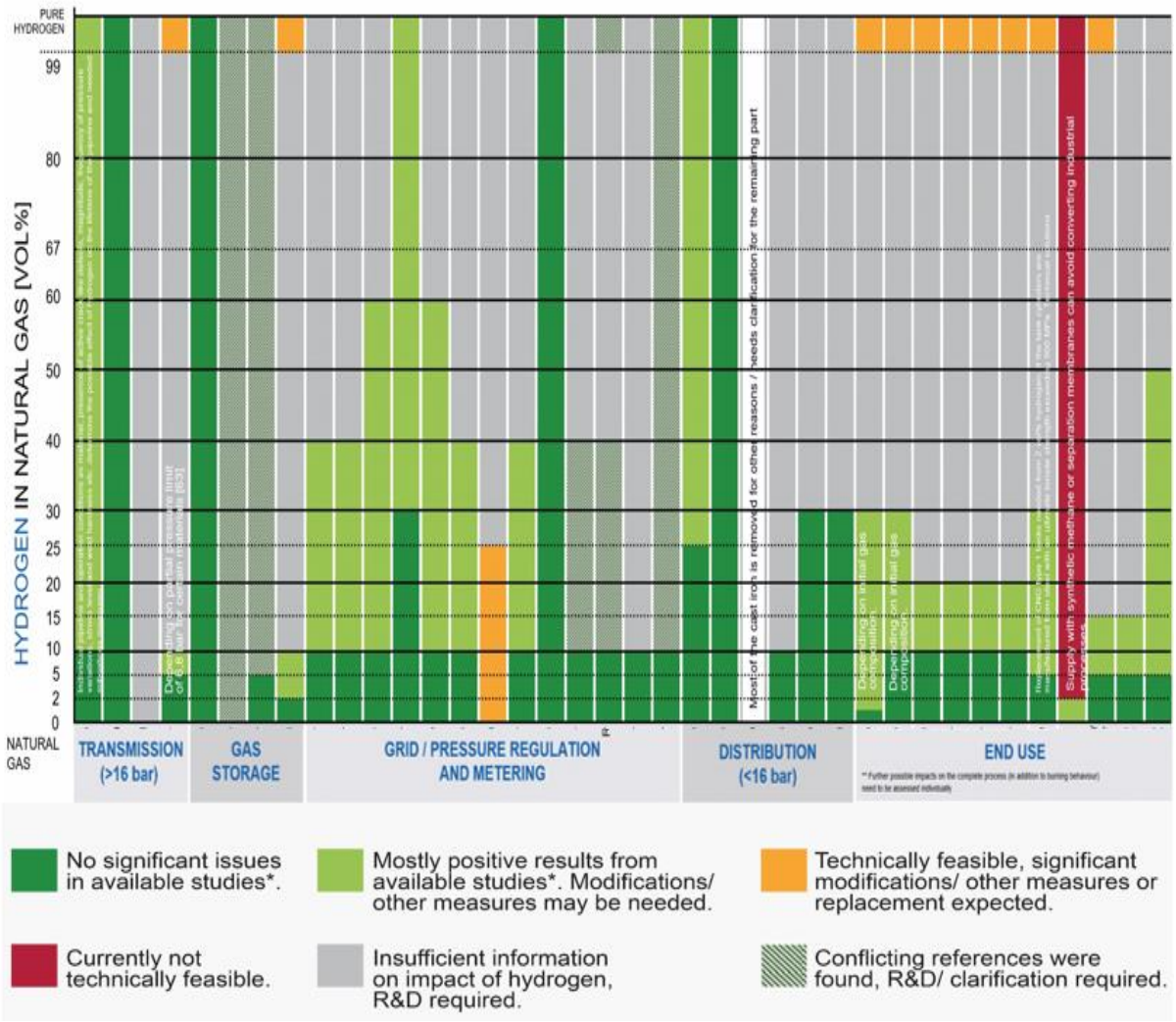
Current Status – Hydrogen Admission Levels in the Natural Gas infrastructure

- **Many industrial processes** (except feedstock) are expected to be able to accept **5 vol.-% H2 without modification**.
- Current **power plant gas turbines**, **industries** using natural gas as feedstock and also **CNG steel tanks** are assessed to be sensitive to even small quantities of hydrogen and **need further R&D/mitigation measures** when planning to convey higher hydrogen concentrations.
- **Thermoprocessing** equipment (such as furnaces and burners) are expected to be able to accept **15 vol.-% H2** with **modifications***.
- **Higher concentrations** (> 15 vol.-% H2) can be tolerated **through R&D**, further measures or replacement.



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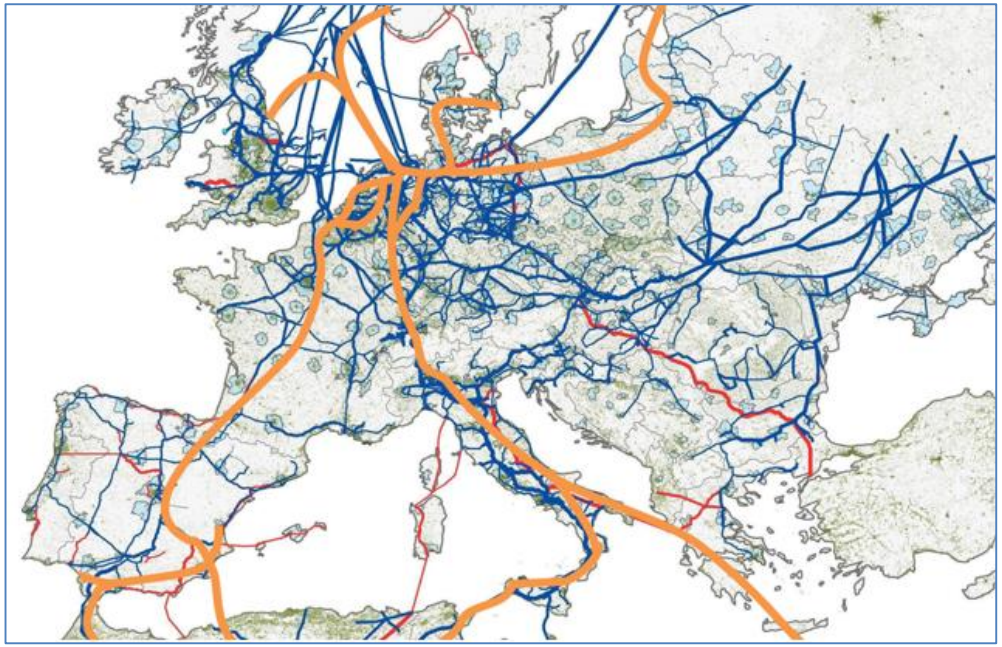
Ideas for a European „Hydrogen Backbone“ – presented at „North Sea Wind meets Gas 2019“

- It is suggested that Europe utilise existing Natural Gas Infrastructure to create a „Hydrogen Backbone“
- Existing under ground storage corresponds to: ~ 900 TWh
- Underground salt caverns can be used for H2 Storage and salt formations can be found throughout Europe



Source: Prof. Dr. Ad van Wijk, TU Delft, “North Sea Wind meets Gas”, October 2019

- In the study, focus was put on connection between Europe and Africa:
  - The main part of the hydrogen backbone infrastructure consists of re-used natural gas transport pipelines with new compressors.

  -> Similar approaches could be investigated with other bordering regions

Summary

- „Molecules“ is the largest part of final energy consumption – and it will remain so +/-
- De-carbonisation of the molecules is the biggest challenge and influencer on natural gas sector
- The existing natural gas infrastructure is a key asset with corresponding „Strengths & Weaknesses“ to the power system
- We are going from a „Mono Gas System“ to a „Multi Gas System“
- How to manage Hydrogen in coherence with CH4 is the key questions for the future

Thank you for your attention !

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