Hydrogen in Natural Gas Pipelines
GPPS Forum 2020

Dr. Thomas Hüwener
Open Grid Europe
Open Grid Europe at a glance

- One of Europe’s leading natural gas transmission companies
- Responsible for the operation, control, expansion and marketing of the OGE pipeline network
- Approx. 12,000 km of pipeline
- 27 compressor stations with 98 compressor units
- 17 border crossing points and approx. 1,000 exit points
- More than 450 German and international customers
What drives us?

Internationally agreed climate protection targets extremely challenging

Immediate action is required!

A number of studies have come to the following conclusions:

- **Sector coupling is a key element** in efforts to meet the climate goals.
- **No preference should be given to any specific technologies**, instead there should be real competition between different CO$_2$ avoidance options.
- "**All-electric" is too expensive."

German Ministry of Economics and Energy confirms gas as a key pillar of the turnaround in energy (Oct. 2019)
In an average week in September...

Biomass and hydropower provide "green" base load on a continuous basis.
…the sun usually shines during the day…

Solar power provides energy at regular intervals, but the energy quantities depend on weather conditions.
...and the wind blows in a totally random way

Wind power cannot be predicted in terms of quantity and time.
Electricity from renewable sources offers a volatile and unpredictable spectrum
The gap between consumption and available electricity from renewable sources remains.

The gap to relatively regular consumption varies in size.
Today, conventional electricity closes this gap
The big part of the transformation is still to come

If conventional power plants are shut down, large energy quantities must be provided in a climate-neutral way and in line with demand.

grey today, green tomorrow

If conventional power plants are shut down, large energy quantities must be provided in a climate-neutral way and in line with demand.
Dual energy carrier system for the total energy consumption in all sectors required

Source: Arbeitsgemeinschaft Energiebilanzen for 2017 (08/2018)

Dr. Thomas Hüwener | GPPS Forum Zürich | 15.01.2020
Dual energy carrier system for the total energy consumption in all sectors required

“Electrons“
2798 TWh

Renewable electricity
1.078 TWh

Market

System stability

“Molecules“
10.719 TWh

Other renewables
1.190 TWh

Source: eurostat: Energy balance flow for European Union (28 countries) 2017

Dr. Thomas Hüwener | GPPS Forum Zürich | 15.01.2020
Coupling renewable energy production and consumption — A major challenge for the energy transition

- calculable base load
- production = consumption
- consumption close to production facility
- few storage capacities required

- volatile energy production
- production ≠ consumption
- consumption far from production facility
- high storage capacities required
The gas infrastructure is essential for the security of energy supply in Germany.

Transport capacities from north to south

Electricity: 18GW

Gas: 75 GW

Total German storage capacities

Gas: 3 months

Electricity: 36 minutes

Quelle: Frontier Economis, Grober Vergleich der bestehenden Strom- und Gastransportkapazitäten von Nord- nach Süddeutschland

Quelle: DVGW

Dr. Thomas Hüwener | GPPS Forum Zürich | 15.01.2020
One gas pipeline (ø 1,20 m) transports as much energy as eight high-voltage pylons (3 GW each)

- No significant interference with the landscape
- Cost-efficient, because infrastructure is available
- Large storage potential within the network
Long-term vision of the gas infrastructure

PYR = Pyrolysis
SMR = Steam reforming
ATR = Autothermal Reformer
CCU = Carbon Capture & Usage
CCS = Carbon Capture & Storage
MET = Methanation
IP = Interconnection Point to adjacent system operators
NCP = Network Connection Point to distribution network

Dr. Thomas Hüwener | GPPS Forum Zürich | 15.01.2020
OGE is pushing ahead with green projects
- Make Power to Gas fit for the energy transition by 2030 - system integration and size growth must begin today

- Our project region in the southern Emsland: Intersection of suitable power and gas lines

Planned hydrogen infrastructure
- reclassified natural gas pipeline
- potential extension
- to be newly built
Green hydrogen and decarbonisation on an industrial scale
Natural gas supply

CO₂ storage

Transportation in gas grid

Hydrogen production

NRW

Dr. Thomas Hüwener | GPPS Forum Zürich | 15.01.2020

Facts & Figures:

- 1 GW Reformer
- 8.6 TWh Energy per year (approx. 450,000 households)
- CO₂ reduction of 1.9 Mio. t CO₂ per year (approx. 680,000 cars)
Getting prepared – How much H₂ can the gas grid take?

H₂ Scenarios

10% BLENDING
100% HYDROGEN
EXISTING PIPES
NEW BUILT PIPES

Quality Measurement
Piping Materials and Welds
Valves and Piping Components
Gas Turbines
Seals
Compressors

Dr. Thomas Hüwener | GPPS Forum Zürich | 15.01.2020
What about…? We need answers!

- Fuel gas system?
- Rotordynamics?
- Maintenance intervals?
- Risk analysis?
- Start performance?
- Gas- and flange seal?
- Materials?
- Gas leakage?
- Instrumentation?
- Gas detection?
- Auxiliary components?
- Combustion and monitoring?
- CE-certification?
- Ex-area and -protection?
- Start performance?
- Electronic drives?
- Ventilation concept?
- Mapping?
- Machine protection (surge control/ regulation)?
- Rotation concept?
- Emissions?
Hydrogen Compatibility in the fleet has to be clarified

- Existing fleet OGE, 78 gas turbine, ≈ 2/3 GE and Solar
- Results of first tests with natural gas-H$_2$-mixtures → 4-5% possible
- Test in laboratory with ca. 10% H$_2$

→ H$_2$-“Compatibility Gap“ to be closed
In peak times of wind energy production electricity grids are not capable to transport all produced renewable energy.

New e-compressor (13,6 MW) is key enabler to use non-integratable excess power:

- Renewable electricity profiles flattened
- Regional electricity grid expansion reduced
- Methane emissions of CS reduced
We shape energy supply.
Today and in tomorrow’s energy mix.

- Climate targets can only be achieved through sector coupling, power-to-gas and hydrogen
- Gas grids are an indispensable part of the energy transition
- Open Grid Europe actively promotes "green" projects and hydrogen transportation
- We must act now to meet the climate protection goals of the future
- Research on H₂-Compatibility in all gas grid components (covering compressors and turbines) to be done