Pathways for ramping-up hydrogen into the natural gas system

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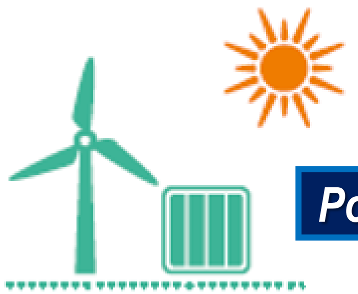
Content

Introduction

Renewable hydrogen applications

- Energy system in transition → net zero
  - Energy carriers structure and innovative applications

- Preferred fields of application:
  - metallurgical and chemical industry
  - heavy duty transport
  - peak power generation



fluctuating electricity generation from renewable energy

Power –to-Gas

Feedstock in industry applications

Fuel in transport means (direct or intermediate use)

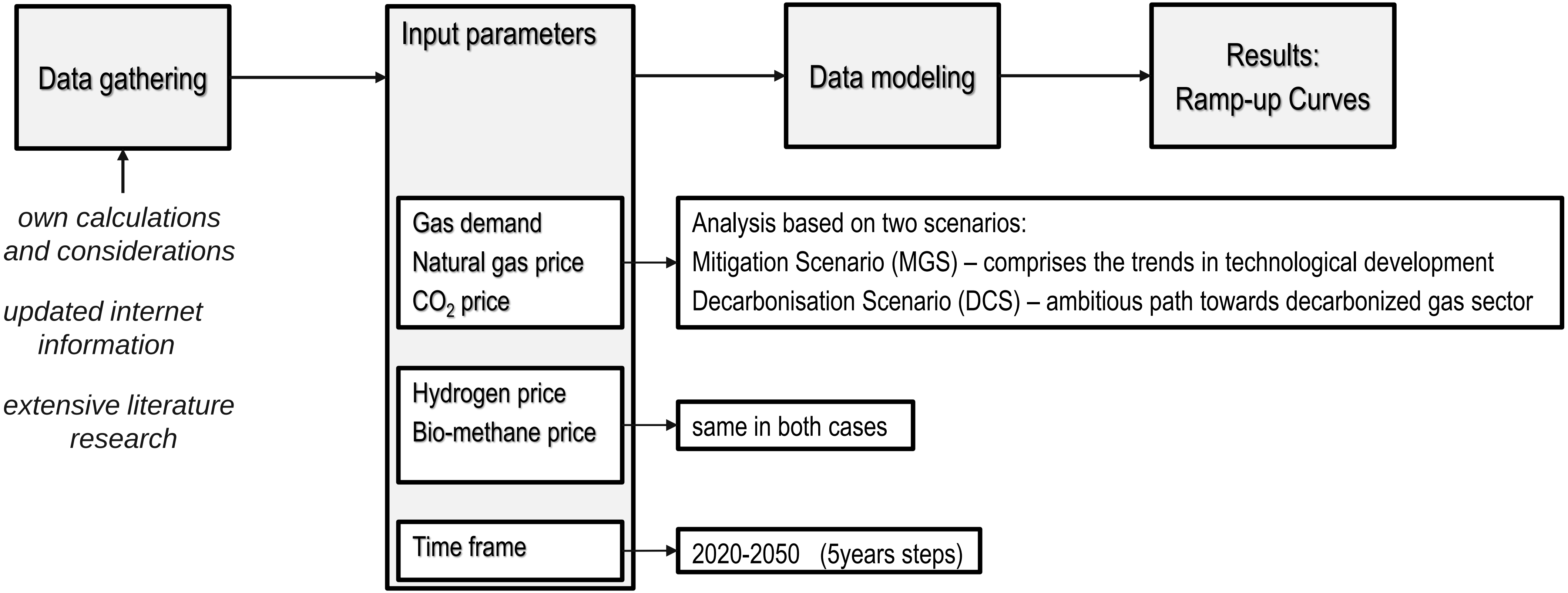
Energy carrier for electricity and heat production

- Benefits of blending:
  - reduction of greenhouse gas emissions (greening natural gas)
  - storage and transport of hydrogen
  - reliable source of demand
  - can provide learnings and incremental changes towards 100% hydrogen network

It's not so much about blending as it is about increasing H2 production.
→ For instance, 15 % H_2 in the gas system might be used directly (e.g.at industrial sites) or blended into natural gas grid.

Methodology

Data set and scenarios definition



Limitations: - application to dedicated direct use of hydrogen
- requirements of end-use appliances

Specific costs

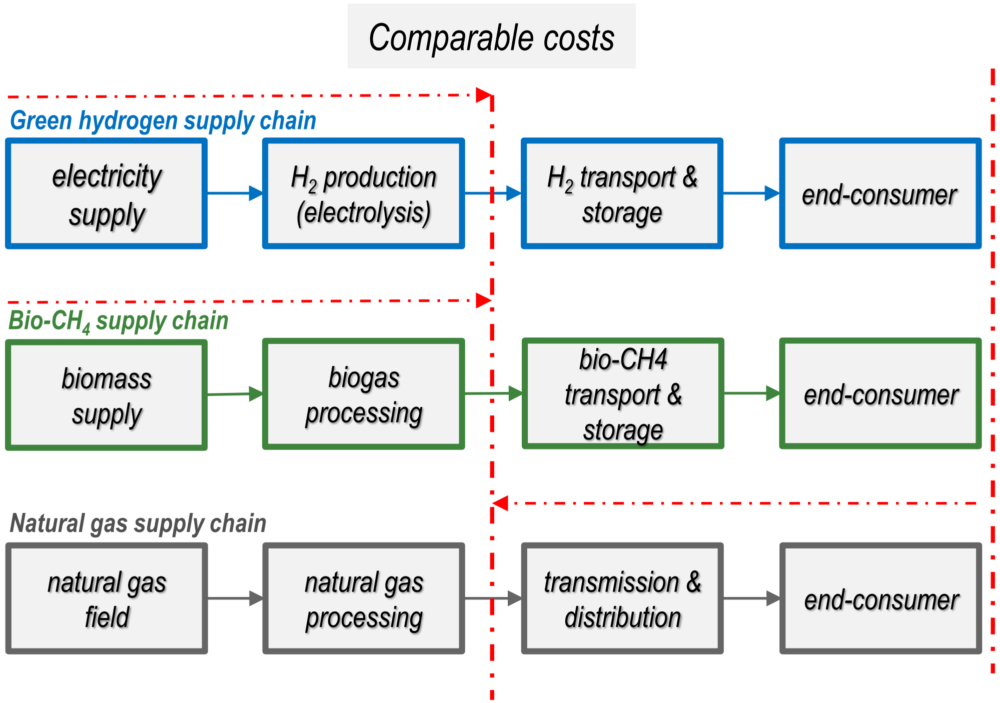
Natural gas, hydrogen, bio methane, carbon emissions

- Comparison of the production costs of hydrogen and bio-methane with the energy share of the price of natural gas and the related carbon emissions

- **Production costs of hydrogen:**
  - CAPEX (size of plants considered 1-100 MW)
  - OPEX (electricity cost)

- **Production costs of bio-methane:**
  - CAPEX (size of plants considered 50 – 1000 Nm^3/h)
  - OPEX (substrate costs)

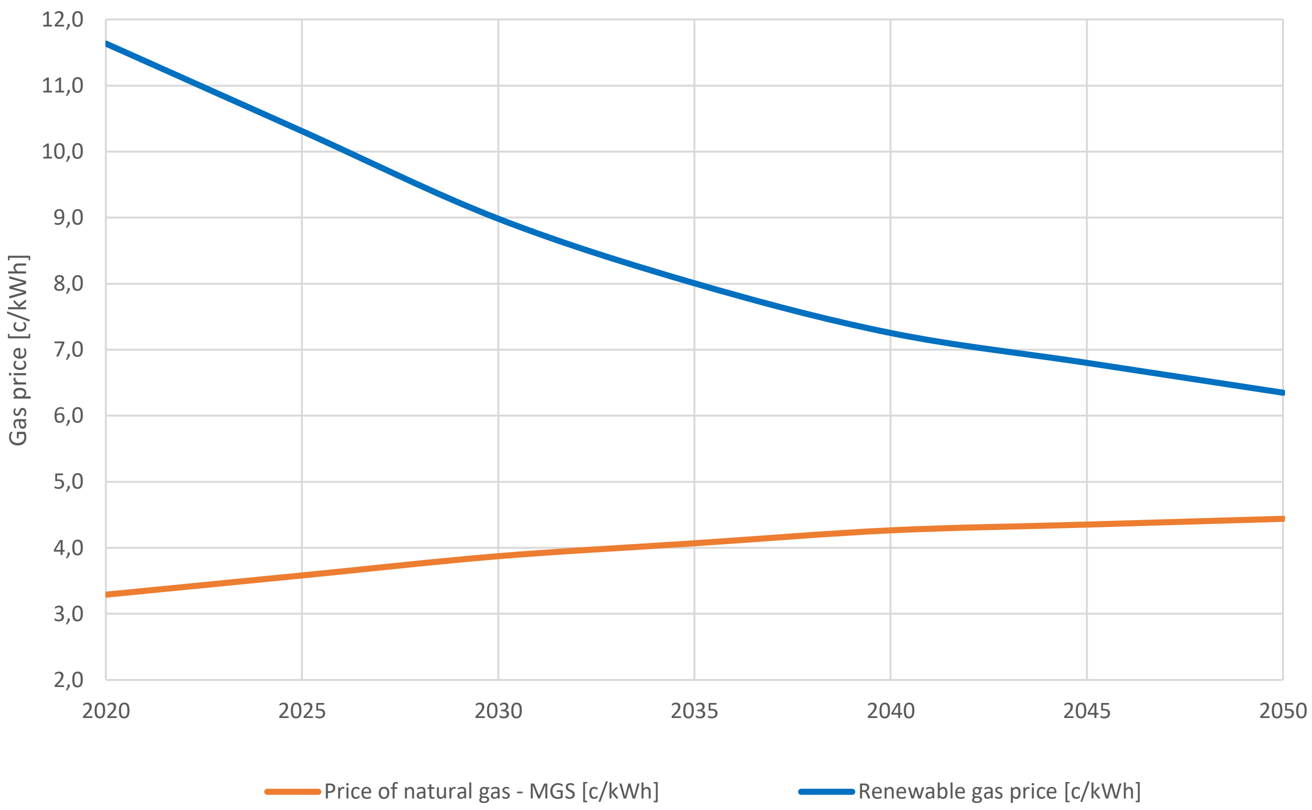
- **Costs for natural gas:**
  - Energy share of the price (~50%) + CO_2 price



Specific costs

Natural gas, hydrogen, bio methane, carbon emissions

- **Development of H2 costs:**
  - expected decrease based on learning curves, technology development and production scaling-up effects
- **Development of bio-CH4 costs:**
  - Expected decrease based on scaling-up and plant size
- **Development of natural gas costs:**
  - CO_2 costs – main supporting mechanism fronting cost-competitivness against H_2



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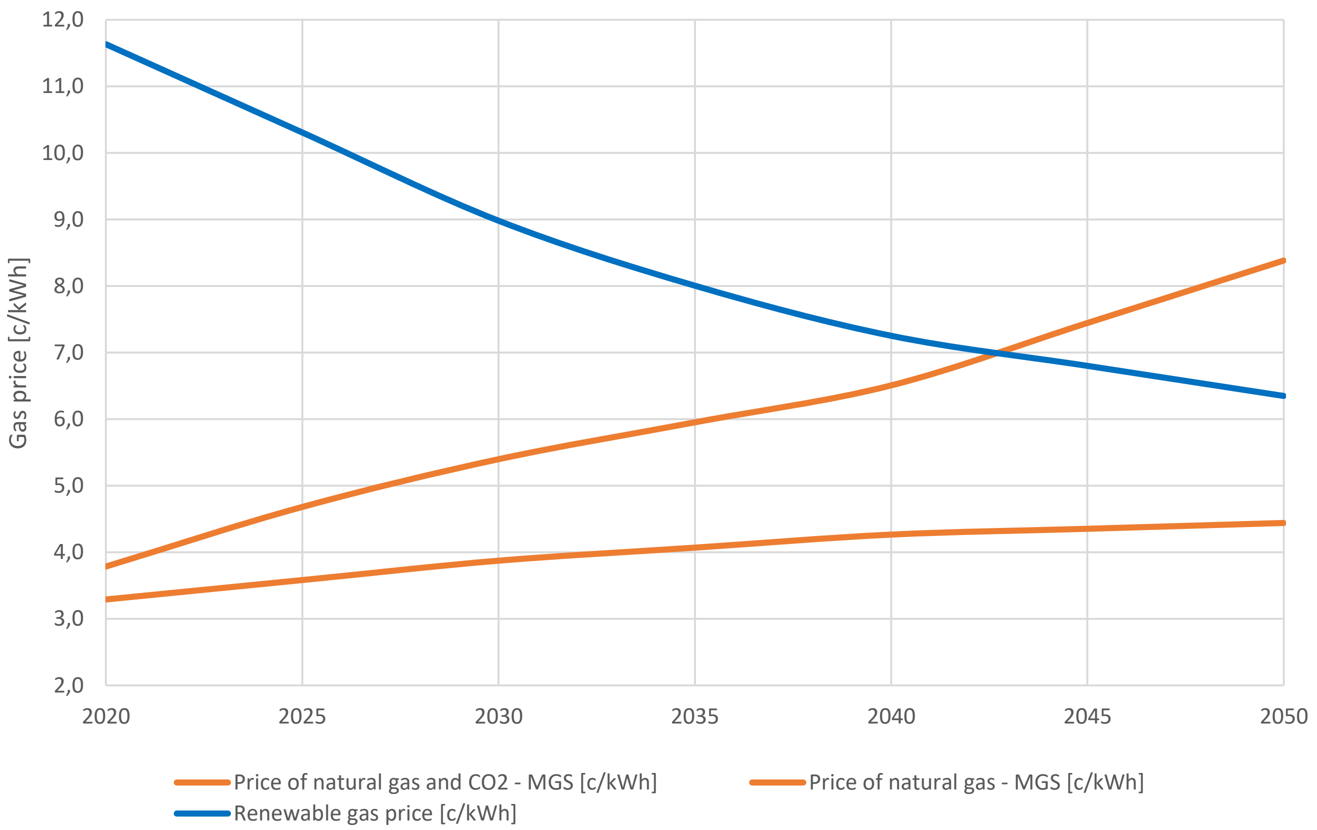
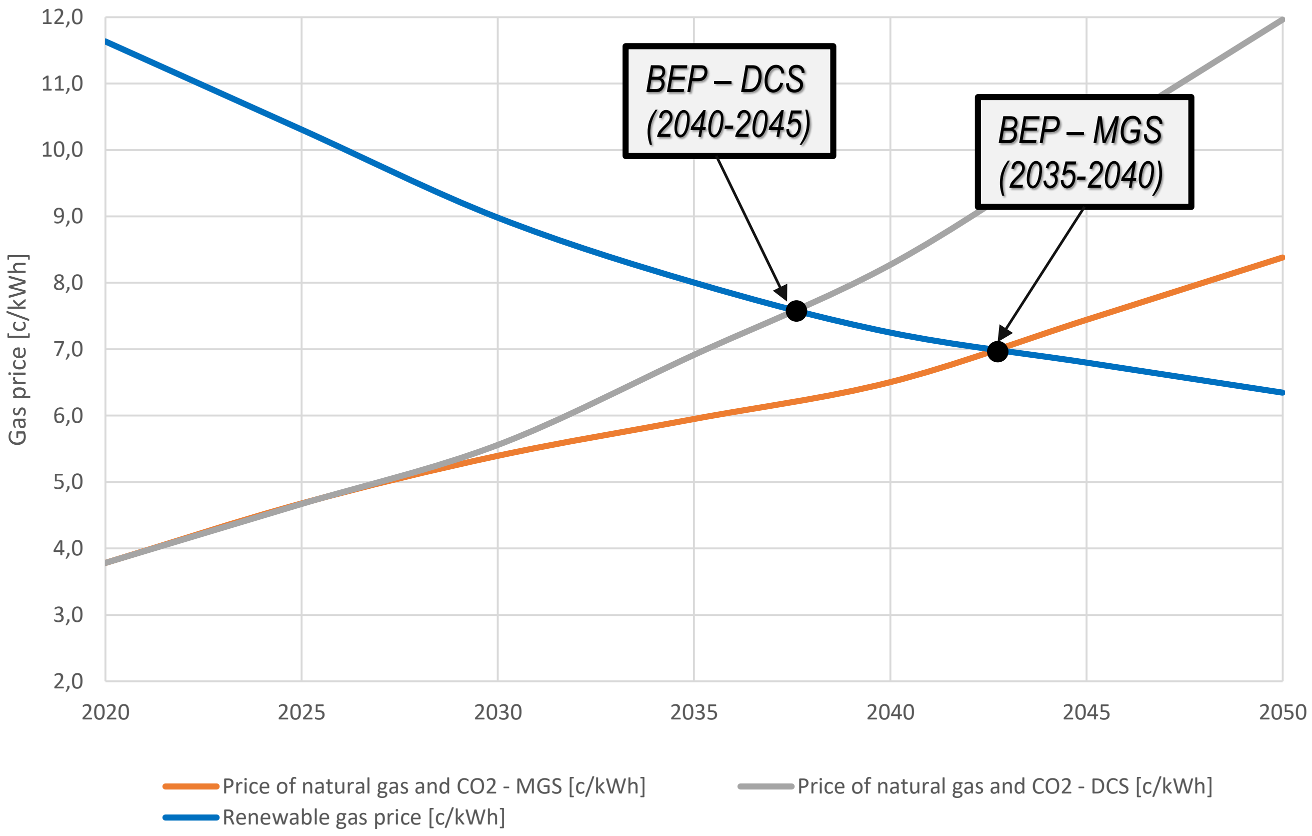


Specific costs

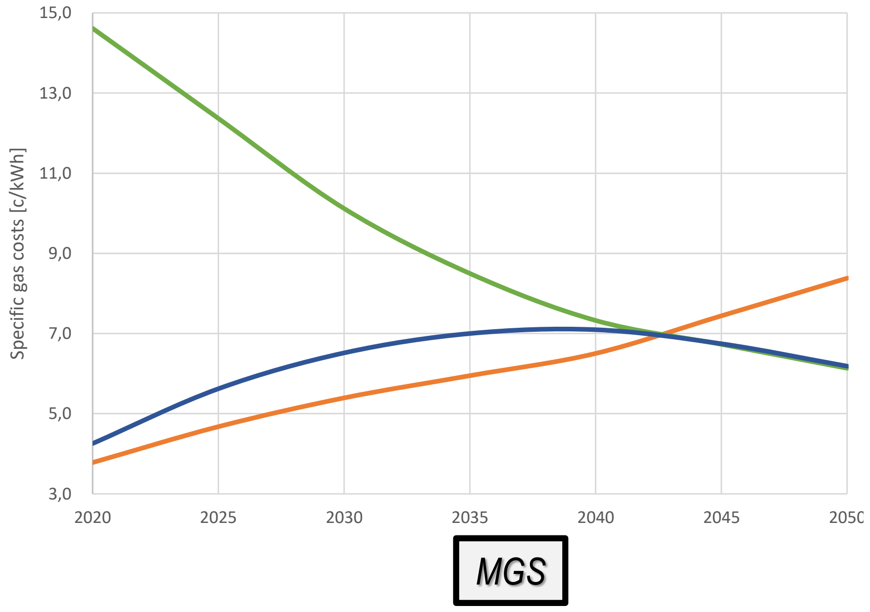
Natural gas, hydrogen, bio methane, carbon emissions

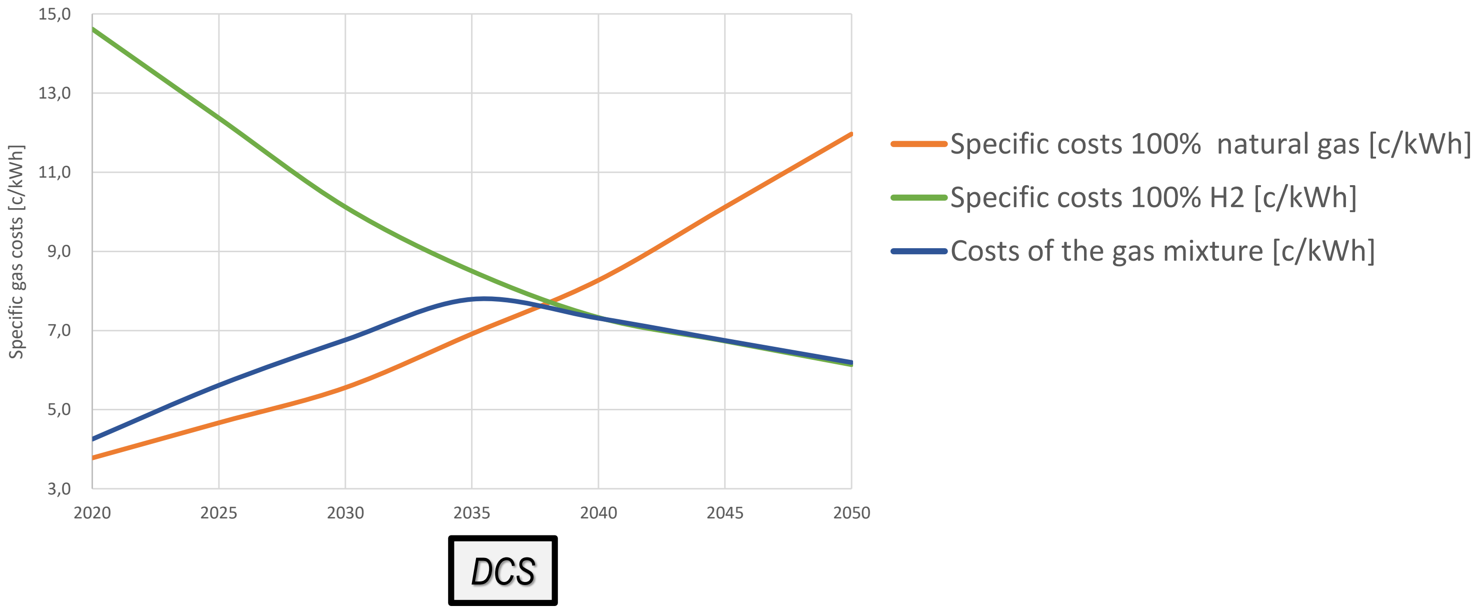
- “**Break-even point**” is defined as a point in time at which hydrogen and bio-methane become cheaper than natural gas
- BEP is foreseeable after 2035 but before 2045
- CO_2 price-range:
  - MGS: 25 (2020) – 200 (2050) €/t CO_2
  - DCS: 25 (2020) – 270 (2050) €/t CO_2



Ramp-up curves

injecting hydrogen in the natural gas network



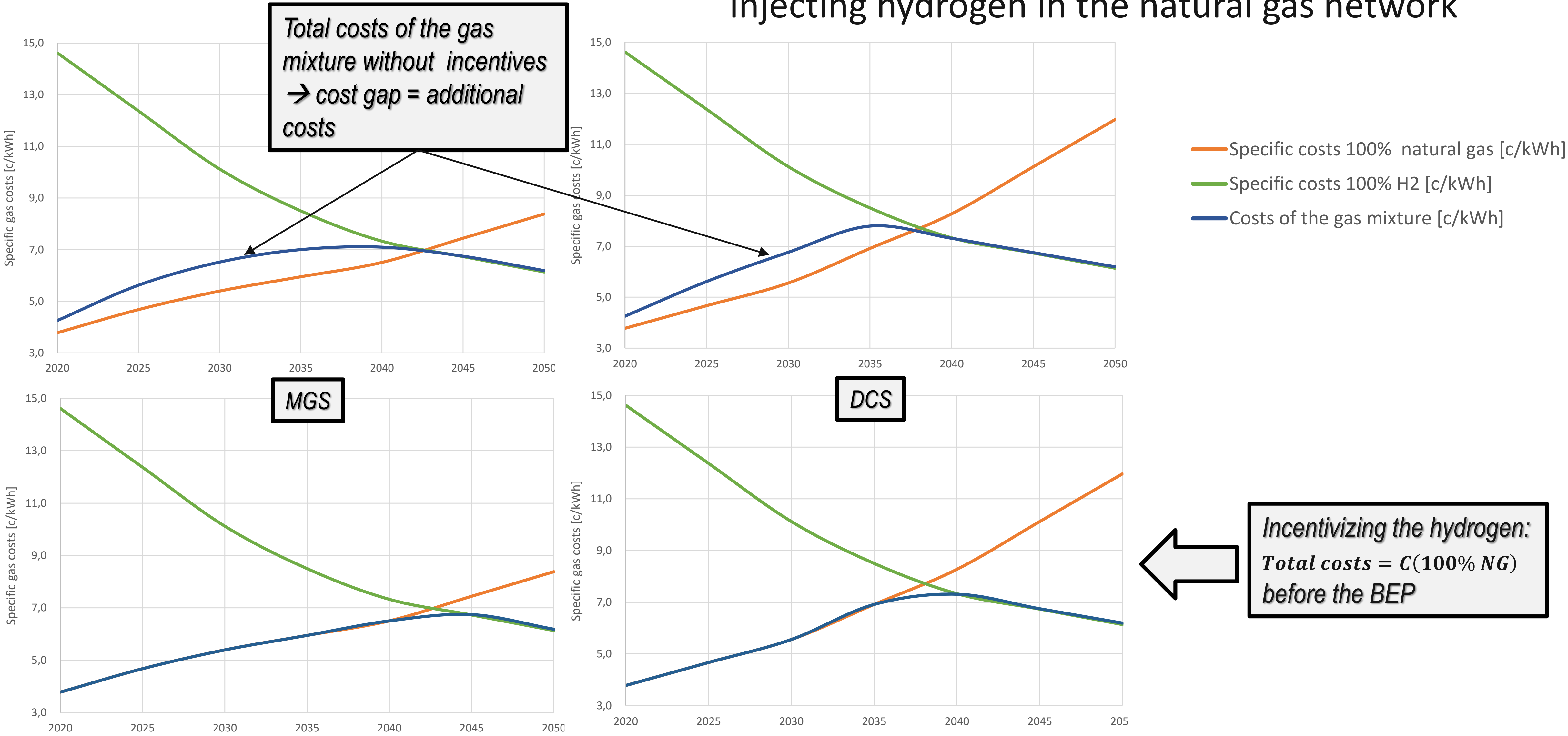


- Maximum total costs of the gas mixture have upper limit equal to the fictious cost of gas network using solely natural gas → $\boldsymbol{Total\ costs = C(100\%\ NG)}$

- Using the CO_2 costs to incentivize hydrogen production
  → $\boldsymbol{Total\ costs = C(100\%\ NG) = C(gas - mixture) - C(CO_2)}$

Ramp-up curves

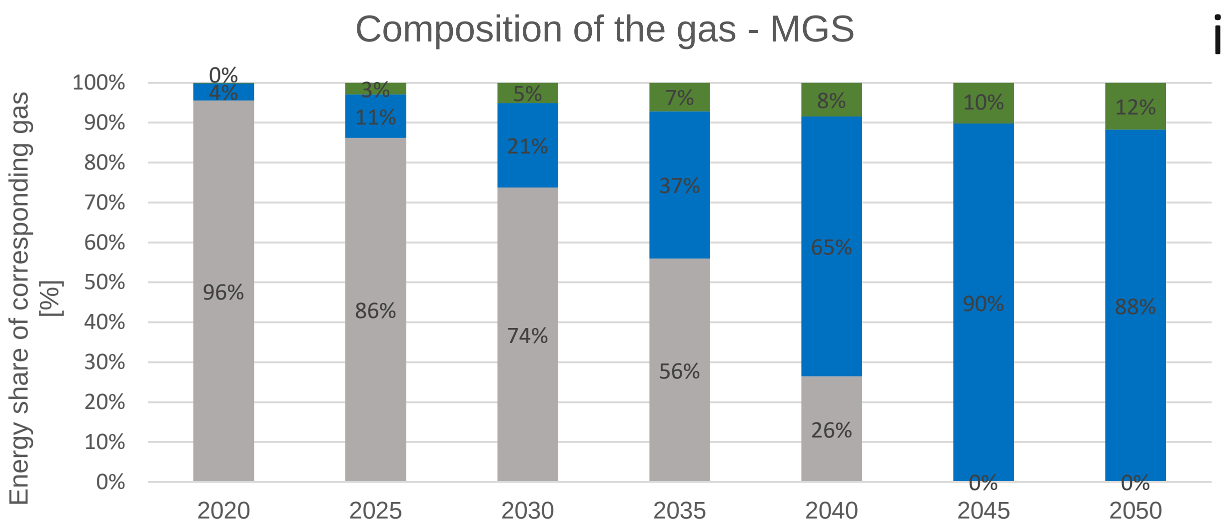
injecting hydrogen in the natural gas network

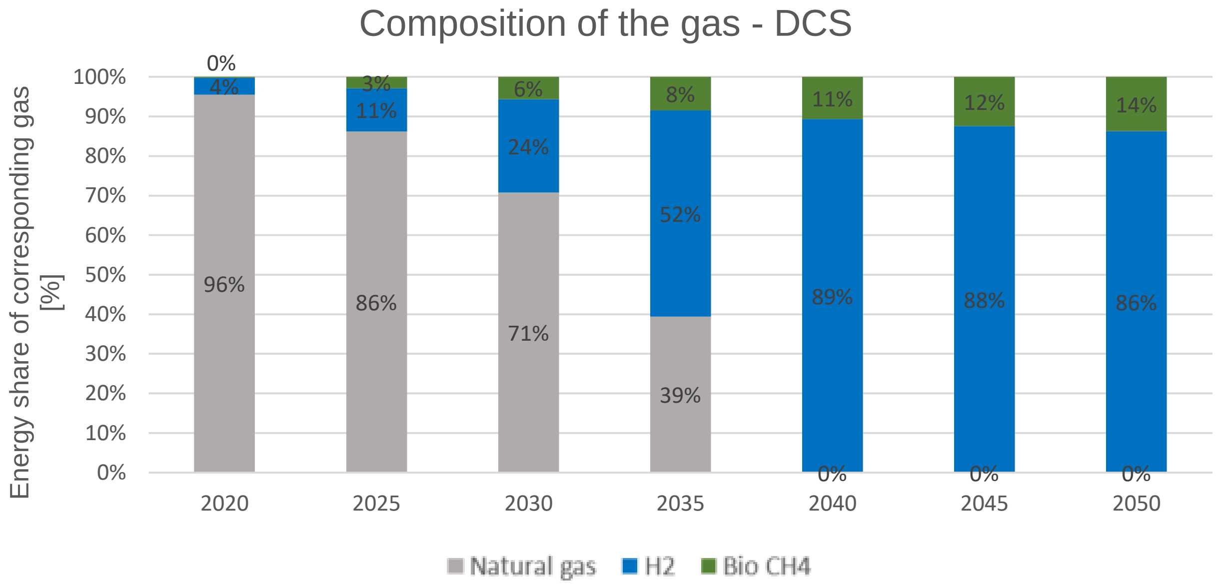


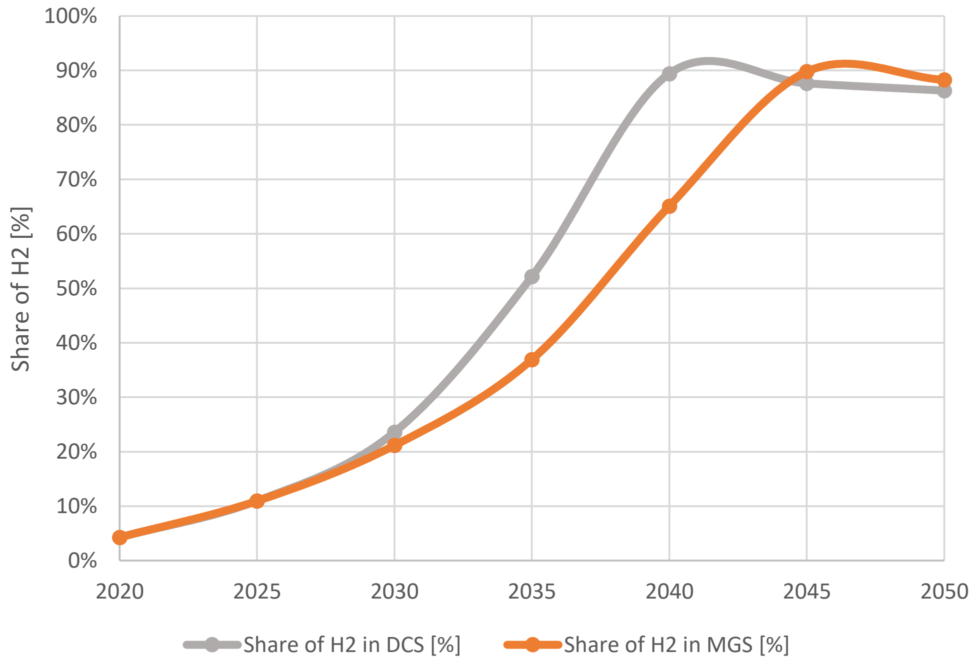
Incentivizing the hydrogen:
$\boldsymbol{Total\ costs = C(100\%\ NG)}$
before the BEP

Ramp-up curves

injecting hydrogen in the natural gas network







EnergieVerbundTechnik

Summary

- Hydrogen facilitates the decarbonisation of key areas of the industrial, transport and heat sectors which are difficult or expansive to electrify
- Production cost structure will shape the deployment and utilization of hydrogen as a fuel and as a feedstock
- Inducing natural gas blending can be beneficial in the early phases of larger-scale hydrogen production units by ensuring a consistent demand for hydrogen
- The subsidies of hydrogen production empower its share in the natural gas network without additional energy-related costs for the end-consumers

Thank you for your attention!

Presented by Roberta Cvetkovska

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