NEFI
NEW ENERGY FOR INDUSTRY

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NEW ENERGY FOR INDUSTRY

The NEFI innovation network of science, technology providers and companies demonstrates a pathway towards the decarbonisation of industry

NEFI is an Energy Model Region funded by the Austrian Climate and Energy Fund

1/3 OF GHG EMISSIONS IN AUT FROM MANUFACTURING INDUSTRIES

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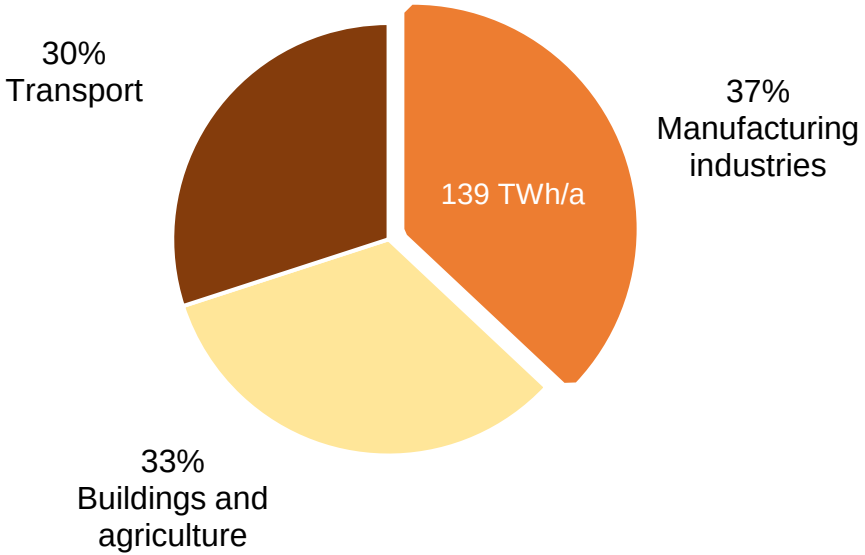
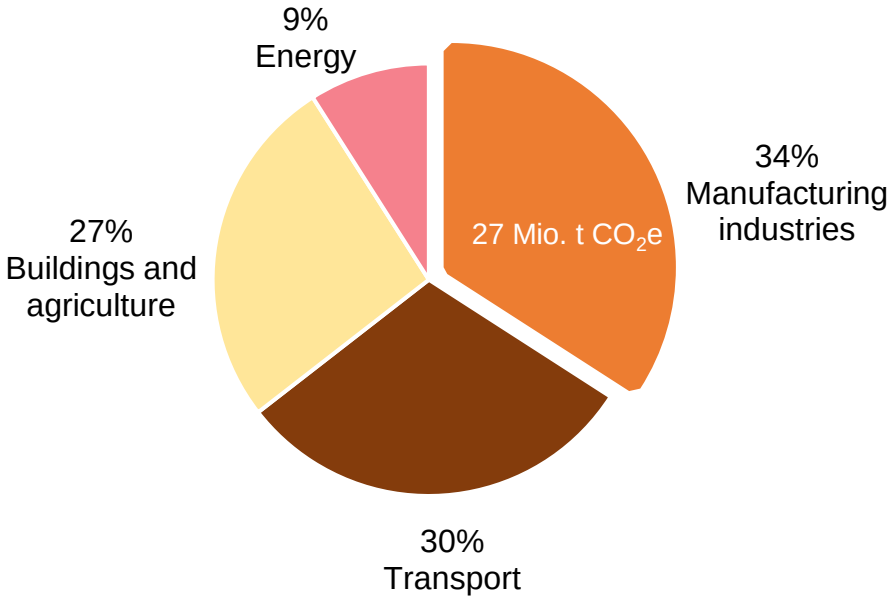
Primary energy demand by sector[1]



GHG-emissions by sector[2]



1) Sejkora et al., „Exergy as Criteria for Efficient Energy Systems – A Spatially Resolved Comparison of the Current Exergy Consumption, the Current Useful Exery Demand and Renewable Exergy Potential", *Energies*, 2020

2) Austrian Federal Envrionment Agency, „National Inventory Report 2021"

MOTIVATION FOR SCENARIO DEVELOPMENT

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ENERGY SCENARIOS CAN BE A VALUABLE TOOL FOR ATTAINING CLIMATE GOALS

Strong drivers:

- Industrial climate neutrality goals
- European Green Deal / Austrian government goals / etc.

Clear target.
Yet, the road is very much unclear!

Previous energy scenarios:

- End-energy resolution of industrial demands
- Industrial aggregate; no industrial subsector focus

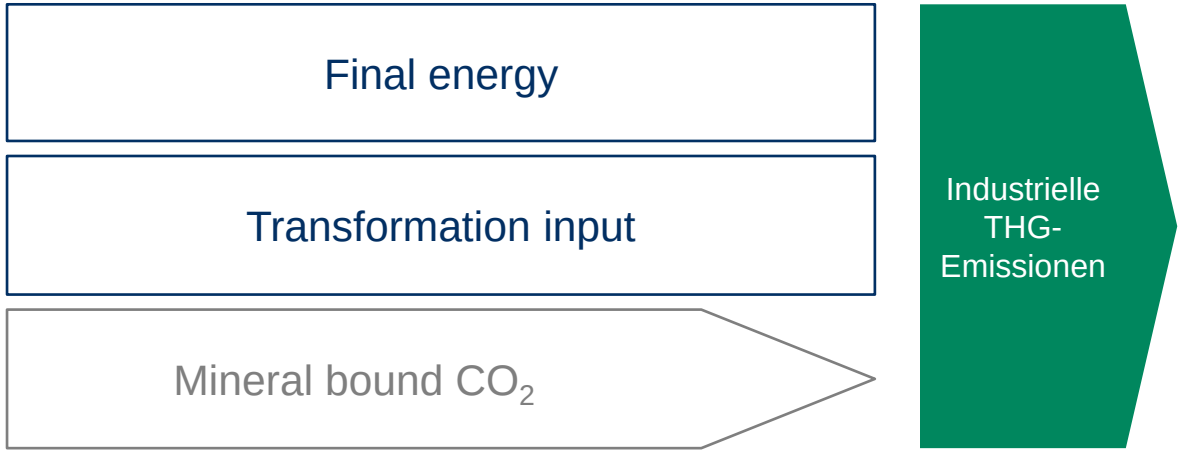
THE NEFI SCENARIOS

WHAT‘S ON THE PLATE TODAY

- What balance border in industry is necessary for these scenarios?
- What scenario narratives were chosen?
- What technology groups constitute the road to climate neutrality?
- Core results

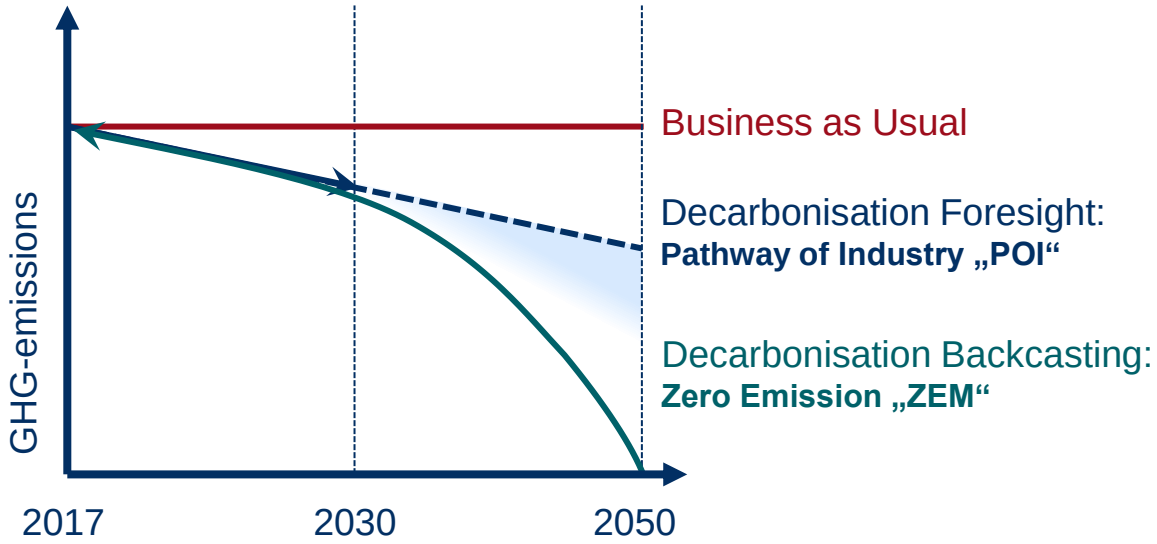
ENERGY AND EMISSIONS BALANCE OF INDUSTRY

THREE GHG-SOURCES EXIST



THE NEFI SCENARIOS

THREE SCENARIOS OPEN UP A BANDWIDTH OF DEVELOPMENT POSSIBILITIES



CLASSIFICATION OF DECARBONISATION STRATEGIES

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FOUR TECHNOLOGY FAMILIES CAN BE DISTINGUISHED

Electrification

- Heat pumps
- Stationary engines

Use of CO_2-neutral gases and biomass combustion

- Hydrogen
- Bio-CH_4 and synthetic CH_4
- Solid biomass

Carbon Capture

- Especially for the sequestration of geogenic emissions
- Requires additional energy

Circular Economy

- Increased use of end-of-life products
- Substitution of primary resources

CLASSIFICATION OF DECARBONISATION STRATEGIES

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INITIAL FOCUS LIES ON THREE OPTIONS:

Electrification

- Heat pumps
- Stationary engines

Use of CO_2-neutral gases and biomass combustion

- Hydrogen
- Bio-CH_4 and synthetic CH_4
- Solid biomass

Carbon Capture

- Especially for the sequestration of geogenic emissions
- Requires additional energy

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Scenario Zero Emissions

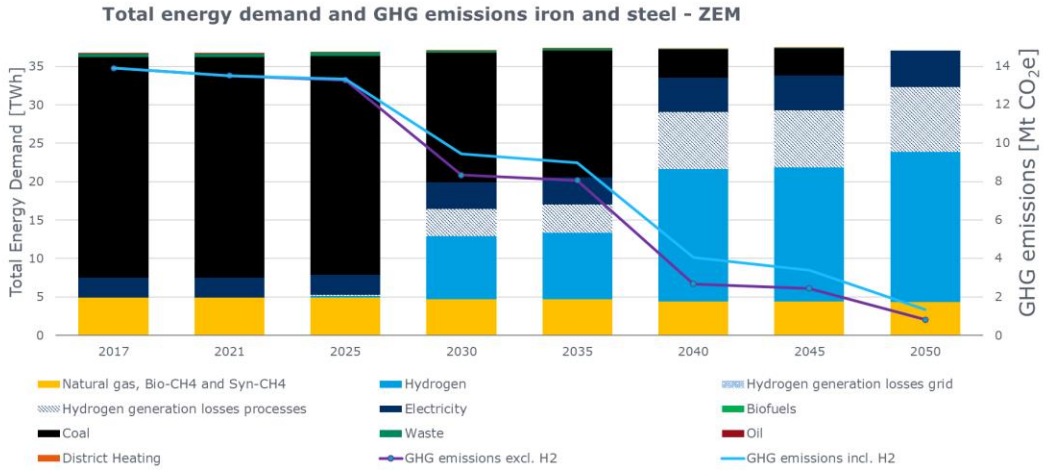
Exemplary results

IRON & STEEL

PRIMARY STEELMAKING IS THE MAIN DRIVER

preliminary

- Usage of H_2-DR/EAF [3)]
- Increased electricity demand for electrolysis
  - Depending on the location: can sit in- or outside the industrial balance border
  - Residual emissions: 1 Mt CO_2



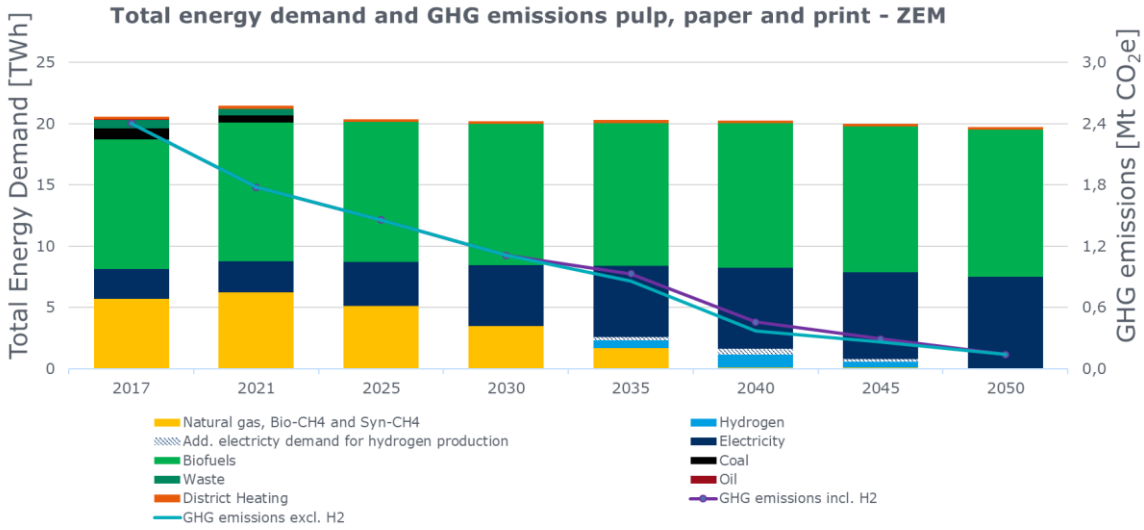
3) DR/EAF: Direct Reduction / Electric Arc Furnace

NON-METALLIC MINERALS

INCREASED ELECTRIFICATION (DIRECT+INDIRECT)

preliminary

- Carbon Capture with Oxyfuel
- No investigation of further usage/storage after sequestration
- Electrification
  - e.g. melting glass

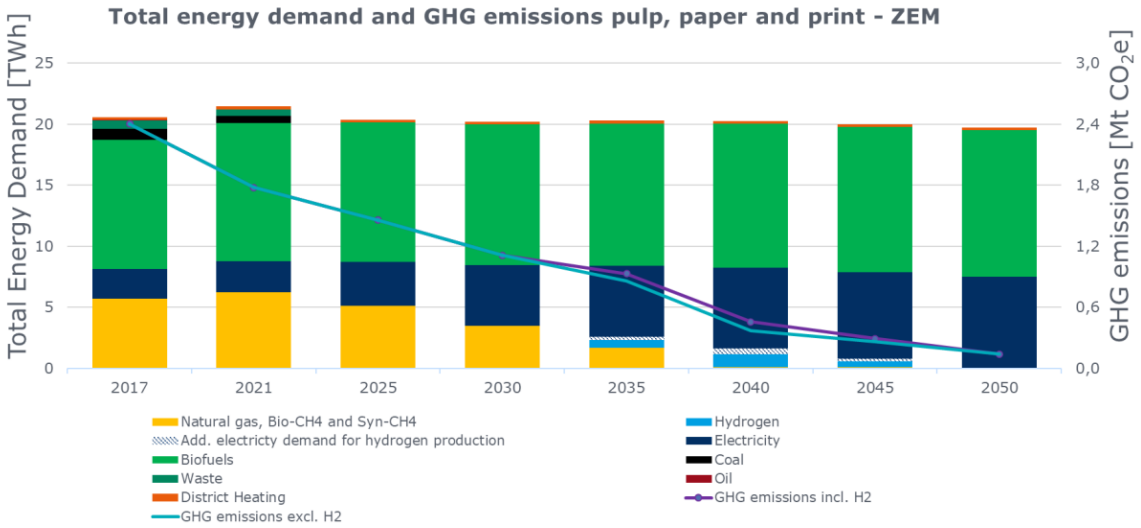


PULP, PAPER & PRINT

USE OF HEAT PUMPS UP TO 150°C

preliminary

- Increased electrification
  - CHP operated exclusively with biogenic residues
  - Increased amounts of electricity purchased from outside
  - Production growth counterbalances increased efficiency



CHEMICAL AND PETROCHEMICAL INDUSTRY

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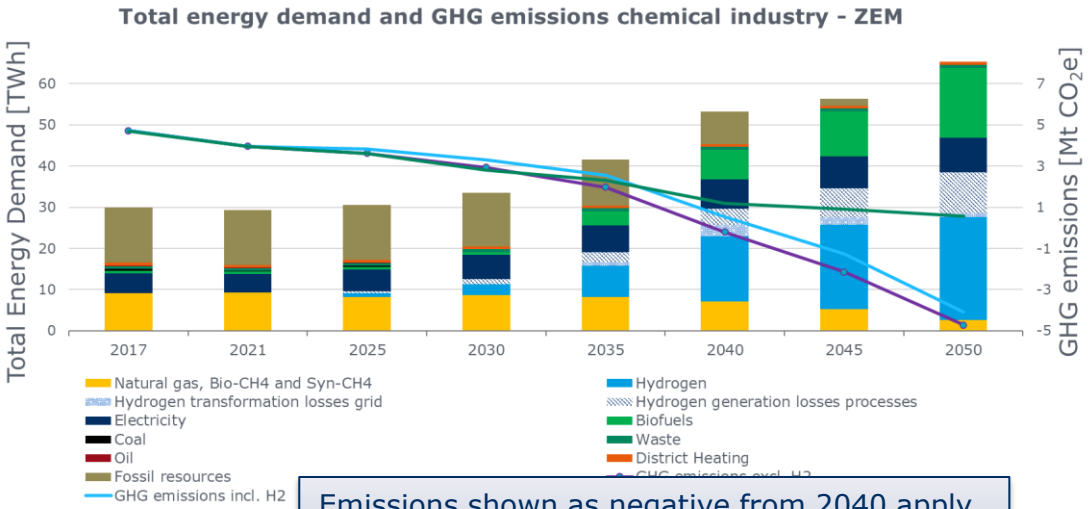
preliminary

NATURAL GAS IS REPLACED BY HYDROGEN AND BIO-CH_4

- Olefin production from naphtha will be phased out by 2050.
- Methanol synthesis from 2040 only from biomass and hydrogen + CO_2
- Complete electrification of the saltpetre, urea and fertilizer production
- Electricity requirement increases from 5 TWh to 8 TWh, or including hydrogen production to 44 TWh!



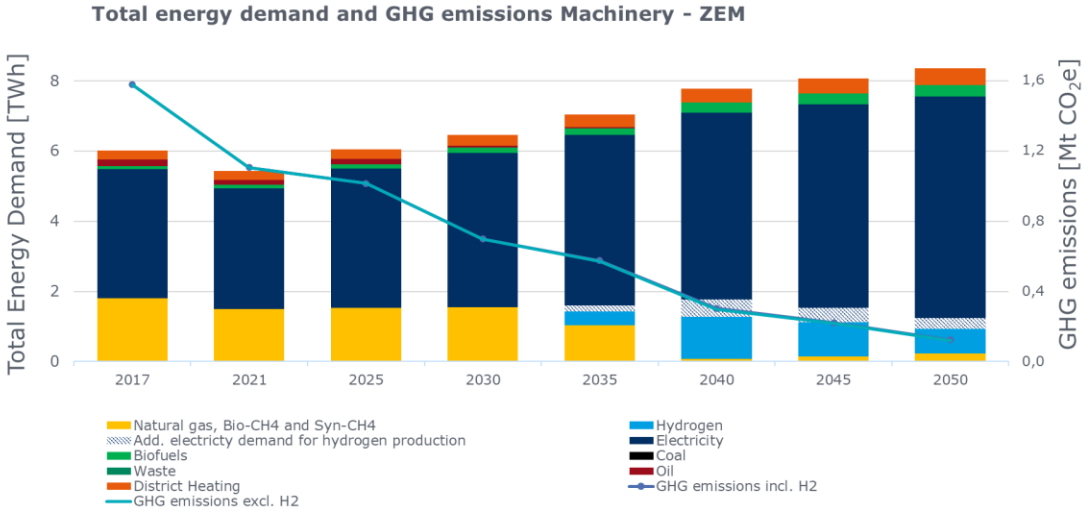
Emissions shown as negative from 2040 apply in the balance limit of the chem. Industry. However, 4 Mt of absorbed CO_2 is released again with current end-of-life recycling.

MACHINERY

preliminary

EMISSION REDUCTIONS ARE GRID-DRIVEN

- Machinery sector is representative of other less energy intensive sectors
- Production growth outweighs energy efficiency gains
- Main drivers are heat recovery and use with heat pumps
- Hydrogen is only used in high temperature applications



„ZERO EMISSION“ SUMMARY

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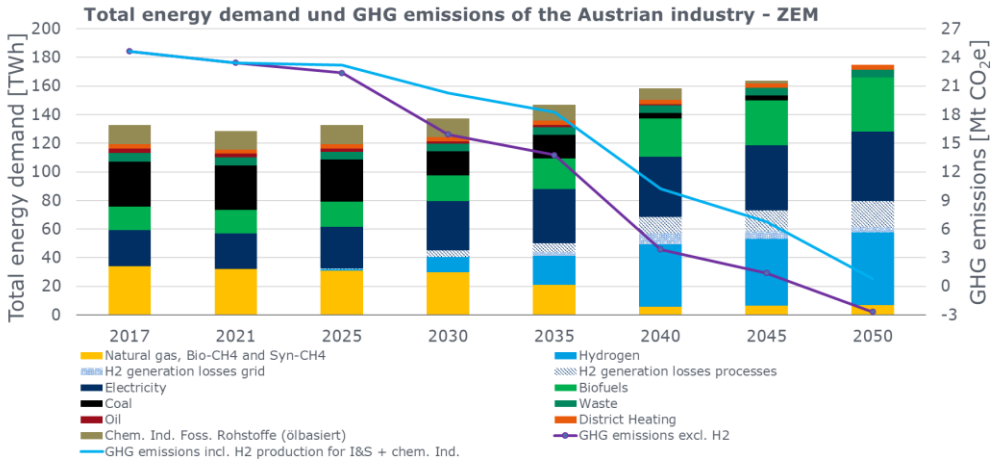
preliminary

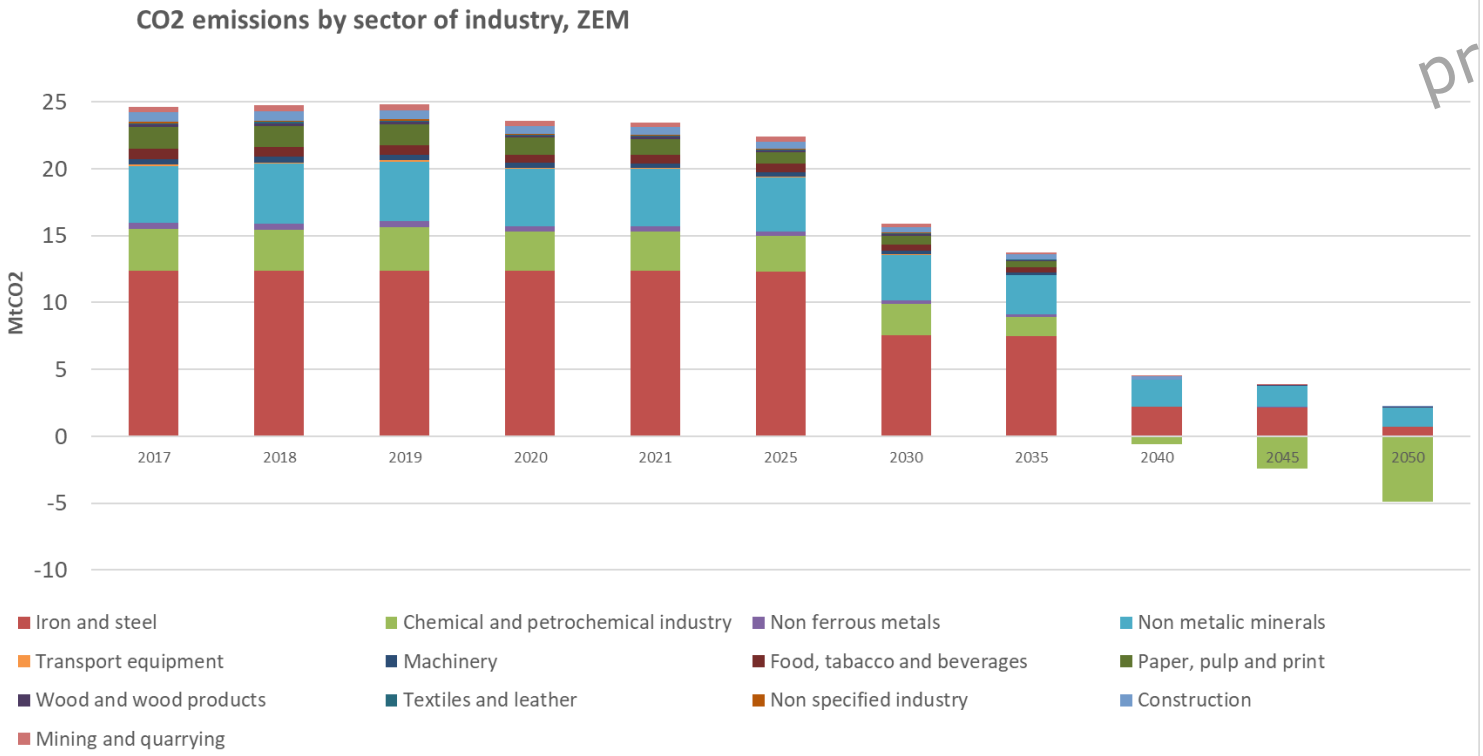
AVAILABILITY OF RENEWABLE ENERGY SOURCES IS CRUCIAL

- Technology change allows phase-out of fossil fuels by 2035
- Emission reductions from then on through an increasing share of renewable electricity and gas
- **GHG-neutral supply is required:**

49 TWh power: +91% compared to 2017
51 TWh hydrogen, +73 TWh power
38 TWh biomass: +130% compared to 2017
6.9 TWh CH_4:
-80% compared to natural gas 2017



„ZERO EMISSION“ SUMMARY



preliminary

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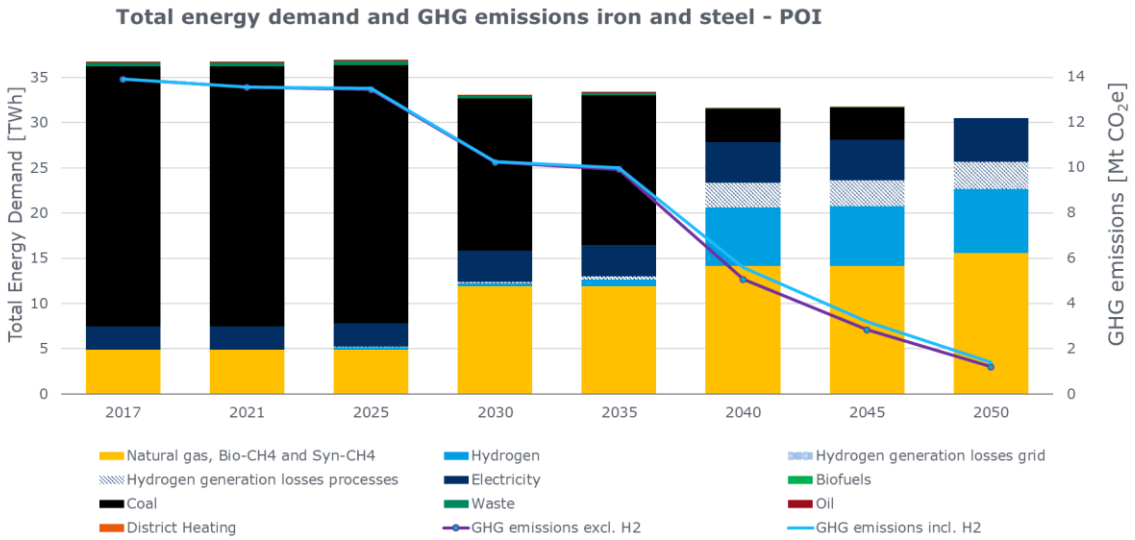
Scenario Pathway of Industry

Exemplary results

IRON & STEEL

CH_4-BASED DIRECT REDUCTION AND EAF

- Increasing usage of CH_4-DR/EAF incl. 30% H_2 per unit
- Substitution of 29 TWh coal/coke with 22 TWh of green gases
- Electricity demand for electrolysis can sit in- or outside the industrial balance border

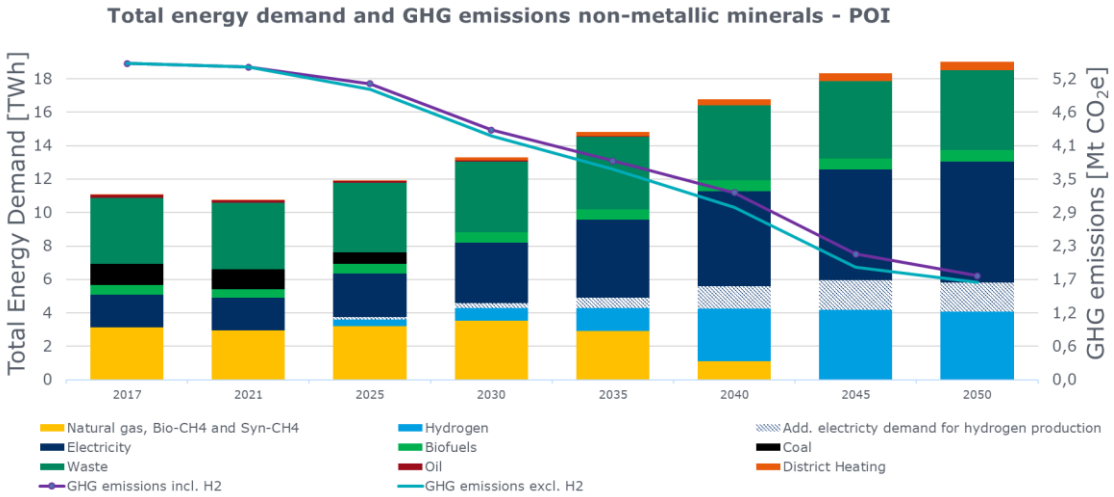


DR: Direct reduction, EAF: Electric arc furnace.

NON-METALLIC MINERALS

AMINE SCRUBBER REQUIRES ADDITIONAL ENERGY

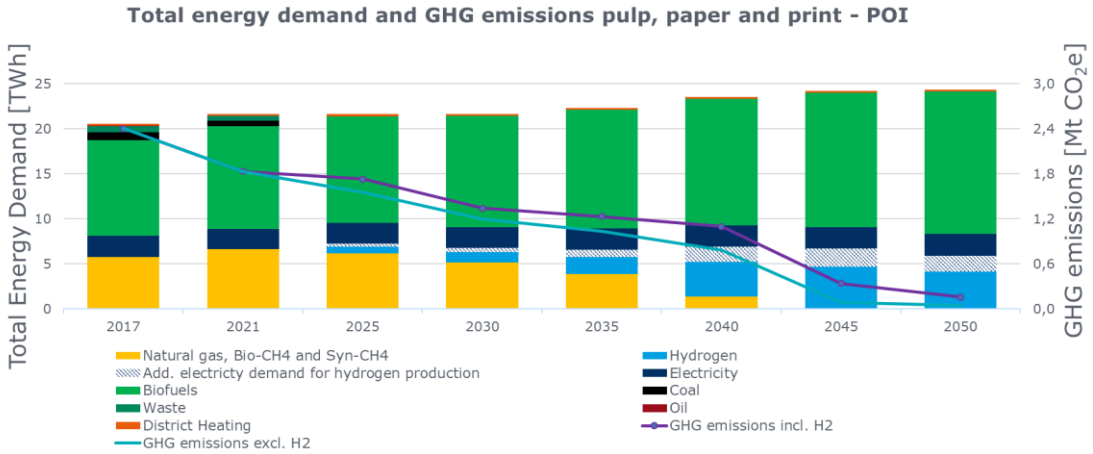
- Carbon Capture by amine scrubbing
  - Readily available technology
- No investigation of further usage/storage after sequestration
- Required energy provided through heat pumps (@130°C)



PULP, PAPER & PRINT

INTENSIFIED BIOMASS COMBUSTION

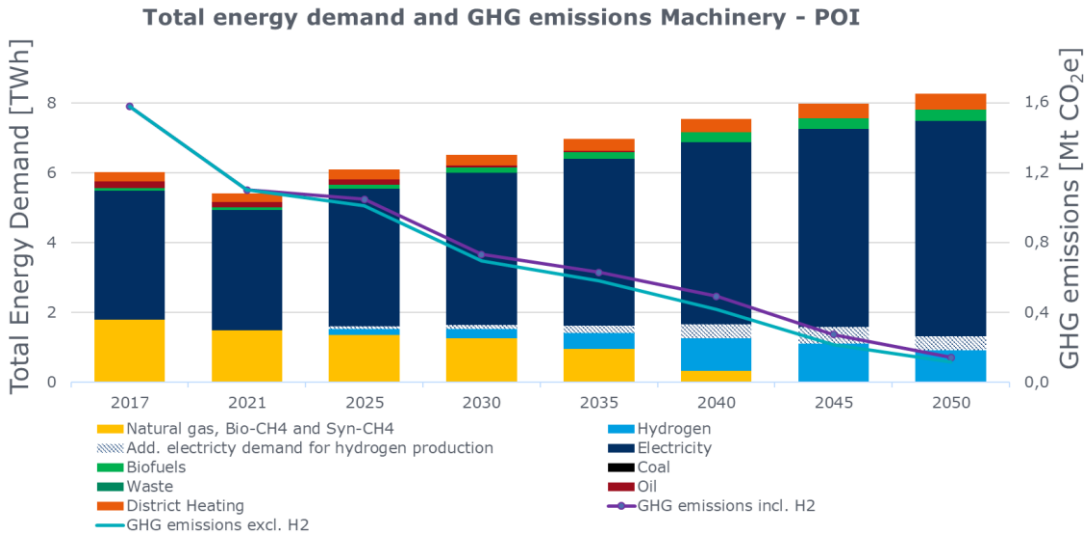
- Extension of current supply routes for biomass for combustion
- Retention of current plant structure
  - e.g. CHP-plants



MACHINERY

EXTENSIVE ELECTRIFICATION OF PROCESS HEAT

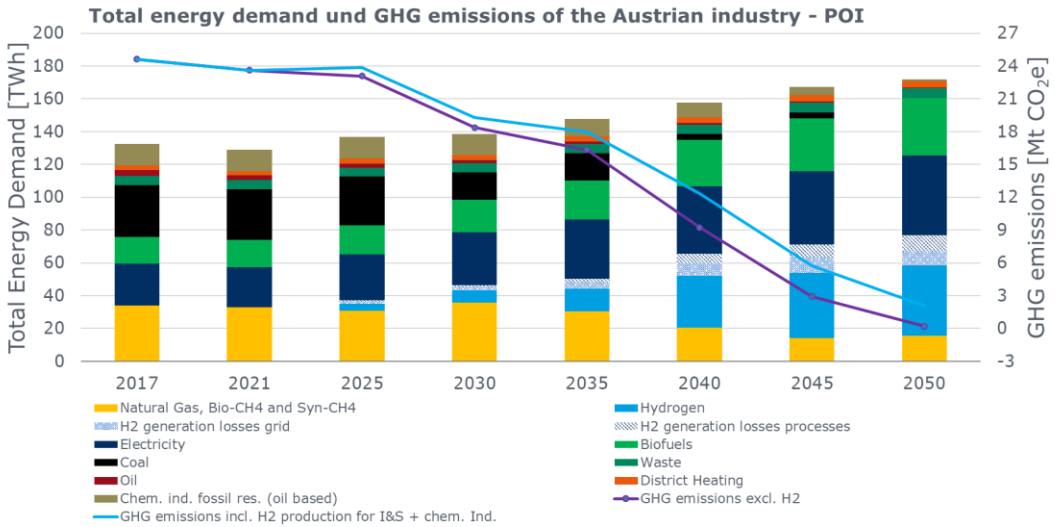
- Lower temperature levels provided by heat pumps
- Higher temperature levels (>150°C) provided by direct heat
- Energy efficiency cannot compensate fully for production increase (approx. 50%)



„PATHWAY OF INDUSTRY“ SUMMARY

CO_2-NEUTRAL ENERGY SUPPLY IS KEY

- Two fuel-based decarbonisation solutions are visible
  - CO_2-neutral gases and biomass
  - Electrification
- **GHG-emission reduction of 86%** is possible (comp. to 2017)
- **GHG-neutral supply of electricity and CO_2-neutral gases is key!**
  - 49 TWh electricity: +90%
  - 58 TWh CO_2-neutral gases
    (>61 TWh of electricity, if provided by H_2)
  - 35 TWh solid biomass: +113%



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