OPTIONS FOR DECARBONIZATION OF THE INDUSTRIAL SECTOR

SUSTAINABLE HIGH-TEMPERATURE PROCESS HEAT AS KEY TECHNOLOGY

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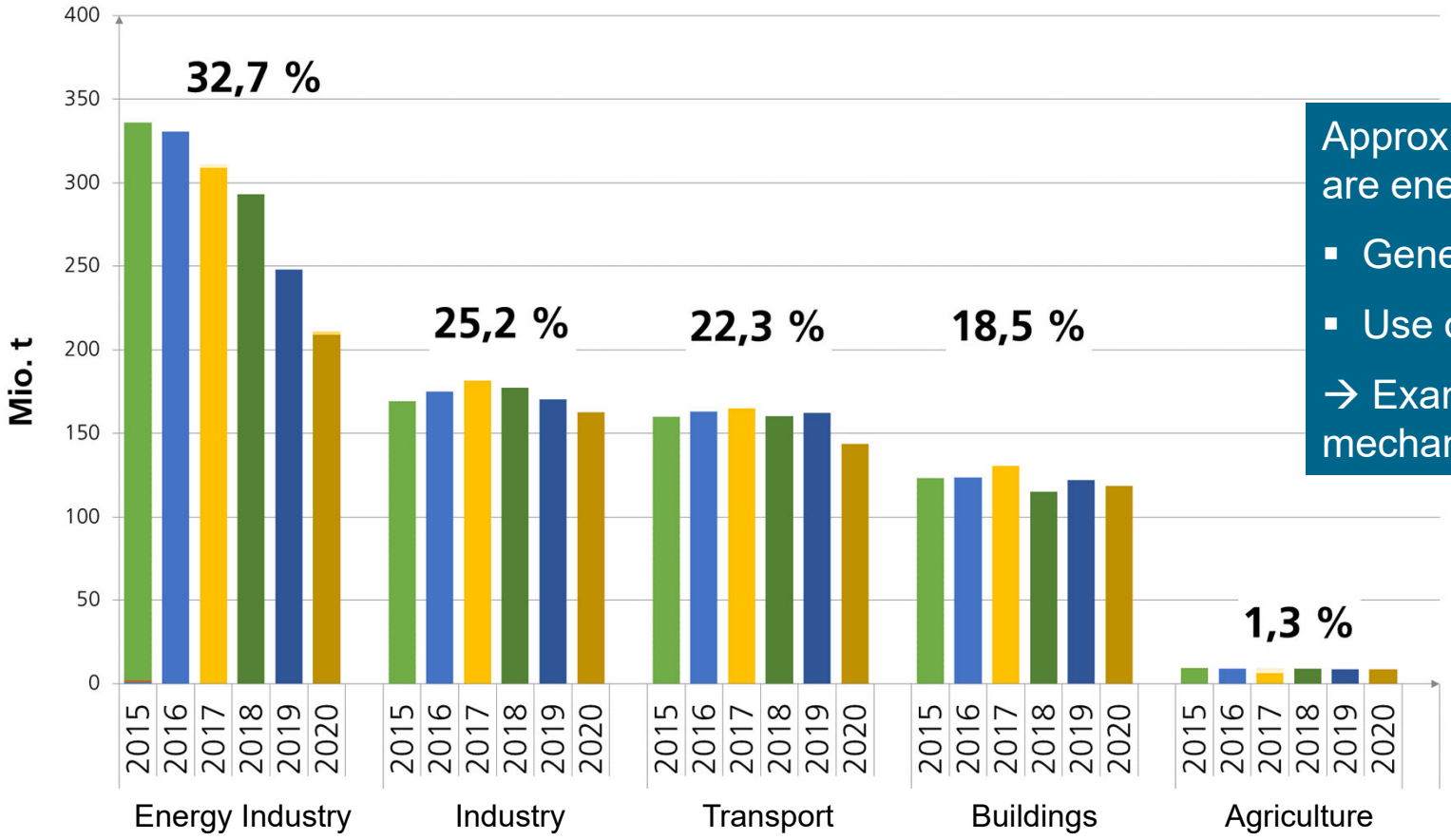
DLR

CO_2 - Emissions from 2015 to 2020 in Germany

- **Industry** the second-largest CO_2-emitter in Germany after **Energy Sector**
- Decrease of CO_2-emissions too low



Approx. 75 % of industrial emissions are energy-related CO_2-emissions

- Generation of the electricity used
- Use of fuels to provide energy

→ Example: process heat, steam, mechanical work

Source: National Inventory Report (Germany), Own evaluation

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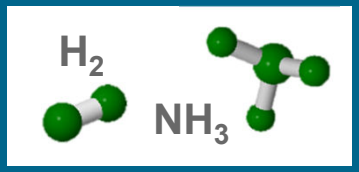
High-Temperature Heat Pumps

Simulation and Virtual Design



Low Carbon Reducing Agents

University Library Cottbus

City Center Zittau

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Aim

Reduce CO_2- and pollutant emissions from industrial processes and power plants

Mission

Research and development for a successful energy transition in industry

CO_2-Reduction Options for Industry

Climate-neutral energy sources/feedstocks

- Electrification
- H_2 / synth. / carbon-free energy sources
- Biomass
- Solar process heat

High-Temperature Heat Pumps

H_2-utilization Biomass

Energy efficiency

CO_2 utilization & capture

- Carbon Capture and Use (CCU)
- Carbon Capture and Storage (CCS)

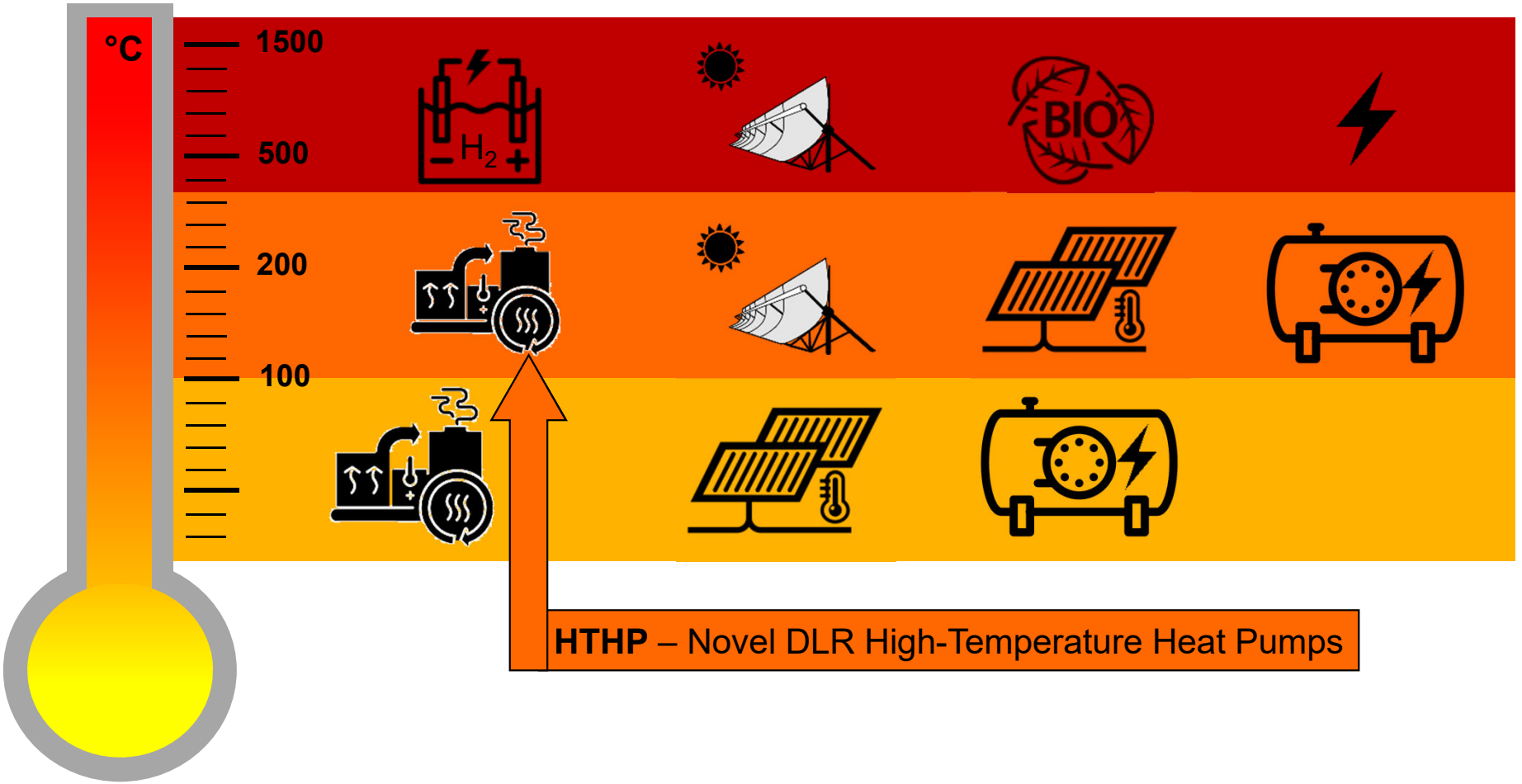
Reduction in demand for primary materials

- Reduction of final demand
- Material substitution
- Circular economy
- Material efficiency

Process Chemistry

Nach Leipprand et al., DLR, FVEE-Tagung 2020

Sustainable Process Heat
Classification of technologies – based on temperature range

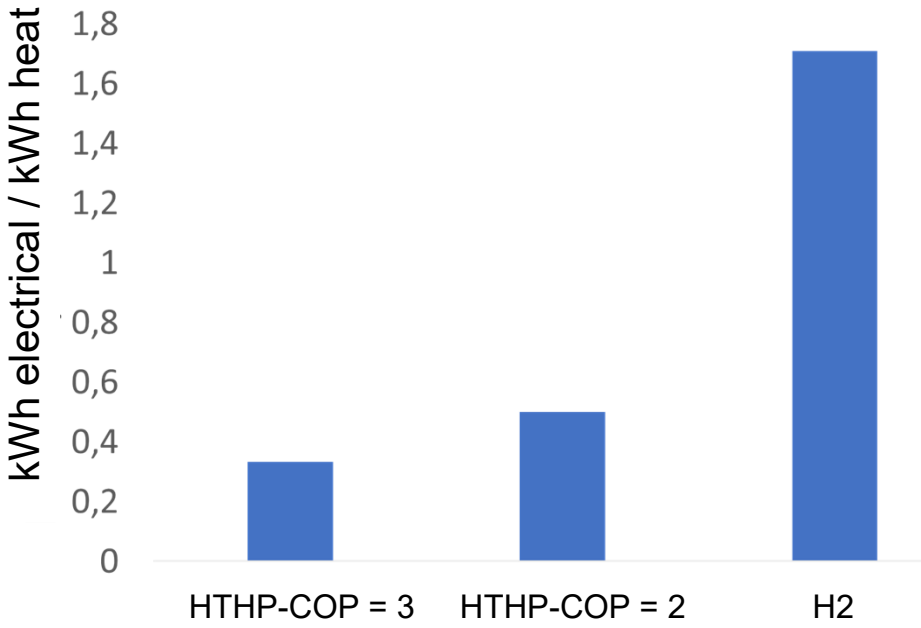


HTHP = high-temperature heat pump

Sustainable Process Heat
Availability of technologies

up to ~100 °C	up to ~500 °C	> 500 °C
Well established technologies available **Applications** • Food industry • Paper … **Tech** • District heating • Heat Pumps • Solar-thermal ... **R&D** • System integration and optimization	**New product development required** **Applications** • Industrial heating networks • Drying processes • Rubber .... **R&D (Low TRL, high risk)** • High-Temp. Heat Pumps • Concentrated solar-thermal • Storage technologies • Hybrid approaches • System integration and optimization	**Established technologies available** **Applications** • Metals • Cement … **Tech** • Electrical energy, hydrogen or synthetic fuels → Maximum efficiency required **R&D** • System integration and optimization

Hydrogen / Biomass in medium-temperature range



Not covered here, but…

- Green hydrogen is one of the most expensive energy carriers
- Biomass is a limited resource

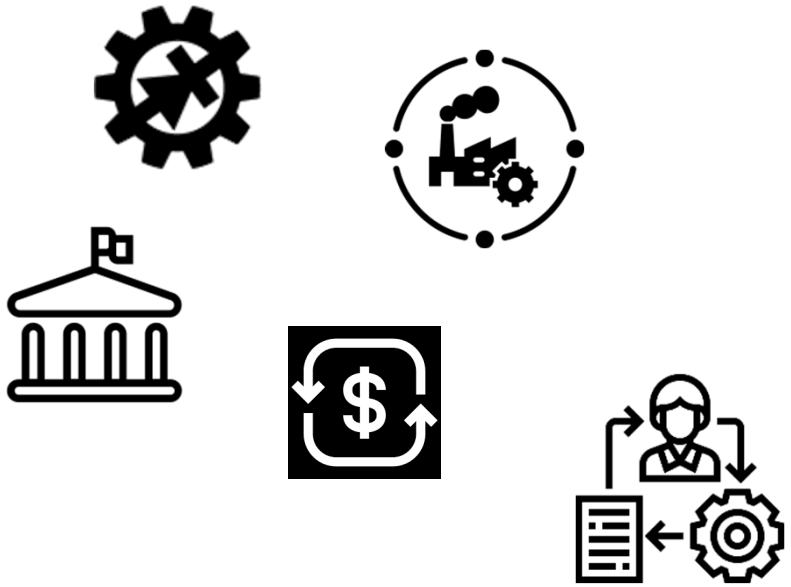
Medium-temperature range

- High-Temperature heat pumps can help save hydrogen and biomass in this temperature range

COP = Coefficient of performance

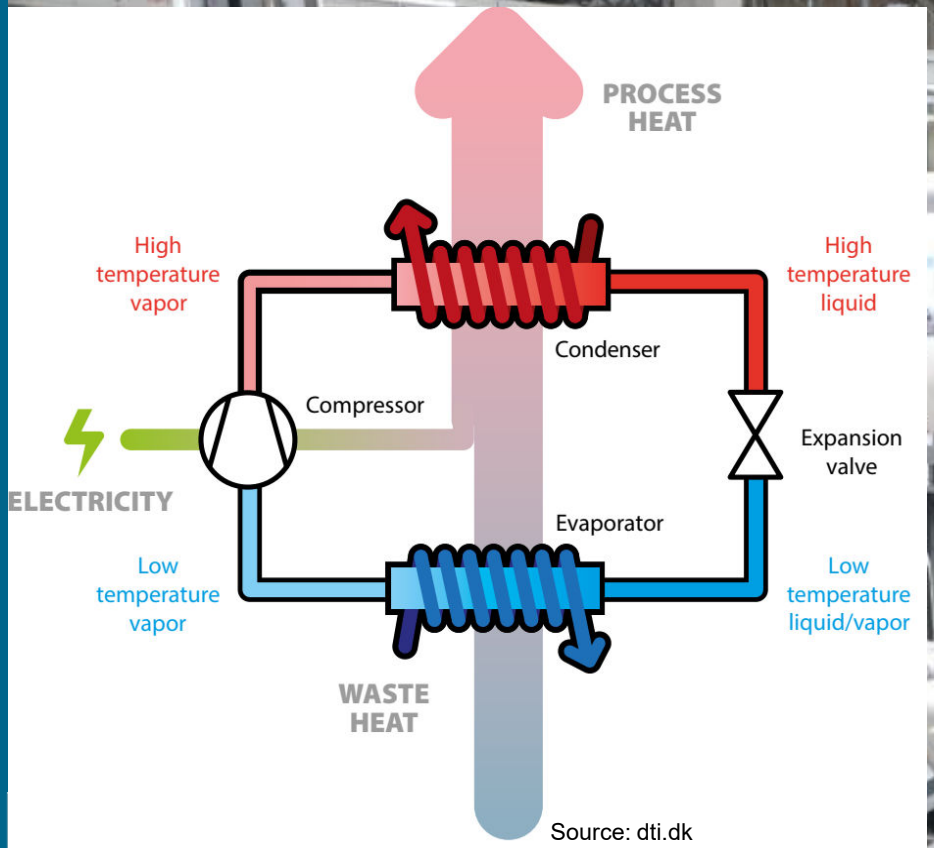
Technology assessment based on …

- Technological boundary conditions
- Process requirements
- Political and legal matters
- Economic viability
- Skilled labor shortage
- Social acceptance



- Very dynamic environment
- It‘s crucial that decisions don‘t lead to stranded assets

Medium-temperature range: High-Temperature Heat Pumps



Research goal of DLR:

- Provision of CO_2-neutral high-temperature process heat of relevant scale for industry
- Sink-temperature: > 300 °C (up to 500 °C), power: Megawatt range
- Development of the HTHP-system and the main components

Pilot plant „CoBra“ (Cottbus Brayton)

„First of its kind“ – pilot plant

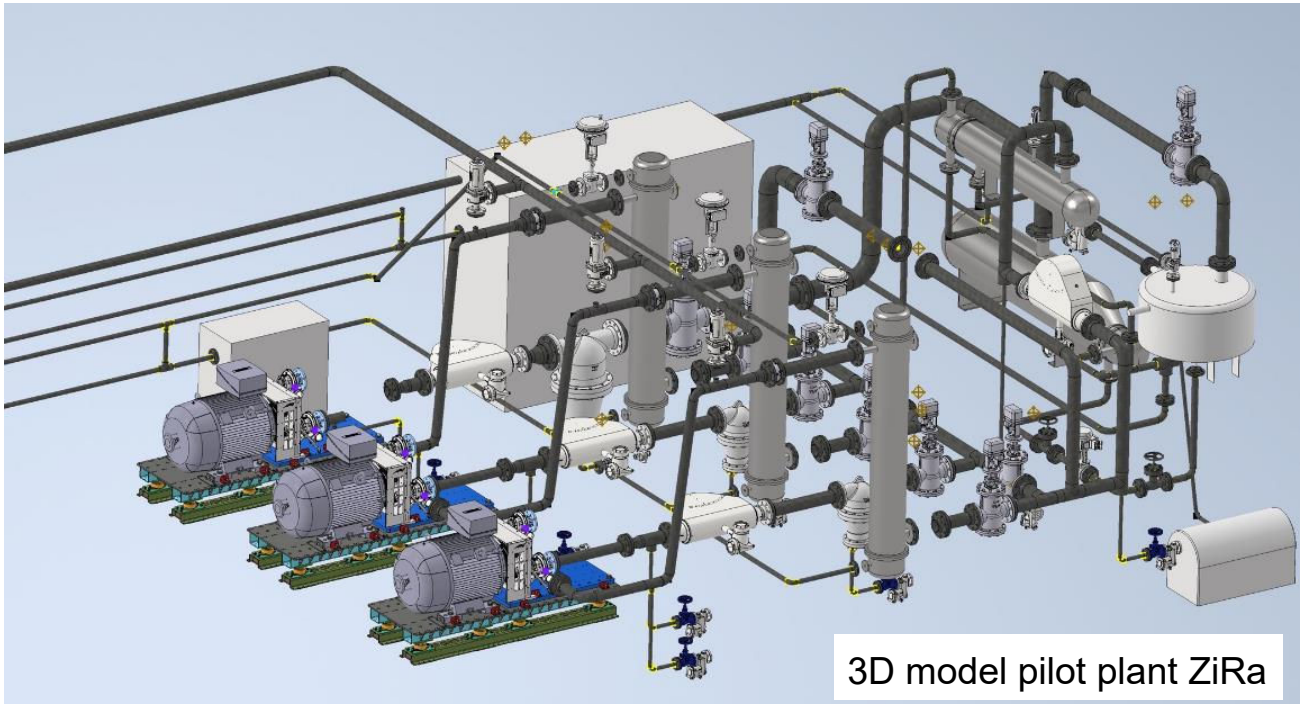
- Performance data:
  - 280 °C
  - 180 kW_{th}
  - Working medium Air
  - Also unique:
    - Cooling @ – 40 °C
    - Cooling capacity 60 kW

First operation in May 2023

Pilot plant „ZiRa“ (Zittau Rankine)

„First of its kind“ – pilot plant

- Performance data:
  - 200 °C
  - 860 kW_{th}
  - COP = 3.5
  - Working medium water steam



3D model pilot plant ZiRa

First operation in 2024

Contact

Thank you!

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