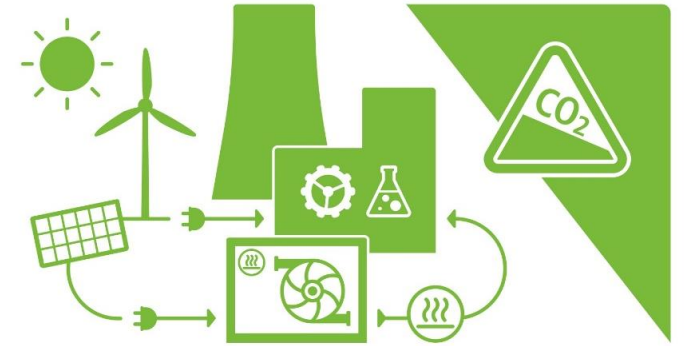


High-Temperature Heat Pumps – Efficient and green heat for industrial processes

Prof. Dr. Uwe Riedel

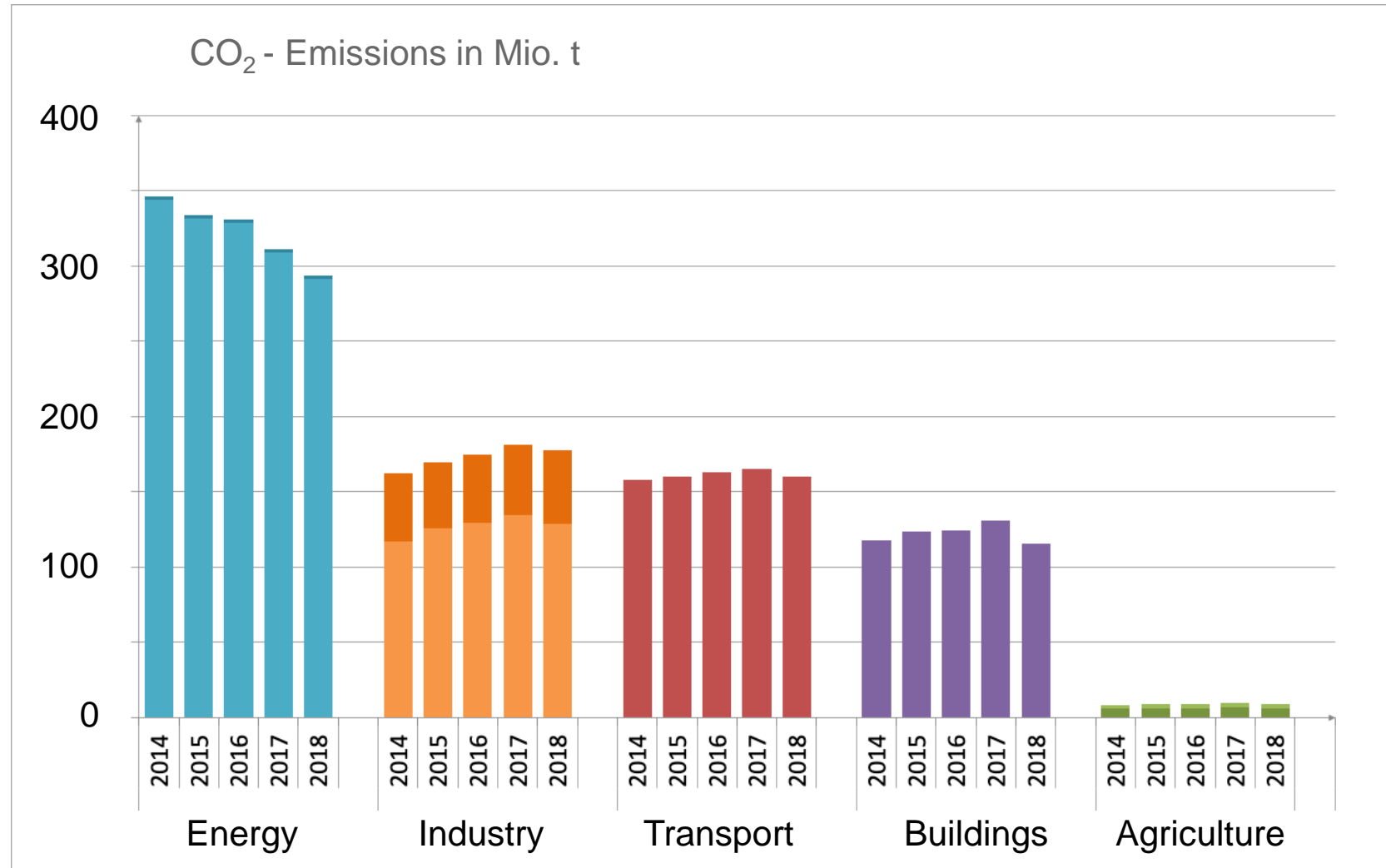
Institute of Low-Carbon Industrial Processes
Cottbus and Zittau

11. Deutsch-Japanisches Umwelt- und
Energieforum,
16.-18. Februar 2021



Knowledge for Tomorrow

CO₂ - Emissions from 2014 to 2018 in Germany



DLR-Institute of Low-Carbon Industrial Processes

Challenge: CO₂-emissions from industry

- **Energy-related CO₂ emissions**
 - From the production of the electricity used
 - Use of fossil fuels to provide energy → process heat, steam, work
- **Direct process-related CO₂ emissions**
 - From non-energetic use of carbon in raw materials or from process-related release

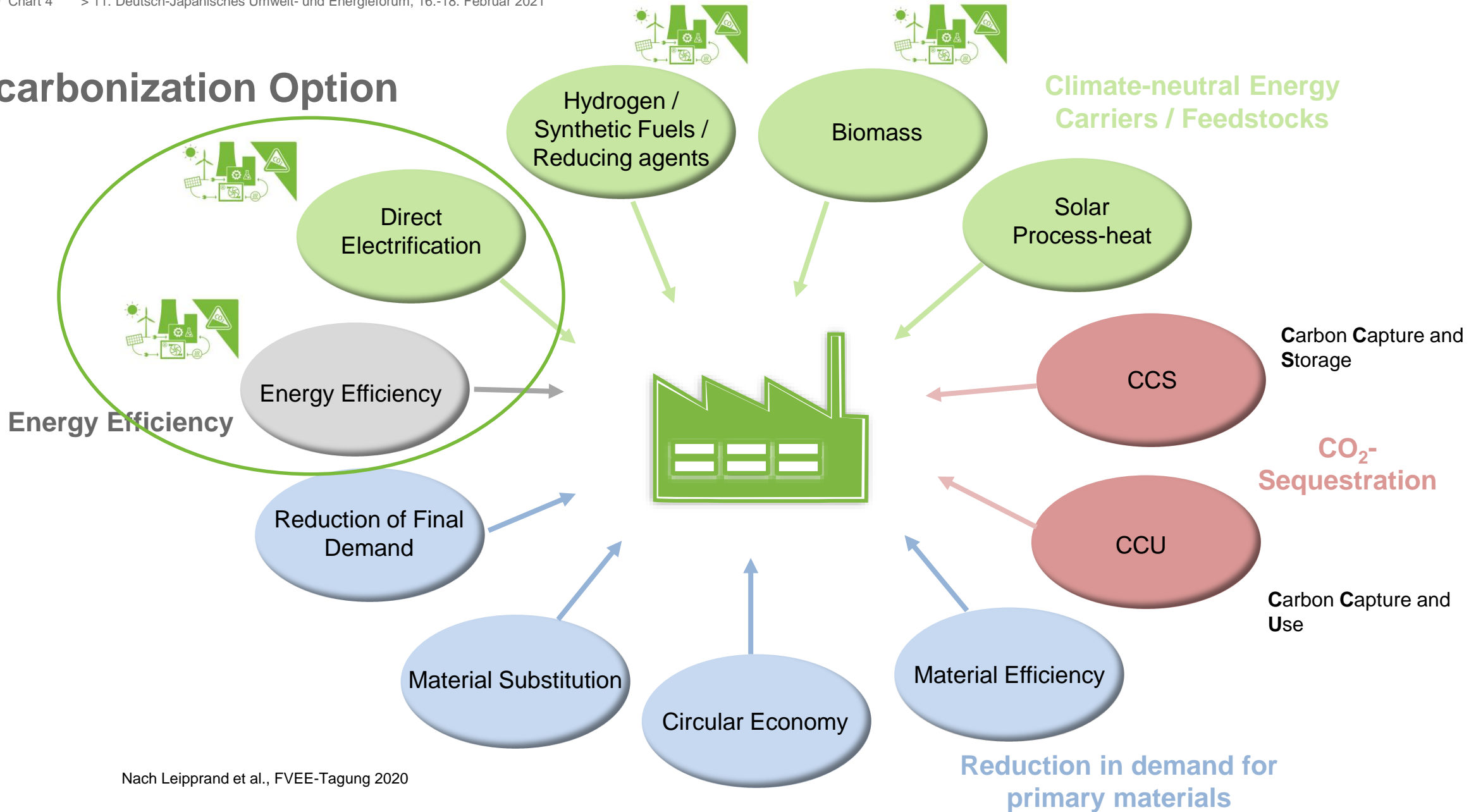
Our mission

- Offering solutions in the field of energy research and energy system transformation for industry
- Reduction of CO₂ and pollutant emissions from industrial processes and power plants



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Decarbonization Option



Nach Leipprand et al., FVEE-Tagung 2020

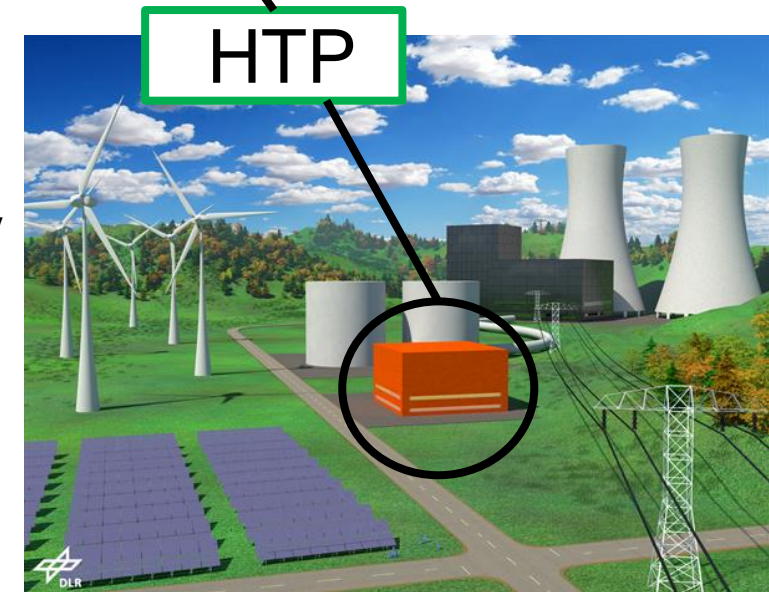
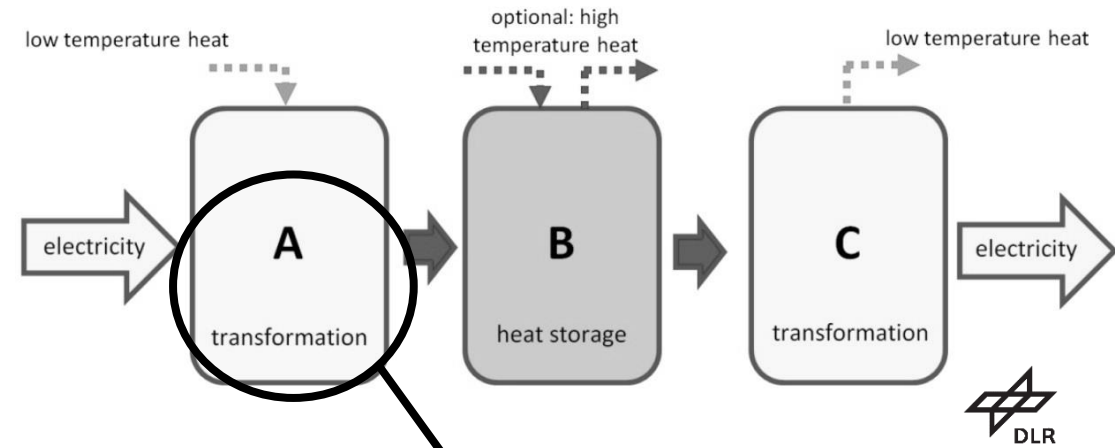


Why High Temperature Heat Pumps?

- **High demand for process-heat >150 °C in the industry**
 → Process heat at 100 – 550 °C accounts for 30 % of total heating and cooling demand in Europe*
- **Target range: 150 – 550 °C, megawatt scale**
- **Key Component in Carnot Battery concepts**
 → Improving round trip efficiency of Carnot Battery
- **Transformation of Coal Fired Power Plants in Lusatia region / Germany**
- **Boundary conditions and challenges:**
 - Use of industrial waste heat
 - Provision of heat and cold is possible
 - High efficiency of all components and the system
 - Adaptation to specific industrial process required

* Heat Roadmap Europe 2015

Carnot Battery Concept



Third Life Coal-Fired Power Plant



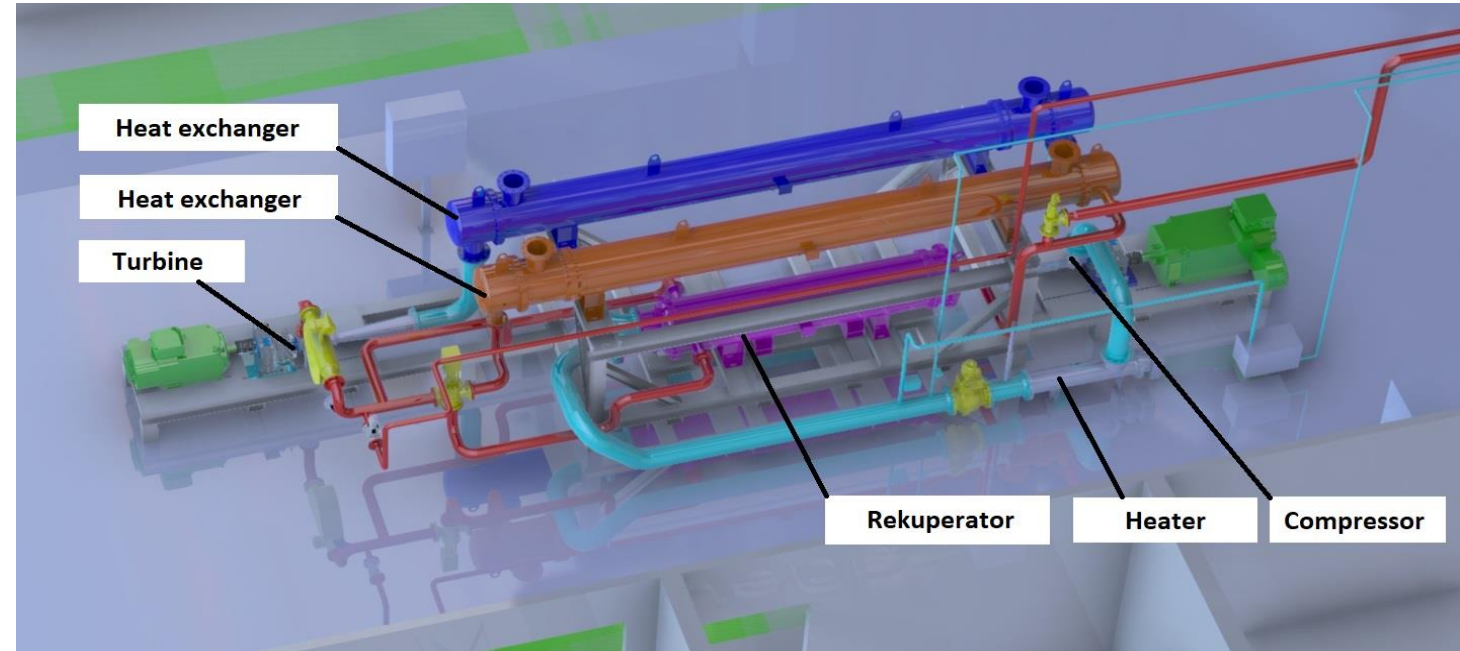
Development of HTHP

Concept for a prototype (pilot scale)

- Fully functional HTHP-System
- Reverse Brayton Cycle
- Modular design
- Extensive measurement and control equipment

Development strategy

- Brayton and Rankine cycle
 - Different working fluids
- Simulation suite for different model levels (fidelity)
- Large scale test facilities
- Identification of technology gaps for the components:
 - Compressor, turbine, heat exchanger



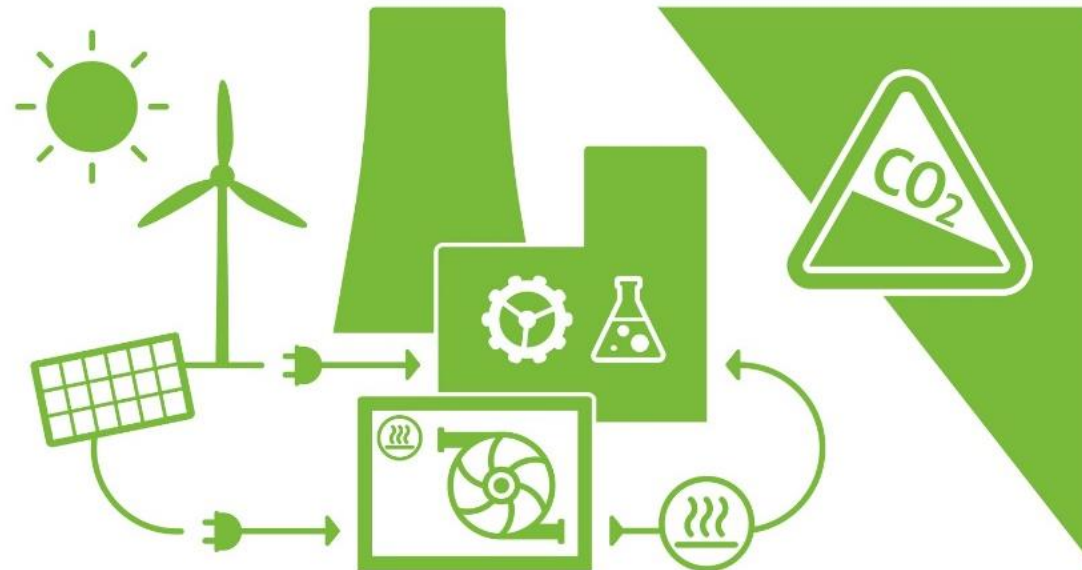
„Pilot CoBra“

- Prototype
- Flexible platform
- Preparation for large scale plant



Challenges to be Addressed

- **Development** of innovative heat pumps
- **Optimization and control** of the heat pump process and its components
- **System Integration** of high-temperature heat pump in large scale industrial processes



Outlook and Summary

- First prototype using air will be operational early in 2022
- Second prototype using steam operational early in 2023
- Institute founded in July 2019 is developing well
- One Institute, at two sites – Cottbus and Zittau
- Scientific work started in *all* research fields / departments

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