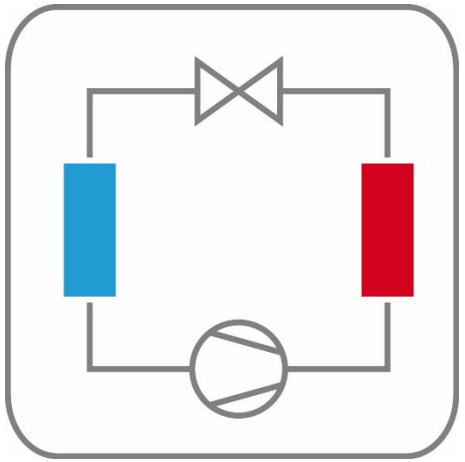
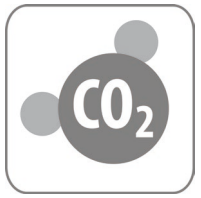


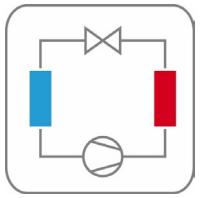
Fields of application of large-scale heat pumps and challenges in planning

Dipl.-Ing. Franziska Bockelmann

Background



- current CO_2-emission 7.75 t/a per person (energy-related – electricity and heat, in Germany)
  - 1 t/a would be climate compatible » reduction of around 90 % necessary
  - to achieve climate neutrality, major contribution by reducing emissions in the residential sector required and possible



- coupling of heat and electricity sector » achieved by using heat pumps
  - larger planning scope required
  - many challenges: heating source, electricity sector, transferability, …
  - large-scale heat pumps: framework conditions and prerequisites are given, technical components are available, individual solution required (more expensive than series products), modular system up to 3 MW and up to 130°C achievable

Planning of energy concepts with large-scale heat pumps

- demand assessment and load profiles
  - existing quarters: different building age classes and inhomogeneous structure → varying energy conditions of the buildings
  - use of existing heat sources on site

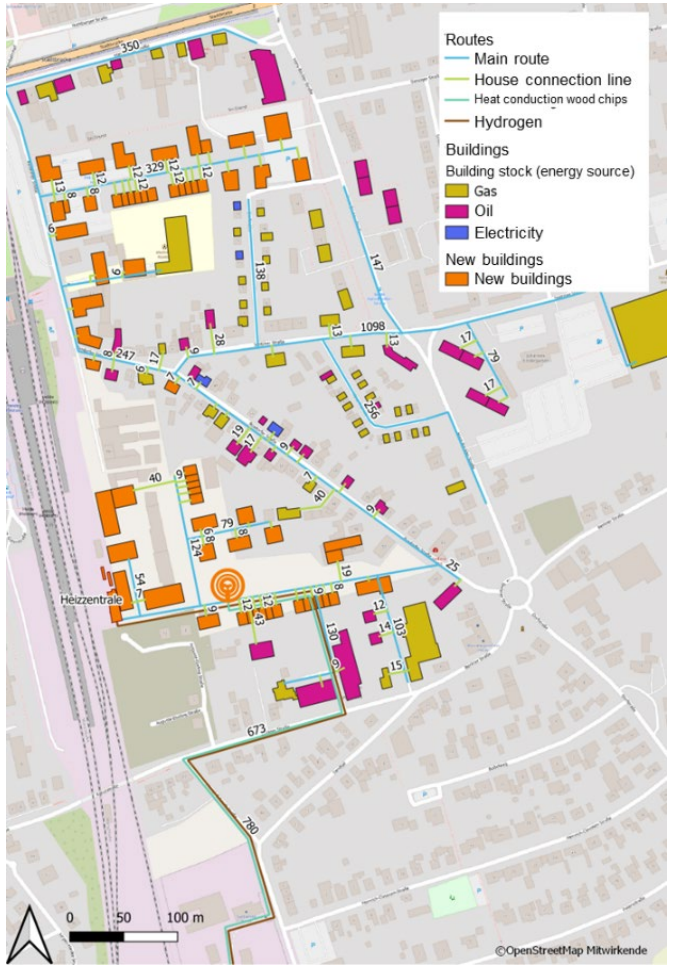
- simplicity and multifunctionality
  - to consider: scenarios with regard to future expansions, space requirements and use-specific needs
  - heat and electricity storage adds an additional requirement
  - to examine the expandability of the respective heating system and the combination with storage and photovoltaics (self-produced electricity)

application examples

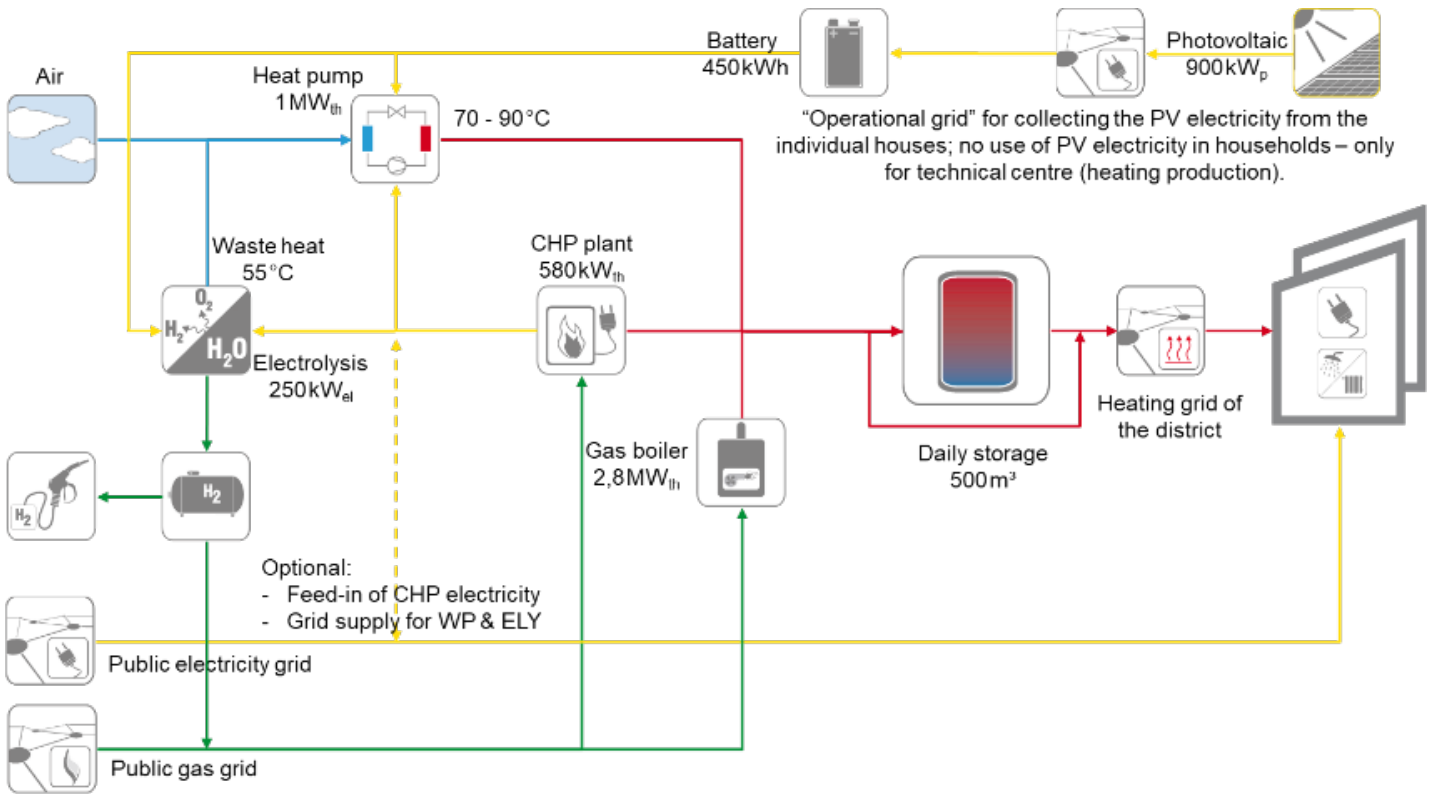
supply concepts for heating grids
with large-scale heat pumps

Project: district in Heide

- existing area of 20 ha with approx. 500 people
- diverse building structure (old and new): single- and multi-family-houses as well as non-residential buildings
- planned air/water heat pump should produce and provide:
  - ➢ temperature of at least 80°C
  - ➢ thermal output of 1 to 2 MW_{th}
- current supply: natural gas, oil and electricity
- planned stage:
  125 connected buildings (connection rate of 56 %)
  → 6,560 MWh/a heating demand



Project: district in Heide



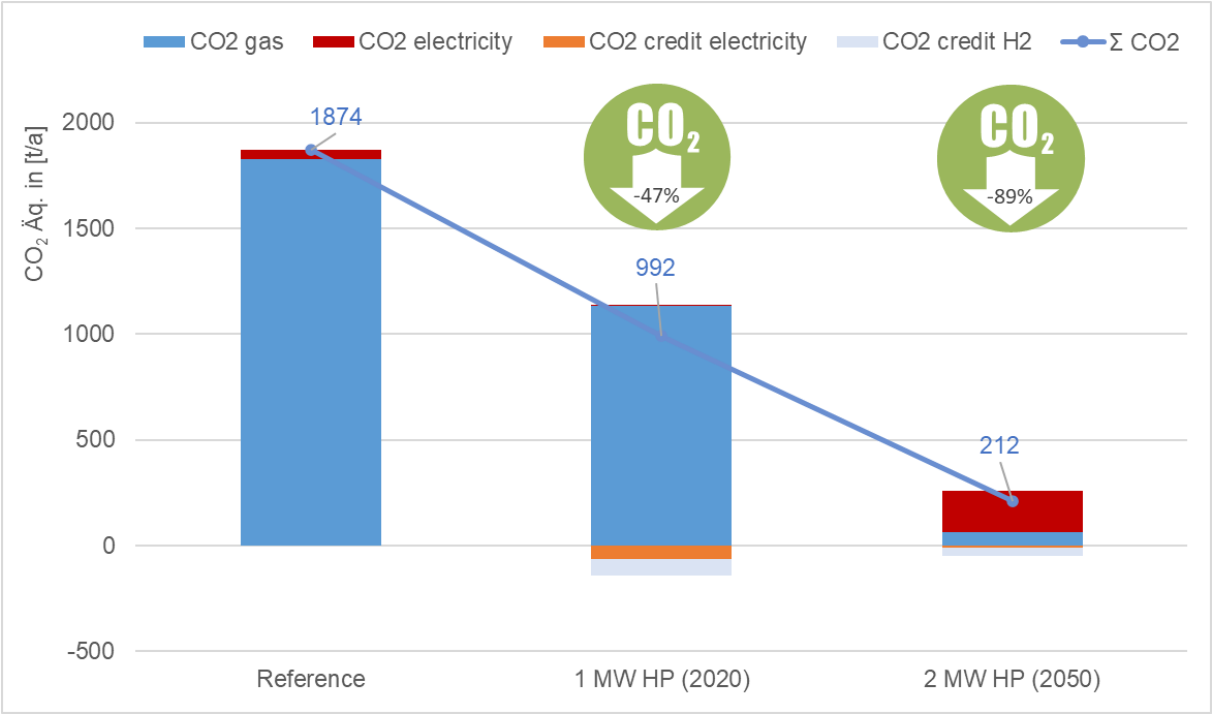
energy supply concept

- project aim: to design and implement a multimodal and sustainable energy supply system
- integration of heat pump
- integration of electrolysis for R&D purposes

Project: district in Heide

enormous ecological saving potential

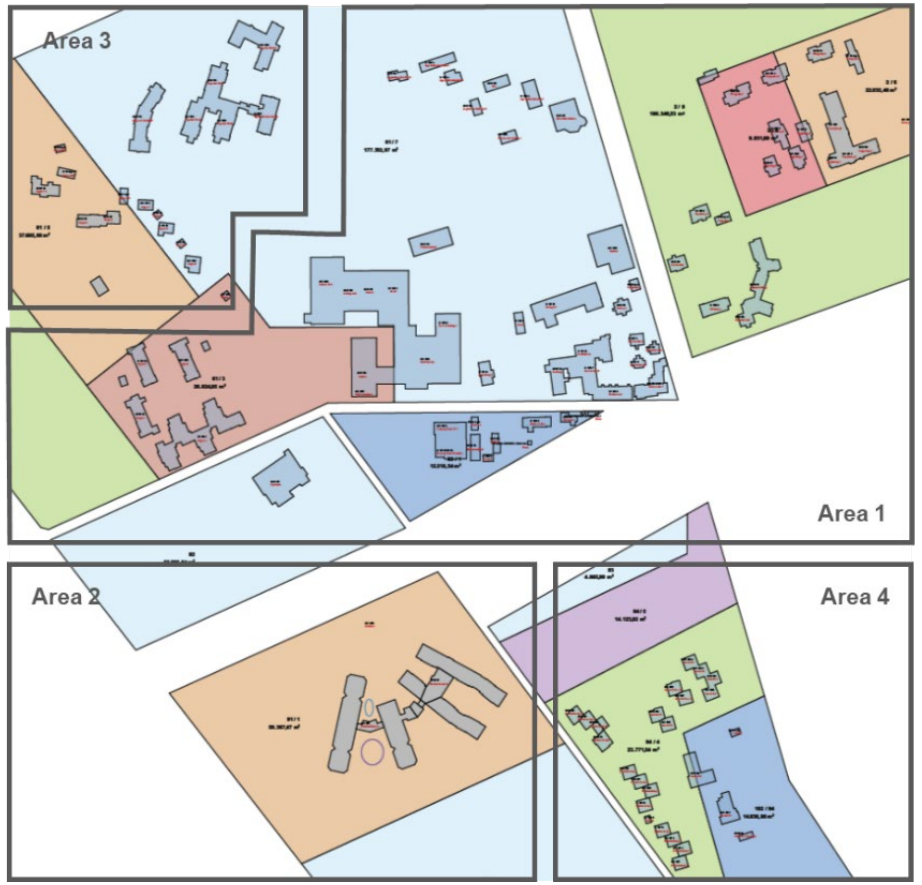
- annual CO_2 saving potential of 47 and 89% respectively compared to the current supply concept with gas boilers
- annual CO_2 reduction of around 882 to 1,662 tCO_2



Project: district supply with heating centers

aim of the project
convert existing heating centers to make buildings and facilities fit for the future - achieve climate neutrality for the properties

- four separate small heating grids
- 90 buildings with about 550 residential units
- heated floor space of about 50,000 m²
- different uses such as housing/assisted living, care facilities, workshop/warehouse, administration and social facilities
- current supply: gas boiler and CHP units



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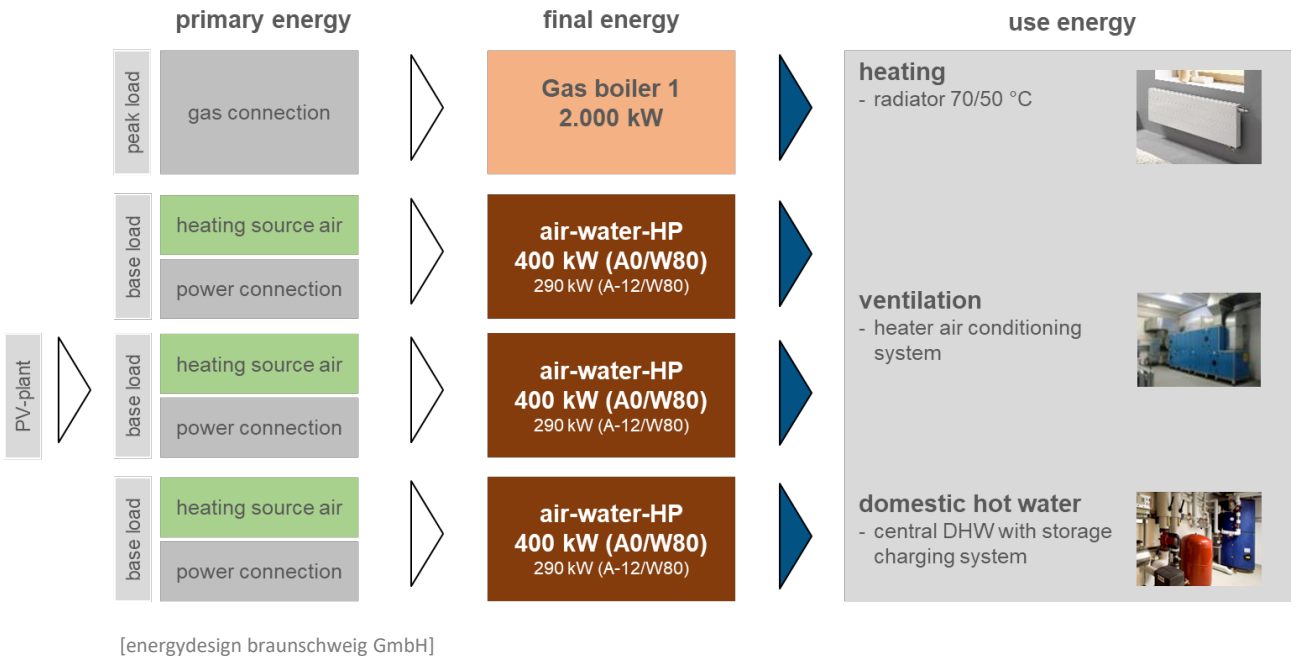
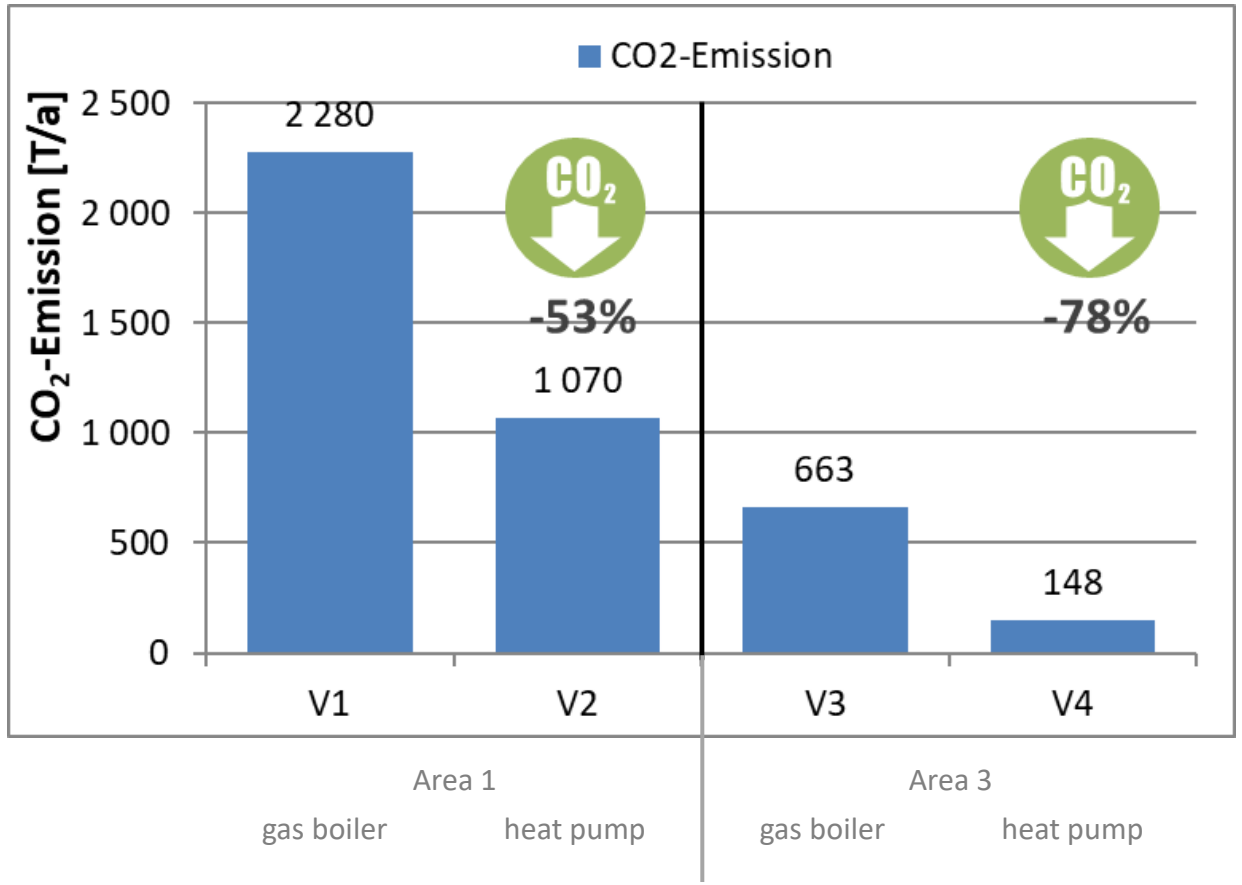
Project: district supply with heating centers



[energydesign braunschweig GmbH]

- planned air/water heat pumps should produce and provide:
  - ➢ temperature of at least 80 to 90°C
  - ➢ thermal output of 7 MW_{th}
- individual heating centers must cover a heat output of 485 kW to 5,145 kW
- operating temperature level of 80/60°C or 90/70°C
- bivalent supply system; 65 - 95% of the heat supply per heating center via air-water heat pumps

Project: district supply with heating centers



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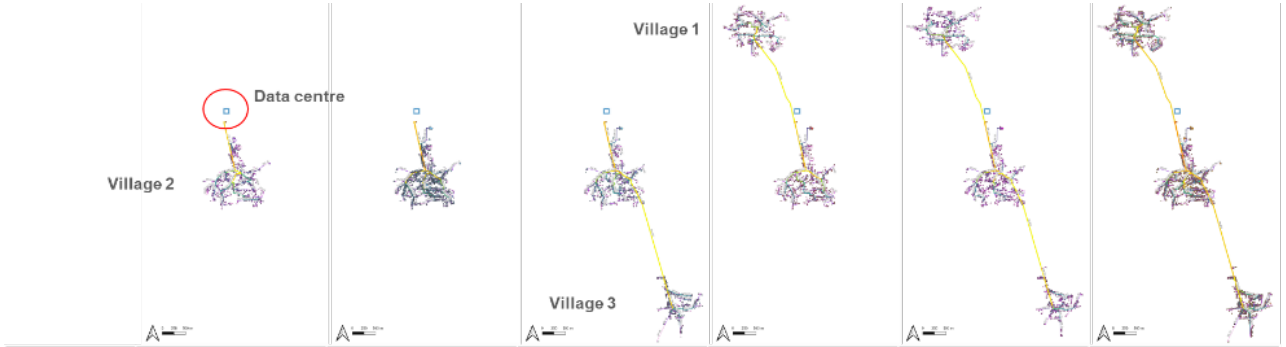
- annual CO_2 saving potential of 53 and 78 % respectively compared to the current supply concept with gas boilers
- annual CO_2 reduction of around 515 to 1,210 tCO_2

(CO_2 emission factors: natural gas 270 g/kWh, electricity 400 g/kWh, displacement electricity -700 g/kWh)

Projekt: data center as source (concept study)

aim of the project
to use the waste heat from a data center as a source for a new district heating network

- located between two rural villages with approx. 2,000 to 2,500 inhabitants each
- planned air/water heat pump must produce and provide:
  - ➢ temperature of 80 to 90°C
  - ➢ thermal output of 10 MW

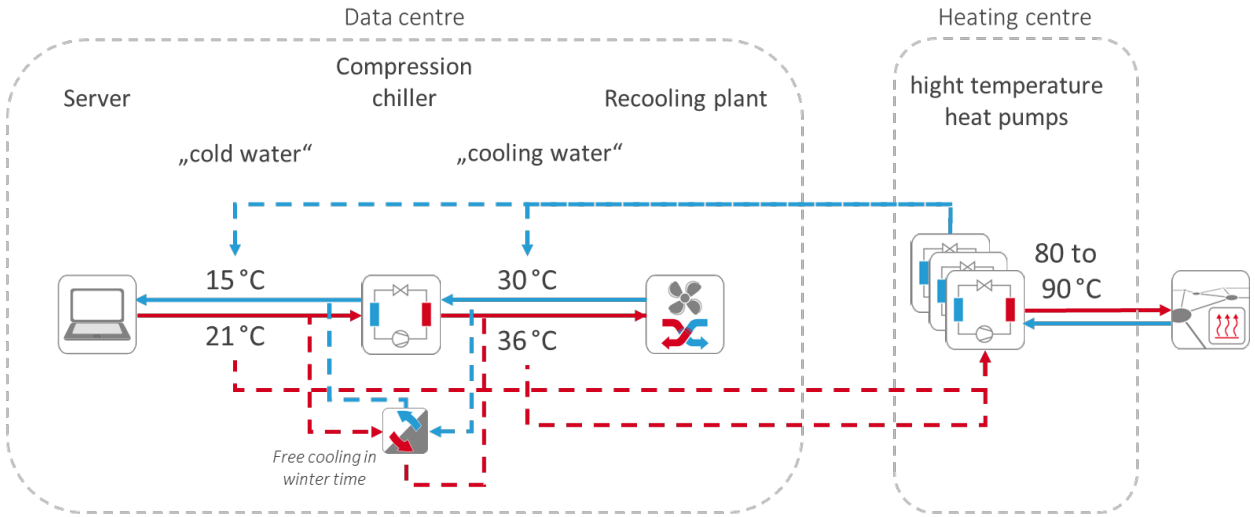


	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	Village 2	Village 2	Village 2 + 3	Village 1 + 2	Village 1 - 3	Village 1 - 3
Connection to the grid	60%	100%	60%	60%	60%	100%
Inhabitants	1,455	2,432	2,076	2,569	3,183	5,300
Buildings	482	804	735	847	1,099	1,833
Total heating demand	16.2 GWh	28.5 GWh	25.7 GWh	28.8 GWh	37.0 GWh	62.5 GWh
Total heating capacity	5.8 MW	10.0 MW	9.1 MW	10.3 MW	12.4 MW	20.1 MW
Route length	14.0 km	16.0 km	22.8 km	27.1 km	35.5 km	39.2 km

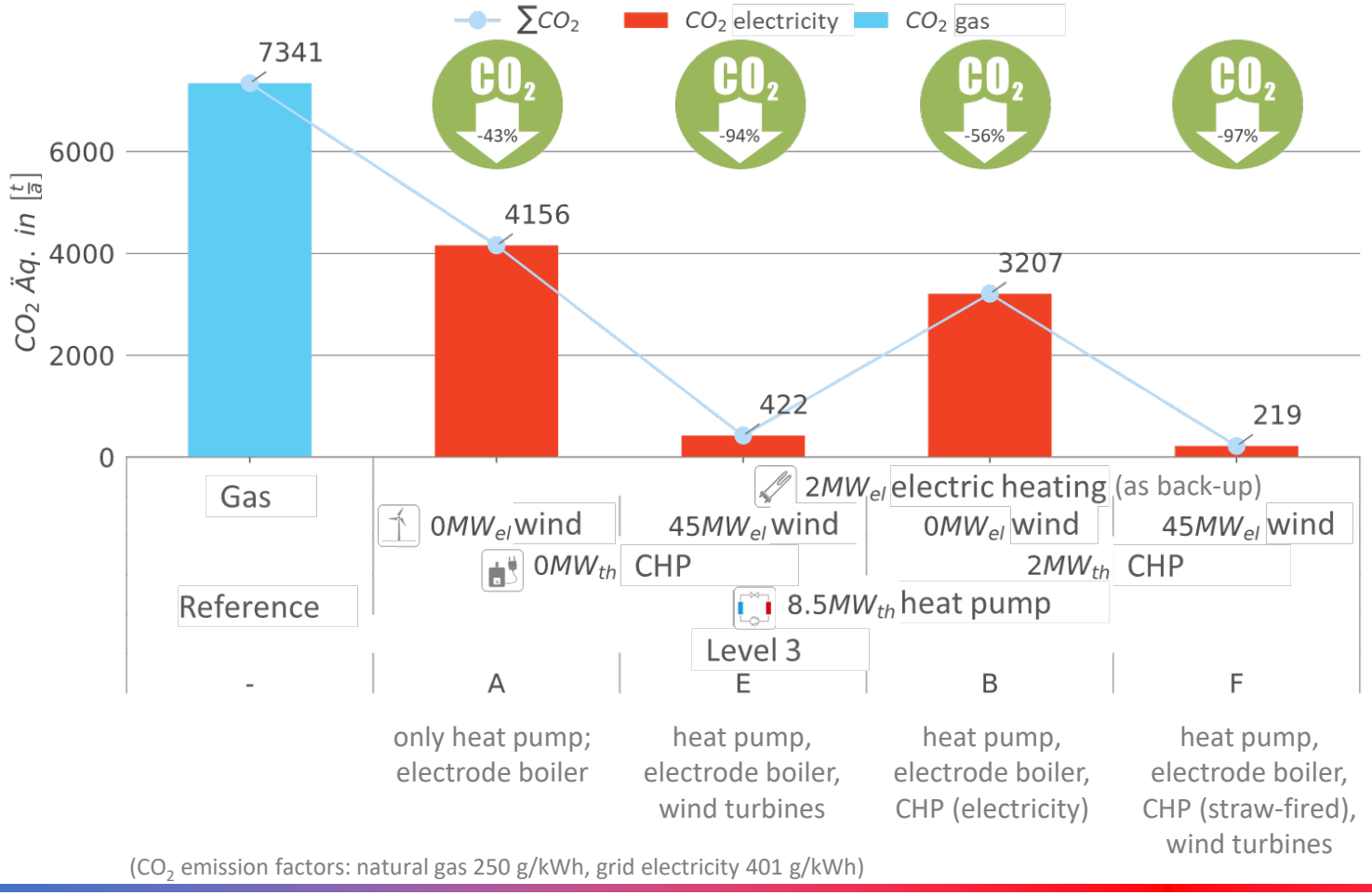
Projekt: data center as source (concept study)

Supply concept

- available waste heat throughout the year at a temperature level of 20 - 36°C
- approx. 7 - 8 MW waste heat output (full expansion) results in a heat supply for the grid of 87,600 MWh/a > total heat demand of the three villages
- storage of heat required: large heat storage tank and additional heat generators



Projekt: data center as source (concept study)

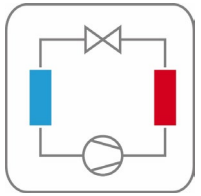


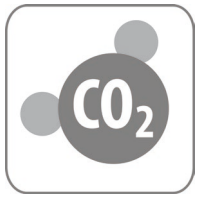
(CO_2 emission factors: natural gas 250 g/kWh, grid electricity 401 g/kWh)

enormous ecological saving potential

- annual CO_2 saving of about 43 - 97 %
- annual CO_2 reduction of around 3,185 to 7,122 tCO_2

Conclusion





- Aim: become greenhouse gas neutral by 2045 (Germany) -> how to proceed:
  - heat pumps have already become standard for heating appliance in new buildings
    but: for commercial sector, in existing buildings and at the neighborhood level, heat pumps are rarely seen as ideal technology
    → large-scale heat pumps will therefore play an important role
- Large-scale heat pumps
  - are very diverse in use **but** need a special design that has to be planned according to the specific application.
  - represent a replacement and exchange of gas boilers and are integrated into the existing supply.
  - Concepts changing from a decentralized to a centralized supply.
  - By exchanging the old heat generators to a heat pump the CO_2 emissions can be reduced more than 50%.

Thank you for your attention!