Concepts of regional energy transition

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ENERGY ECONOMICS AND ENERGY SYSTEM TECHNOLOGY

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Energy Informatics

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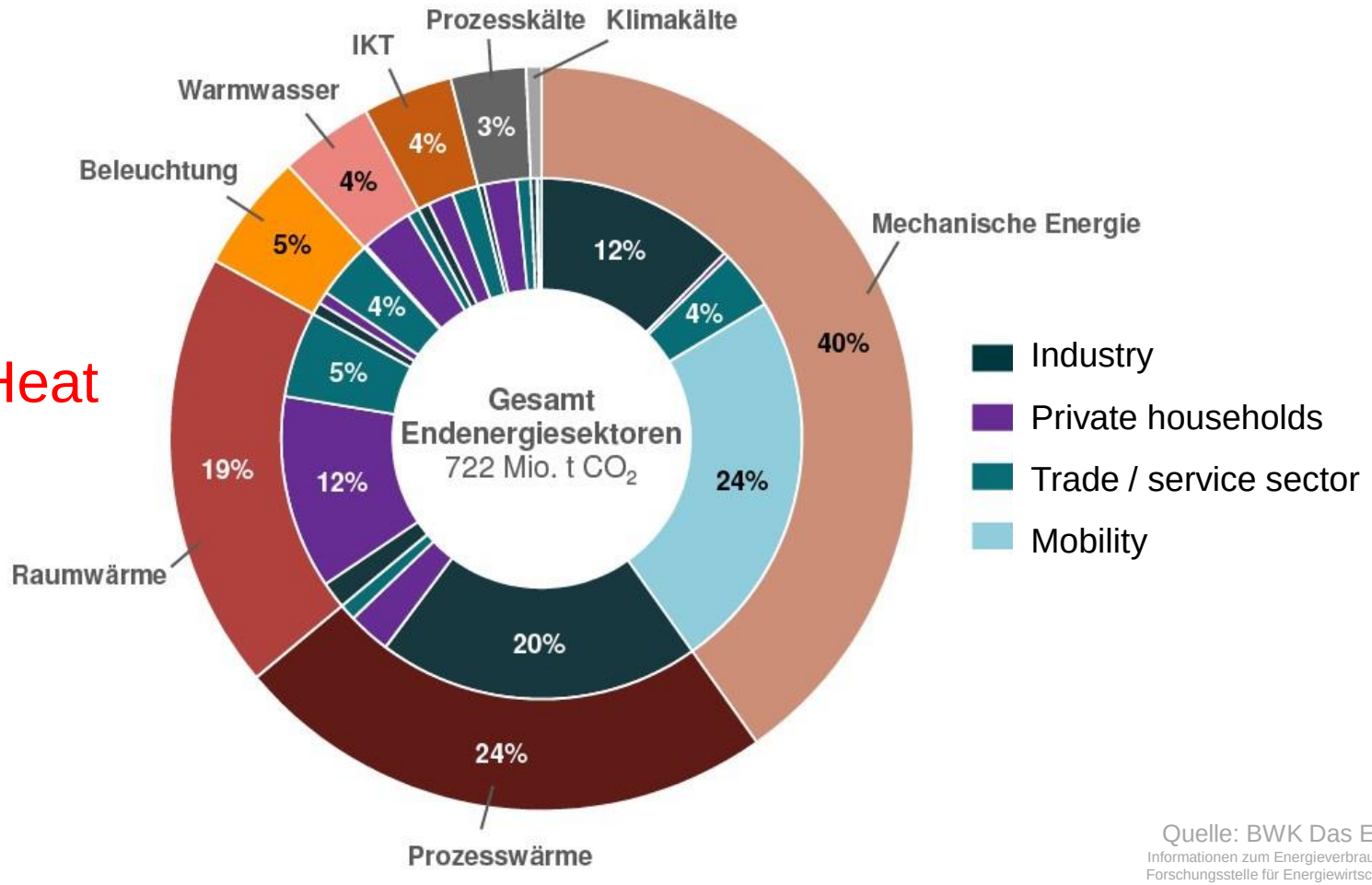
and System Design

Energy Meteorology and
Geographic Information Systems

CO2-Emissions of different end energy sectors in Germany

47% Heat



Quelle: BWK Das Energiefachmagazin:
Informationen zum Energieverbrauch in Deutschland 2007. München: Forschungsstelle für Energiewirtschaft, Lehrstuhl für Energiewirtschaft und Anwendungstechnik der Technischen Universität München, 2011

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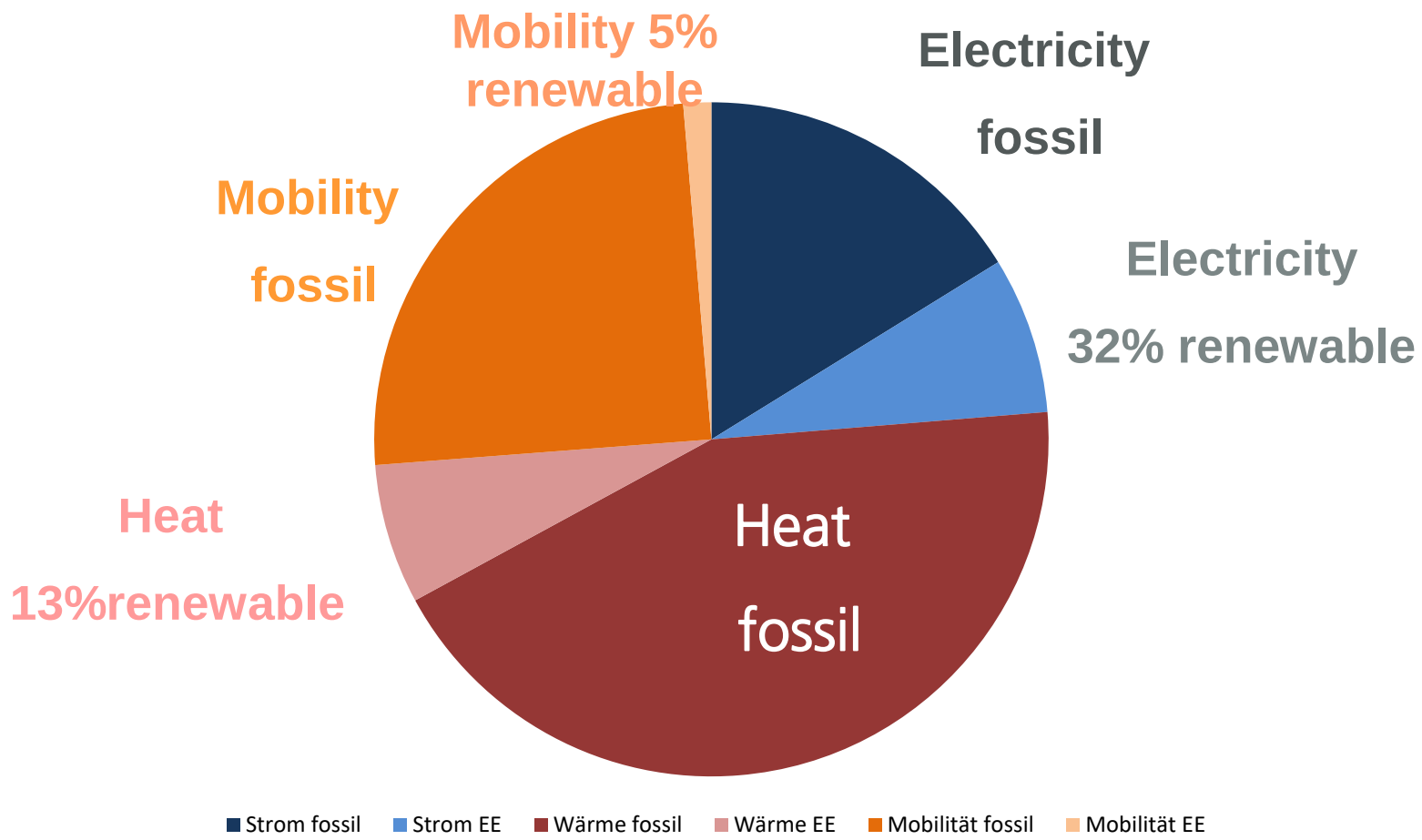
Renewable fractions of end energy use in Germany



Quelle: BEE Studie Sektorkopplung IWES/E4

Challenges for the realisation of the „Energy Transition“

- Cities and buildings are main consumer of energy
- New buildings are constructed as “small power plants”
- Retrofit rates need to be increased for a more efficient use of energy
- Developments are focussing on the **community / district level**

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Solutions for urban districts

Innovative heat supply on a community level

„Low temperature district heating is a key technology for an efficient integration of renewable energy sources and waste heat in our energy systems.“

IEA DHC Annex TS1

IEA DHC|CHP

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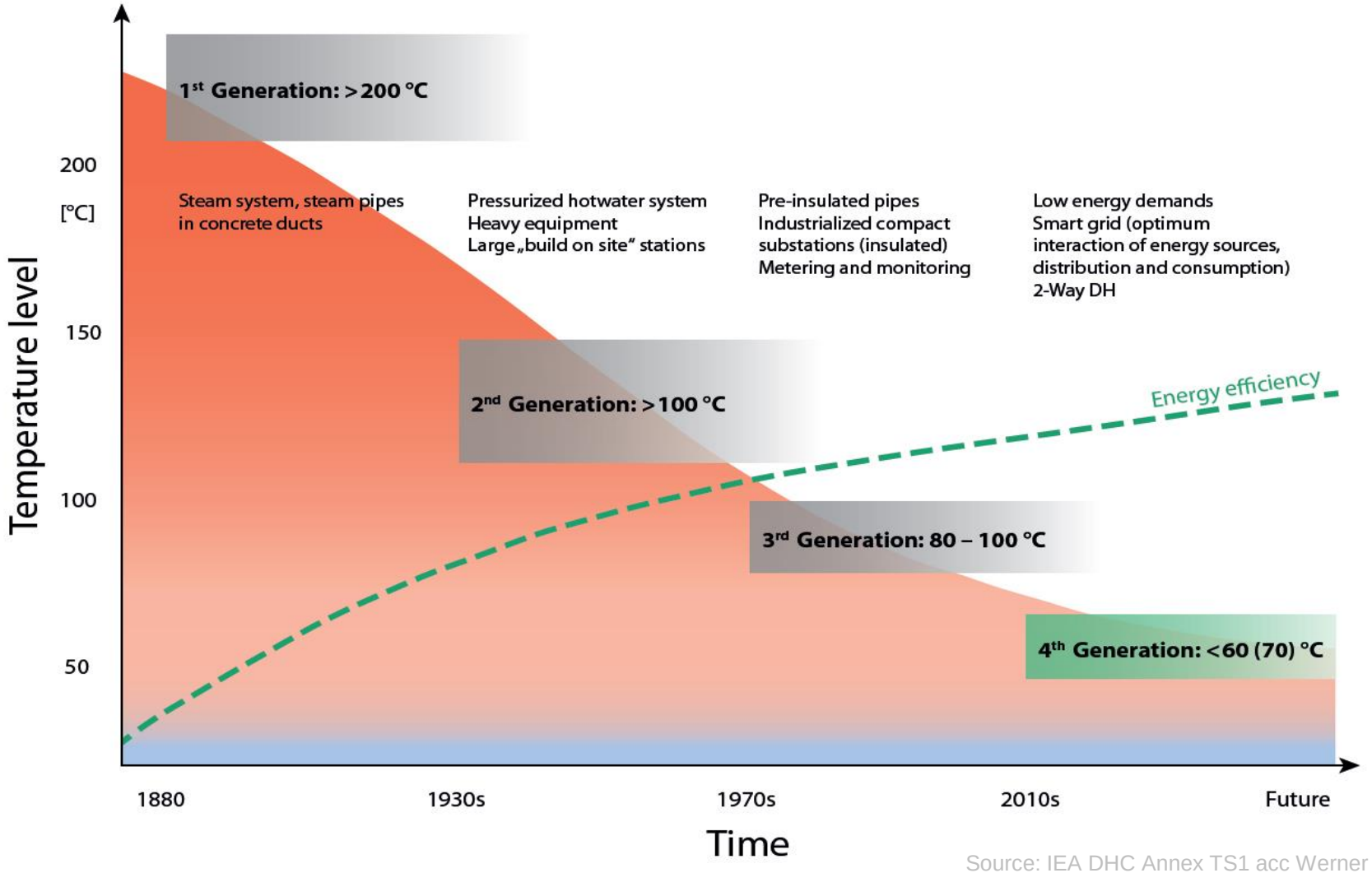
Low temperature district heating



Source: IEA DHC Annex TS1 acc Werner and Fredriksen 2014

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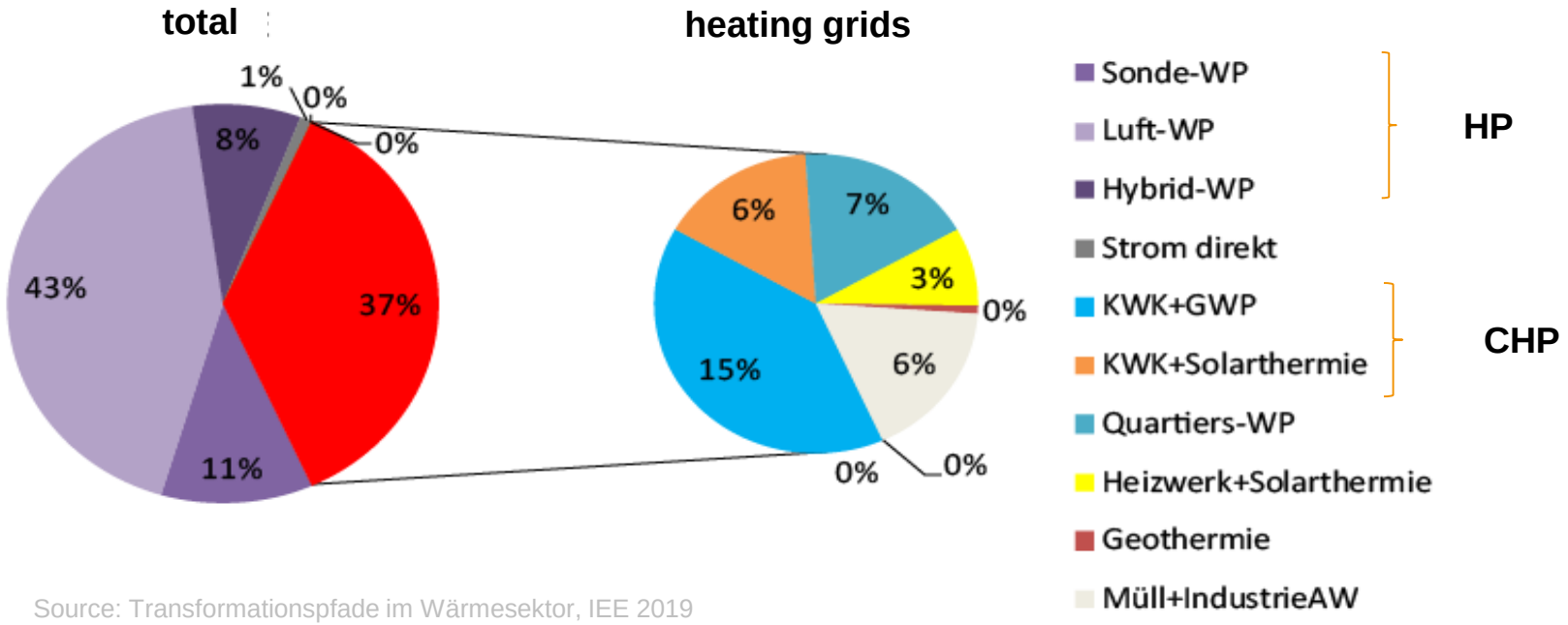
Why is there a need for action?

- In Germany (in contrast to the Nordic countries), only a minor part (11%) of heat demand is covered by (mostly older) district heating (DH) networks → low public awareness
- Innovations in DH are increasingly important, due to necessary decarbonization of the heating sector by e.g. the use of renewables or waste heat
- New technologies and supply strategies are required for e.g. the expansion, the transformation of the (existing) networks and sector coupling
- Consideration of future developments of new business models, cost-effectiveness DH supply but also acceptance and incentives.
- Examples for successful implementation of DH in Germany and especially in the Nordic countries are available. Gained "Lessons Learned" have to be used to facilitate sustainable DH systems.

To reach the German Climate Goals
the heating markets and systems need to be changed

- For the mass market single family buildings air or ground source as well as hybrid heat pumps will dominate (total 62%)
- **Expansion of district heating from today 11% to 37%**
  - Mainly larger heat pumps
  - But also solar thermal plants, geothermal plants, waste heat, waste incineration



Source: Transformationspfade im Wärmesektor, IEE 2019

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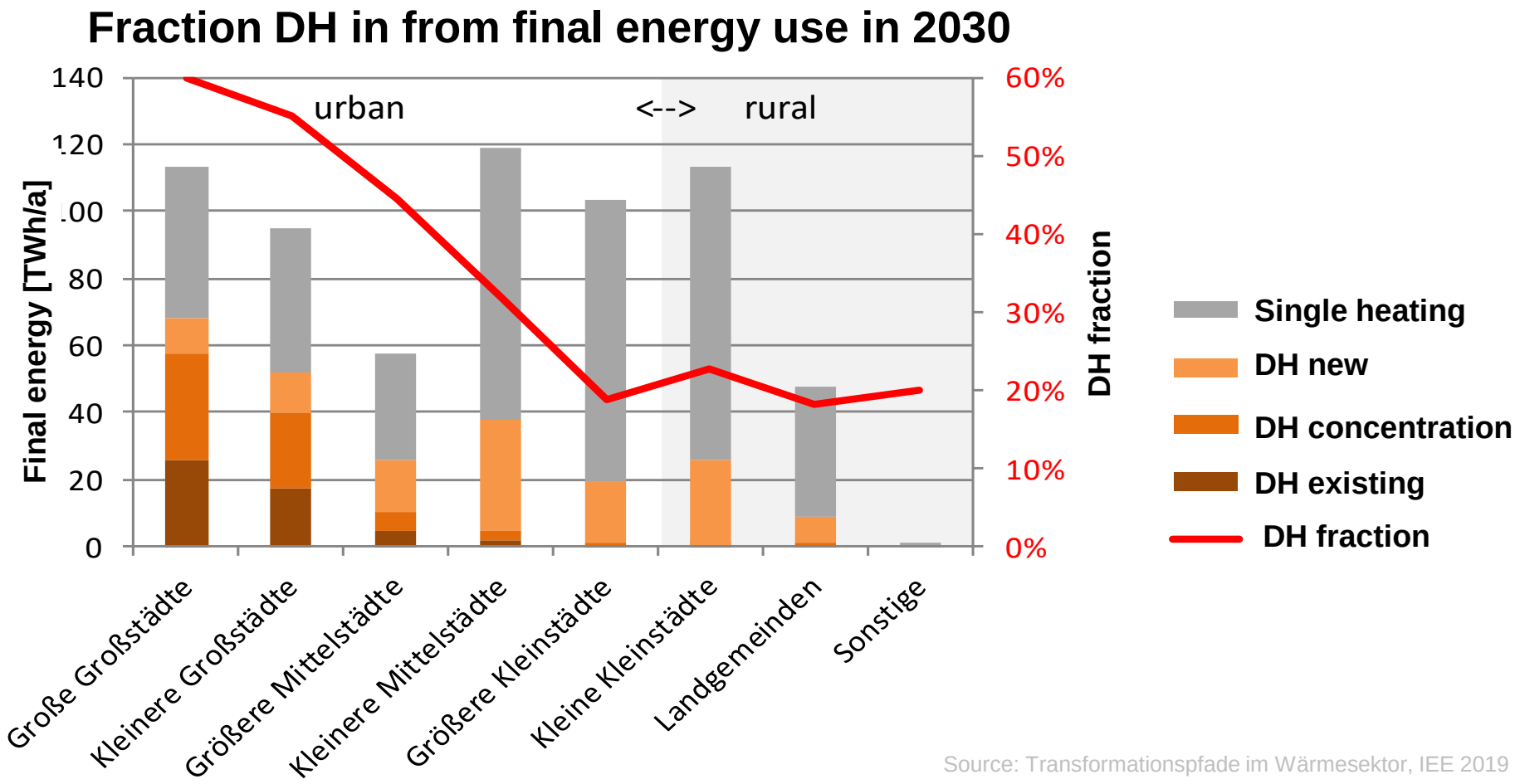
Expansion of district heating

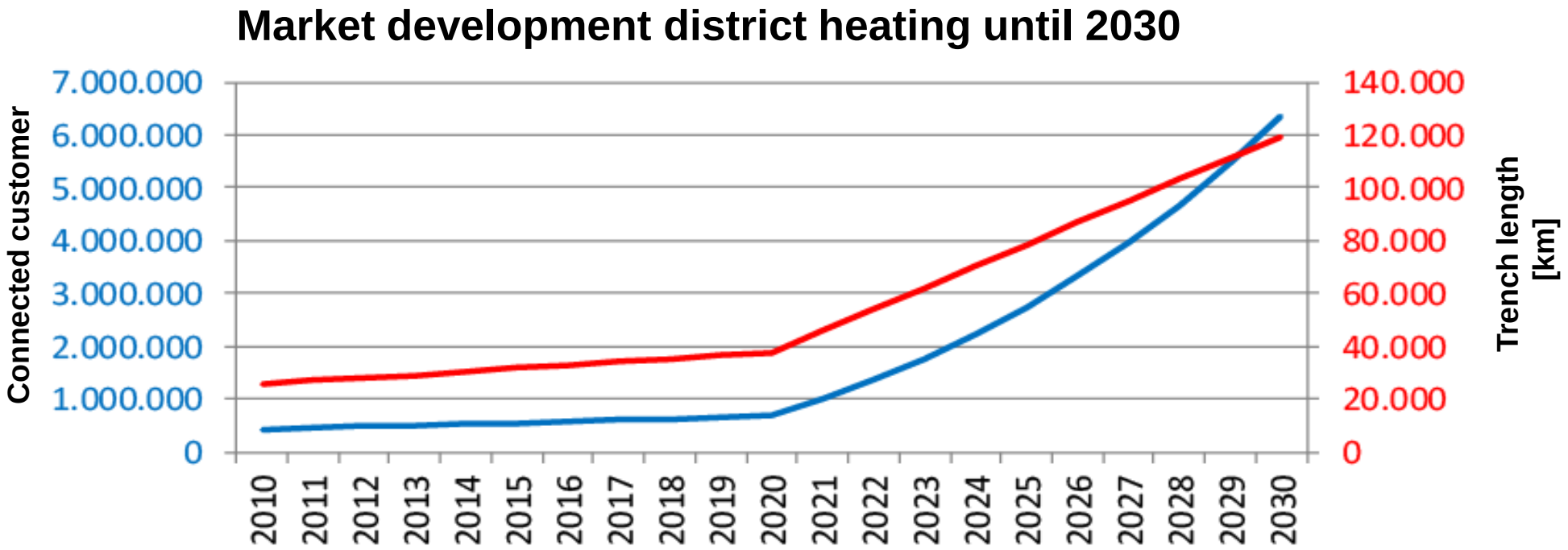
- Expansion depending on the size of the municipality



Source: Transformationspfade im Wärmesektor, IEE 2019

Expansion of district heating grids

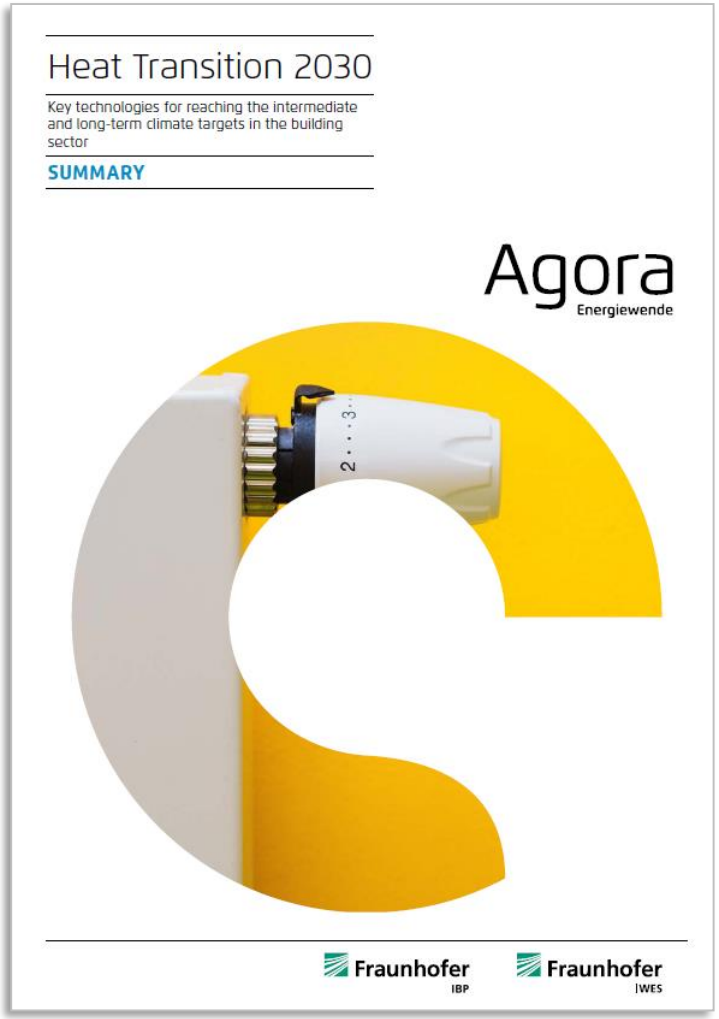
- Expansion of district heating systems need to happen until 2030.
- Within 12 years district heating grids need to be expanded from 11 % to 37 % final energy use. This is a **factor 6 to 7** compared to todays developments.



Source: Transformationspfade im Wärmesektor, IEE 2019

Other studies: Extension of DH until 2030 needed!

Agora: Heat Transition 2030 (2017)



Three main pillars for the German Heat Transition 2030

- Increase energy efficiency, reduced consumption by about 40%
- Implementation of heat pumps, about 5 to six million are needed.
- Expand district heating grids from 10% to 23%

Other studies: Extension of DH until 2030 needed!

AGFW: The German Heat and Power association

- 70% district heating in 70 larger Cities in Germany (2015)

- 40% district heating in 40% of German municipalities (2018)

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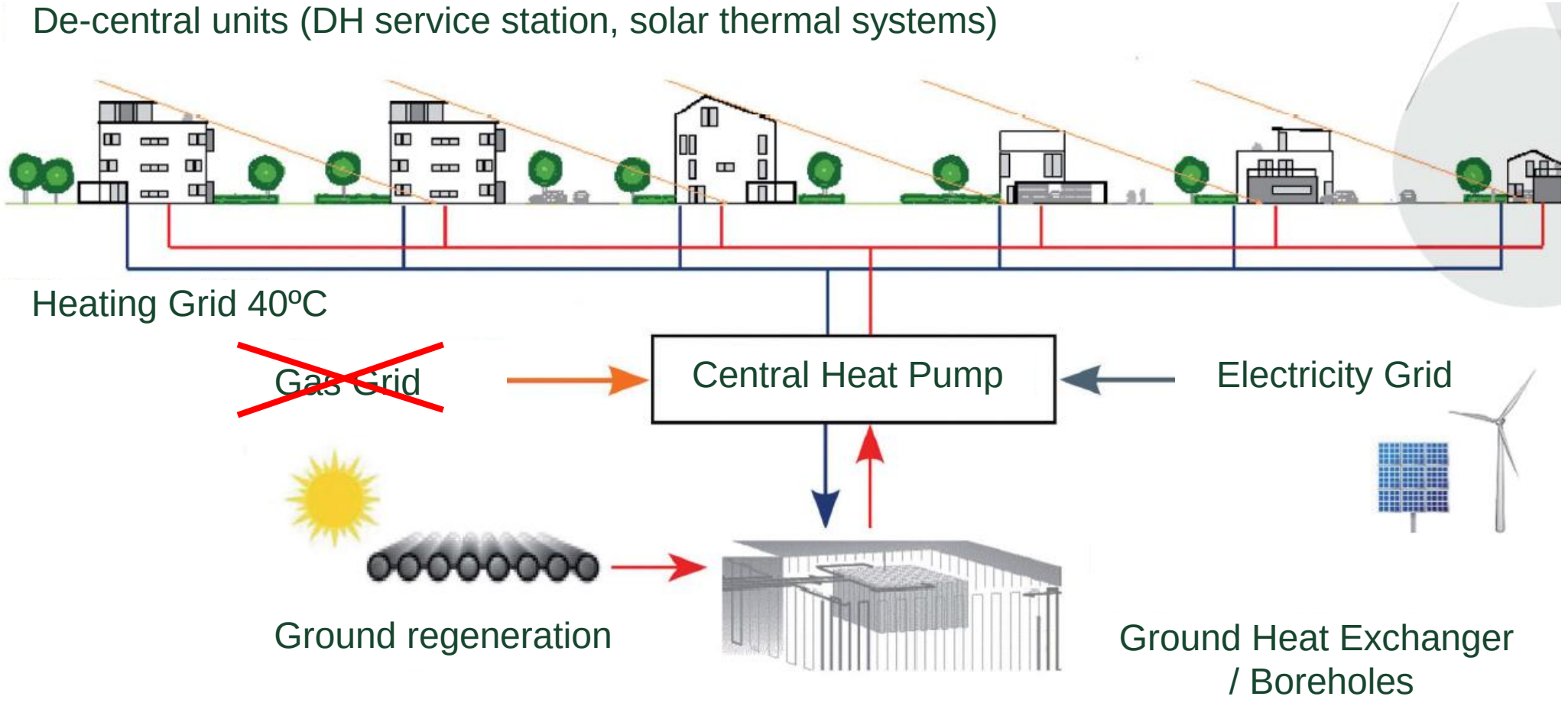
Geo-Solar District Heating in Kassel



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documenta Stadt

AGFW

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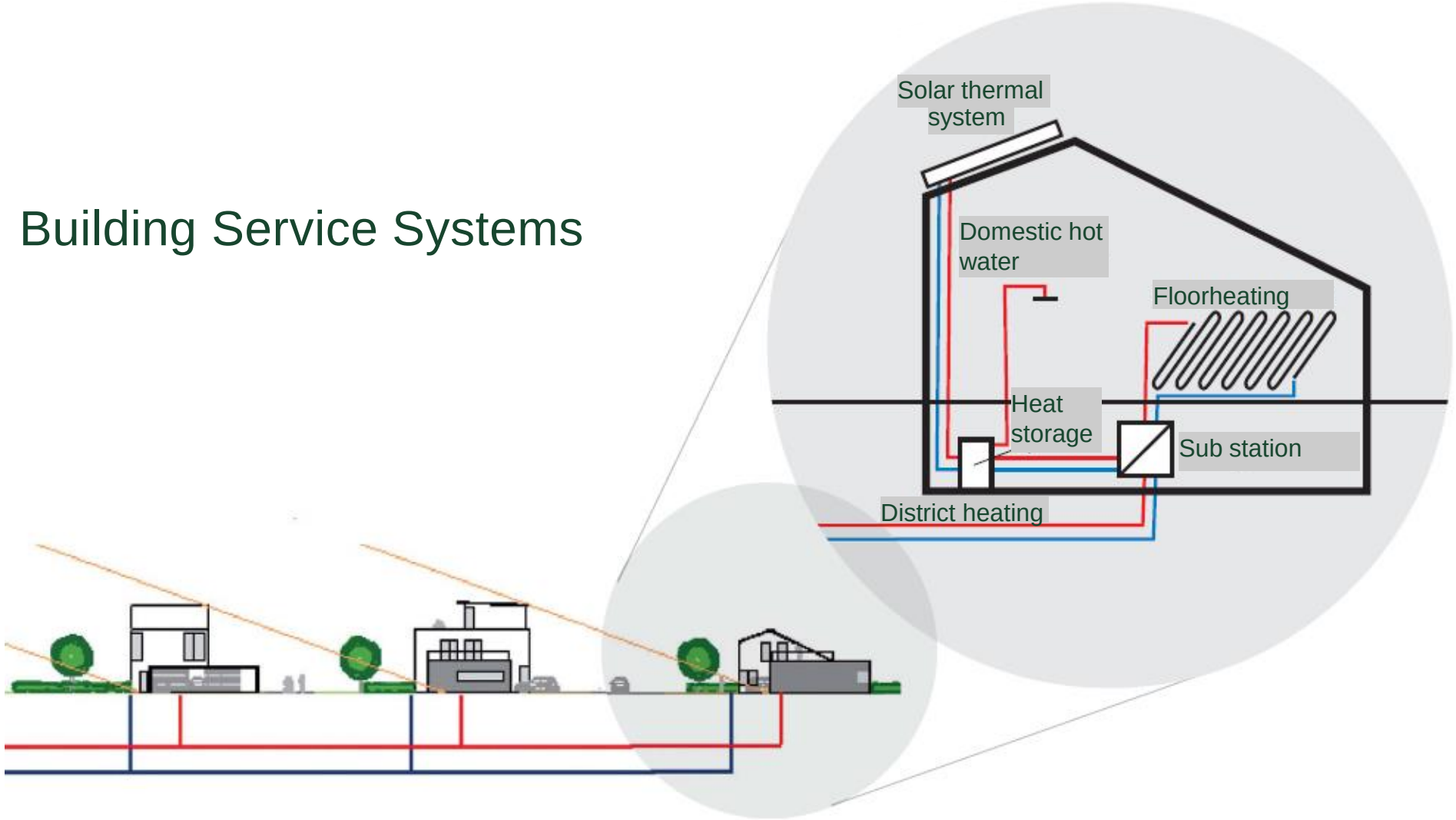
Geo-Solar District Heating in Kassel

Building Service Systems



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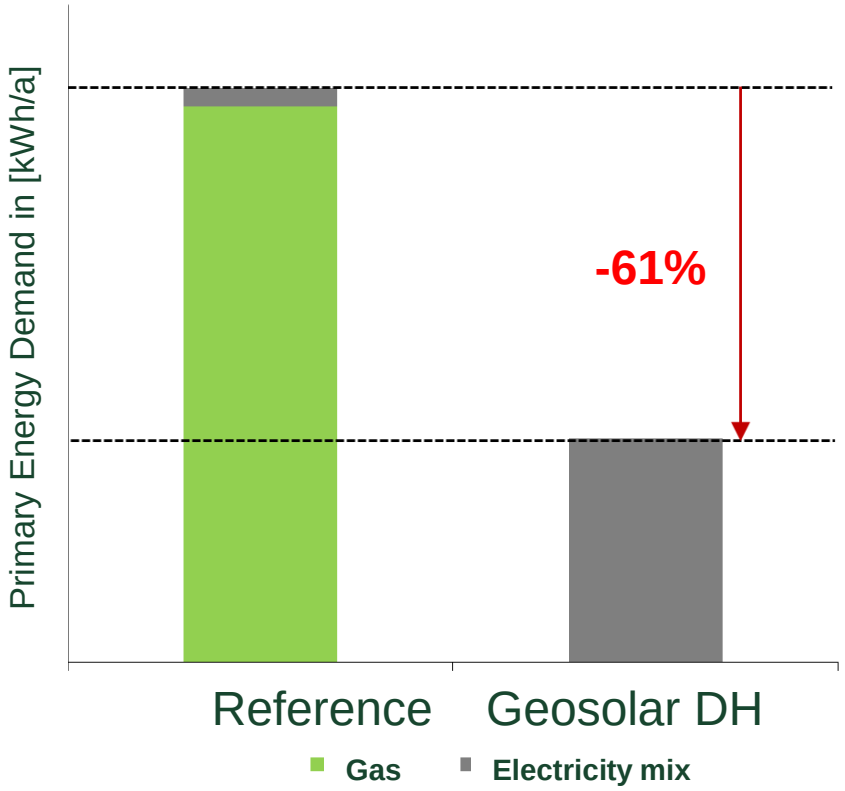
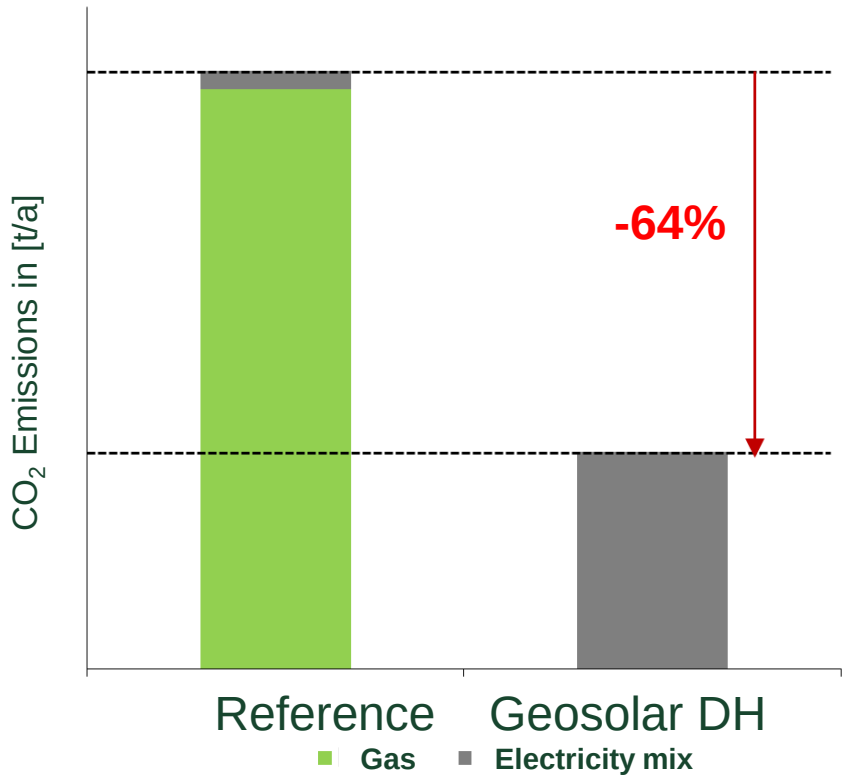
Geo-Solar District Heating in Kassel
Results - Ecological Assessment

Primary Energy Demand



CO_2 Emissions



* Acc EnEV16 for electricity mix with primary energy factor 1,8 and CO_2-Emissions 0,347 kg/kWh

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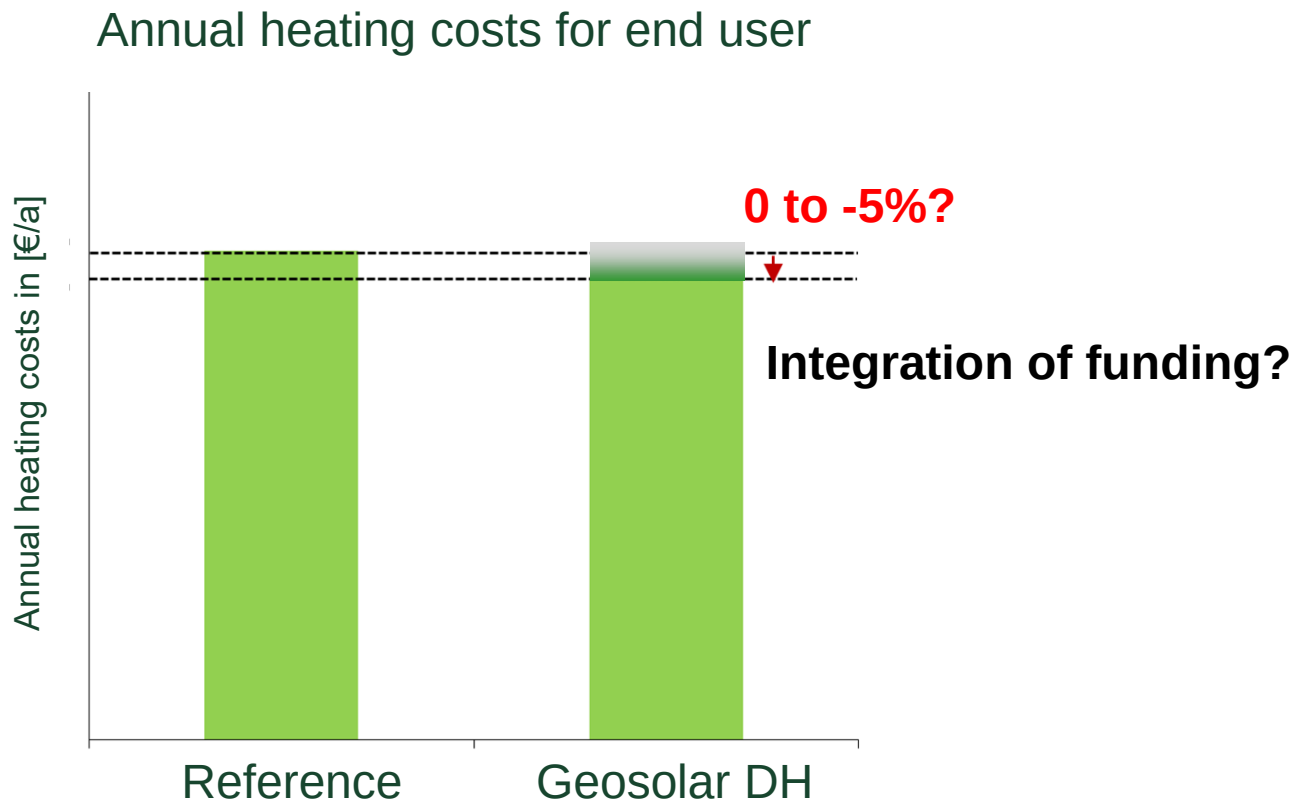
Geo-Solar District Heating in Kassel
Results - Economical Assessment



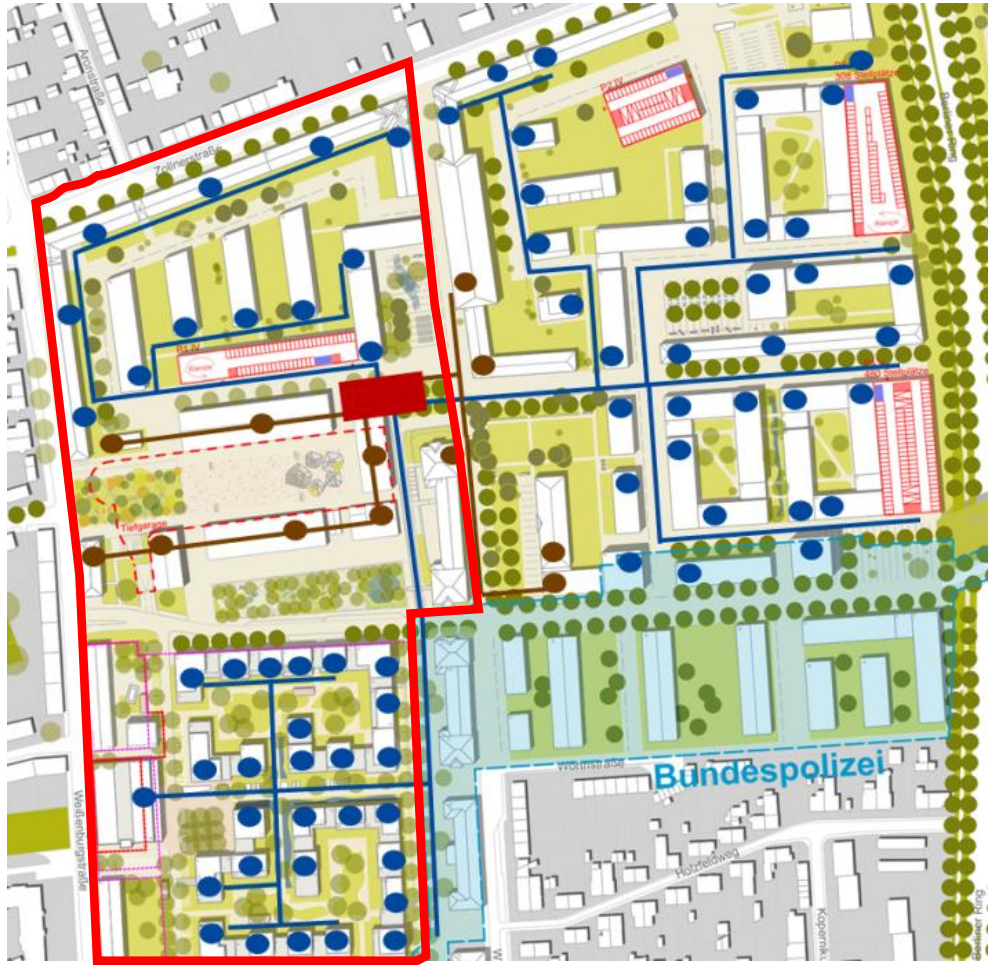
The Lagarde Campus – Bamberg (Germany)

- STRUCTURE:
  - 70% new buildings
  - 30% existing (partly protected)
- USE:
  - 59% dwellings,
  - 34% offices,
  - 4% trade,
  - 3% culture
- Various building standards
- Heat demand 10 GWh

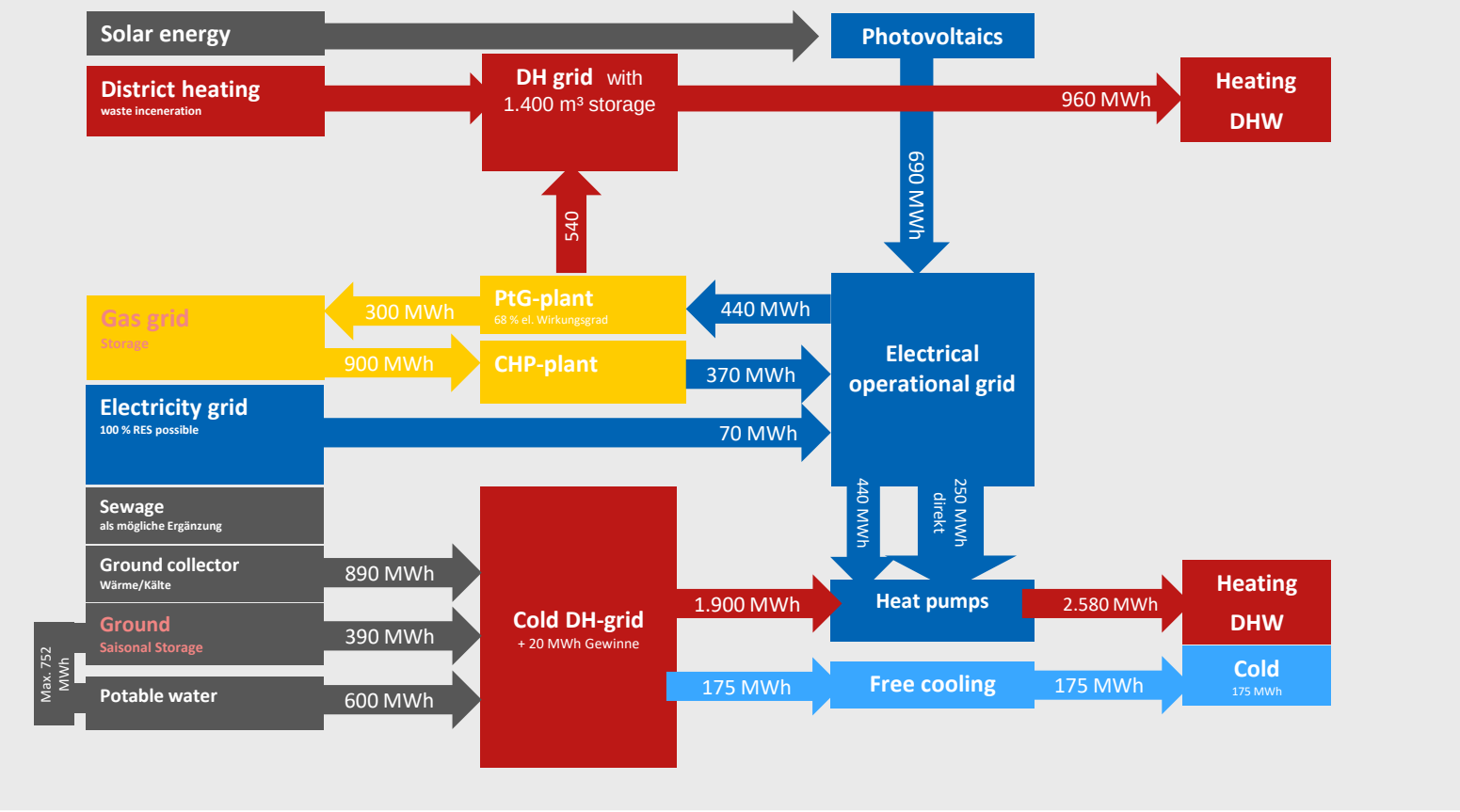
The Lagarde Campus - Bamberg

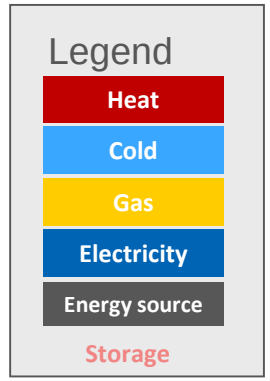
Heating system

- Cold-DH-grid
- LT-Grid
- Energy hub
- Parking
- Lagarde-West
  - Boundary for funding
  - uncertain City development



Resulting energy supply concept



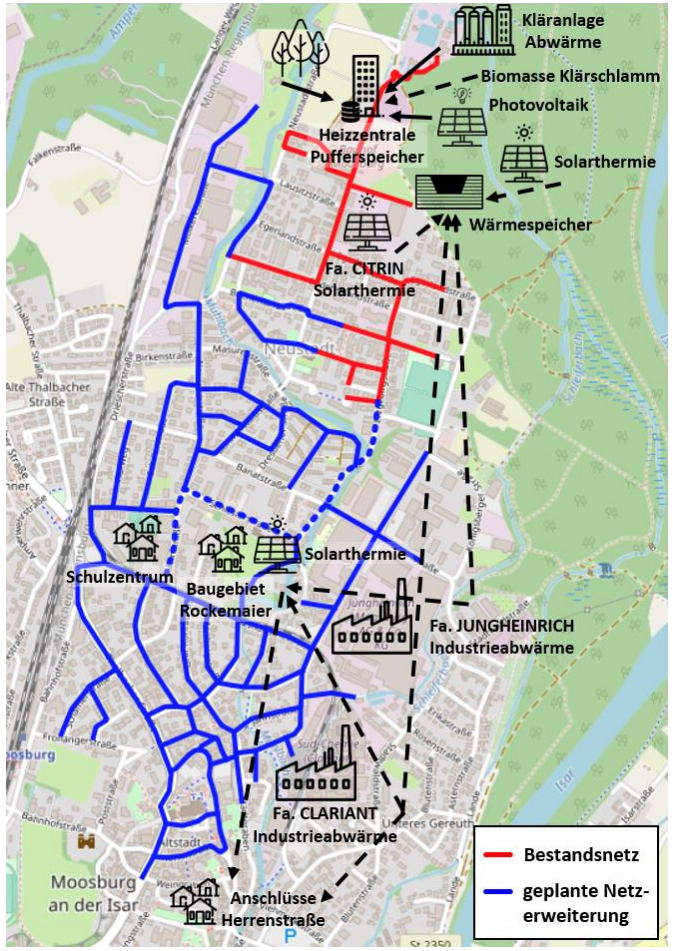


Moosburg an der Isar (Germany)

- Transformation and expansion of an existing heating network
- Utilization of industrial waste heat at rather low-temperature
- Heat supply by solar thermal system and decentralized heat pumps
- Seasonal and short-term thermal energy storage are used for load-shifting
- Cascading for the appropriate reduction of the temperature level

➢ Approach for analysis of hybrid energy networks: Electricity market-appropriate feed-in of energy from PV (power-to-heat)

➢ Preparations for the implementation of the energy concept are currently underway!



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Some more examples from an international co-operation activity

IEA DHC Annex TS2

Implementation of low temperature district heating systems

=> The purpose of Annex TS2 is to facilitate the wider *implementation* of 4GDH systems.

- Participating countries:
  Austria, Denmark, Germany, Norway, Sweden, and United Kingdom.

Coordination by Halmstad University/Sweden:
Kristina Lygnerud & Swen Werner

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Some more examples from an international co-operation activity

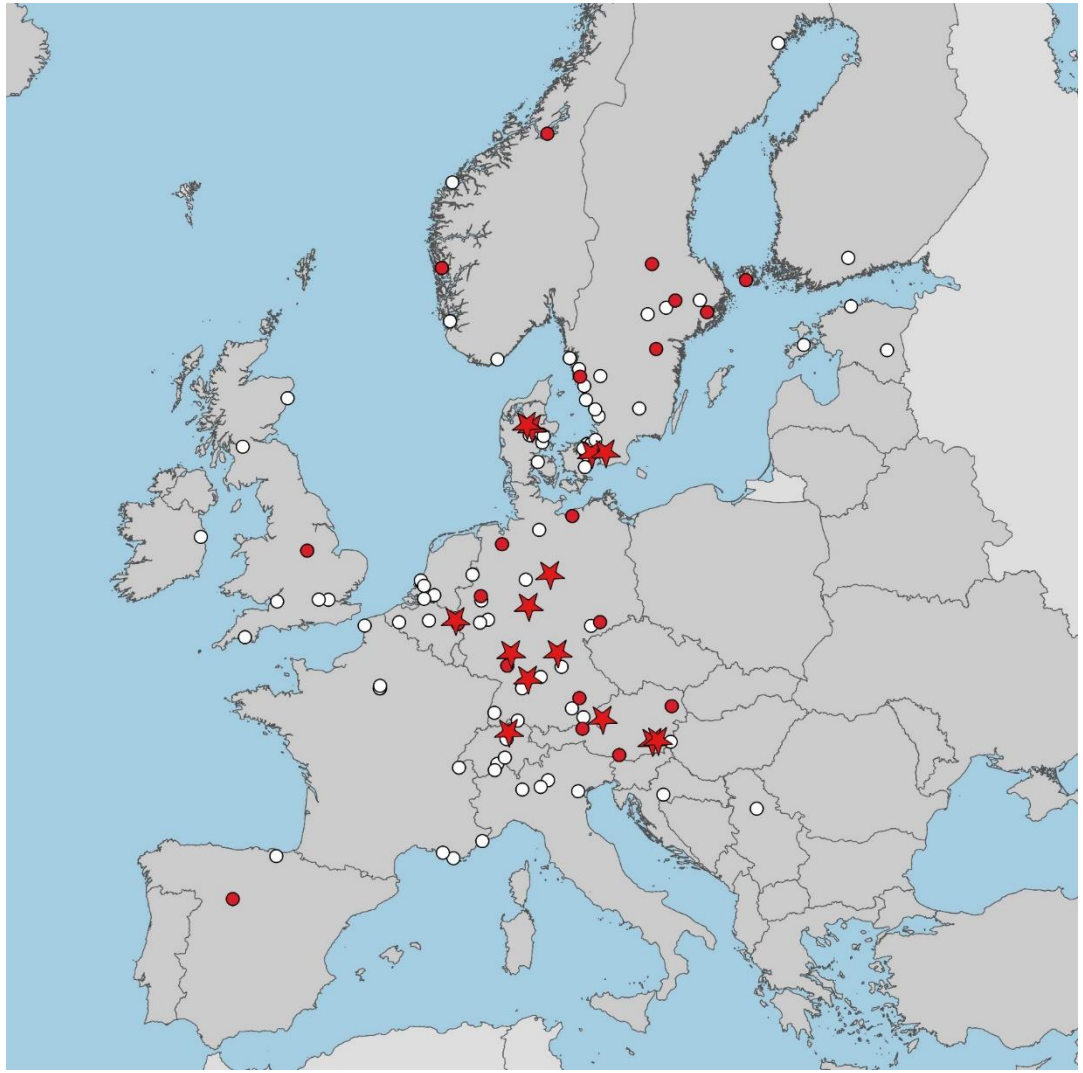
Analysed cases in the IEA Annex TS2

★ Cases analysed in detail and presented

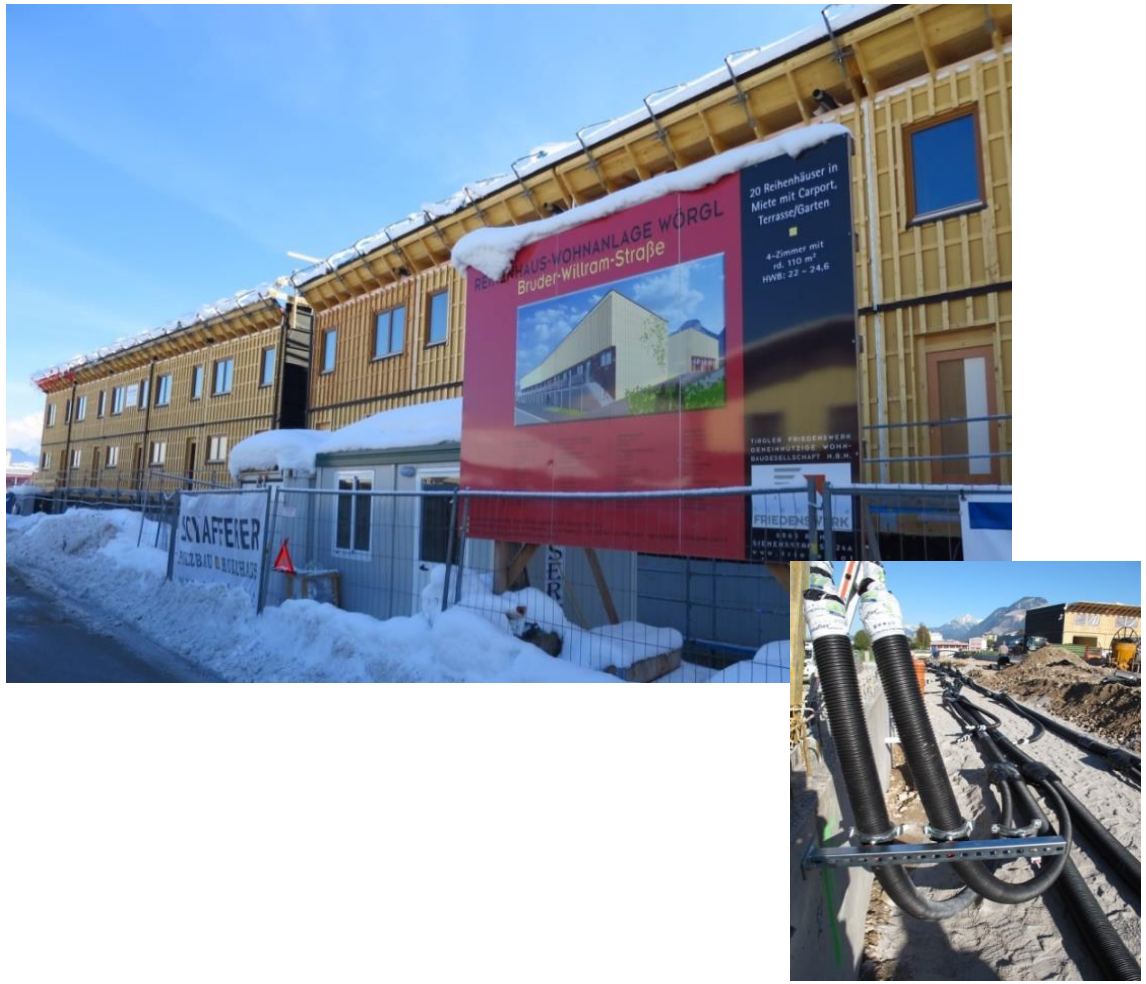
● Cases analysed in the project

○ Identified Cases

⇒ many examples of
concepts of regional energy transition



Woergl (Austria)
⇒ Realised new construction



Low temperature secondary network for 20 affordable row houses (60/40)

- Innovative pre-fabricated piping systems
- Heat supply form industrial biomass plant and from 3 heat pumps
- Direct connection of the heating system

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Benjamin Franklin in Mannheim (Germany)

⇒ New construction and existing buildings

Smart thermal subgrid

- Integration of renewable heat (ca. 20%) from heat pumps / PV systems
  (ca. 25.000 m²) in addition to the classic district heating supply
- Heat pumps are operated with 100% PV power
- Utilization of surplus electricity in summer time for the operation of cooling machines
- Smart control of subgrids
- Modular expansion

Copenhagen Fredriksberg (Denmark)

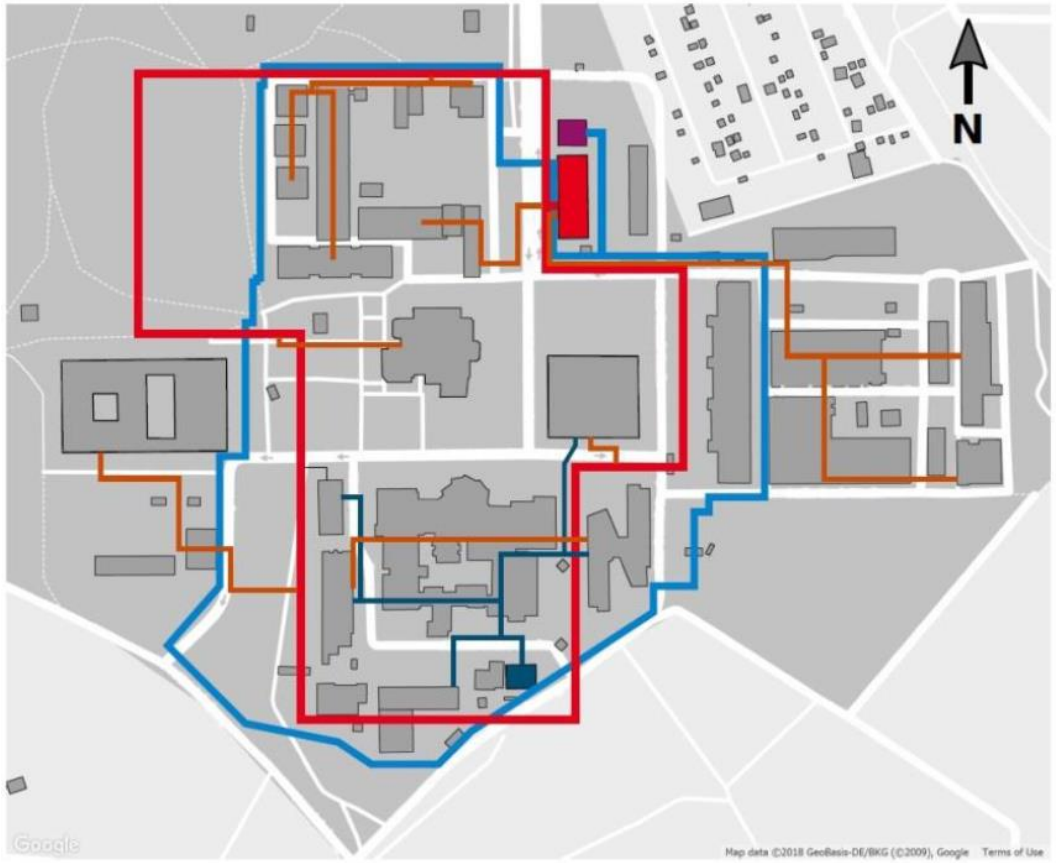
⇒ Building scale

Return temperature optimization in cities

- Central substation including weather compensation
- Online control of substation
- Radiators are equipped with smart electronic thermostats and return pipe temperature sensor
- Optimisation of operation and monitoring

Darmstadt „Lichtwiese“ (Germany)

⇒ Simulation study



Source: TU Darmstadt

Energy efficient campus Lichtwiese

- Heating and cooling network
- Based on monitoring a virtual model / digital twin has been up
- Strategy developed to reduce network temperatures
- Waste heat utilisation from high performance computer centre

Sigtuna (Sweden)

⇒ Realised new construction

Low temperature neighbourhood (60°C supply)

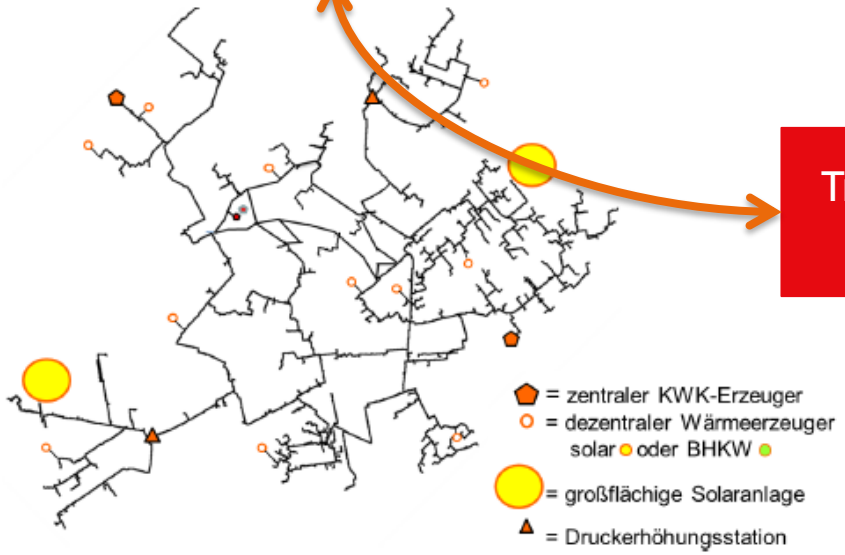
- Solar heating parking (1000m² collector)
- Electric heat pumps with geothermal source

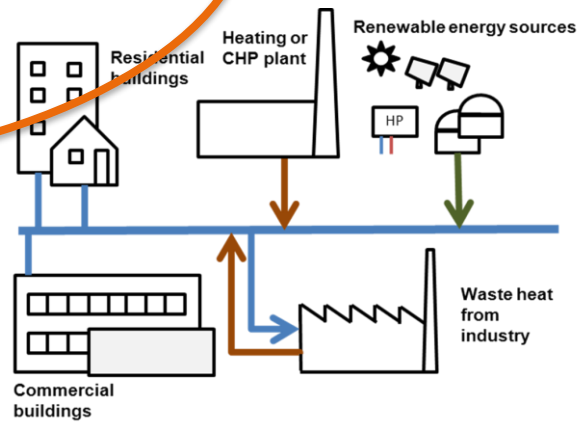
Identification of new challenges for the transition of heat supply / energy concepts

Digitalisation

Decarbonisation

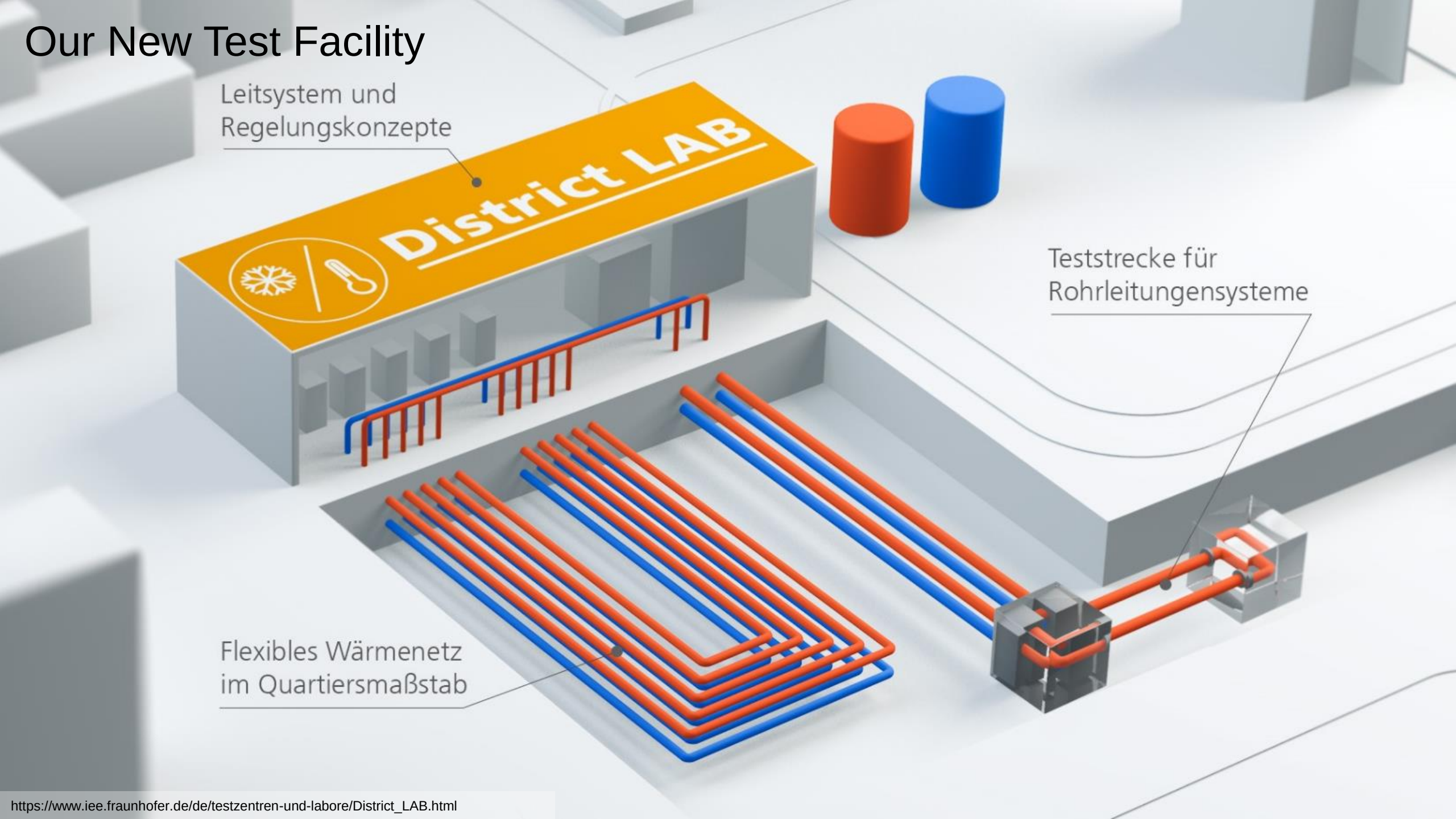
Transformation of the urban heat supply





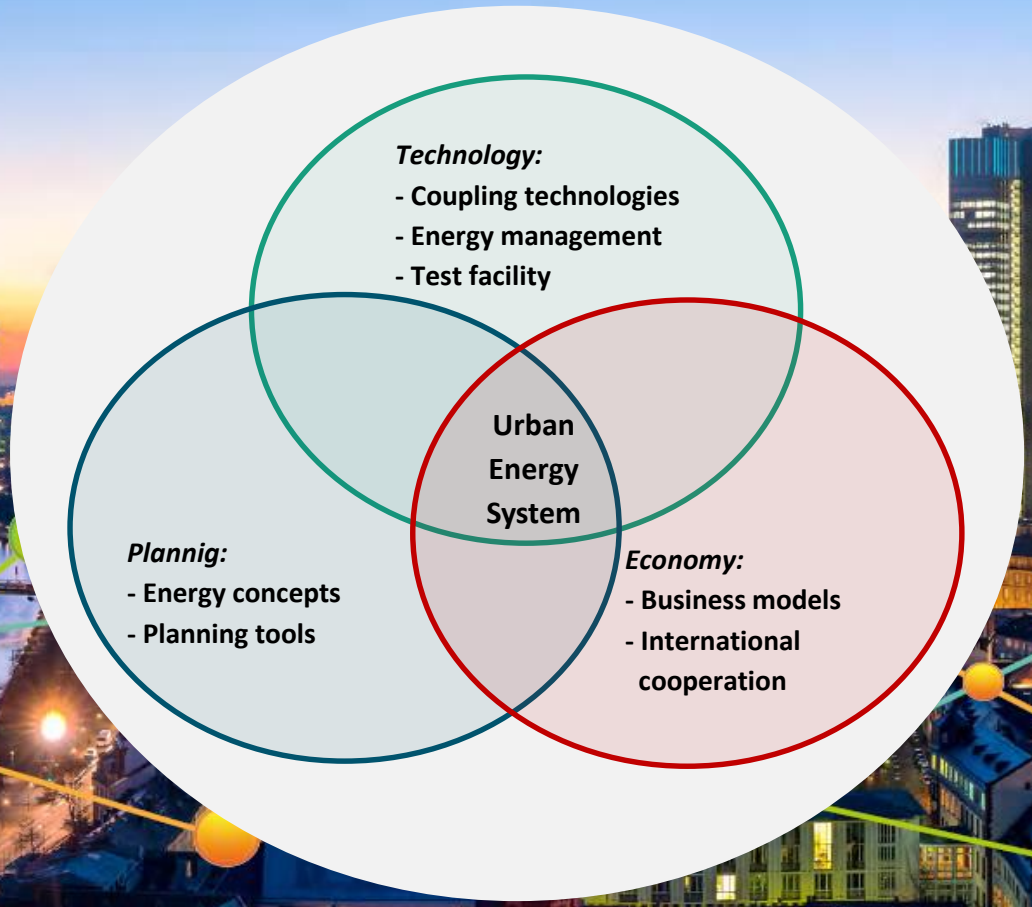
Abschlussbericht DELFIN: Jentsch, A. et al. „DELFIN – Decentralized Feed-In Prognose der Auswirkungen dezentraler Einbindung von Wärme aus erneuerbaren Energien und anderen Wärmeerzeugern in Fernwärmenetze, Abschlussbericht zum Verbundvorhaben

Our New Test Facility



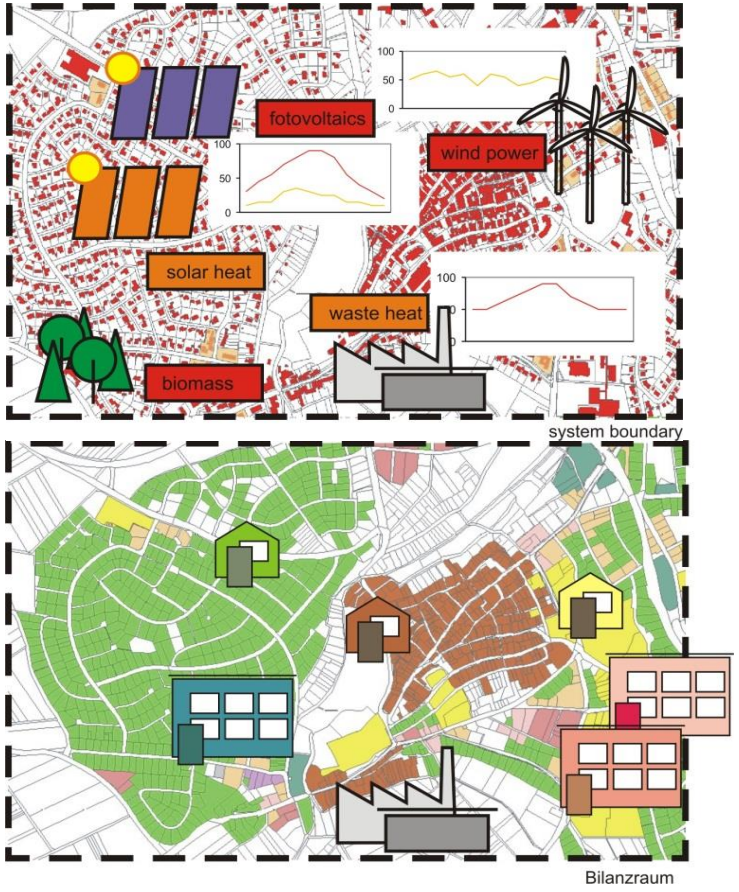
https://www.iee.fraunhofer.de/de/testzentren-und-labore/District_LAB.html

Research focus area "Urban Energy System"



Summary

- Energy efficieny is our biggest Energy source!
- Buildings and the heat sector need to attract more attention!
- Electricity from fluctuating and renewable sources will be our future primary energy source.
- Integration of all sub systems in regional energy concepts is our future task!



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