The economic potential of district heating under climate neutrality: the case of Austria

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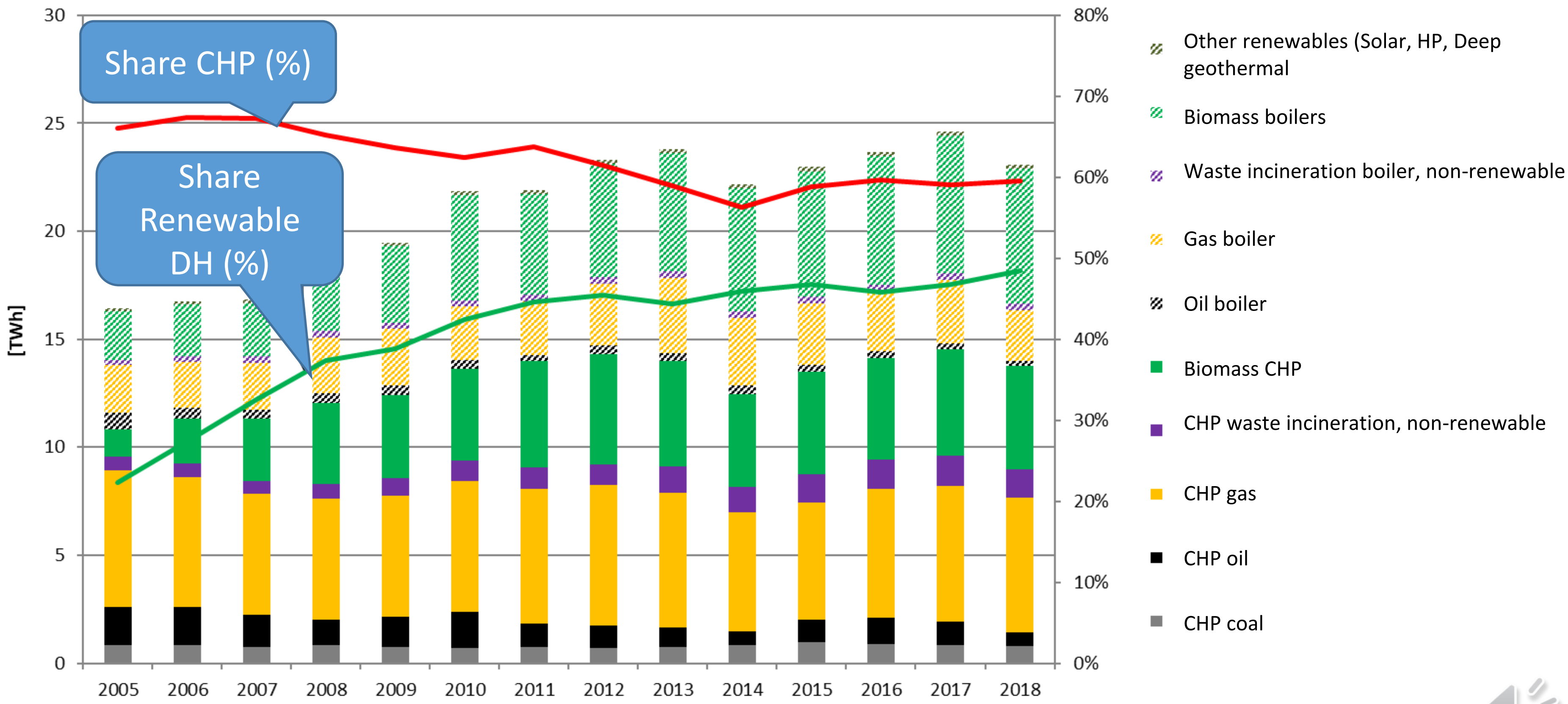
SES Conference, 21.09.2021

District Heat Generation, Austria

- Share of district heating in Austria, 2019: 20% of final energy consumption for space and water heating
- Future evolution and potential?



Motivation and research question

- Energy Efficiency Directive – Art 14: Promotion of efficiency in the supply of heating and cooling
- "Comprehensive assessment of the potential for an efficient heating and cooling supply" is to be carried out by Member States every 5 years (starting in 2015)
- Project on behalf of the Austrian Federal Ministry of Climate Action to fulfill the reporting obligation of Art. 14 & Annex VIII of the EED

- Research questions for this presentation:
  - What is the economic potential of renewable district heating under different scenarios for the case of Austria?
    - Which types of areas can/should be supplied by district heating?
    - What is an economically viable district heating supply mix in different types of district heating systems and in Austria in general?
    - What are drivers for the uptake of future district heating potentials?
  - How do decarbonisation targets affect the way how cost-benefit analyses foreseen in the comprehensive assessment should be applied?

Scope and system boundaries

- Focus on space heating and hot water preparation (industrial process heating only for consideration of industrial waste heat supply)
- „Efficient district heating“: according to the EED currently under revision => considered under the light of achieving climate targets
- According to the current Austrian government programme, we assumed climate neutrality to be achieved in 2040.

Methodology for identifying economic potential of DH

C_{DH} … DH supply cost

[EUR/MWh]

Step 4

Comparison …

Step 2

C_{DE} … Cost of decentralized supply option

[EUR/MWh]

Step 3

K_{WV} … Costs of heat distribution

Step 1

Step 3

K_{WE} … Costs of heat generation

… Within the region types
- Similar supply option potentials
- Similar size (DH potential)

… For various scenarios
- 2030/2050
- Demand scenarios (saving scenarios)
- DH connection rates
- Energy and CO2 prices
- Private and public points of views

$K_{WV} = \Sigma$ (…)
CAPEX
-
-
-

$K_{WE} = \Sigma$ (…)
CAPEX
OPEX
Energy
CO_2

$K_{OE} = \Sigma$ (…)
CAPEX
OPEX
Energy
CO_2

Step 1:

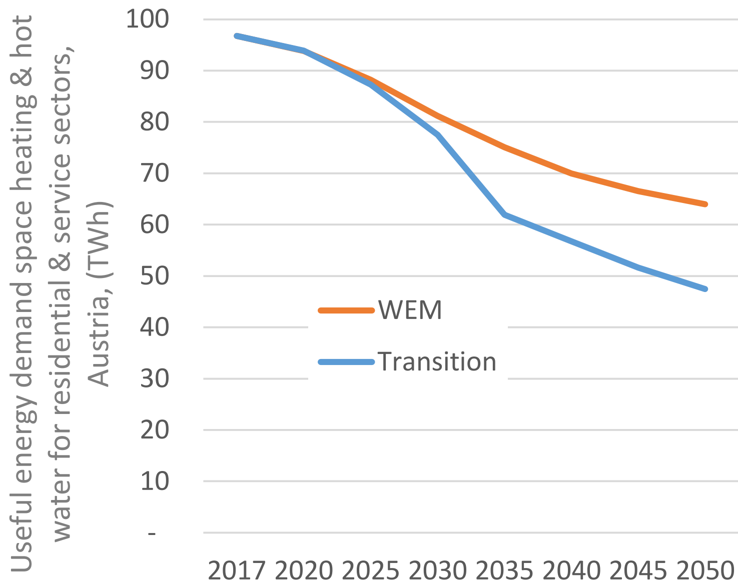
Identification of regions that could potentially be suitable for district heating

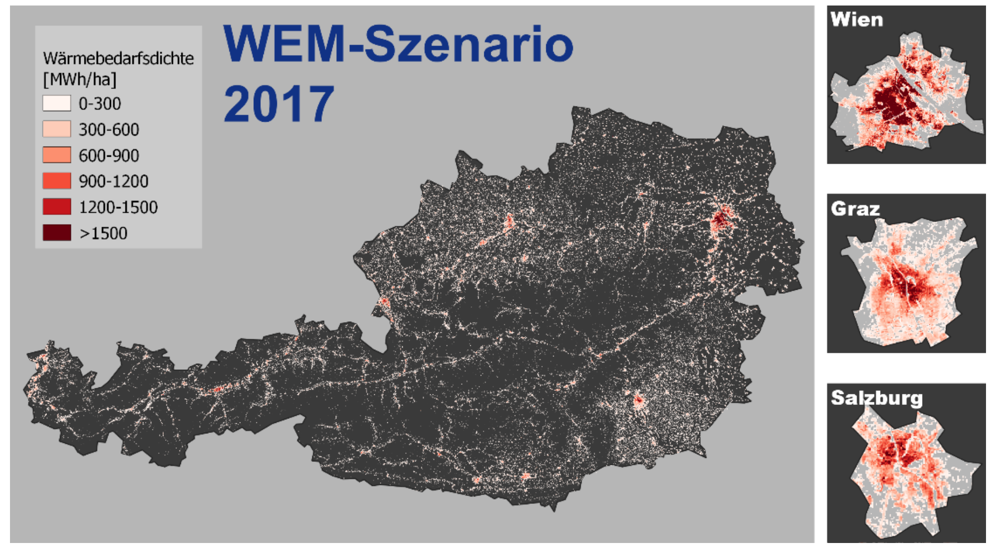
(based on heat distribution costs)

Step 1: Identification of regions that could potentially be suitable for district heating

Scenarios & characteristics of the portfolios

(with different characteristics in different types of regions and depending on the need to meet the needs)





- WEM – With existing measures (includes already implemented measures, May 2016)
- Transition Scenario – a 80% reduction of CO_2-Emissions till 2050 compared to 1990

Further assumptions for full decarbonisation of the gas supply to meet the objective of climate neutrality

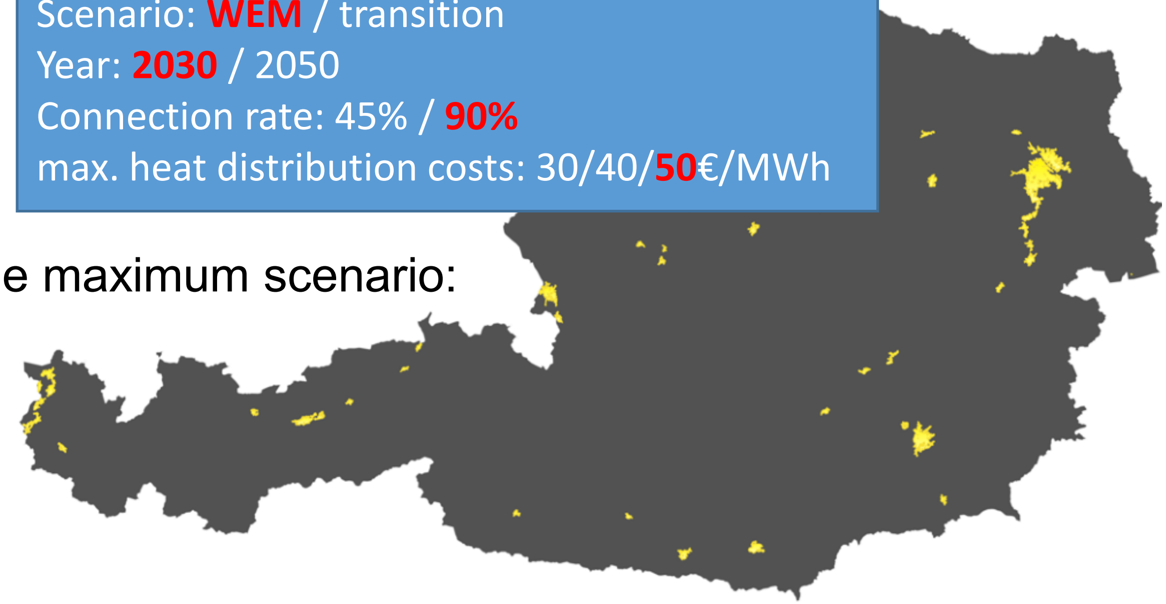
Source: Müller, A., Hummel, M., Kranzl, L., Fallahnejad, M., Büchele, R., 2019. Open Source Data for Gross Floor Area and Heat Demand Density on the Hectare Level for EU 28. Energies 12, 4789. https://doi.org/10.3390/en12244789

Step 1: Identification of regions that could potentially be suitable for district heating

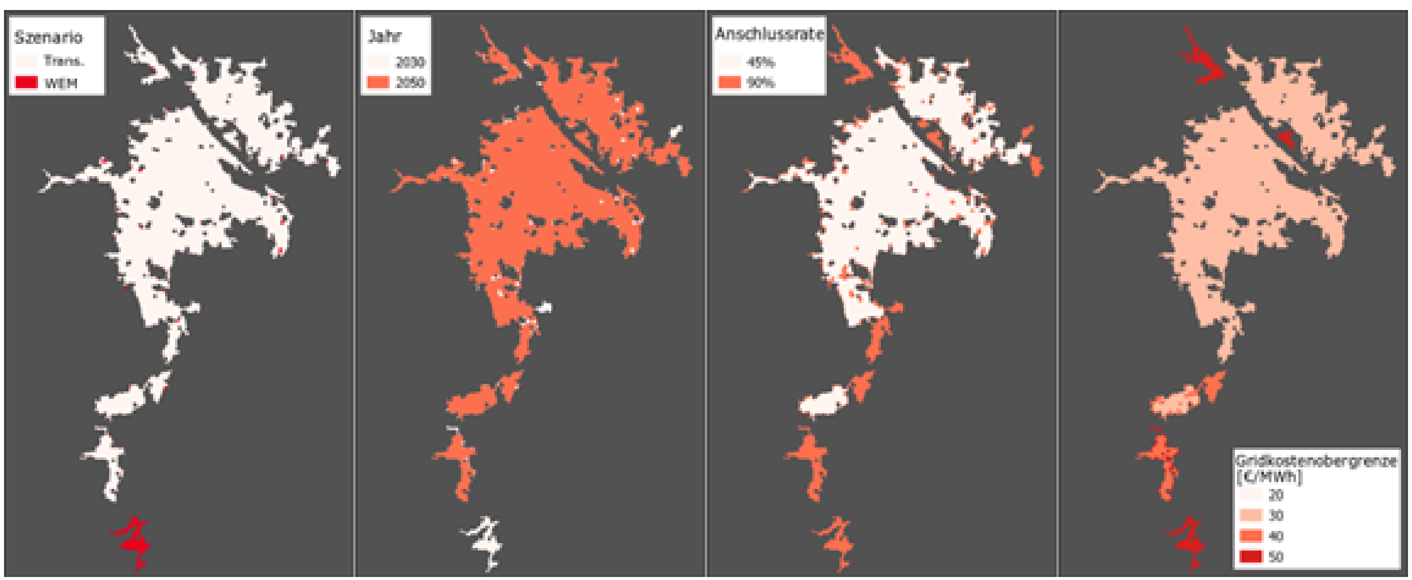
Resulting regions

Scenario: **WEM** / transition
Year: **2030** / 2050
Connection rate: 45% / **90%**
max. heat distribution costs: 30/40/**50**€/MWh

- Identified regions in the maximum scenario:



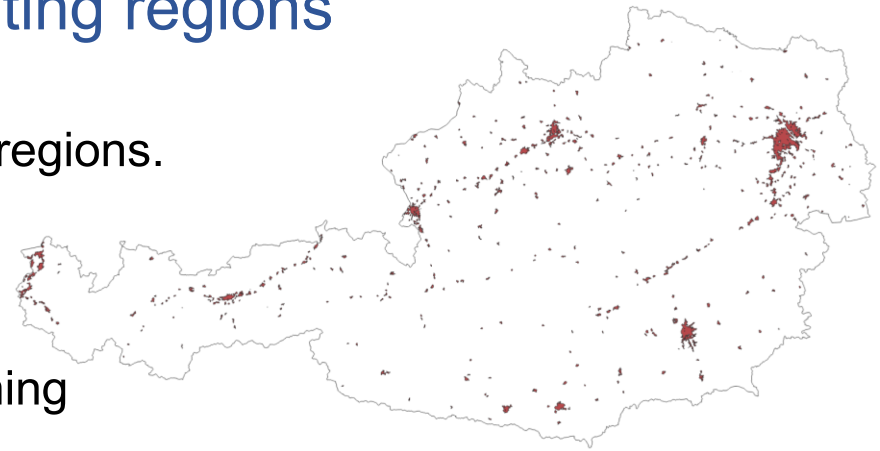
- Impact of different scenarios on the size of district heating areas:



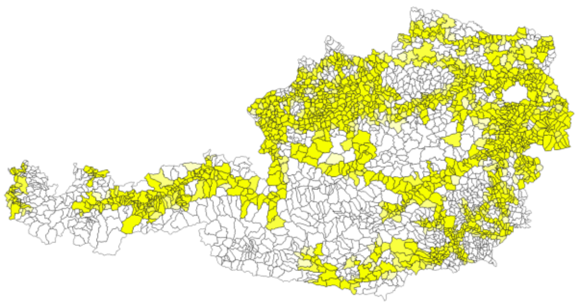
Step 2:

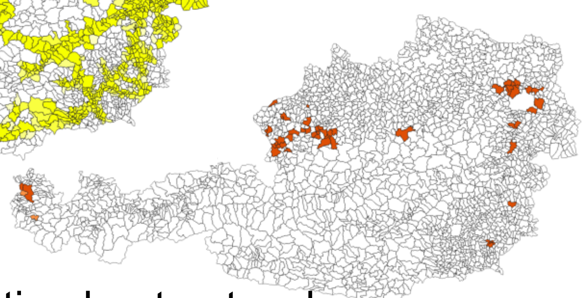
Clustering of regions with similar characteristics (size, resource availability and existing infrastructure).

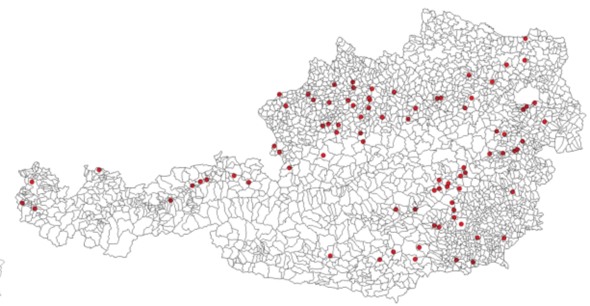
Clustering of potential district heating regions

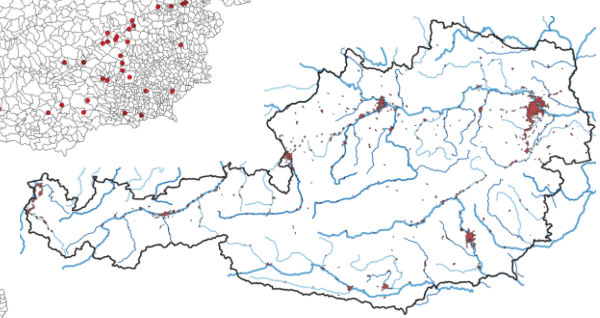


- Individual consideration of the 4 major DH regions.
  - Types 1-4:
    Vienna, Graz, Linz, Salzburg
- Clustering of all other regions into 6 remaining district heating region types.
  - according to heat supply potentials (gas availability, geothermal potential, waste heat potential, river size)

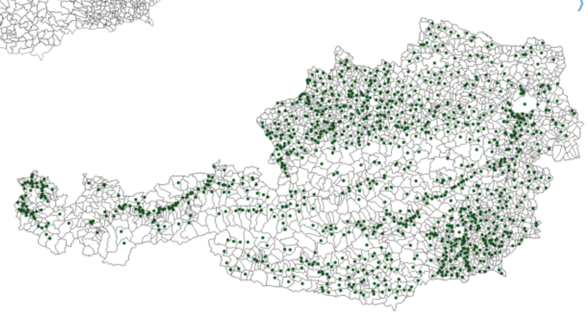








  - and existing heat networks



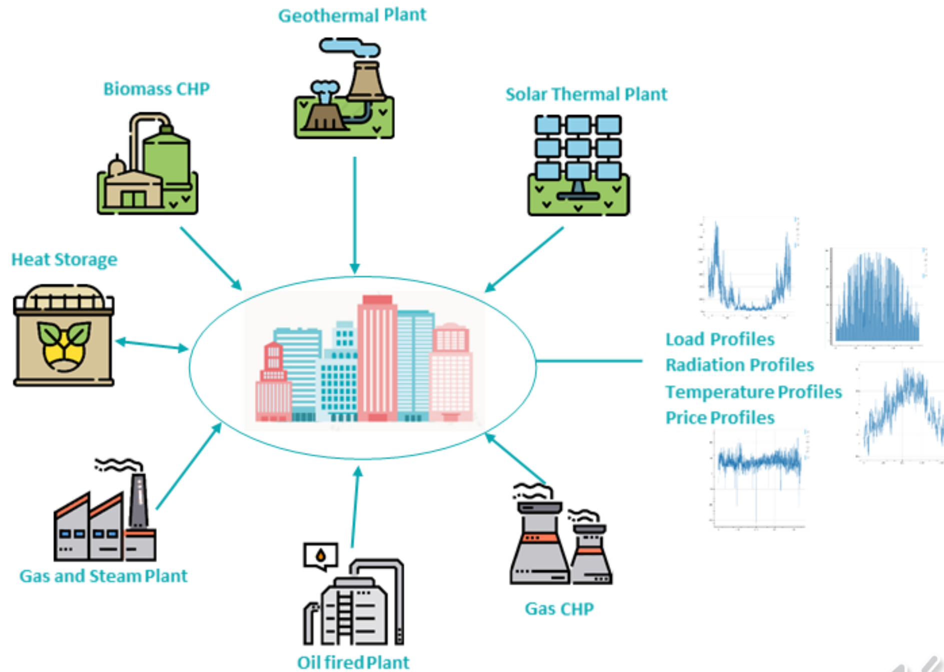
Step 3:

Calculation of costs for heat supply

(District heat supply and object-related supply)

Methodology district heating supply

- Use of the Hotmaps - DH dispatch - stand-alone model [1]
- Minimization of running costs of heat supply to the district heating network
- Calculation for all 8760 hours of a representative year
- COP of heat pumps depending on relevant temperatures (flow, return, heat sources)
- Predefined technology park
- Calculation of numerous variants per region type



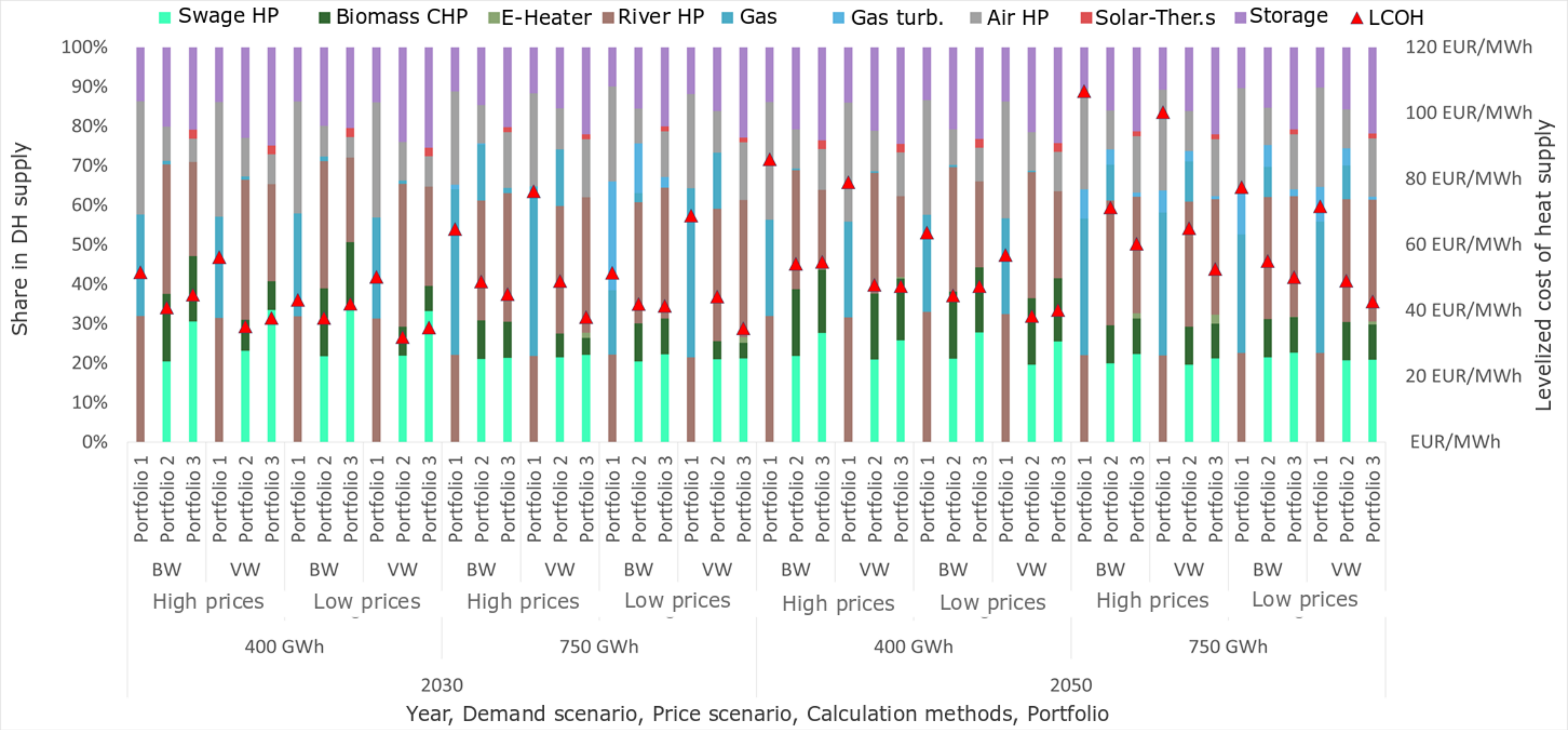
[1] https://hotmapsdispatch.readthedocs.io/en/latest/

Scenarios for district heating supply

Scenario Type	No.	Description
Region types	10	4 specific regions (Vienna, Graz, Linz, Salzburg) 6 typical regions (demand / supply potential) For each type of region:: • Temperatures (air, system, heat sources) • Irradiation • Load profile • Resource availability
Year	2	2030 / 2050
Assessment method	2	Financial (BW) / economic(VW)
Heat demand	2	Two demand levels
Energy carrier and CO2 prices	2	Low vs. high prices
Technology Portfolios	3	A. predominantly gas B. Gas with renewables and excess heat C. Predominantly renewables and excess heat, almost no gas
Total	**480**	

Exemplary result of DH supply:

Cluster 7 (Regions with existing DH grids, gas infrastructure and high potential for river water source heat pump)



Step 4:

Identification of the economic potential for efficient heat supply.

(Comparison of costs for district heating and object-related supply).

Methodology

C_{DH} ... Cost of supply from district heating

EUR/MWh]

Comparison ...

... for each district heating potential area

C_{DE} ... Cost of decentralized supply

EUR/MWh]

$C_{DH} < C_{DE}$ ... District heating is economical

$C_{DH} > C_{DE}$ ... District heating is not economical

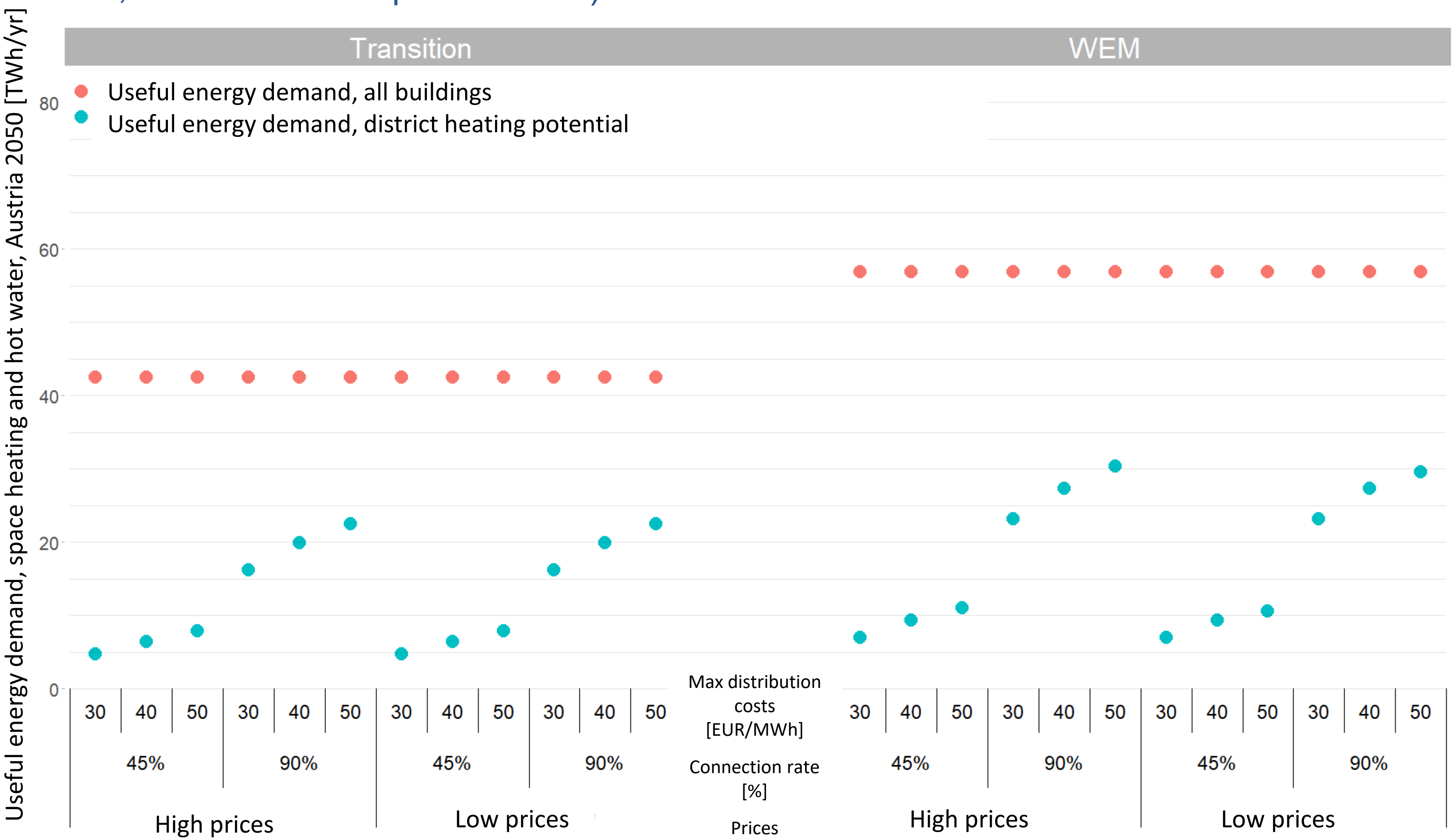
... for each individual scenario and each raster cell (ha level)

Total district heating potential [GWh/yr] in all areas where district heating is economic = Economic potential.

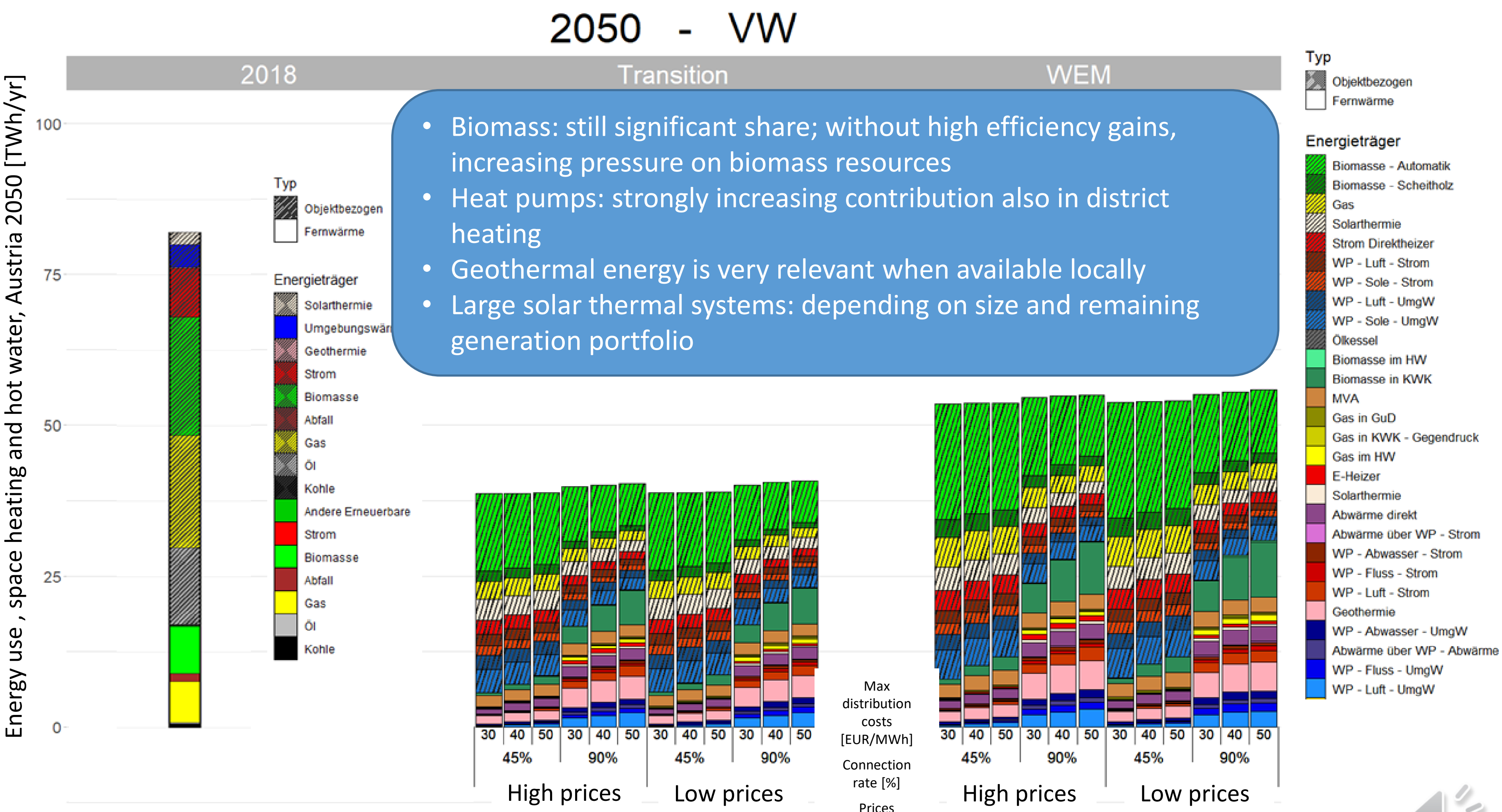
Sum of heat supply from the different technologies [GWh/yr] in all areas where district heating is economical = Economic potential per technology.

Share of economic DH supply from total heat supply

2050, socio economic point of view)



Result of heat supply 2050, socio economic point of view



- Biomass: still significant share; without high efficiency gains, increasing pressure on biomass resources
- Heat pumps: strongly increasing contribution also in district heating
- Geothermal energy is very relevant when available locally
- Large solar thermal systems: depending on size and remaining generation portfolio

Conclusion

- Carrying out the cost-benefit analysis foreseen in the EED under the target of climate neutrality means to exclude all fossil based systems
- Thus, assuming full decarbonization (gas from 100% green gas), gas is not a cost-effective option in the space heating sector (neither for district heating nor decentral).
- Thermal storage systems are becoming increasingly important (uncertainty regarding costs).
- Achievable connection rates have a major impact on the economic potential of district heating.
- The heat demand scenarios have less of an impact on the district heating potential than the achievable connection rates.

Outlook and open questions

- Parameter variation for different scaling of thermal storage in different types of district heating grids and for different generation portfolios

- Analyses for different system temperatures and on district level

- Extension of the approach to an EU-wide set of representative district heating grids (Tender for the EC)

- Granularity and system boundaries in district heating sector modelling?
  - Low level of granularity in full energy system models vs.
  - high level of granularity in our bottom-up consideration without considering feedback loops, e.g. on electricity price

- Comparison of method and results among different countries?

Thank you for your attention!

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www.austrian-heatmap.gv.at

Orig. Photo: Patrick Stargardt