ENERDAY 2021

Role of cogeneration and heating networks in renewable energy systems

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Motivation

Open questions

- Where is H2 a cost-efficient option for decarbonization?
- How can residential and industrial heat supply be decarbonized?
- What kind of thermal backup capacities do high shares of solar and wind require?

Connection with co-generation and heating networks

- Co-generation requires synthetic fuels like H2 (either with conventional turbines or fuel cells)
- Electrification in the heating sector greatly impacts backup requirements

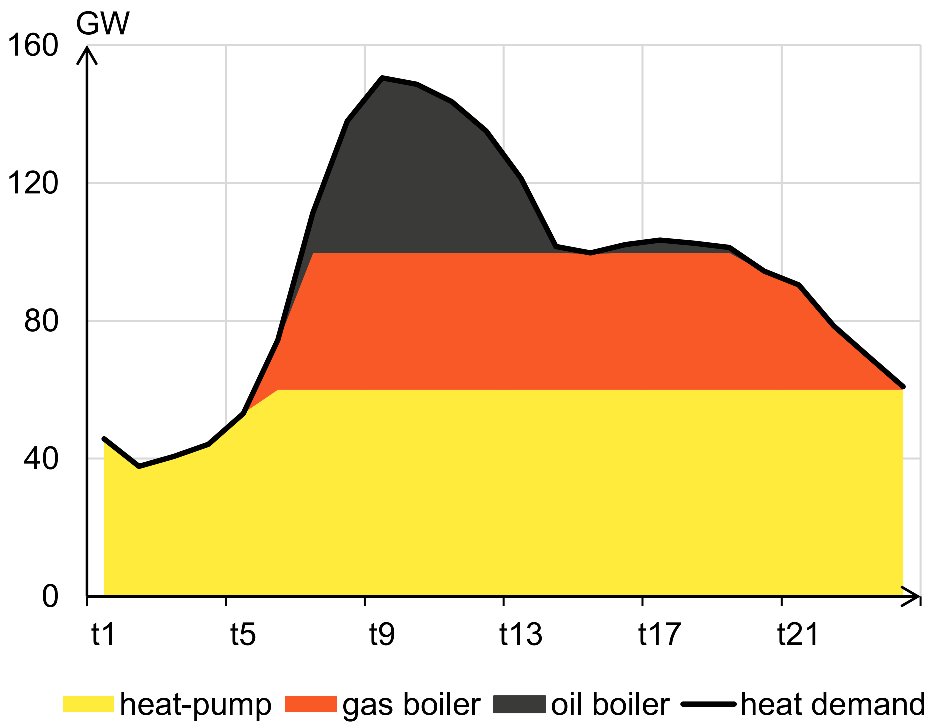
→ Comprehensive analysis of question requires great spatio-temporal detail and a large sectoral and regional scope

Deployed capacity expansion model

	Scope	Detail
Spatial	▪ European continent ▪ H2 import from outside of Europe possible at fixed price	▪ 96 regions ▪ Stylized transmission grid between regions
Temporal	▪ single year with fully renewable system ▪ one year of weather data	▪ 32 representative days ▪ Different resolutions for each energy carrier ▪ 4-hour steps for heat
Sectoral	▪ Electricity, transport and heat (residential and industrial) ▪ No non-energy use in industry	▪ 160 technologies ▪ 6 modes of transport ▪ 4 levels of heat

Concept of technology deployment

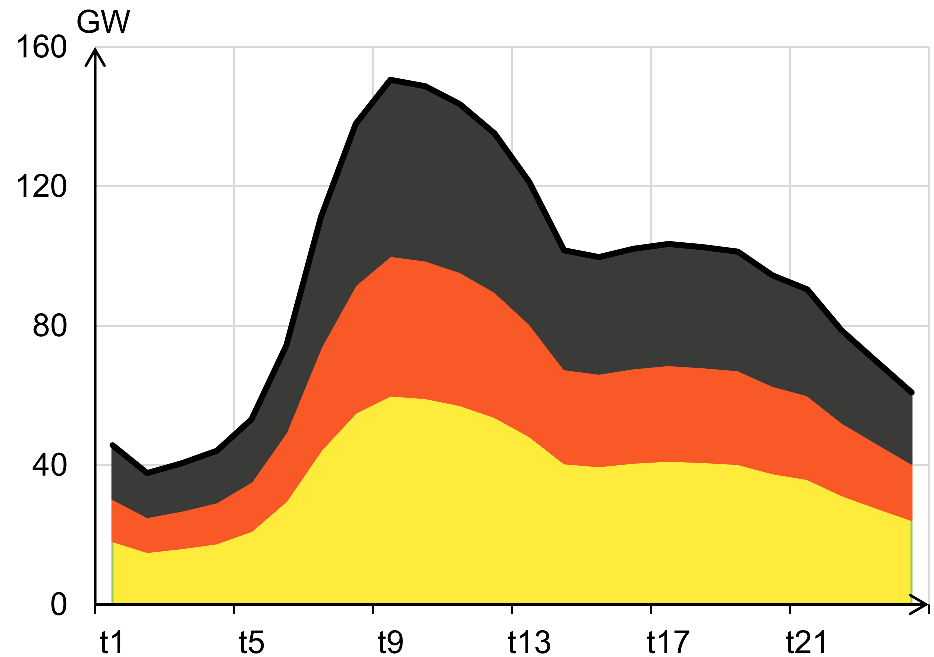
Merit-order



$$\sum_{te \in Te} Gen_{te,t} = dem_t \qquad \forall t \in T$$

$$Gen_{te,t} \leq Capa_{te} \qquad \forall t \in T,\, te \in Te$$

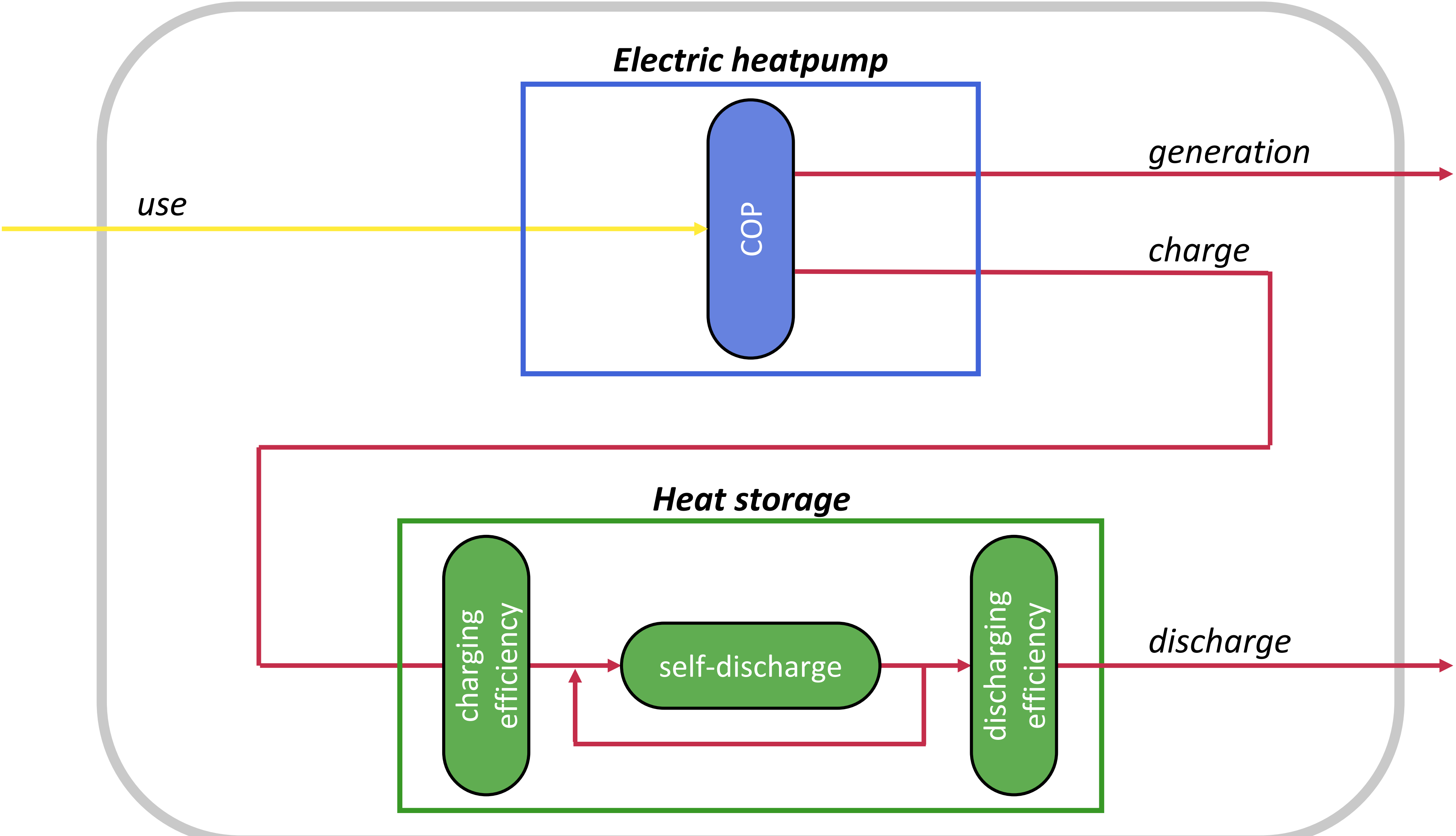
Must-run



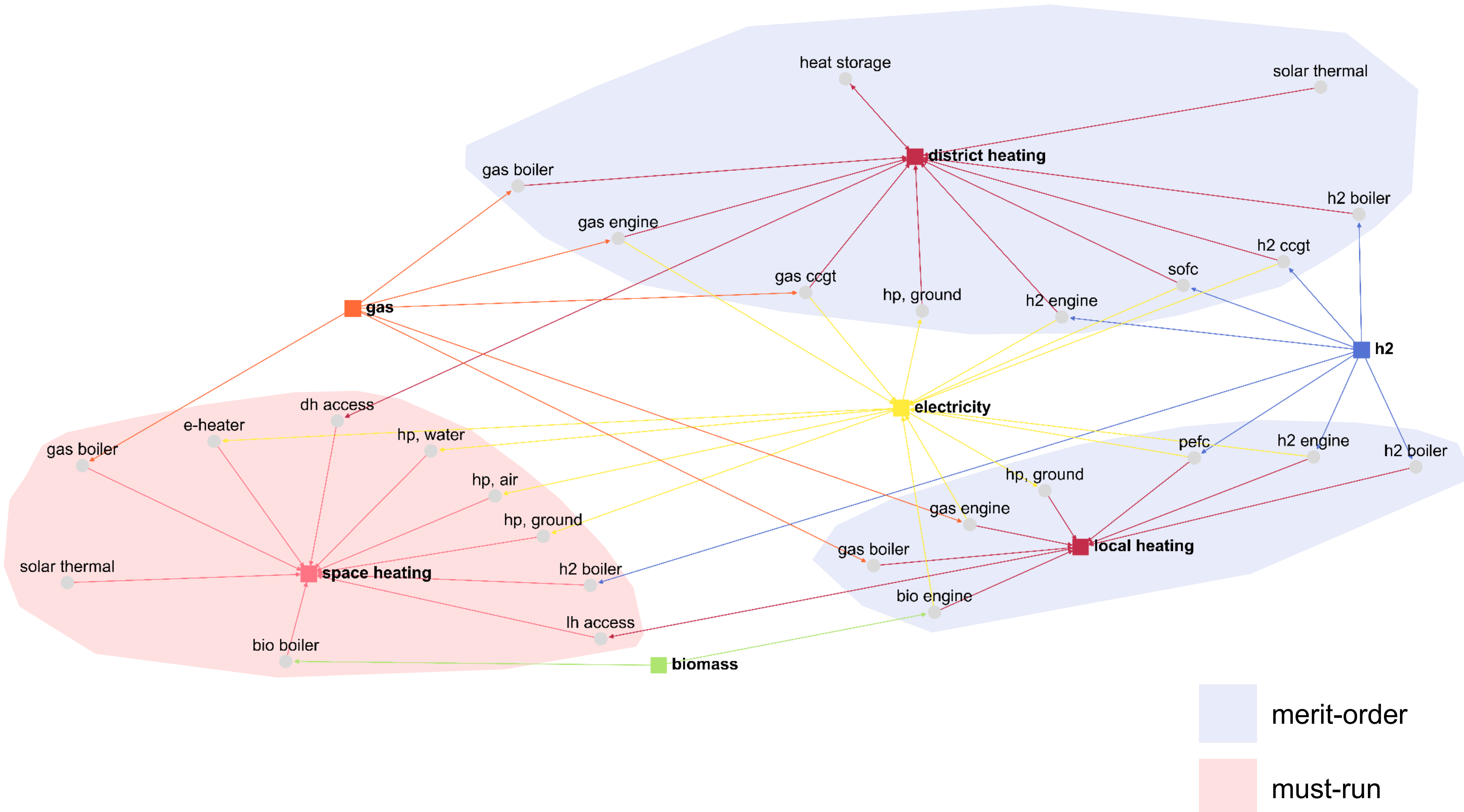
$$\sum_{te \in Te} Capa_{te} = peak$$

$$Gen_{te,t} = \frac{dem_t}{peak} \cdot Capa_{te} \qquad \forall t \in T,\, te \in Te$$

Consequentially representation of heat storage

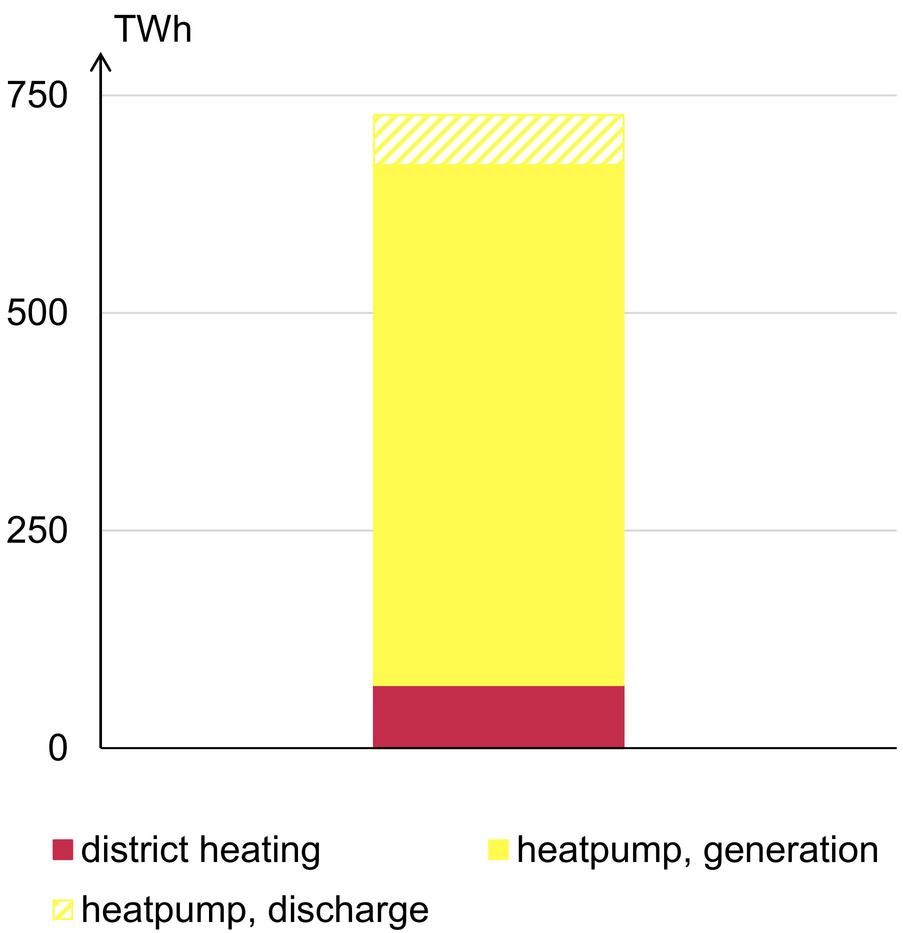


Installed heating capacities

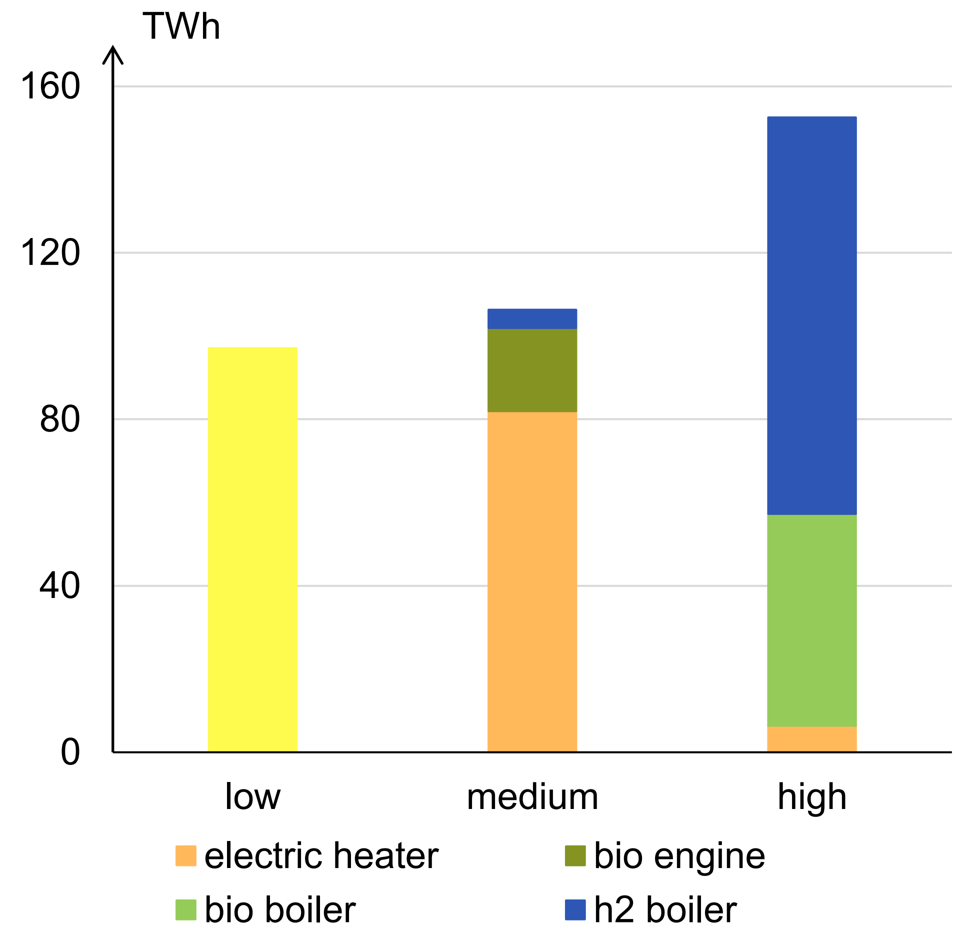


Heat generation, Germany

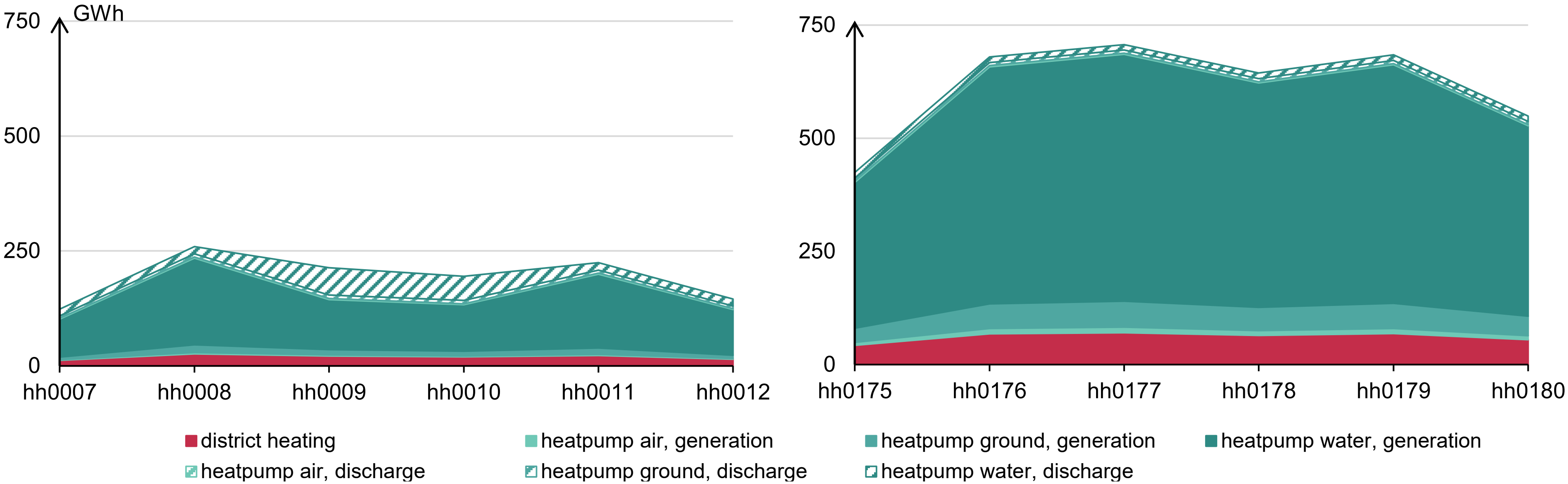
Space heat

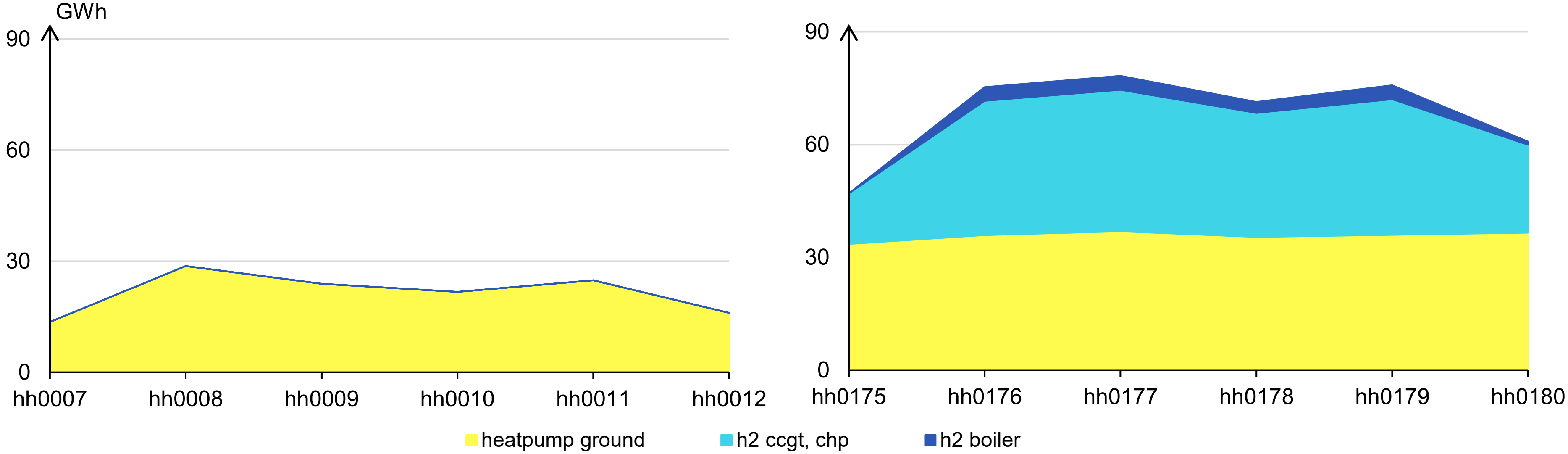


Process heat



Heat supply on low and high demand days





Conclusion

Current limitations

- Not included heating options due to missing data on potential
  - Geothermal, in particular co-generation
  - Waste heat
- Temporal detail and scope is expandable
- Today’s demand levels assumed

Findings

- Electrification is the cost-efficient strategy to decarbonize (district) heating
- Co-generation is useful to cover the highly correlated peaks of electricity and heat demand
- Results suggest a high benefits from renewable co-generation technologies with variable power-to-heat ratios

Thank You for Your Attention!

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