Modelling of heat pumps for the decarbonisation of distric heat

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Heat pumps are very interesting technology options for decarbonizing the district heat

Impact of smart heat pump operation:

- Geothermal energy output can be increased by reducing the injection temperature with a heat pump → increased economics
- Increasing the storage capacity of seasonal storages (factor >2)
- Smart operation of heat pump leads to high COPs and higher utilization factors → better economics

Modelling ideas:

- If heat pump hast to supply the full district heat supply temperature (often larger than 80° - 100°C) → bad COP and low utilization factor → bad economics
- Modelling with hourly variable power price
  - If power price is medium, use the heat pump with high COP. E.g. to:
    - Reheat the seasonal storage to medium temperature
    - Reheat district heat return flow by 10°C and provide the boost with other technology
  - If power price is very low, COP is not that important → boost the temperature level to the full DH supply temperature

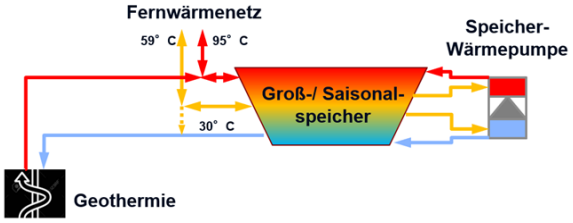
Modelling Implementation:

- Model one heat pump with different operation modes
- Linear model which avoids overbooking of the capacity

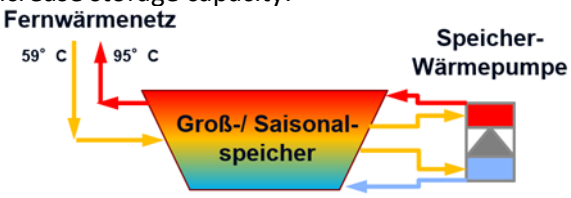
$$\sum_{i \in HP\ modes} MWelec\text{-}HP\text{-}Mode_i(t)/capacityOfMode_i \leq 1$$

- Model (seasonal-) heat storage with multiple temperature levels

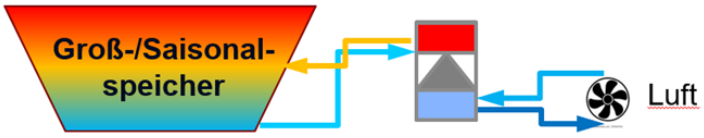
Boost geothermal capacity:

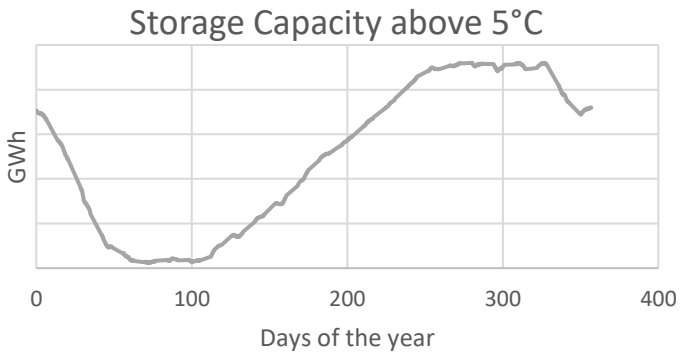


Increase storage capacity:

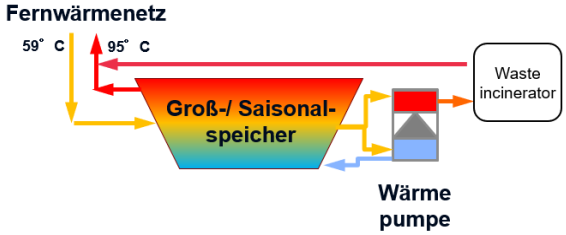


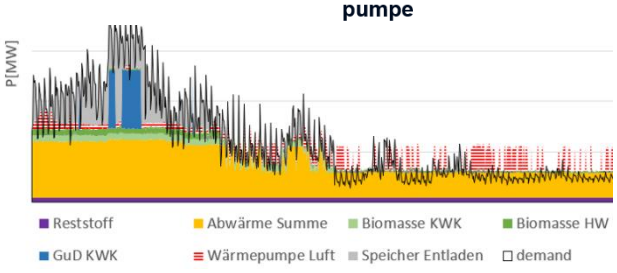
Boost low level storage temperatures → good COP





Provide only mid temperature levels with HP when power price not low → good COP
boost temperature later or with other technology:





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