THE CONTRIBUTION OF HEAT STORAGE FOR CARBON-FREE ALPINE DISTRICT HEATING SYSTEMS

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THE DECARBONIZATION CHALLENGE

The fossil share in district heating is very high in EUROPE: >70% in 2014

Decarbonization options:

- (industrial) waste heat → often limited availability
- geothermal heat → good if available
- ambient heat (ground, air, river) combined with heat pumps
- solid biomass → limited resource with many usages
- renewable gases (biomethane, H2) → limited resource or expensive
- solar thermal heat → space requirement and competitiveness
- waste incineration → only partly renewable

→ Mobilization of all options may be needed

ANALYZED REAL DH SYSTEMS IN ALPS

Here some generic assumptions for presentation

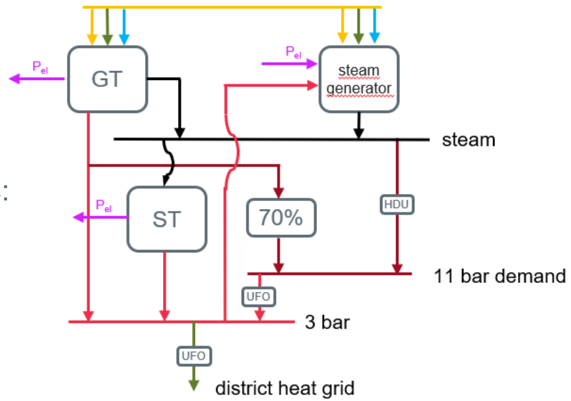
- Peak heat demand in winter above 100 MW
- 95 °C supply temperature, constant
- 59 °C return temperature, constant
- Air temperature: annual average around 10-12°C, coldest hour of simulated year = -12°C

USED TOOL: AIT MIXED INTEGER DISTRICT HEAT PLANNING & OPTIMIZATION MODEL

Characteristics:

- Mixed integer investment **planning over time horizon (2023-2040)** and unit commitment optimization
- Complex and nested configurations can be modelled
- Multiple input and output energy flows per unit are modelled (diverse fuels, electricity, steam, high pressure heat, low pressure heat)
- Different plant configuration and operation modes (steam extraction, backpressure, e.g.)
- Sequential heating of water and mixing
- Part load operation considered at all inputs and outputs
- Startup costs, minimum on and off times

Multiple input and output energy flows:



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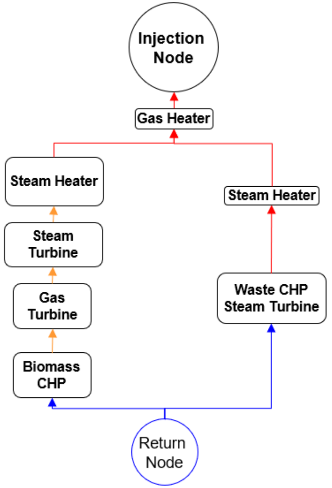
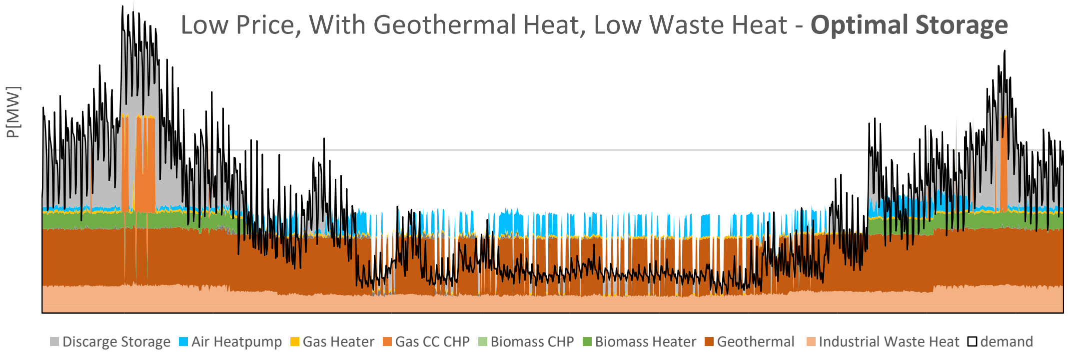
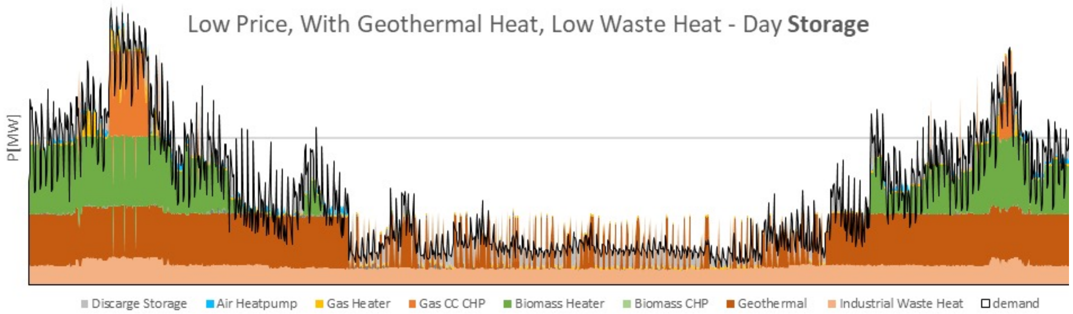


SYSTEM WITH LIMITED WASTE AND GEOTHERMAL





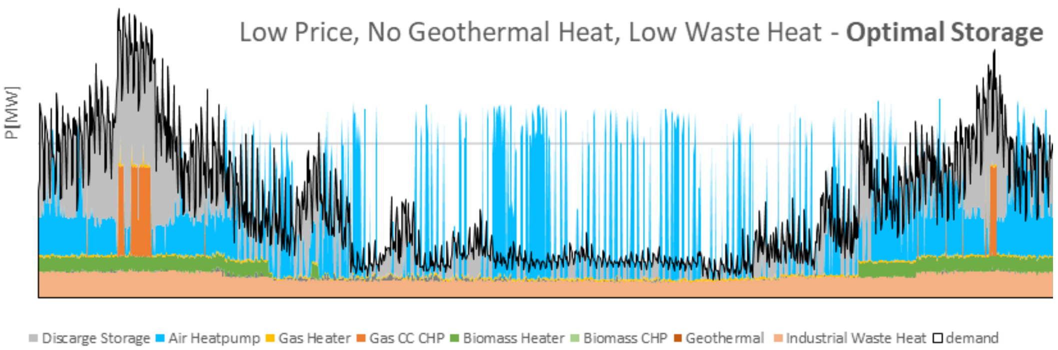
Depending on the storag size the biomass consumption varies heavily:

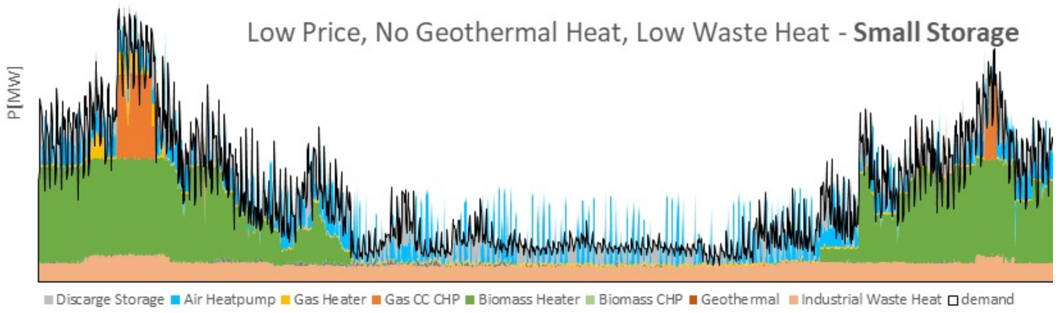
- optimal storage size: 26 days of annual average heat demand
- Day storage size: 0.5 days
  - ➢ biomass usage (+400%)
  - ➢ loss of geothermal energy (-21%)
  - ➢ reduced air source heat pump energy generation (-84%)

cost of generating district heat did not change significantly with or without seasonal storage.

Gas combined cycle with biotmethane or hydrogen needed in case of dark doldrum „Dunkelflaute“ in the electricity system.

SYSTEM WITH LIMITED BASELOAD HEAT





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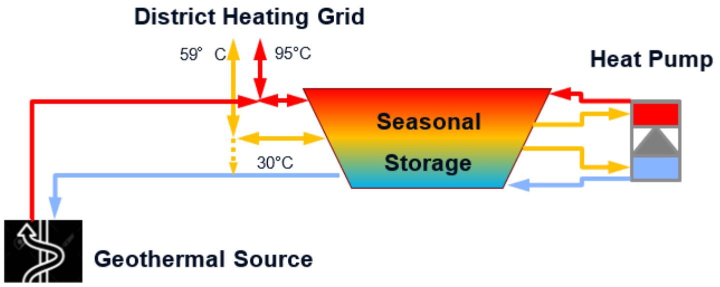
SUMMARY DECARBONIZING DISTRICT HEAT

- Large thermal storage have to potential to:
  - utilize **heap electricity and heat** from summer for the winter
  - enable **higher shares of baseload heat** producers
  - can be used as day, week and seasonal storage
  - avoid **excessive need for limited resources like** solid biomass
  - had **no effect on the district heat generation costs** under given assumptions

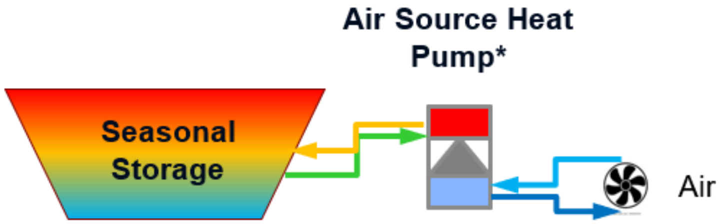
SMART USES OF HEAT PUMPS AND STORAGES

- Better use of geothermal heat by lowering the injection temperature



- Inreasing the storage capacity by cooling the storage lower lever below return temperature

- Smart uses of the heat pump to achieve high COP



BARRIERS FOR COMMERCIAL SUCCESS OF STORAGE

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Possible options for large seasonal storages are e.g.:

- pit storages
- cavern storages

Present project planning is hindered by unclear performance and state of the art design

- The cover of pit storages
- The temperature rating of the membranes
- Cavern storage construction, cost and sealing

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TOMORROW TODAY

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