4. Praxis- und Wissensforum
Fernwärme / Fernkälte
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fit4power2heat

ELECTRICITY MARKET OPTIONS FOR HEAT PUMPS IN RURAL DISTRICT HEATING NETWORKS

Olatz Terreros

BACKGROUND

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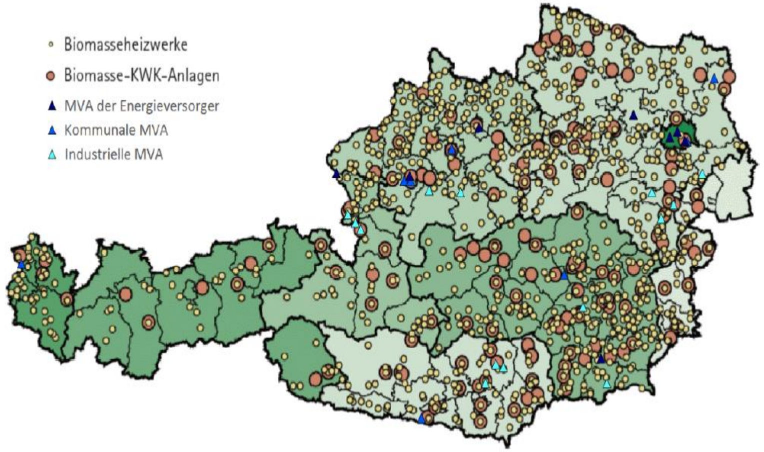
- Austrian renewable energy targets 2020: 71% of electricity demand from renewable energy sources
  - stochastic generation
  - grid-stabilizing strategies required

- Austrian district heating network settings:
  - 900 biomass heat plants above 1 MW with a total of 2.600 MW_{th}
  - old heat plants operating with low efficiency
  - highly replicable business case

- Power to heat solutions:
  - heat pumps support both electricity and DH networks.



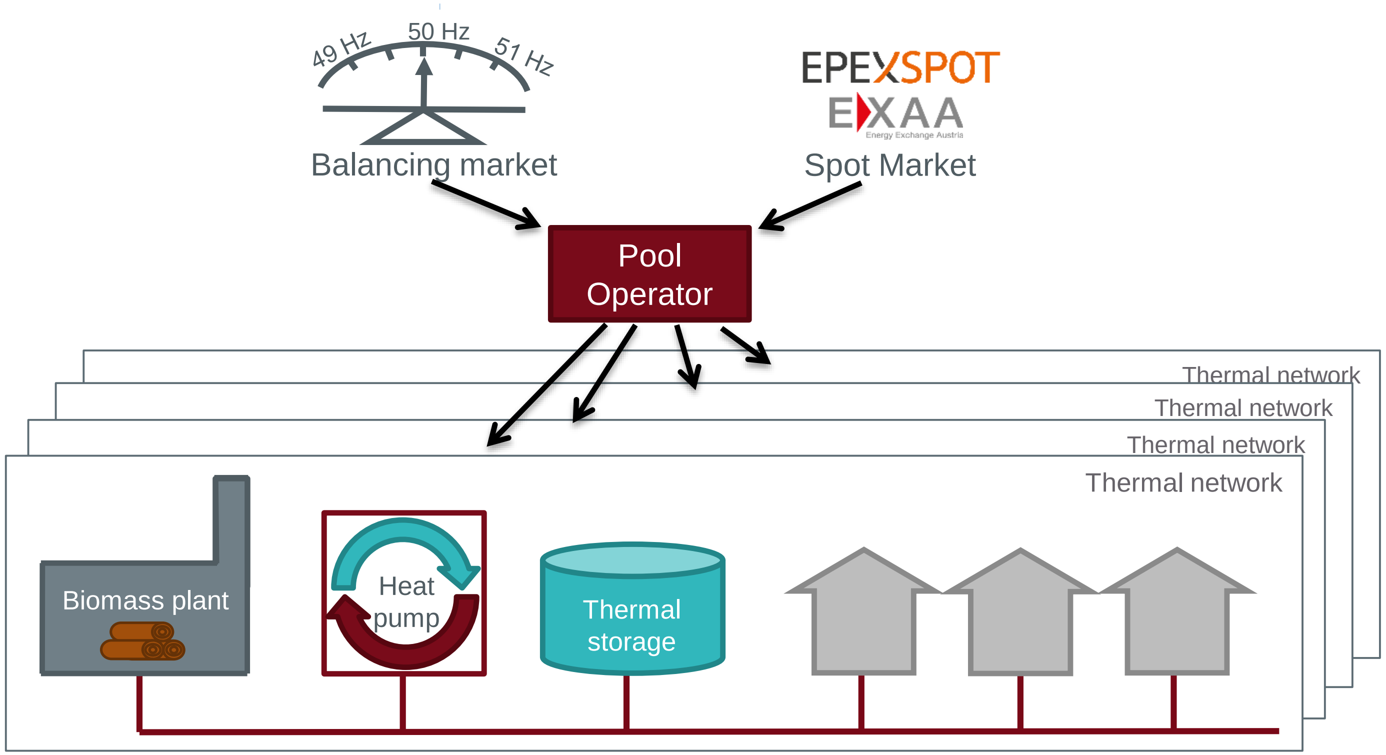
AUSTRIAN INSTITUTE OF TECHNOLOGY

PROJECT CONCEPT

Business models for heat pump pooling in rural district heating networks

- Integration of heat pumps in rural district heating networks.
- Development of feasible use cases and potential business models.

- Synergies between heat and electricity market.
- Participation in the electricity markets:
  - Day-ahead SPOT market.
  - Balancing markets (secondary and tertiary).
- Heat pump pooling over several heating networks.



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Bundesministerium Verkehr, Innovation und Technologie

METHODOLOGY & MODEL

METHODOLOGY

1.Analysis of the status quo of the electricity markets and district heating networks in Austria.

1.Definition of scenarios for heat pump integration

1.Techno-economical assessment of the scenarios (optimization model)

1.Development of business models

SCENARIOS - VARIATIONS

Heating grid

Demand type
A) DH grid
B) Heating grid
C) Hotel facility

Heat pumps

Source
1) Flue gas
2) Sewage water

Electricity grid

Market
- Day-ahead SPOT (EPEX)
- Secondary balancing market
- Tertiary balancing market

Merit order
- Low rev. / High prob.
- Med. rev. / Med. prob
- High rev. / Low prob.

OPTIMISATION MODEL

- Based on the mixed integer linear programming (MILP) method.
- Implemented in Python.
- Objective function: minimisation of the operation costs.

HEAT PUMPS IN ELECTRICITY MARKETS

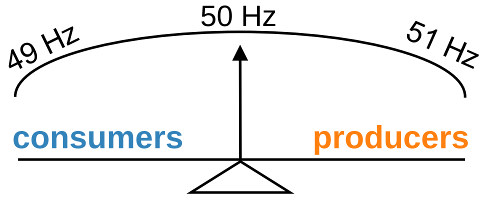
Day-ahead spot market

- Heat pumps can reduce their electricity costs
- Low technical requirements for market participation

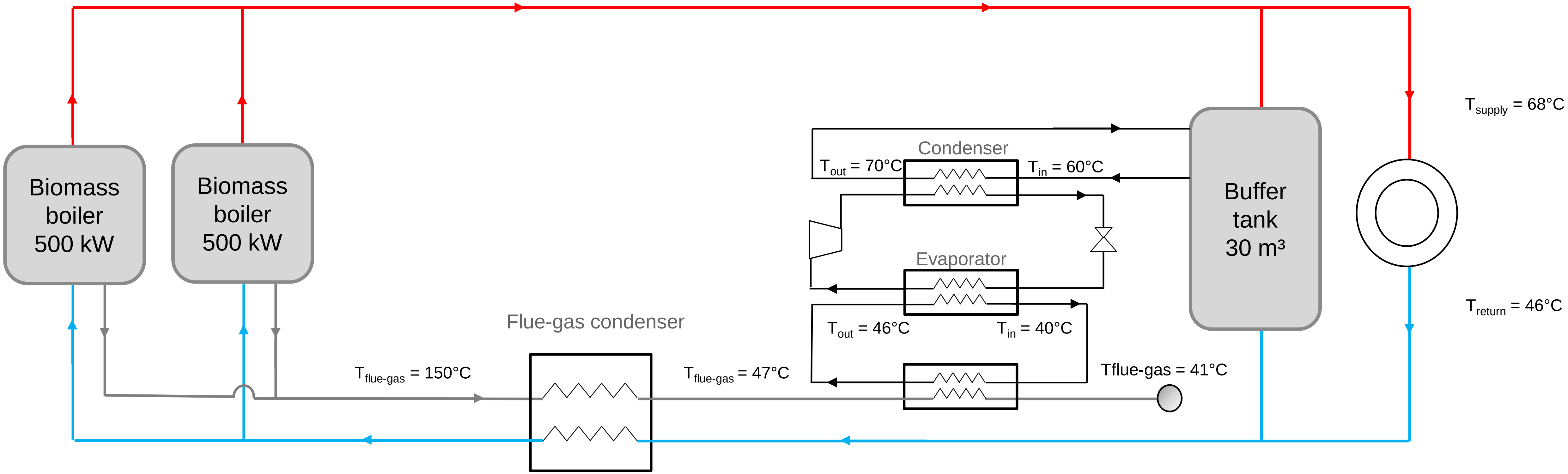
EPEXSPOT EXAA Energy Exchange Austria

Balancing markets

- Heat pumps can support the electric transmission grid + earn revenues
- 3 types of balancing energy: primary, secondary, tertiary
- Positive & negative balancing energy
- Strict technical requirements for market participation
    - Bidirectional communication
    - Fast reaction times: a few seconds / a few minutes
    - Product size: 4 h (secondary, tertiary) / 1 week (primary)
    - Minimum pool size: 1 MW / 5 MW



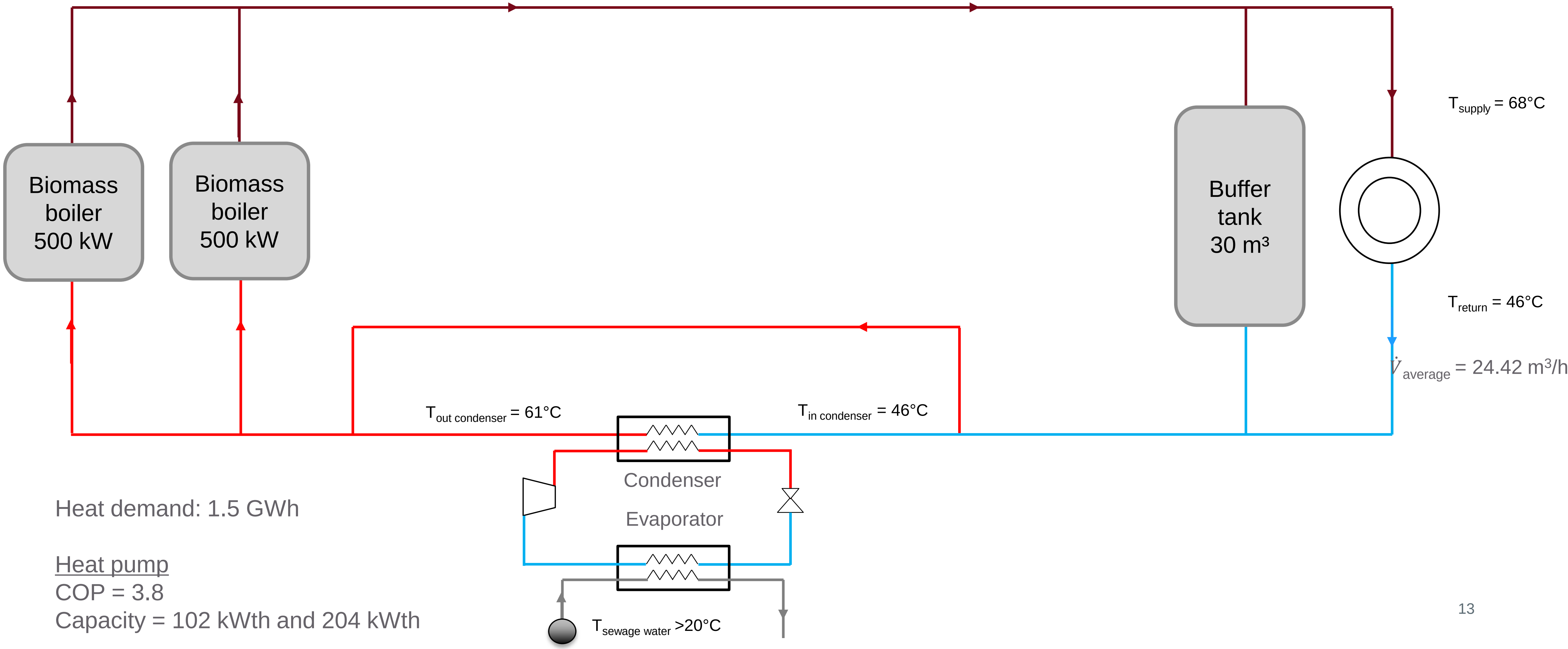
SCENARIO B – VARIATION 1: FLUE-GAS AS A SOURCE



Heat demand: 1.5 GWh

Heat pump
COP = 5.1
Capacity = 102 kWth

SCENARIO B – VARIATION 2: SEWAGE WATER AS A SOURCE

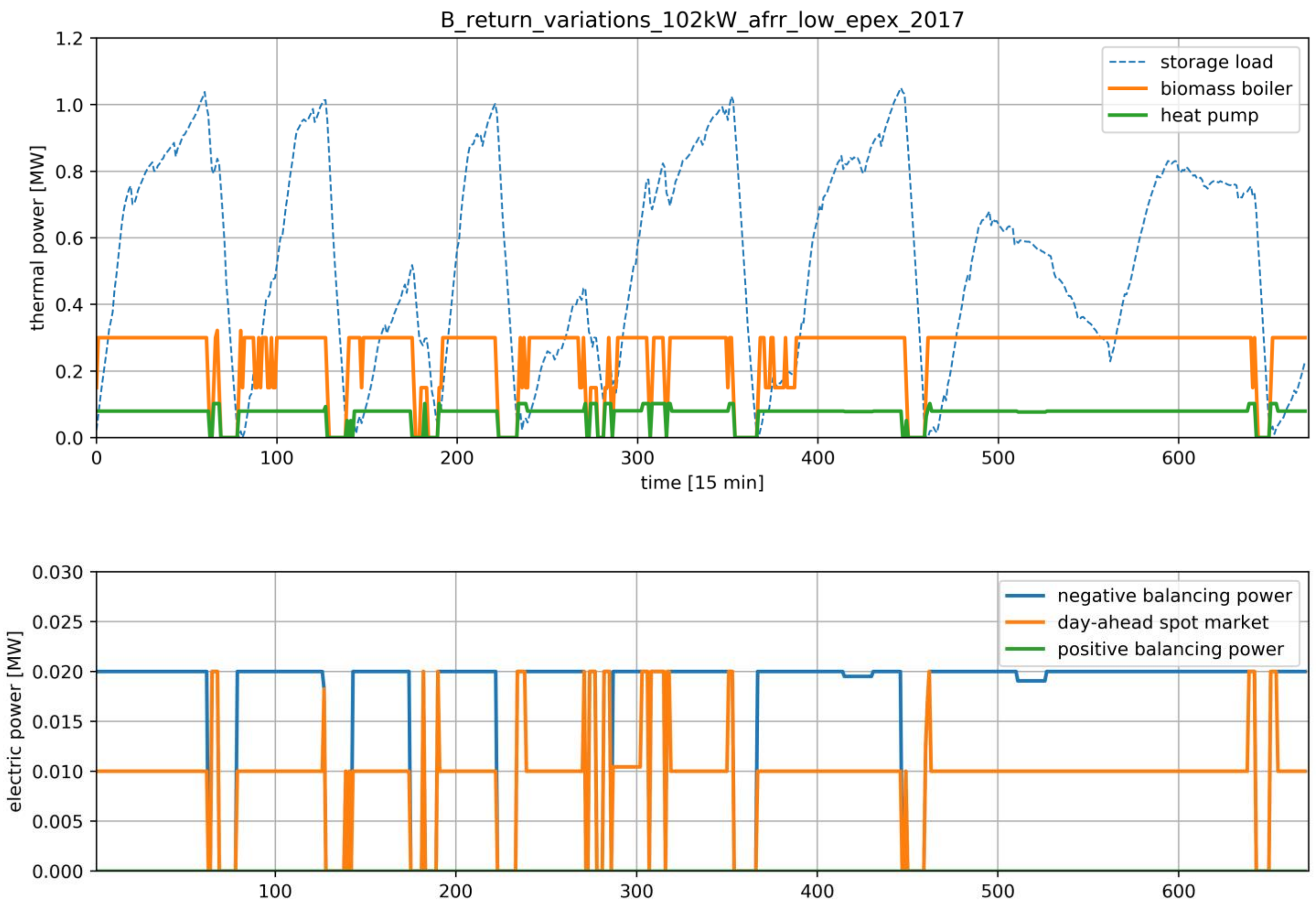


Heat demand: 1.5 GWh

<u>Heat pump</u>
COP = 3.8
Capacity = 102 kWth and 204 kWth

RESULTS

SCENARIO B – VARIATION 1: FLUE GAS AS SOURCE



- The heat pump uses the **flue gas** as a heating source

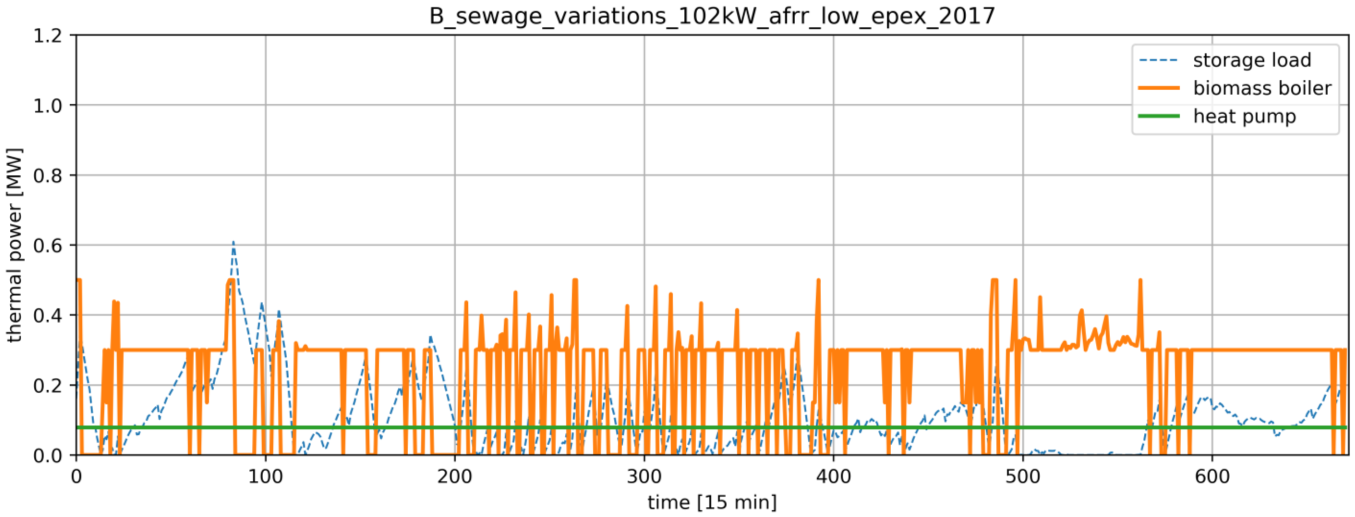
→ the heat pump can only operate when the biomass boiler is running

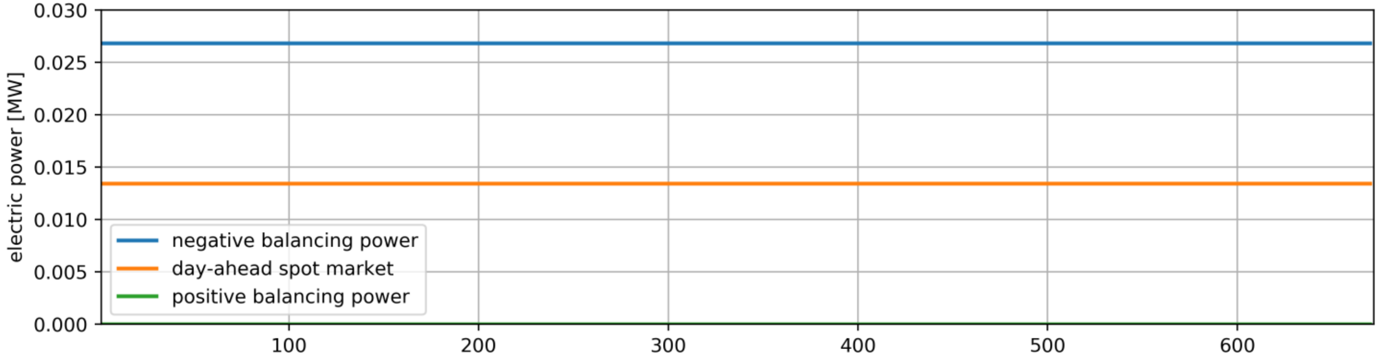
→ the **biomass boiler** runs mostly **market driven**

- The **storage is used frequently**, when the heat plants are off
- It also acts as a **back-up** for the balancing market participation

- The best strategy for the heat pump is to buy 50% of the energy on the day-ahead market and offer 50% for negative balancing energy

SCENARIO B – VARIATION 2: SEWAGE WATER AS A SOURCE





- The heat pump uses an **external heating source** (sewage water)

→ it is the cheapest heat producer and runs as **base load**

→ the **biomass boiler** runs mostly **heat driven**

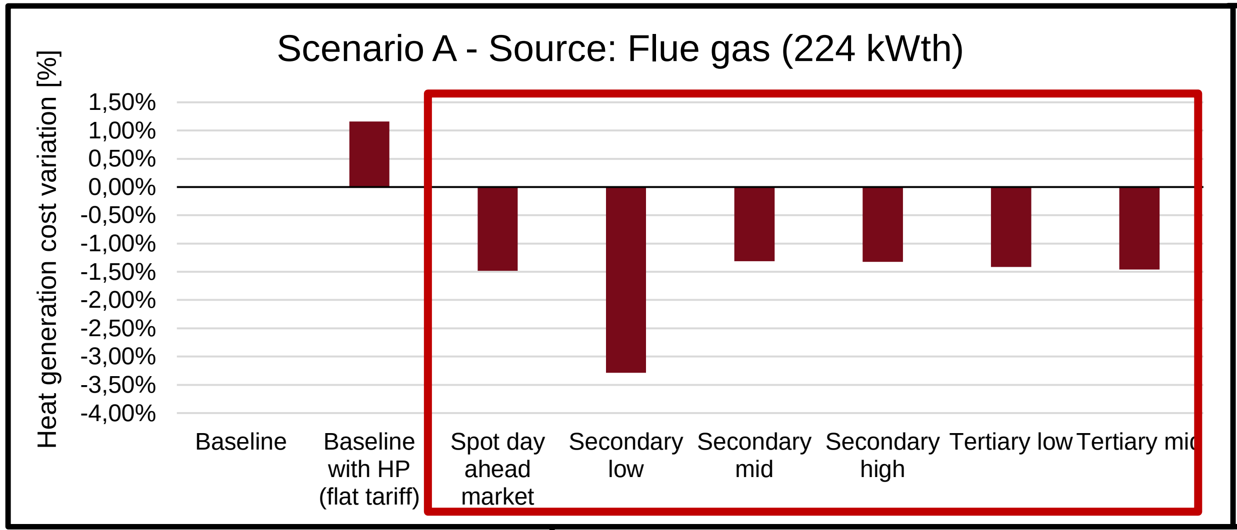
- The **storage is used less**.
- It also acts as a **back-up** for the balancing market participation

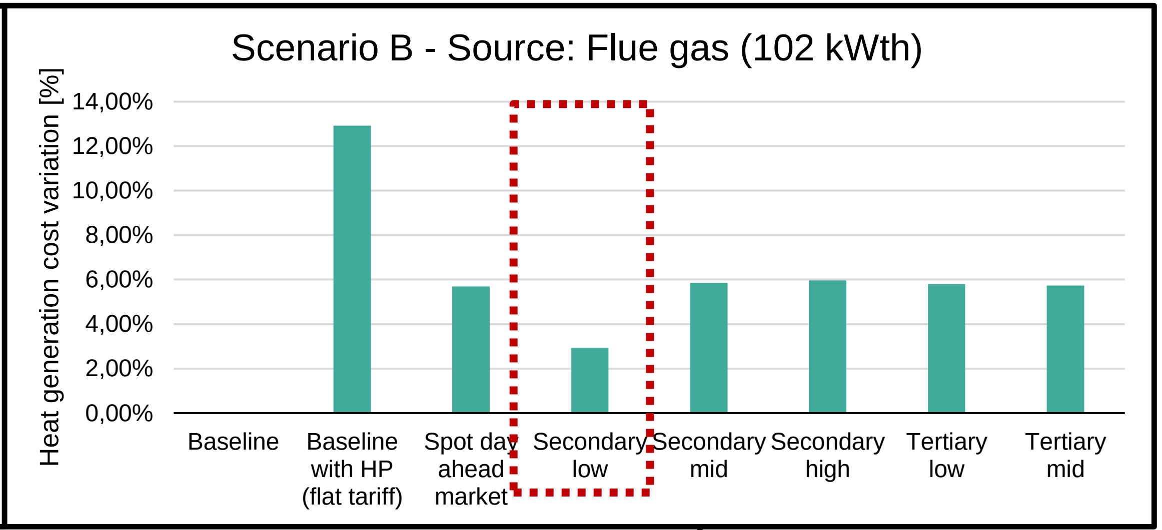
- The best strategy for the heat pump is to buy 50% of the energy on the day-ahead market and offer 50% for negative balancing energy

BUSINESS MODELS

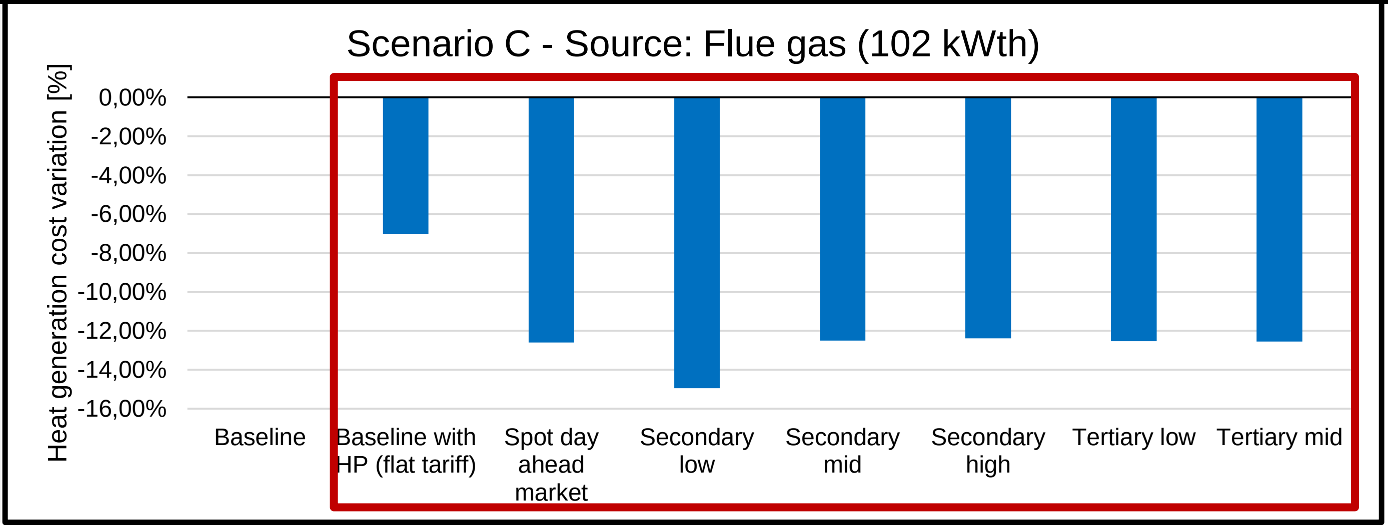
ECONOMIC EVALUATION – BUSINESS MODELS

Heat generation cost variation [€/MWh]



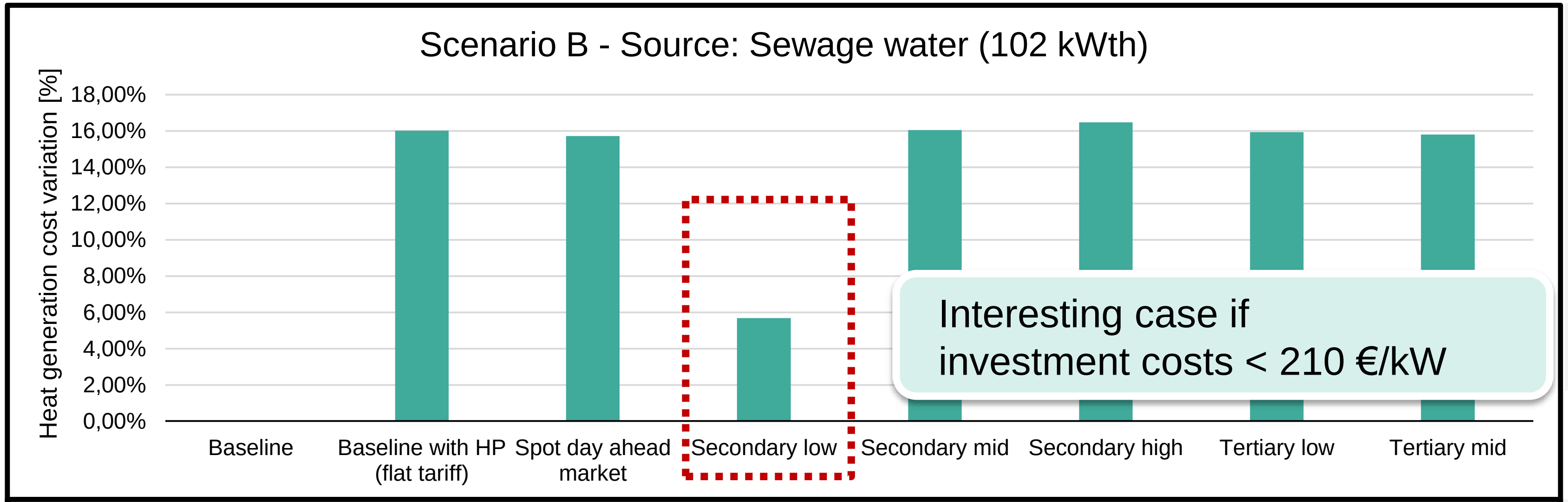


- Existing heating network with biomass boilers and storage.
- Investment in a heat pump (source: flue gas)

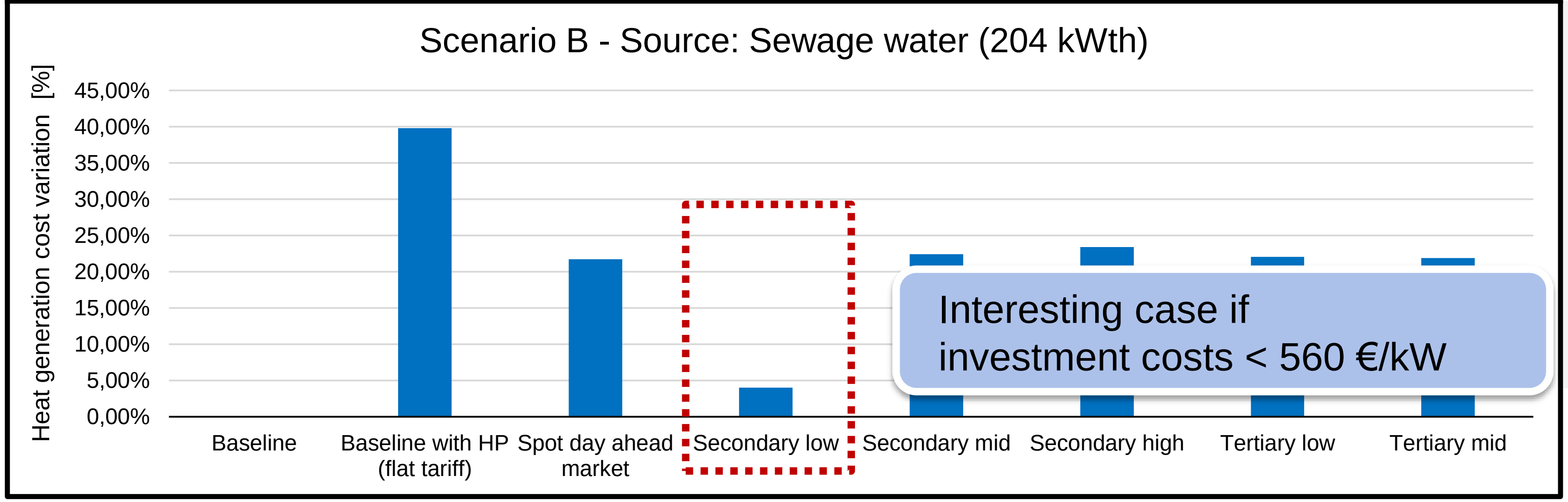


ECONOMIC EVALUATION – BUSINESS MODELS

Heat generation cost variation [€/MWh]



- Existing heating network with biomass boilers and storage.
- Investment in a heat pump and sewage water heat exchanger.



Investment cost of the sewage water heat exchanger (750 €/kW) too high for a positive business case.

CONCLUSIONS

OUTCOME

The integration of heat pumps in rural district heating networks is technically and economically feasible.

- **Reduction of heat generation costs.**

  Scenario C presents the most attractive results: heat generation cost reduction up to 15% (12600€/year).
- Most attractive case: combination of **day-ahead spot and secondary low.**
- The results for the current scenarios are **not highly influenced by the future** development of biomass/electricity prices and call probabilities. The scenarios are **feasible** under future conditions.

- **Capacity increase** in the district heating network.
- **Prolongation of the lifetime** of the existing old boilers.
- **Counteract the high costs** associated with the expansion of the electricity grids.

THANK YOU FOR YOUR ATTENTION

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