Papieri District Cham – Monitoring and Simulation

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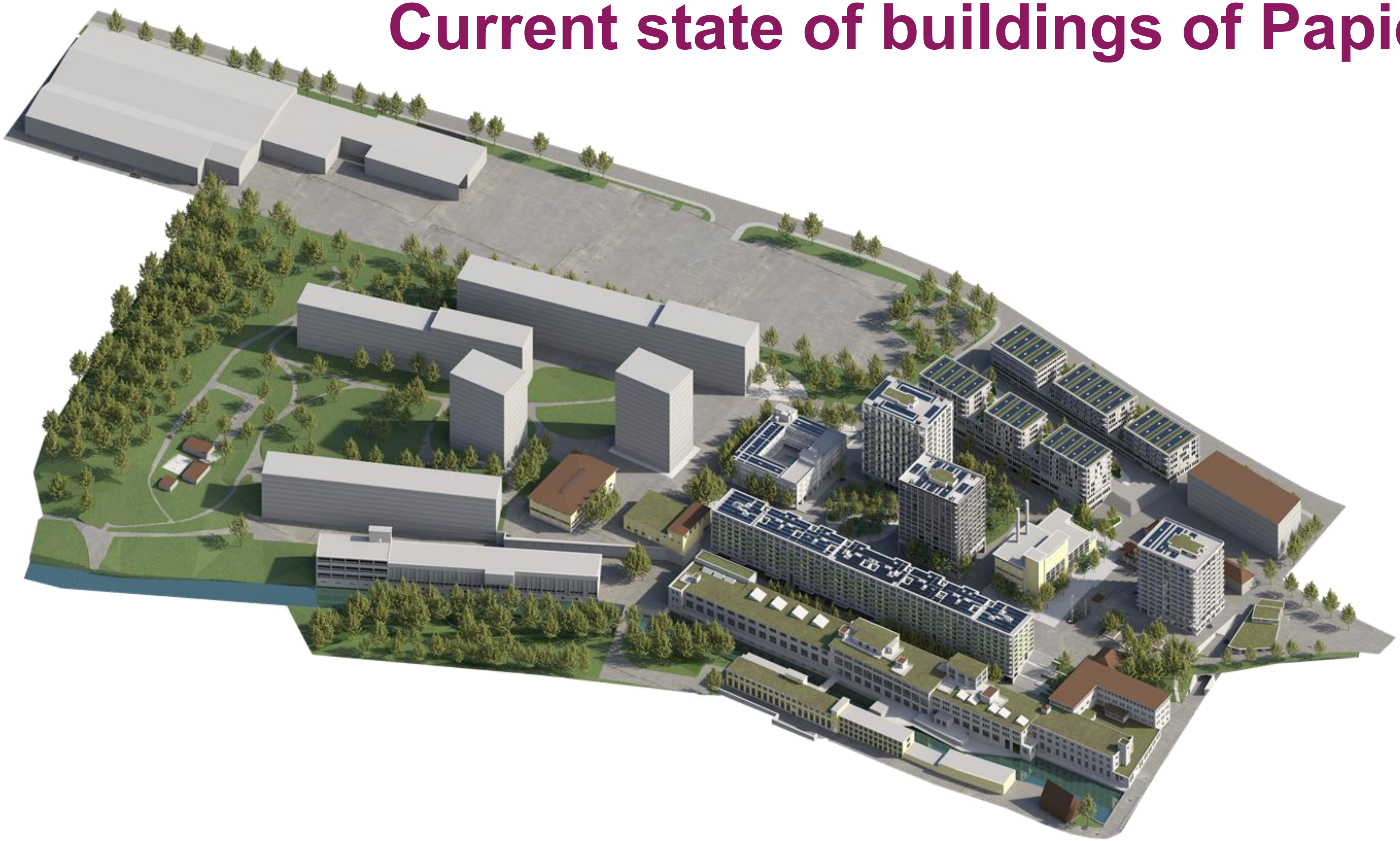
Outline Papieri District

- **Papieri District**
  - Development until 2035
  - All electric district
  - 11 ha district area
  - In final stage 2035 170,000 m^2 ERA
  - 1000 Flats/4000 people
  - 1000 Workplaces
  - 6 heritage buildings retrofitted to MINERGIE-P
  - Watt d'Or 2024 category "Renewable Energy"
  - Certified as 2000-W-site/ MINIERGIE site

Outline Papieri District

Current state of buildings of Papieri Cham



Papieri District Cham - Impressions



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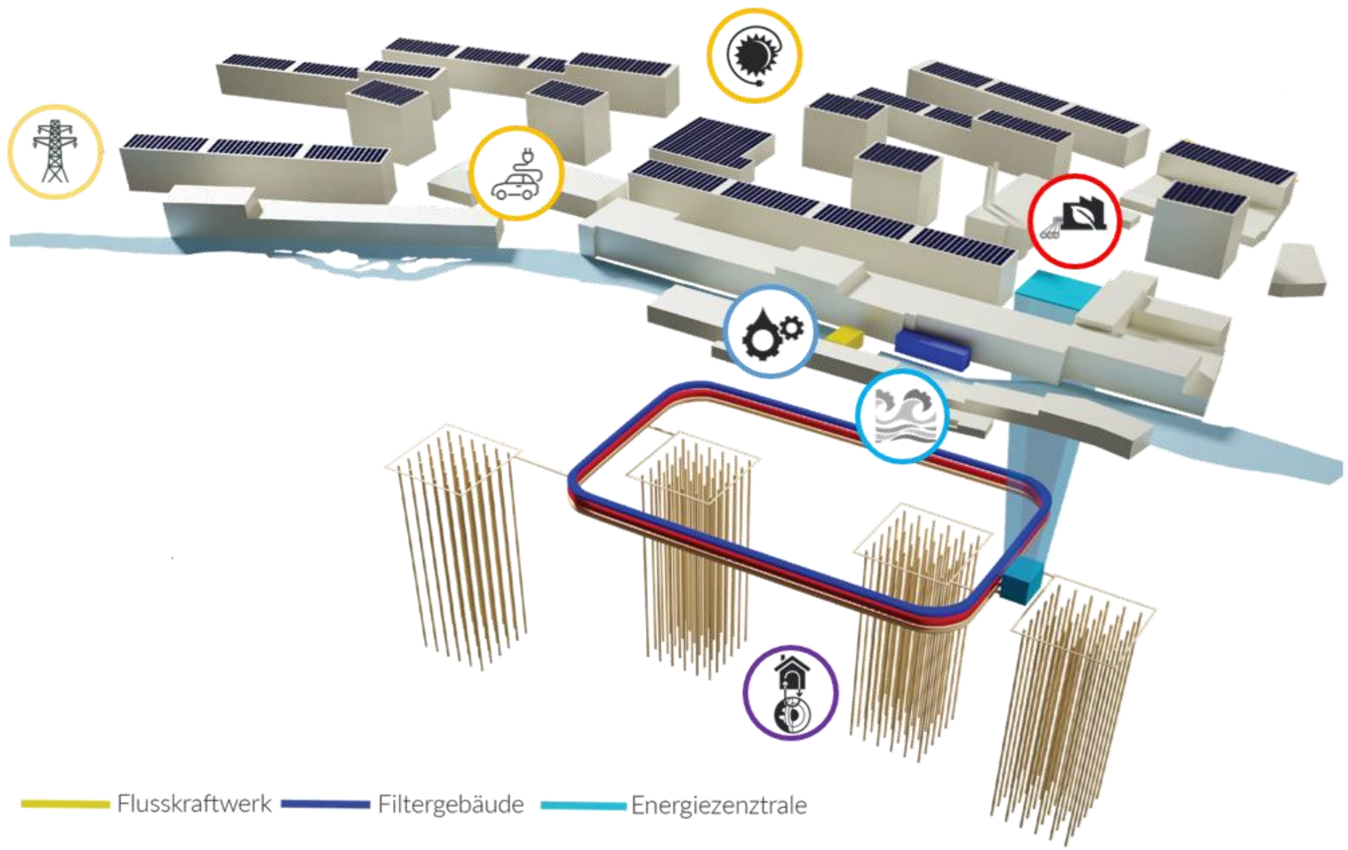
Outline Papieri District

- **Papieri District**
  - Entirely renewable Heat- and Cold supply with central HP
  - 4-pipe Heating-/Cooling grid
  - Dual-Source-system with Borehole HX and River water
  - On-site electricity generation with Run-of-river power plant and PV production on new buildings
  - Charging stations for E-mobility
  - Smart homes with energy displays in each flat
  - Projected with 75 % Self-sufficiency



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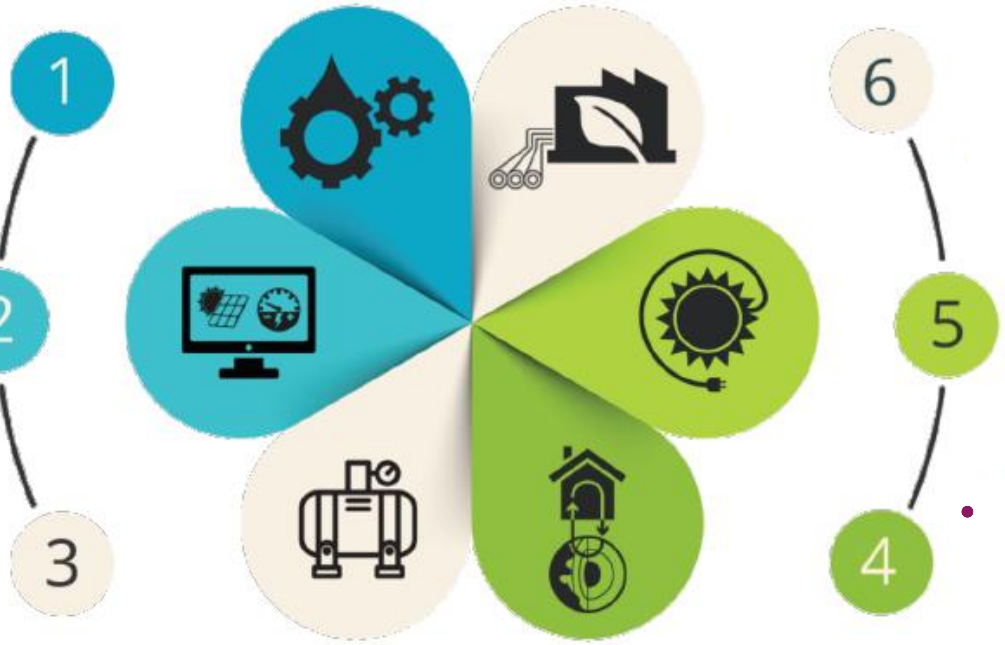
Outline Papieri District – Energy concept

- **River (Lorze)**
  Run-of-River power plant
  (230 kW. 1.25 GWh)
  and thermal energy source
  (3 lines with 2.9 MW)

- **Energy management**
  Energy management of electricity use for enhanced self-consumption and reduced grid interaction

- **Heat pumps**
  Centralised heat pumps with natural refrigerant ammonia
  (3 x 1.7 MW installed)



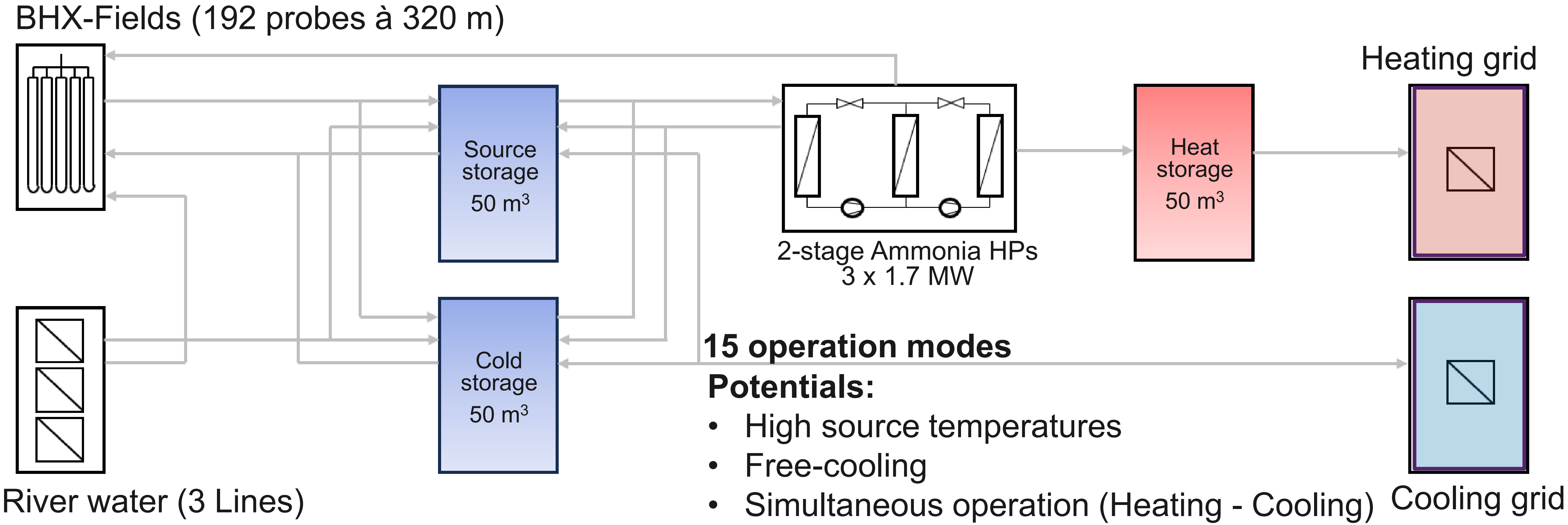
- **Thermal grid**
  Integrated space heating, DHW and space cooling

- **Electricity generation**
  6500 m^2 PV systems on new buildings
  ($1.27\ MW_p$, $1.11\ GWh_{el}$)
  ZEV: Tenant electricity model

- **Geothermal heat source/sink**
  8 Borehole fields with totally 192 ground probes of 320 m depth

Papieri District – Simplified hydronic integration

- Main components heating center and heat sources



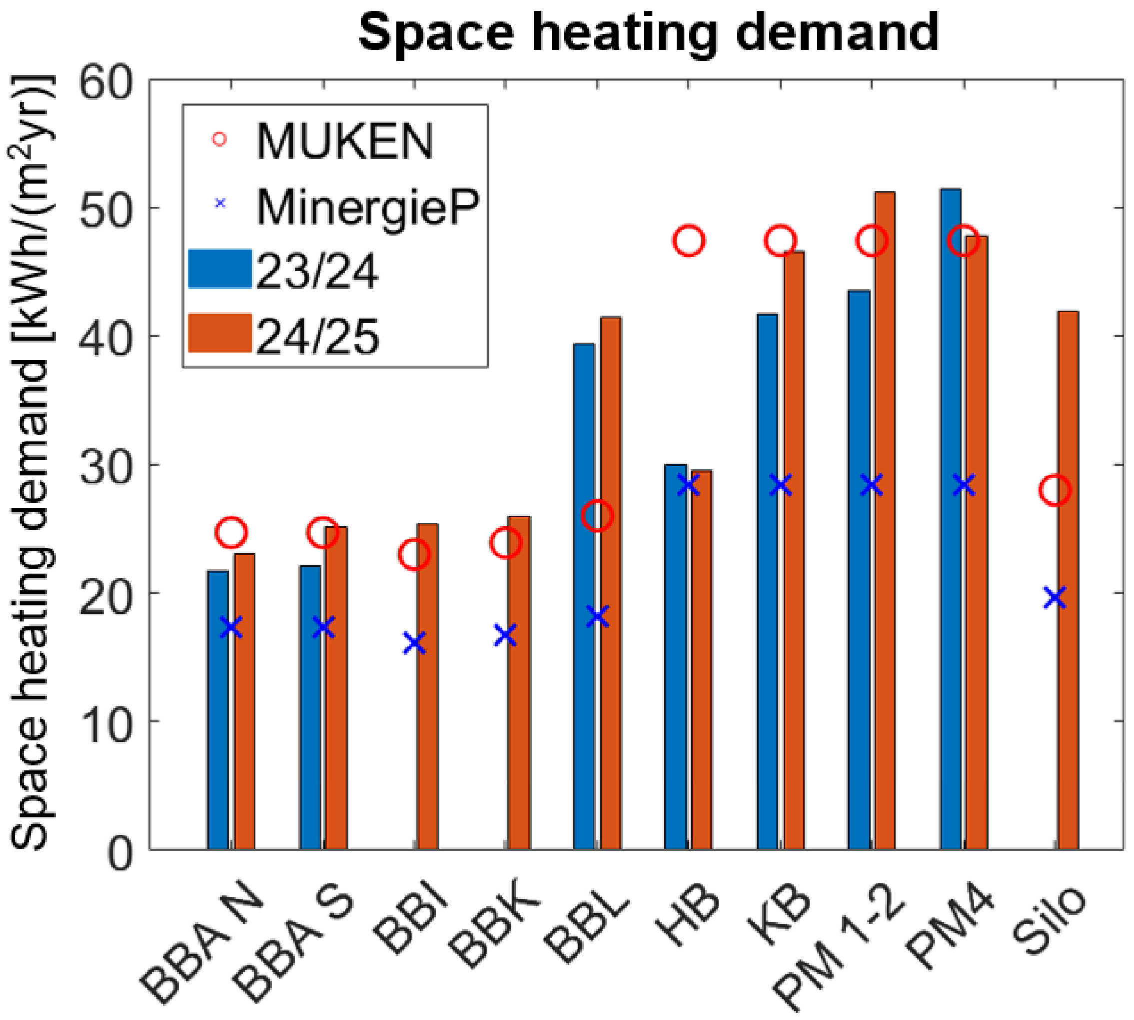
15 operation modes

Potentials:

- High source temperatures
- Free-cooling
- Simultaneous operation (Heating - Cooling)
- Ground regeneration

Space heating

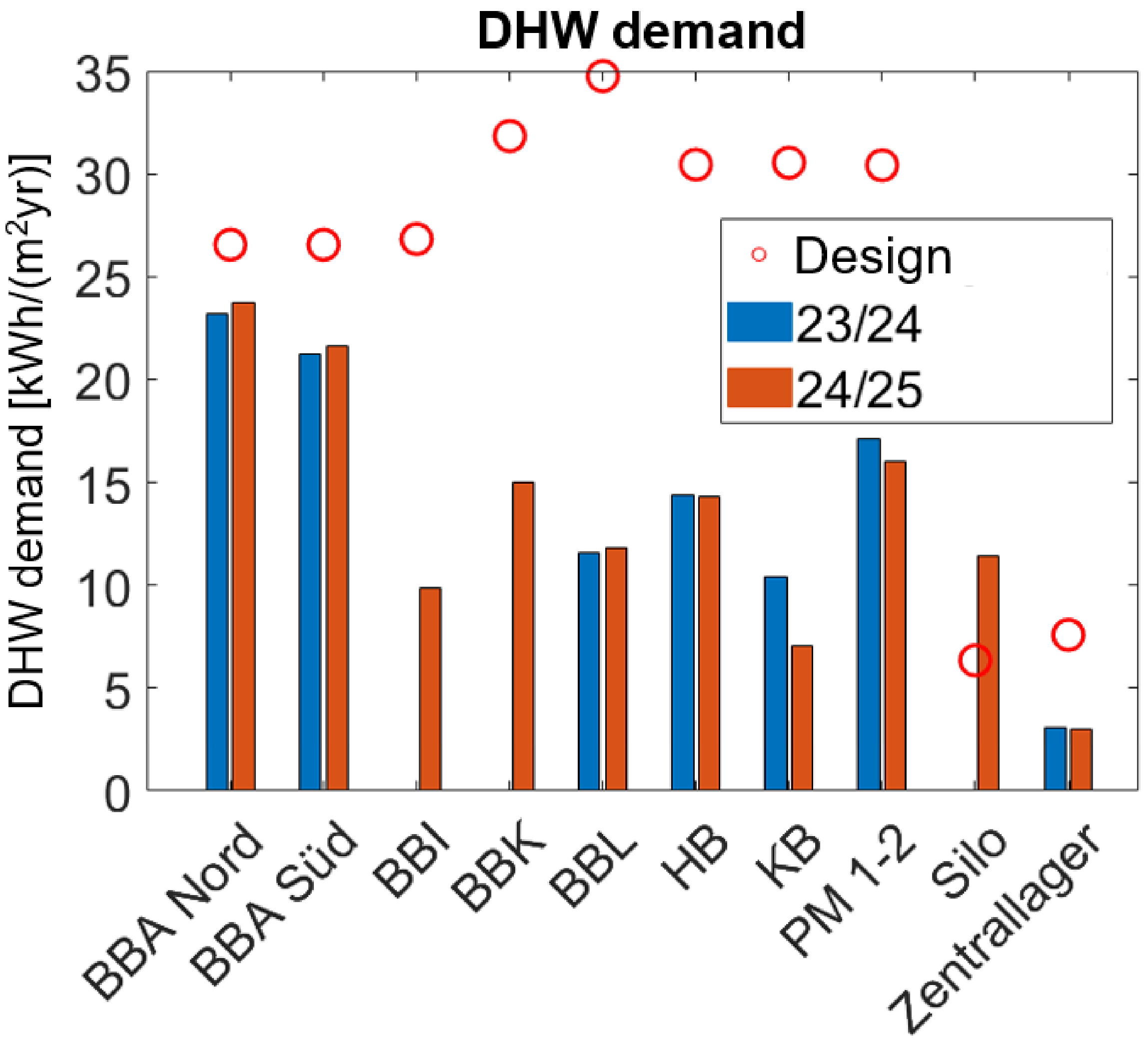
- Heating Demand generally meets the requirements of MUKEN
- Minergie P requirements are not achieved
- Silo and BBL both exceed significantly the target demand
- In general the temperature threshold for the heating is set too high



Monitoring Papieri

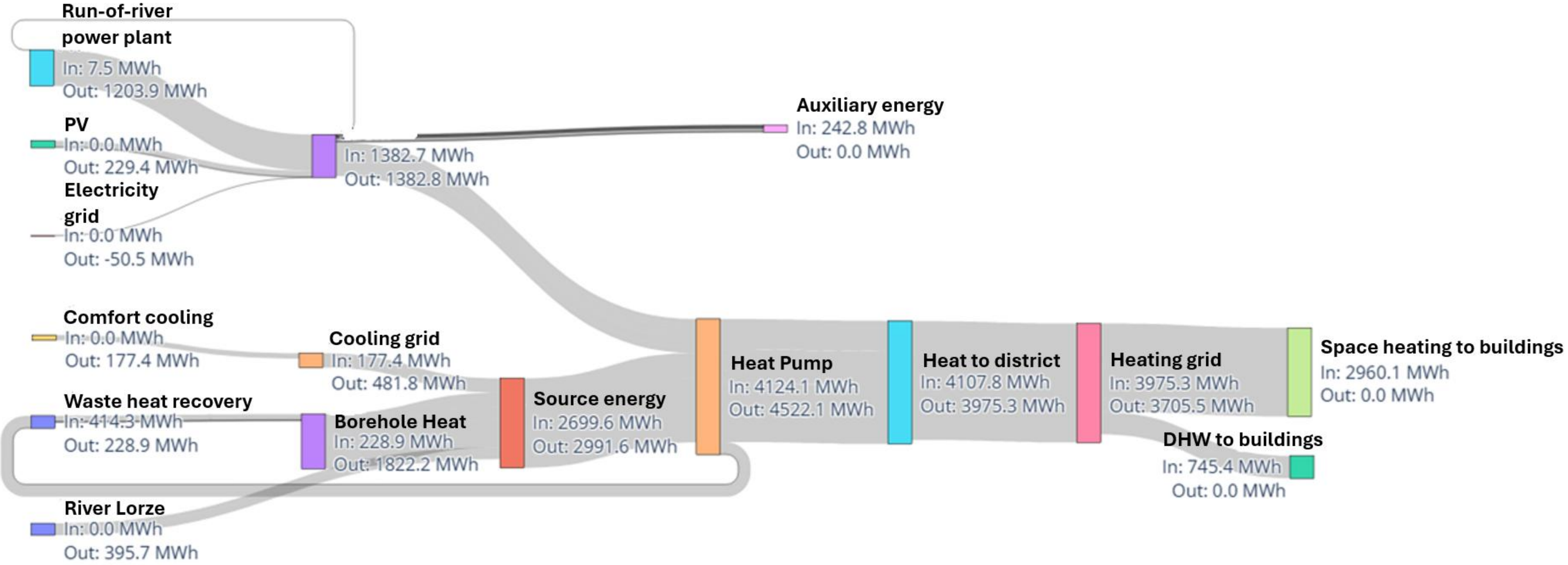
DHW

- Domestic hot water (DHW) Demand is in general much lower than expected although the planning values were in general high.
- In the buildings which are fully occupied and used «as planned» (BBA N und BBA S) the DHW usage is closer to the planned values
- In certain buildings the occupation level remains lower than planned



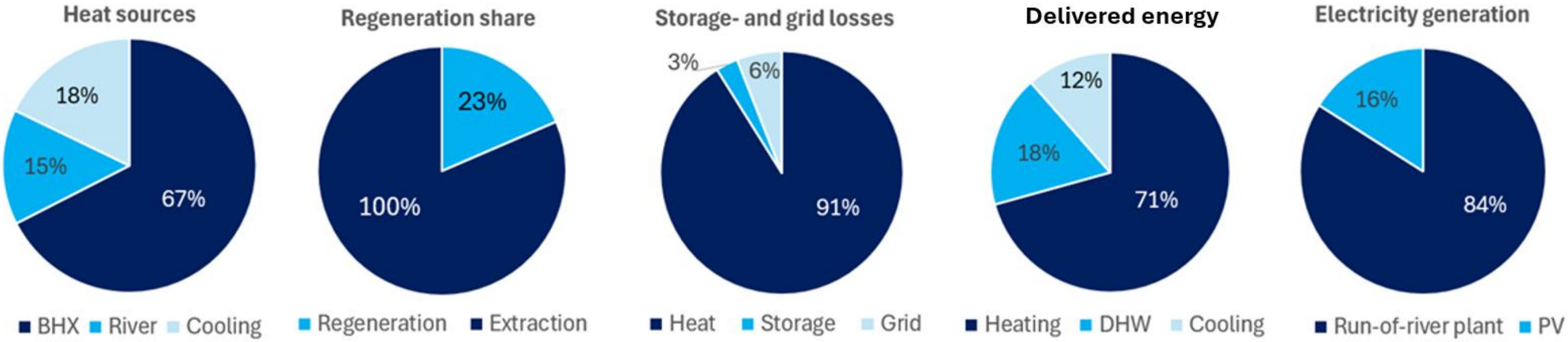
Energy flow diagram 2024/25

- **Energy flow diagram from heat-/cooling source to heat-/cold use**



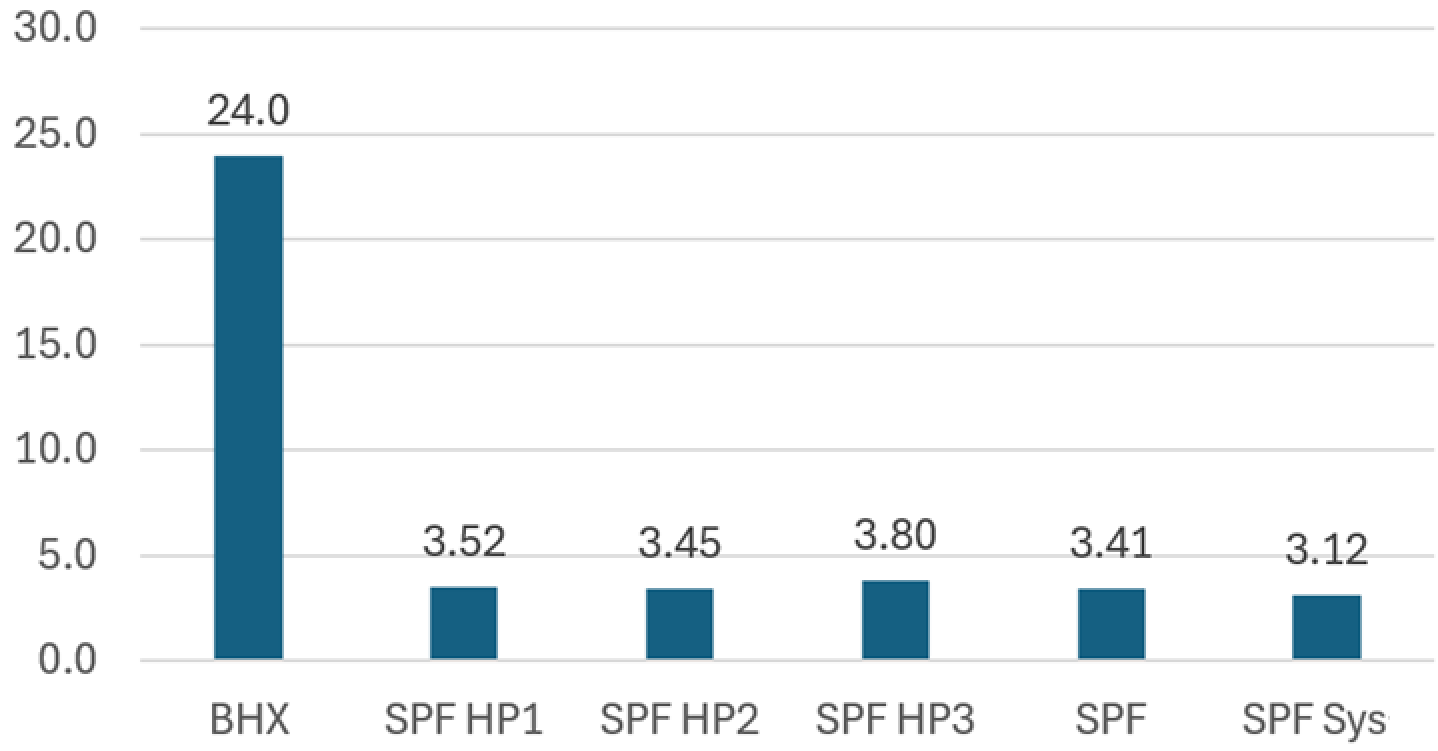
Energy flow diagram 2024/25

- **Source fractions, System losses and delivered energies**
- Main heat source applied is the Borehole heat exchanger (BHX) with 67%, River 15%
- Total Regeneration of the BHX is 23% of the extracted heat
- Moderate system losses with 3% heat storage losses and 6% heating grid losses
- 71% of delivered energy for space heating, low DHW (18%) and cooling (12%) fractions
- 84% of on-site electricity production by run-of-river power plant, 16% PV fraction



Energy flow diagram 2024/25

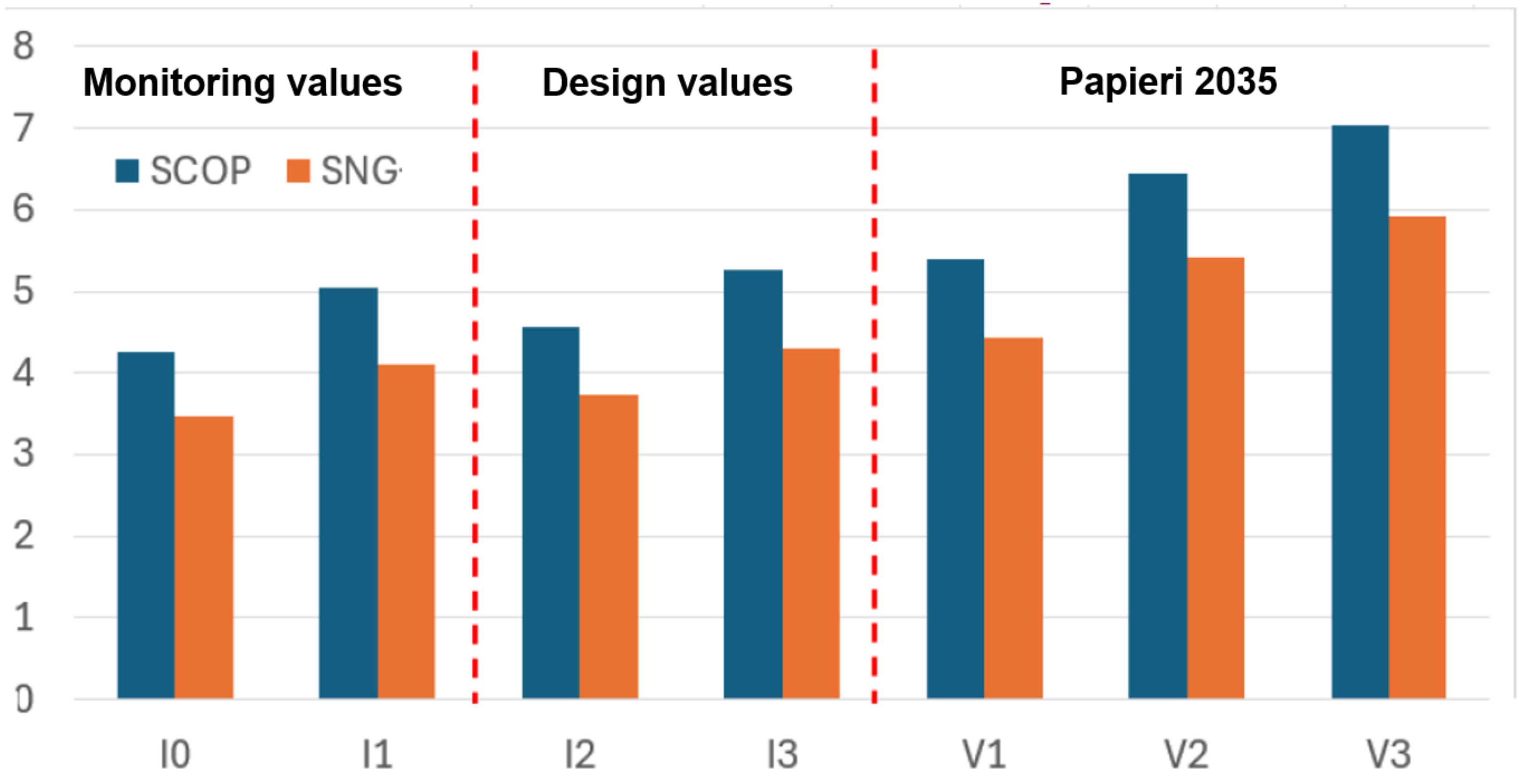
- **Heat pump performance**
- Good performance of the heat pump based on operating conditions
  supply 67 °C
  source 10 °C
- However, high grid temperature are operated 24/7 around the year
  => optimisation potential



Simulations scenarios and hypothesis

- Comparison with design values
  - System efficiency improves with more cooling demand as per the planned demand. Simultaneous heating (warm water) and cooling.
- Scenarios with reduced grid temperatures
  - Reduction of the network temperature offers potential for more efficient operation of the heat pumps
  - Network temperatures are dictated by the DHW operation
  - Variant: Temporary increase of the network temperature 3 times daily for hot water production (loading windows) with decentral storage in boilers

Simulation results with reduced grid temperatures



Variants:

I0, I2, V1:
67 °C supply,
continuous

I1, I3, V2:
57 °C supply
2 charging windows à 2 hours

V3:
47 °C supply
2 charging windows à 2 hours

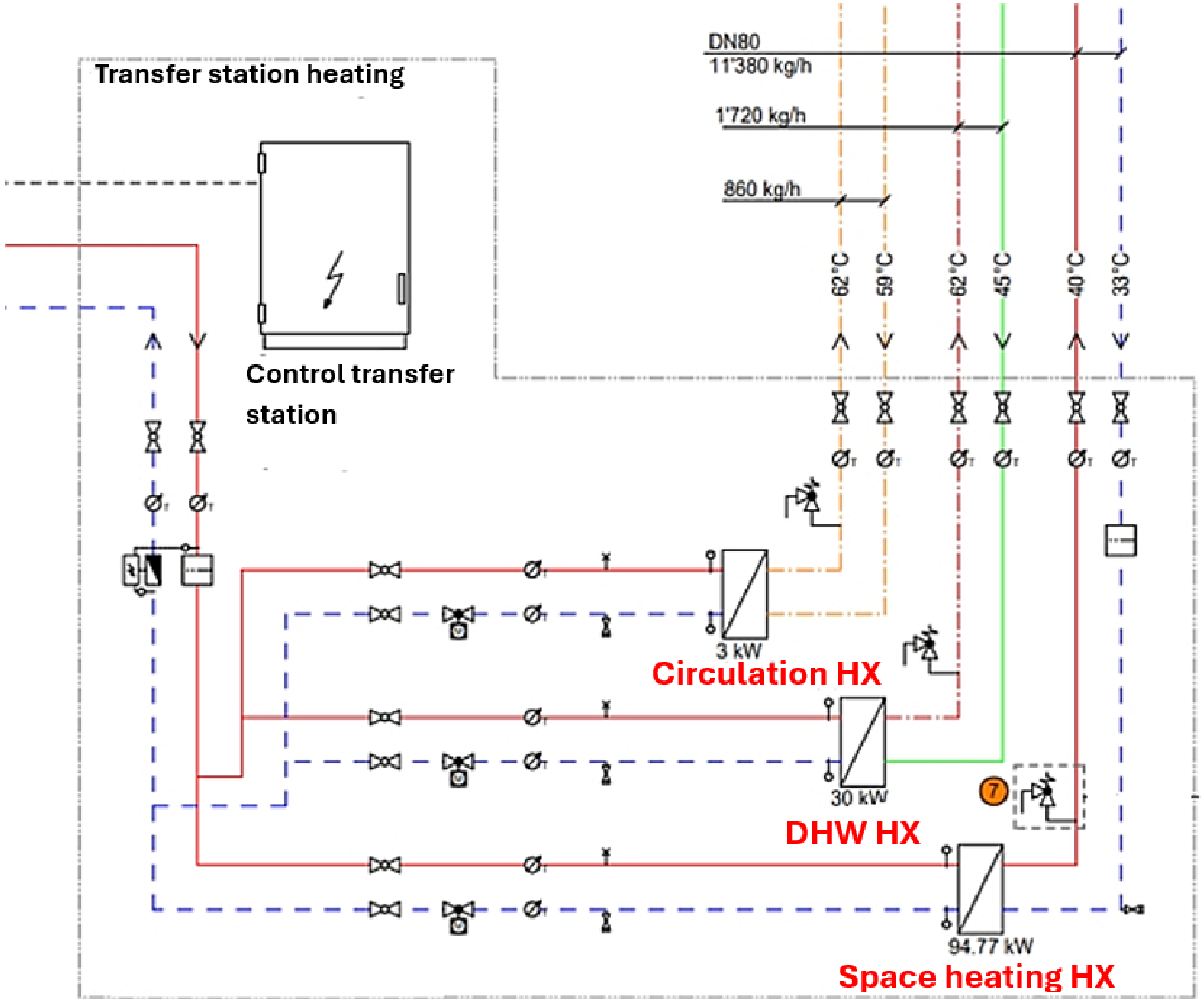
Cost savings: -52500 CHF -46800 CHF -150'000 CHF -216'600 CHF

Assumed electricity price 30 Rp./kWh

Optimisation potentials

Integration DHW

- DHW could be supplied during temporary loading windows and stored in decentral hot water tanks (already installed)
- Circulation losses are currently covered directly from the heating network. This prevents the network temperature from being reduced.
- The circulation losses could be covered by the hot water tank or with decentral small HPs.



Current work and perspectives

- Step-wise implementation of reduced grid temperature
- Simulations of source integration
  - Improved control for high source temperatures
  - Source management Freecooling and Regeneration
  - Regeneration with river water and waste heat from cooling
- Comparison of different grid configurations
- Optimisation of self-consumption and grid–supportive PV and HP use

Conclusion

- Ambitious energy concept for fossil-free district supply
- Good performance of the heat pump and little system losses
- Optimisation potential regarding the integration of DHW/circulationto reduce grid temperature
- Integration matters more than the HP COP
- Further optimiation potentials on the source side currently evaluated
- Accompanying simulations («Digital twin») sare a good means to evaluate optimisation measures, in particular for the complexity of district energy systems
- A minimum monitoring is essential for performance optimisation
- Even with optimisations PED will be hard to reach

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Thank you for your attention

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