

TOWARDS POSITIVE ENERGY DISTRICTS

HEAT PUMP SYSTEM TOPOLOGY DESIGN GUIDELINES

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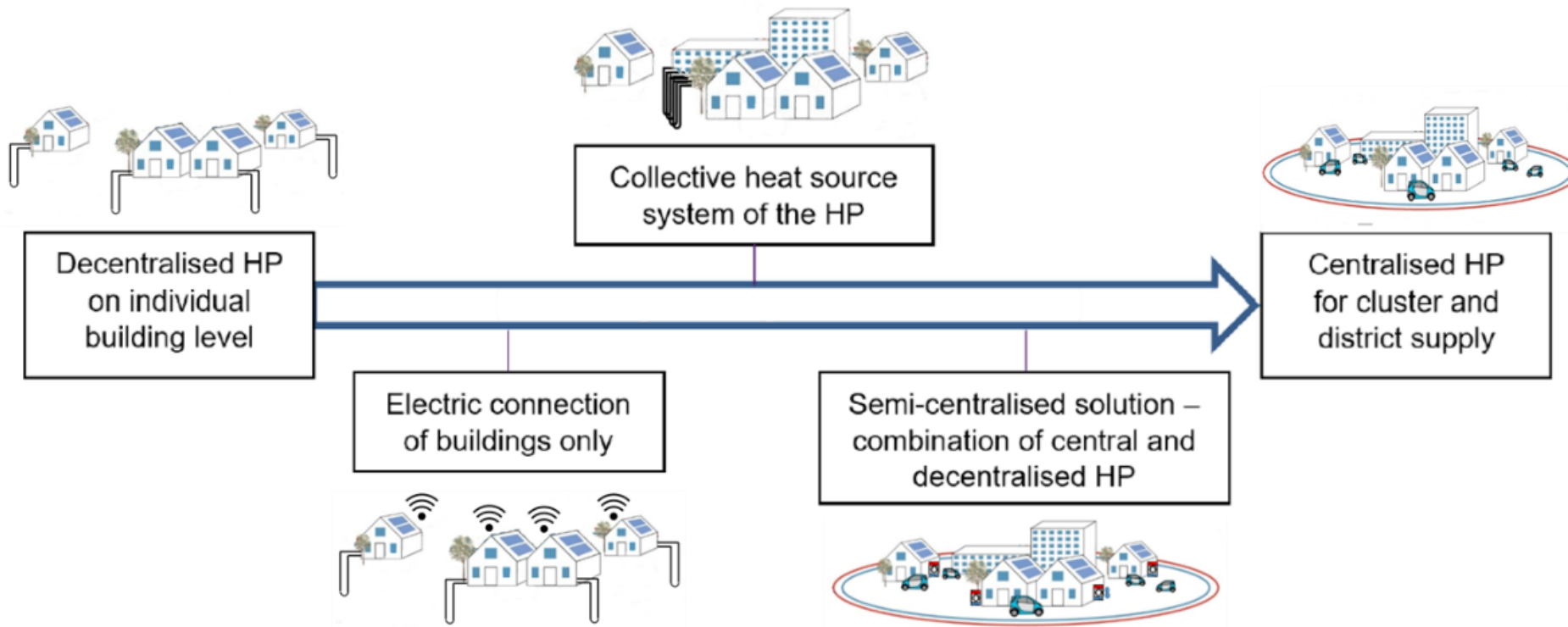
IEA HPT Annex 61 HP in PED



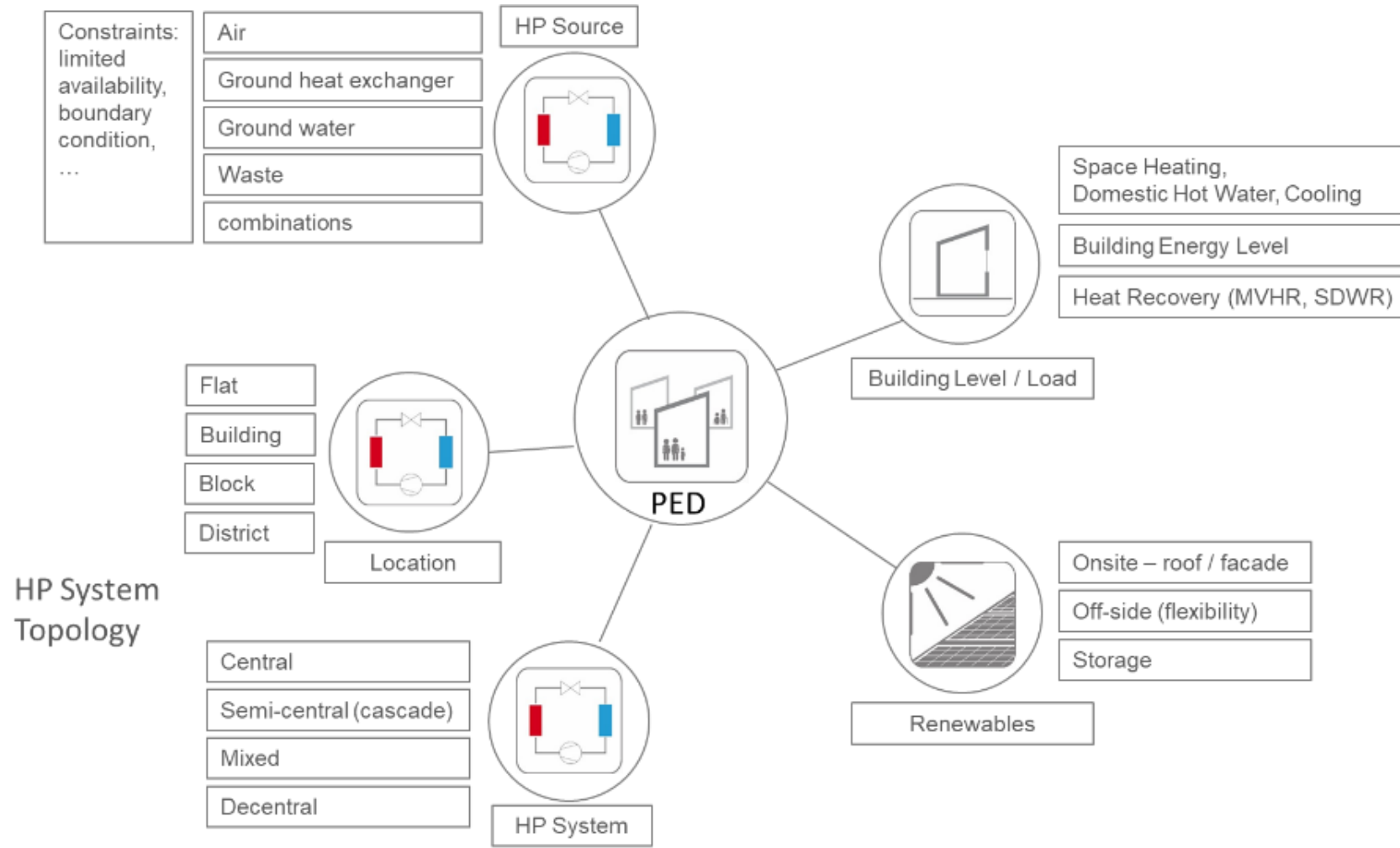
NHT



Innsbruck Informiert

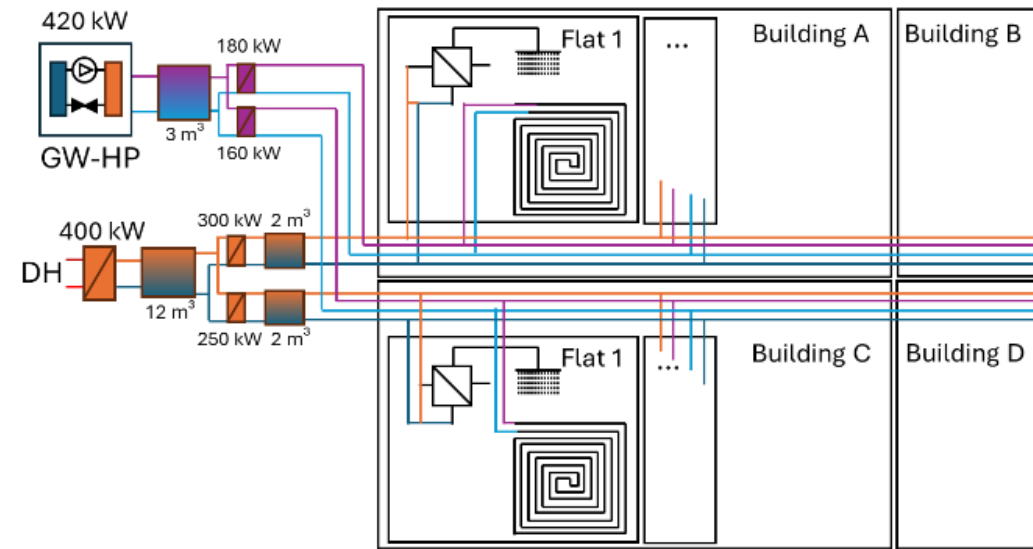
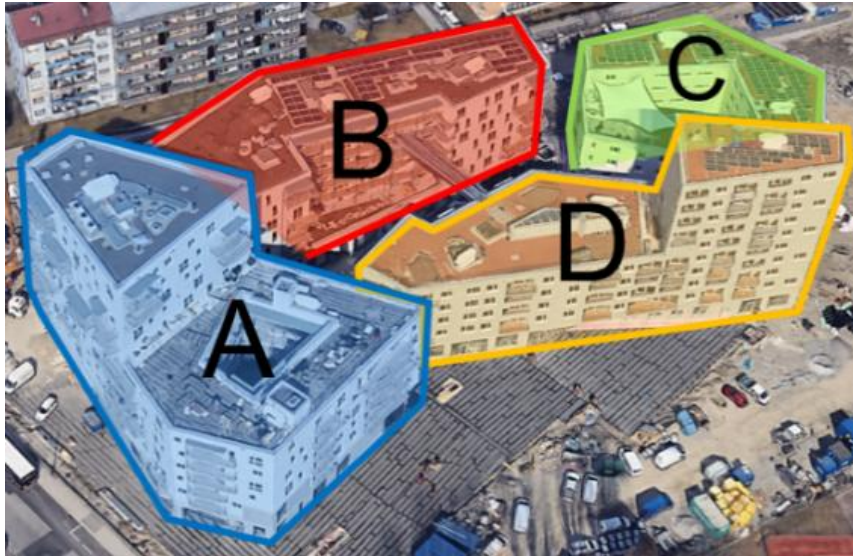


HP System Design Variables

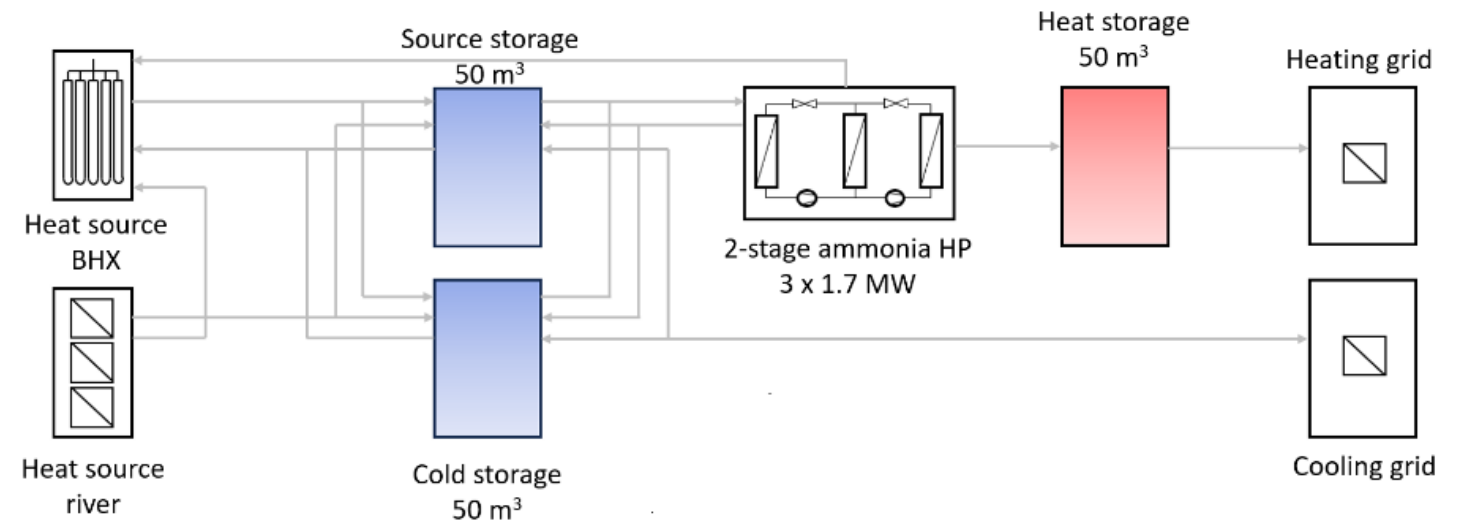


HP System Topology

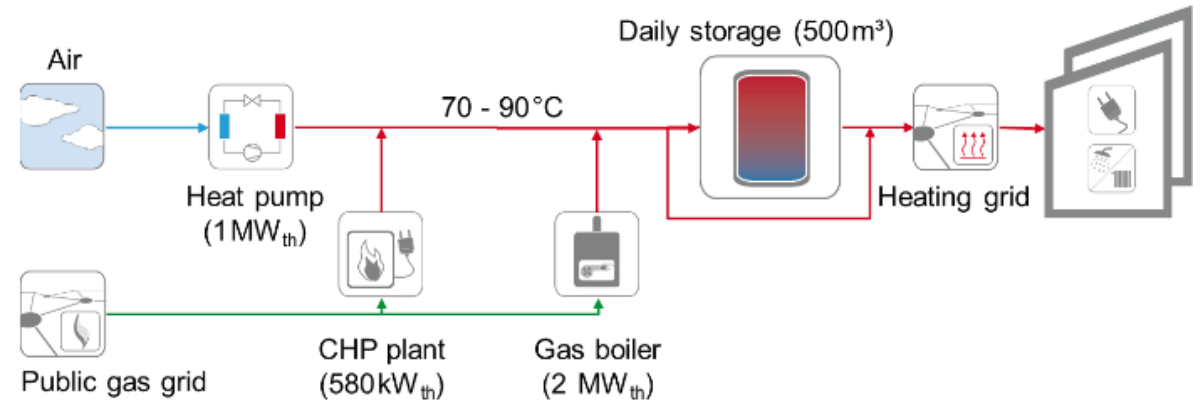
Innsbruck Campagne



Papieri (CH)

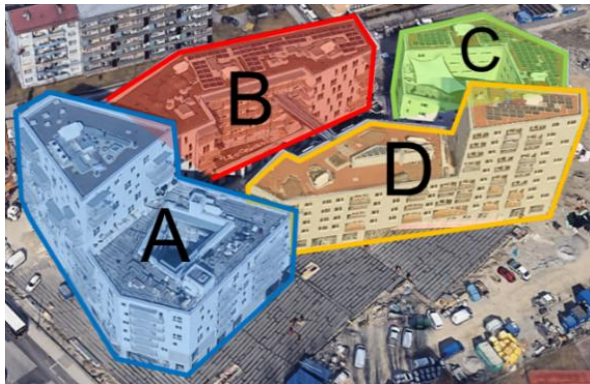


Quarree100 (D)

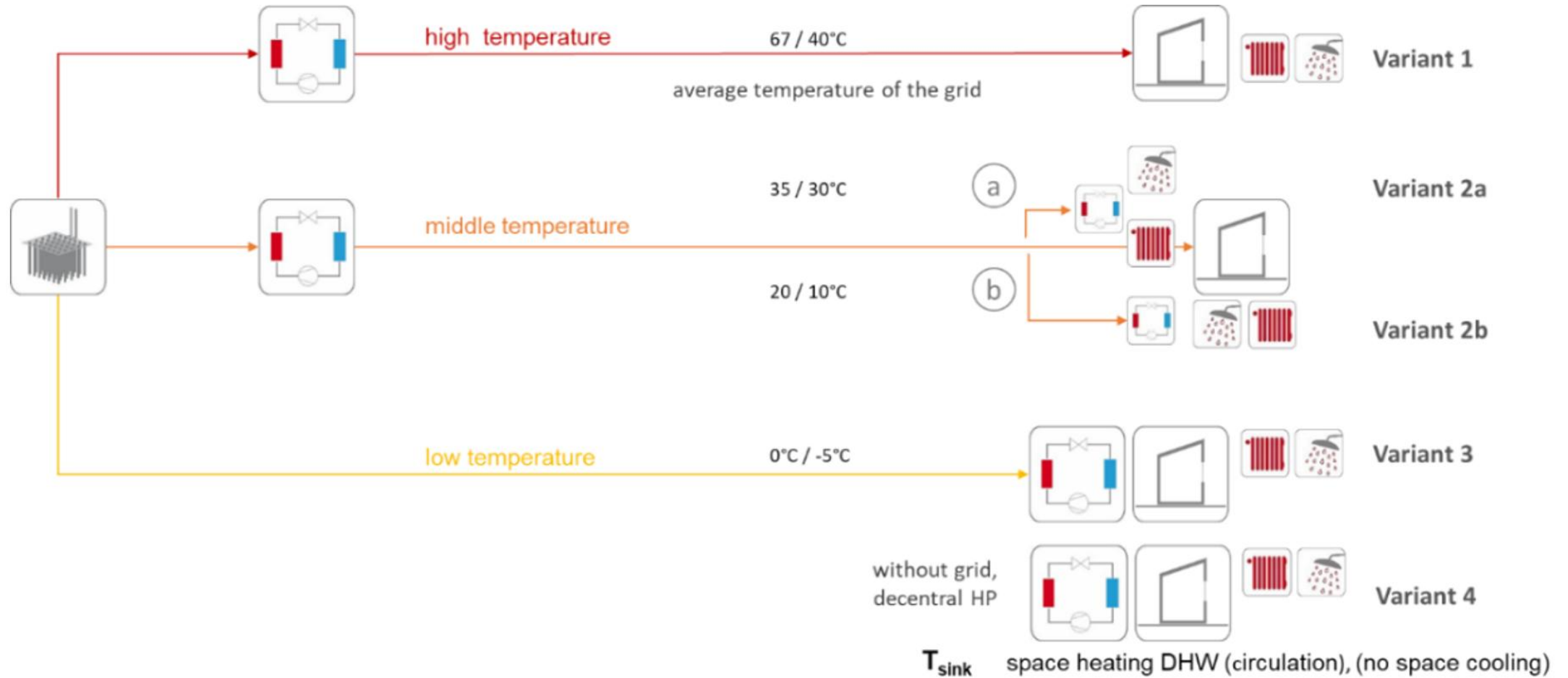


Characteristics of the Three „Towards“ PEDs

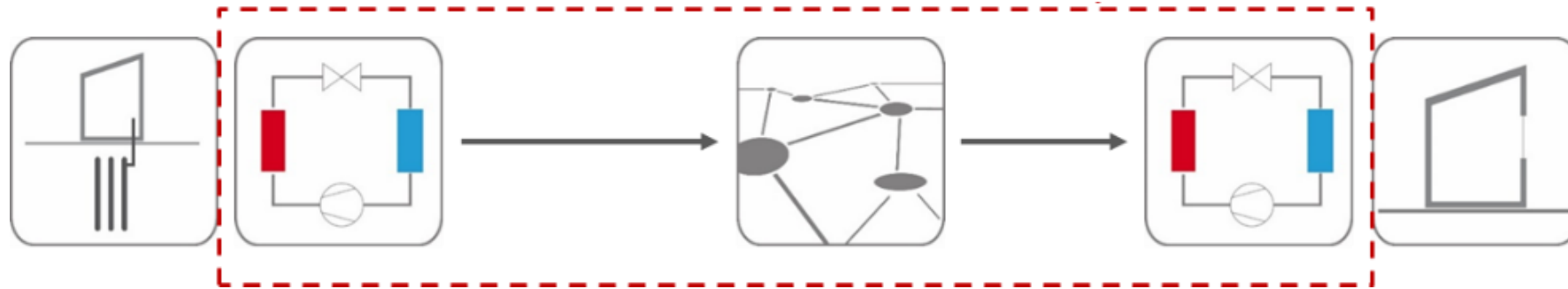
PED	Treated Area [m ²]	Space Heating Demand [kWh/(m ² a)]	Heating Load [kW]
Innsbruck Campagne (At)	29 453	14.6	400
Papieri (CH)	59 267	34.8	1 800
Quaree 100 (D)	64 990	86.2	2 300



Heat Pump System Topology - Space Heating and Domestic Hot Water



System Boundary and SPF

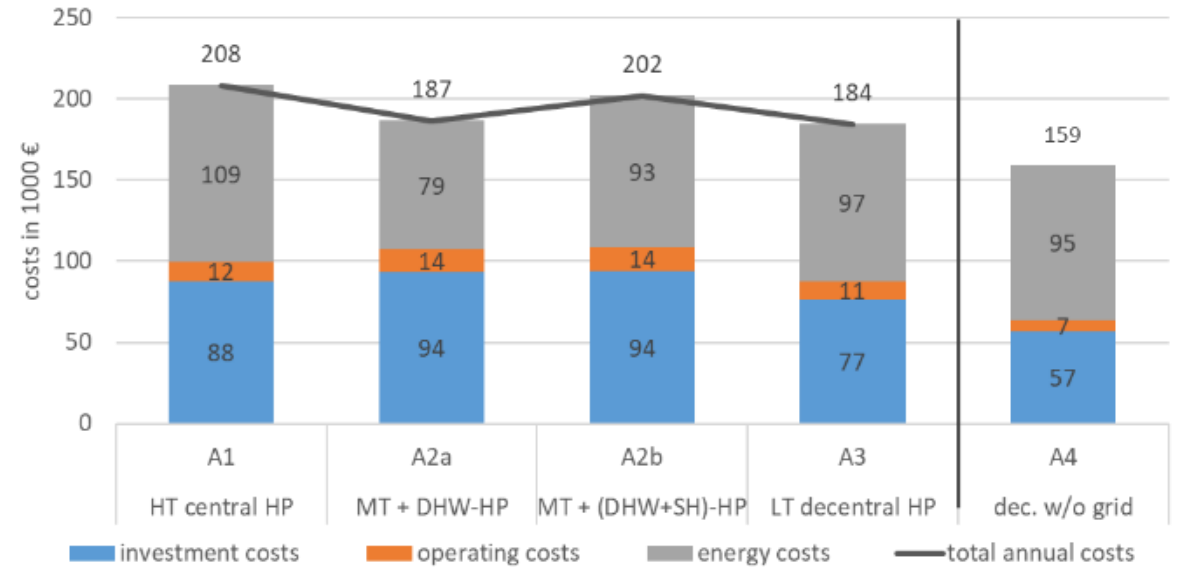
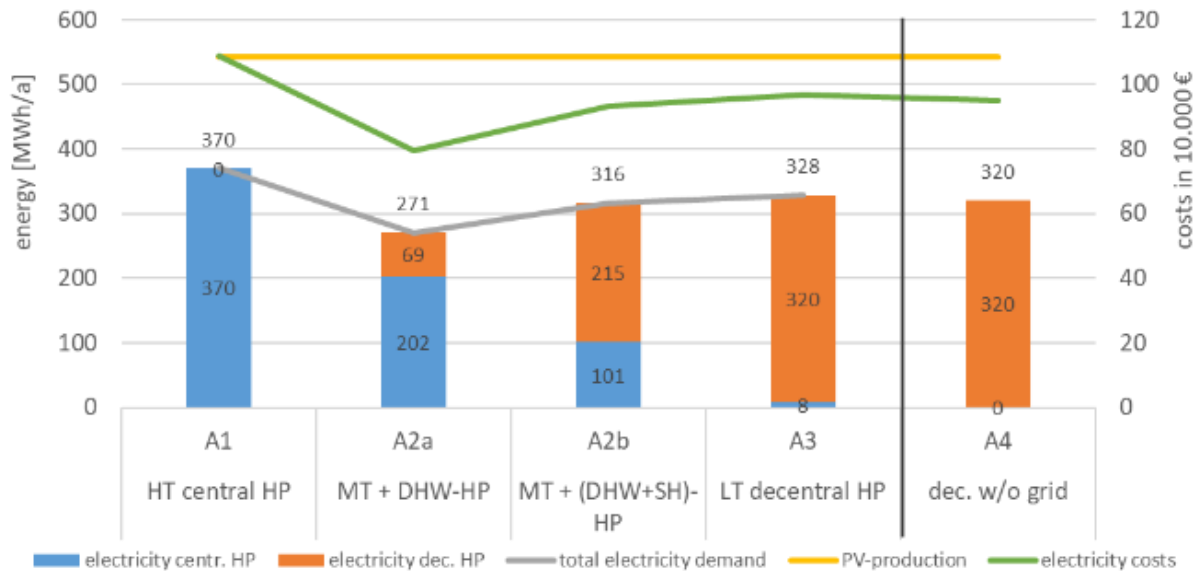


$$COP = \eta_{ex} \cdot COP_C$$

	Decentral (1)	Semi-central (2a)	Semi-central (2b)	Central (3)
Performance Factor	2.7	3.3	2.8	2.2

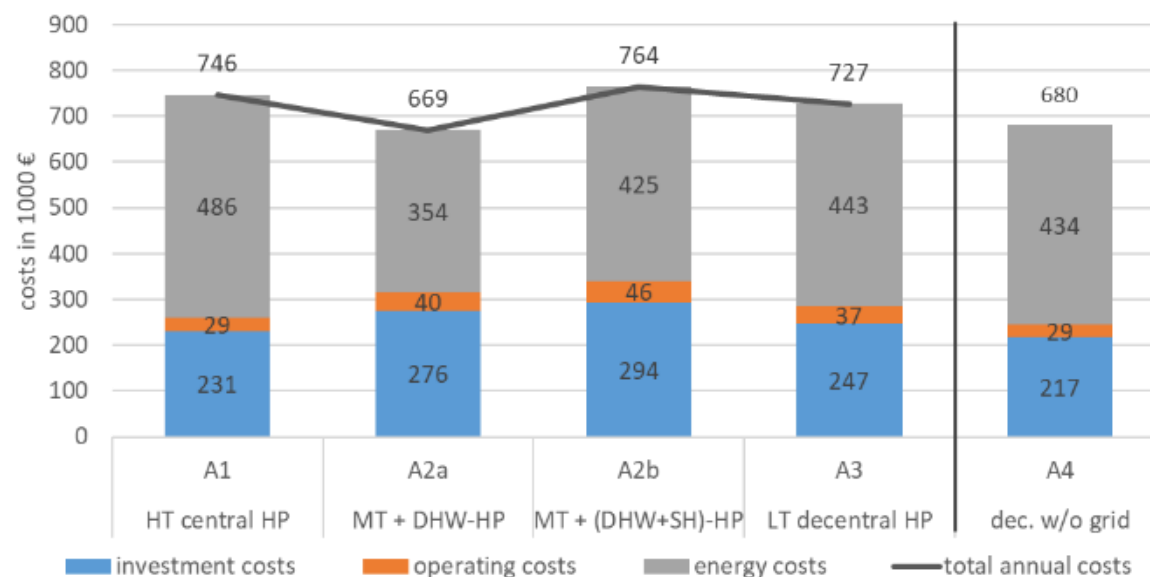
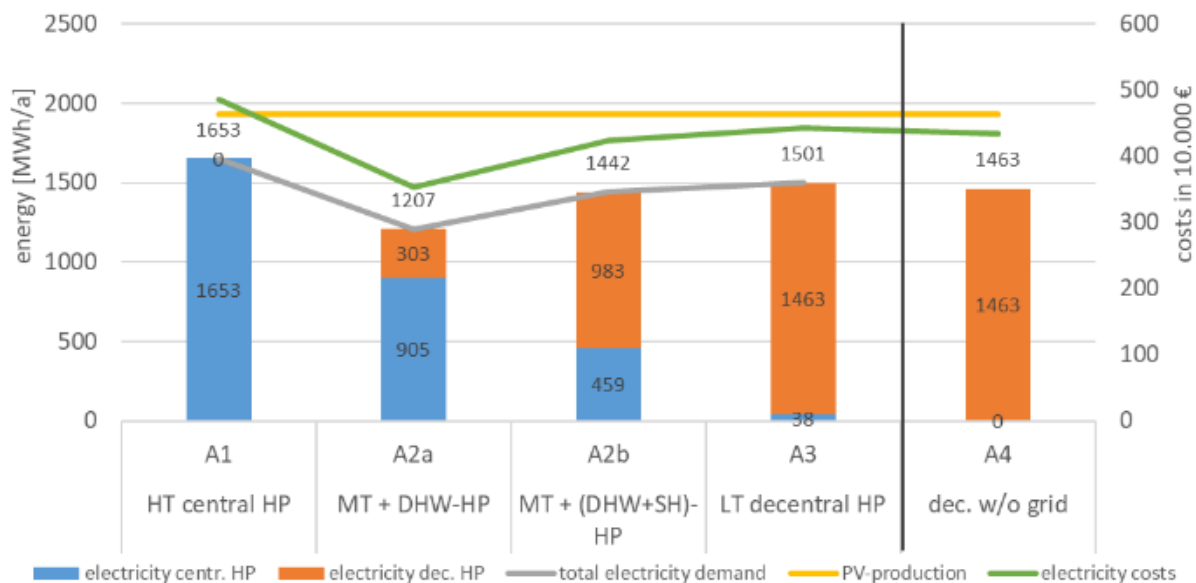
Energy Demand (Electricity) and Total Annual Costs (gross)

Campagne – Block (4 Buildings)



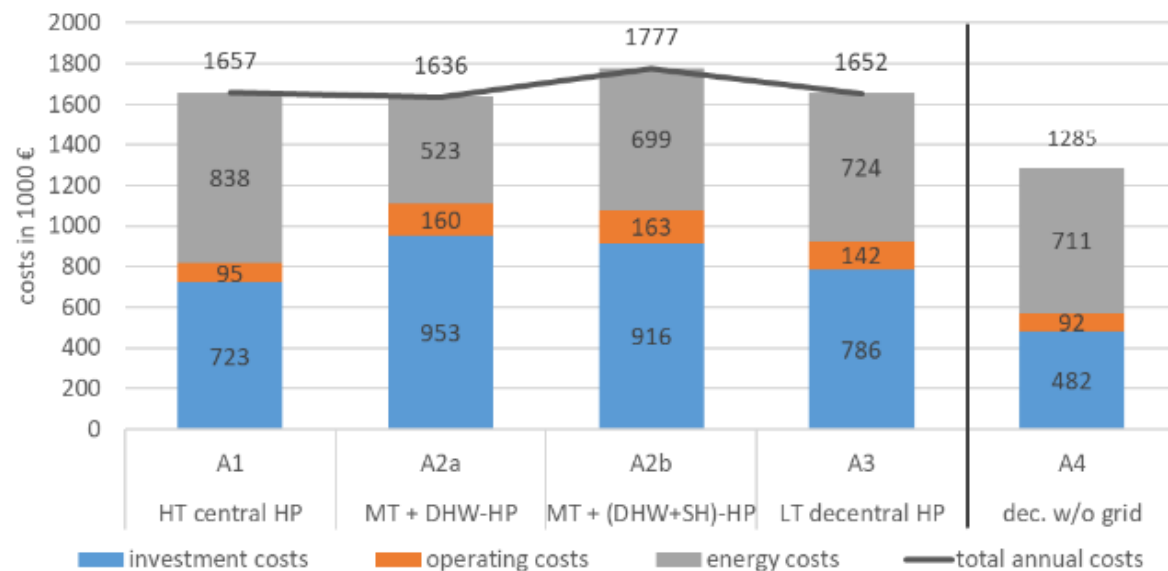
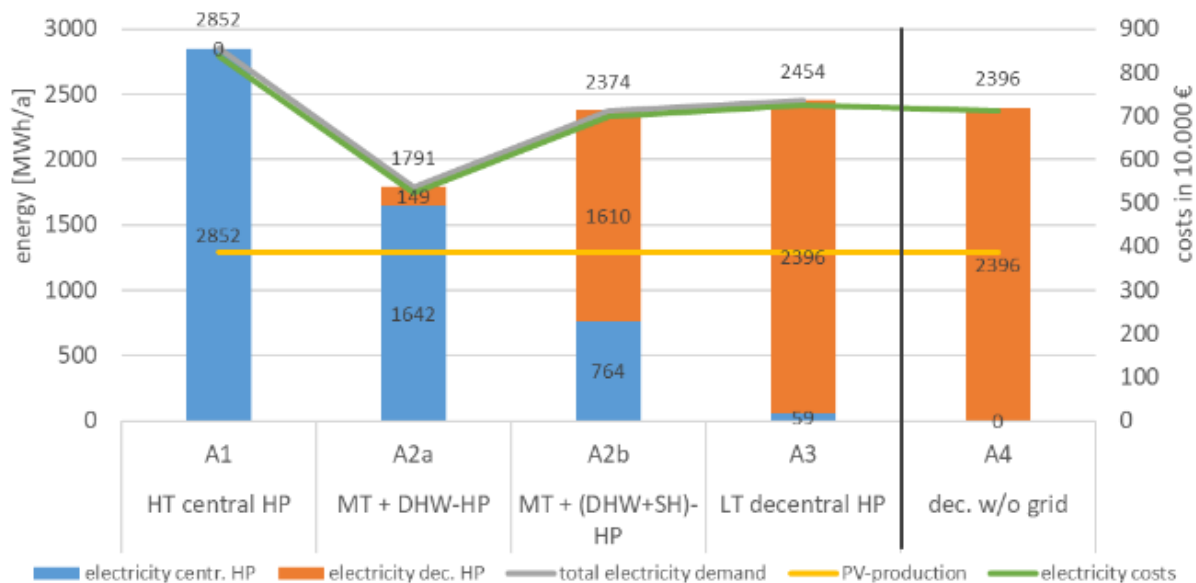
Energy Demand (Electricity) and Total Annual Costs (gros)

Papieri (9 buildings)



Energy Demand (Electricity) and Total Annual Costs (gross)

Quaree 100 (134 buildings)



HP System Topology for PED - Design Guidelines

- Start from PED boundary conditions (total heat demand (kWh/a), network length and layout, heat line density (kWh/m), source availability, climate, renewable potential)
- Optimize the buildings. High efficiency standards with low temperature distribution system and maximum PV yield.
- Prefer decentralized or semi-centralized HP system concepts (decentralized HP with lowest distribution losses and highest performance).
- Minimize network temperature levels - design networks at the lowest feasible temperature level compatible with building demand: cold district or medium temperature semi-central systems (central HP + booster HP for DHW)
- Limit network size and complexity (economically and energetically unfavourable)
- HP system topology defines HP system efficiency
- Annuity method for total annual cost (TAC) calculation

Conclusions - Heat Pump Integration in PEDs

- Cost-optimal integration of heat pump systems is crucial for achieving high performance in (towards) Positive Energy Districts
- Prerequisite: very high building-level efficiency is essential to reach PED targets
- System design depends strongly on local conditions
→ requires a simulation-based planning workflow

Techno-economic analysis enables:

- Identification of promising HP applications in PEDs
- Recommendations for integration, design, and control strategies
- Low-temperature systems outperform high-temperature systems - decentralized solutions are generally preferable over fully centralized systems
- System topology has greater impact than HP efficiency itself

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