Bidirectional low temperature networks

Design methodology based on mathematical optimization

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OBJECTIVE

- Designing **bidirectional low temperature networks**
  - **Selection and sizing** of all energy conversion units
- Design of building energy system depends on energy systems in other buildings (due to bidirectional heat exchange)

METHODOLOGY

- Formulation of a linear program
  - Objective function: **Total annualized costs**
- Simultaneous sizing of conversion units in all buildings

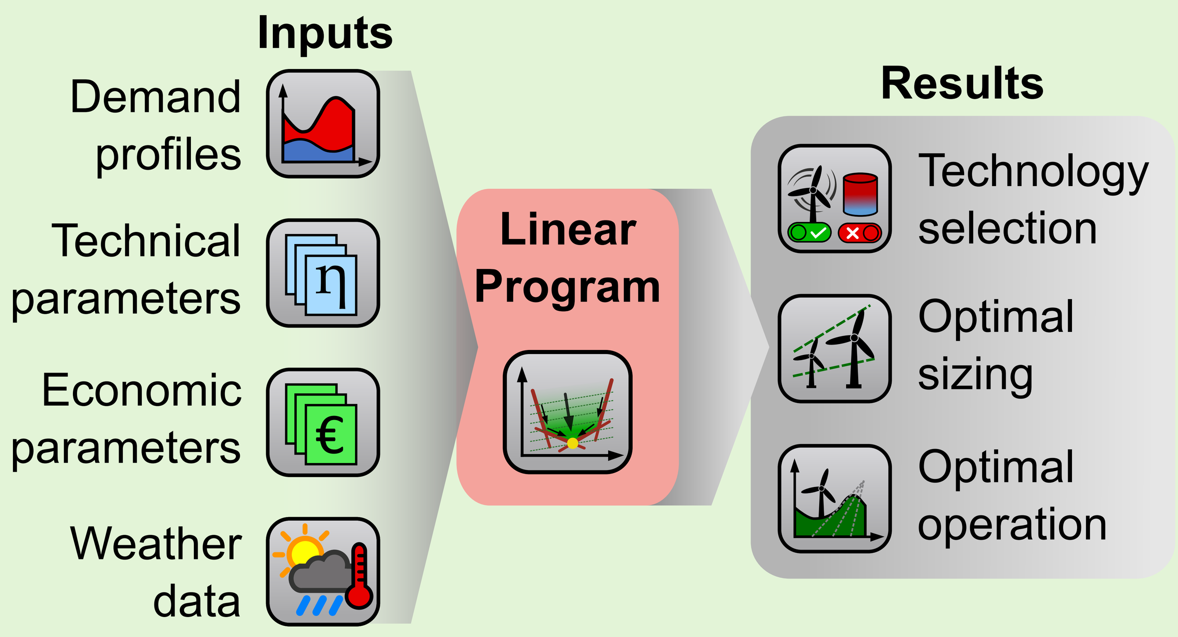

Figure 1: Optimization inputs and results

Linear Program

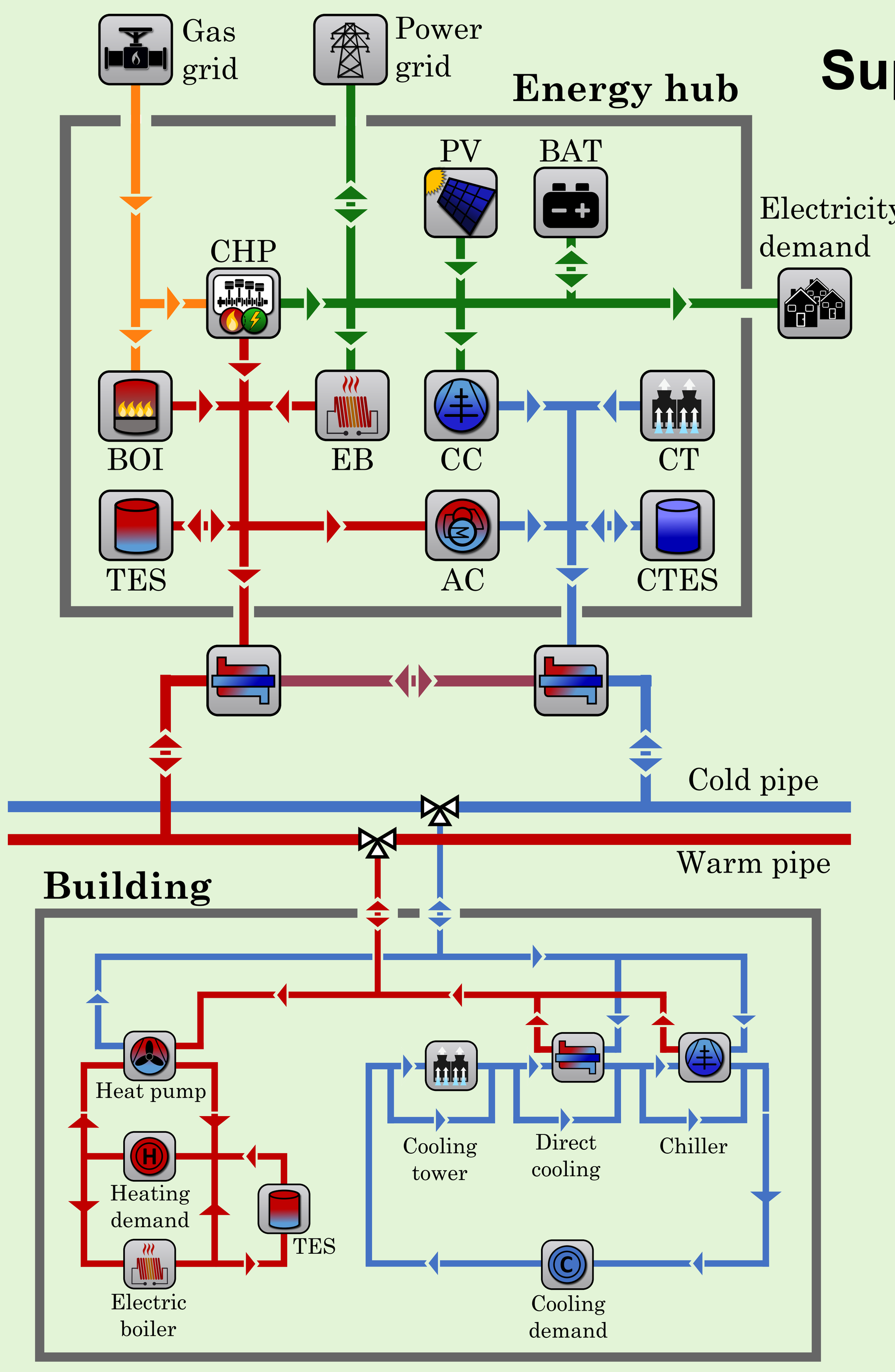

Figure 2: Optimization superstructure

Superstructure of energy hub

- Heat generation:
  - CHP, gas & electric boiler
- Cold generation:
  - Compression and absorption chiller
- Power generation:
  - Photovoltaics
- Storages:
  - Battery, heat & cold storage

Constraints

- Energy balances in buildings and energy hub
- Formulation allows seasonal operation of storages
- Constant or pre-calculated conversion efficiencies

USE CASE

- Research campus in Germany with 17 buildings
- Demand profiles available in hourly resolution
  - Data centers account for 73 % of cooling demand

Input data

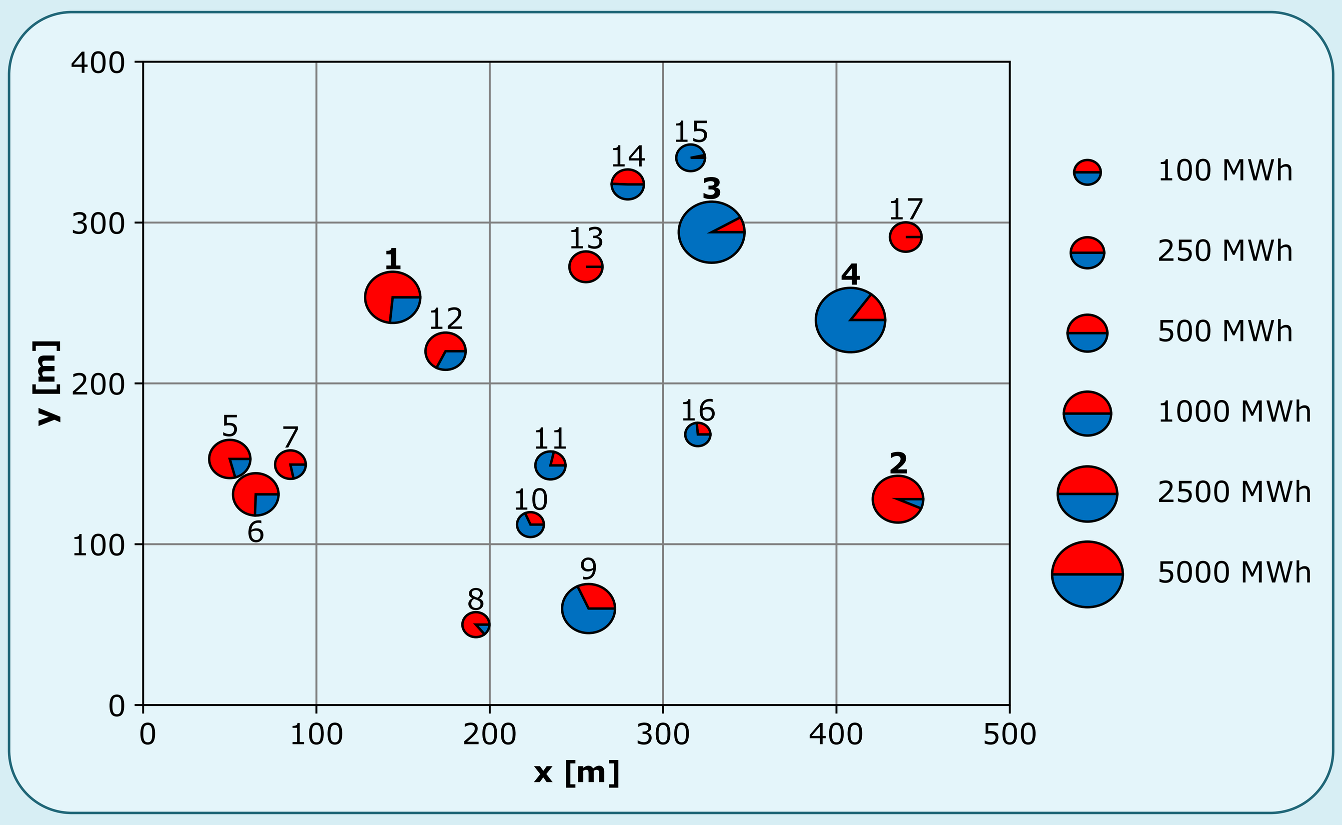

Figure 3: Geographical map of heating and cooling demands

Results

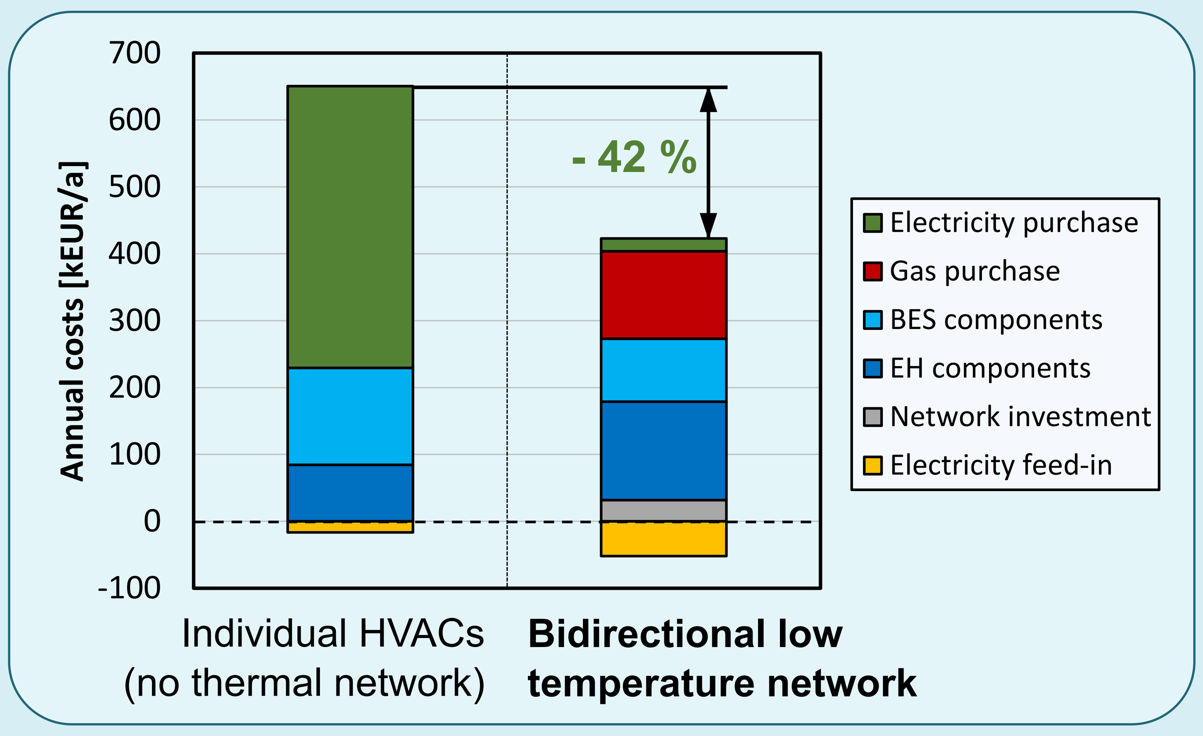

Figure 4: Comparison of annualized costs of BLTN and reference system

- Compared to individual HVAC systems, a bidirectional low temperature network leads to
  - **42 % lower total annualized costs**
  - **56 % lower CO_2 emissions**

CONCLUSIONS

- Optimization model **provides estimation** of profitability and generation capacities **at an early planning phase**
- In use case, large shares of demands are balanced in the system:
  - **32 %** of demands are **balanced within buildings**
  - **51 %** of remaining demands are **balanced within the network**

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