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)

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

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

**INPUTS**
- Demand profiles
- Technical parameters
- Economic parameters
- Weather data

**RESULTS**
- Technology selection
- Optimal sizing
- Optimal operation

**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

**Figure 3:** Geographical map of heating and cooling demands

**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 CO₂ 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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