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Leveraging building thermal inertia for demand side management in integrated district heating and cooling systems

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Goals

- Quantify the economic, environmental, and system benefits of integrating and coordinating building thermal demand side flexibility within an optimized integrated district heating and cooling (iDHC) system.
- Accurately represent individual building thermal behavior using calibrated low-complexity models.
- Evaluate impact of demand-side management (DSM) for alternative scenarios.

Problem

- Building thermal inertia can be used as storage to benefit system operation.
- Current rule-based controllers set an inflexible demand which can lead to:

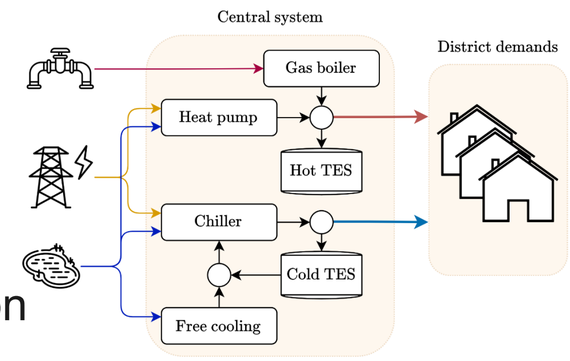
i. Higher operational costs (peak hours)
ii. Higher peak loads (limiting expansion)
iii. Higher emissions (reliance on boilers)

Introduction

- Traditional thermal demand of buildings is determined by inflexible rule-based control.
- Demand-side flexibility can be provided using building thermal inertia.
- Low-complexity model of the thermal behavior of a building is required.
- Potential benefits of DSM depend on boundary conditions, energy system layout and allowed temperature ranges.

Case Study:

- Zurich Fraumünster Network (EWZ)
- 2025 period
- Hourly resolution



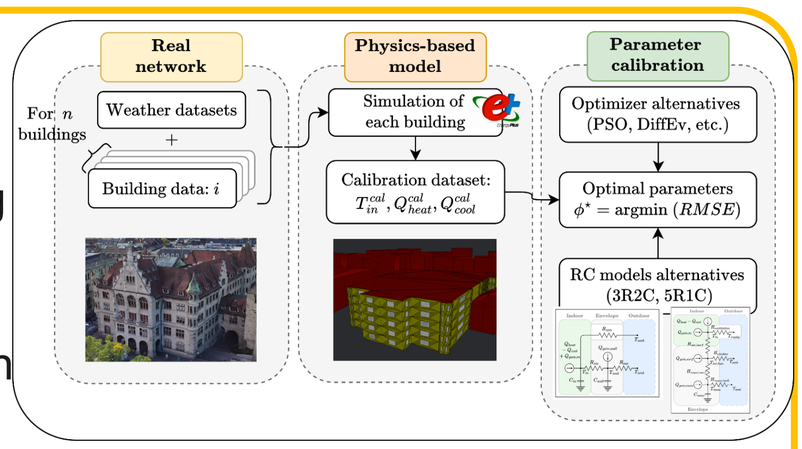
Method

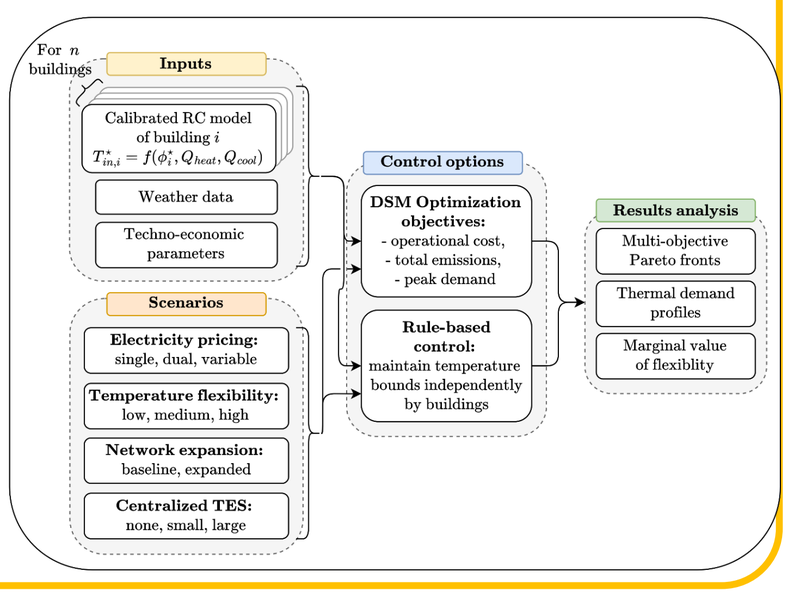
RC Model calibration

- Simulation of each building demand using *EnergyPlus* (*Cesar-P*)
- Calibration of RC Model alternatives with different optimizers
- Select best fit parameters

System operation

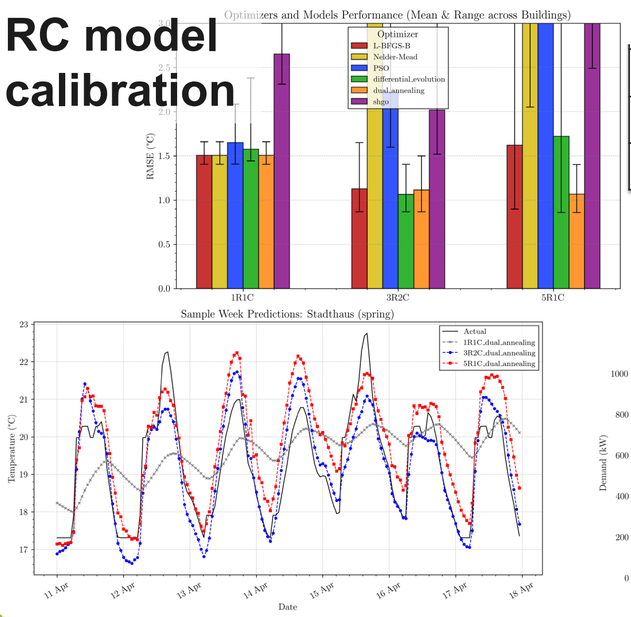
- Run scenarios for (i) optimized control and (ii) rule-based control of thermal demands
- Assess impact of DSM for different scenarios





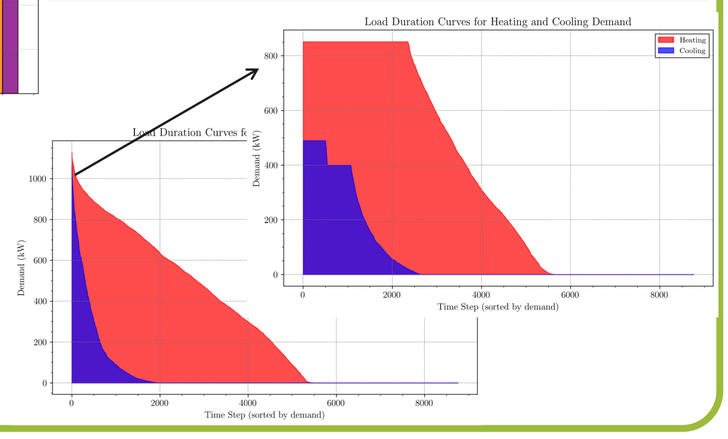
Results

RC model calibration



DSM impact

	No DSM	With DSM
Op cost (excl. TES)	81’900 CHF	77’500 CHF
Op cost (incl. TES)	81’700 CHF	77’300 CHF
Q_{max}(excl. TES)	1’120 kW	850 kW



Conclusions

- Low-complexity RC models can accurately represent building thermal behavior.
  - ✓ RMSE = ~1ºC for one year calibration
  - ✓ 3R2C and 5R1C have comparable performance
  - ✓ 1R1C does not capture temperature dynamics
- Demand-side management has potential to:
  - ✓ Reduce operational costs (~5% for case study)
  - ✓ Reduce peak-demand (~25% for case study)
  - ✓ Reduce emissions if fossil-based boiler used

Core partners

Associate partners