Scalable Control of Heat Loads

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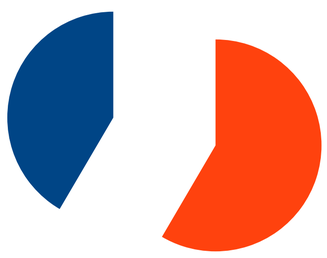
The Importance of Heating

25 % of the worlds' energy consumption goes to domestic heating and hot water, according to IEA.

Renewables 2019 – International Energy Agency

Swedish district heating



In Sweden, **60 %** of space heating and hot water comes from district heating. Heating constitutes **20 %** of the energy consumption in total.

Energiläget 2021 – Energimyndigheten

Trends in District Heating

Lower distribution temperatures decrease heat losses and allow the use of new heat sources

New heat sources, such as waste heat from e.g. data centers, or renewable heat from solar panels

Increased use of heat pumps to boost temperatures of water supplied to customers

Emerging Challenges

→ Higher flow rates compensate for lower temperature levels, which can cause bottleneck effects in the grid

→ Intermittent heat sources complicate the balance between supply and demand

→ There is an increased connection between district heating and the power grid

What we study: How to tackle these challenges through demand response, i.e. controlling heat demand

Demand Response Approaches

Direct Load Control ⟷ **Indirect Load Control**

Customers join programs where their load is directly altered by central algorithm

+Can offer guarantees

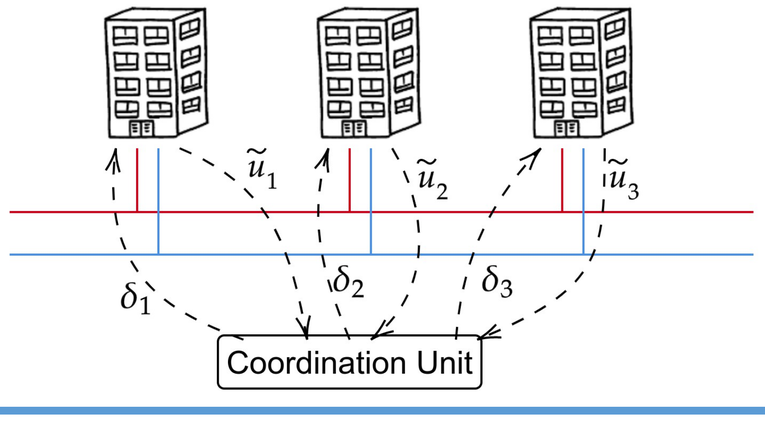
- Can be subject to poor scaling
- Requires invasive measurements
- Fairness and guarantees require good models

Customers are incentiviced to alter their load through a price signal, e.g. time-tariffs.

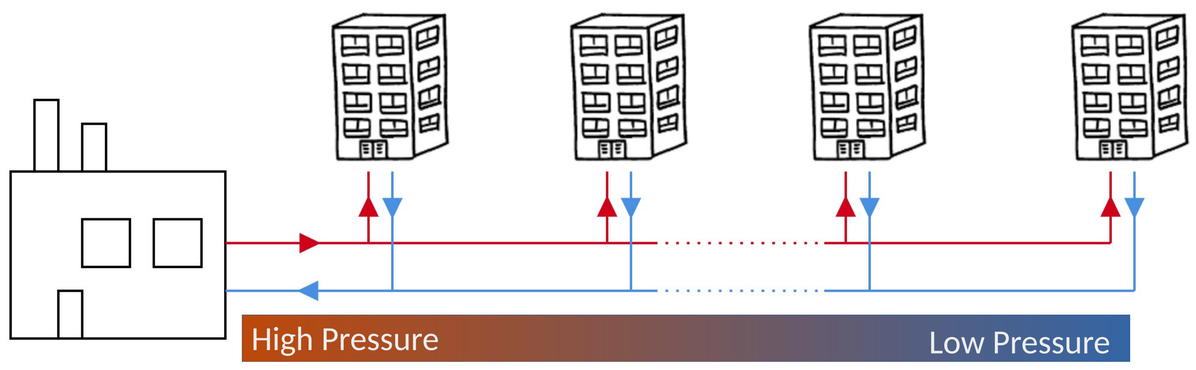
+Scalable and distributed

- Price-flexibility is hard to model
- Does not offer guarantees

Our goal: Combine distributed and scalable properties of indirect load control with performance guarantees of direct load control.

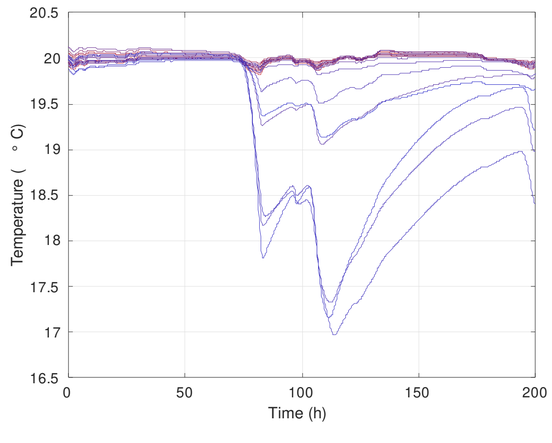


Tackling Bottlenecks Using Load Control

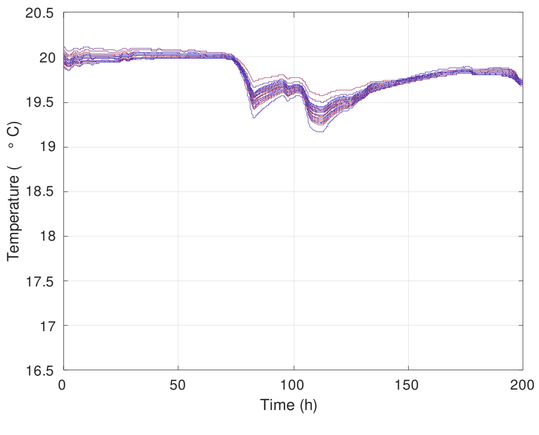


When flows in a district heating network are too large, the pressure can become too low in parts of the network. Below we have simulated the effect on indoor temperatures given no coordination (left) or our proposed coordination (right).

Traditional – No Coordination



Coordinated – Load Controlled



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