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## Scalable Control of Heat Loads

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# Scalable Control of Heat Loads

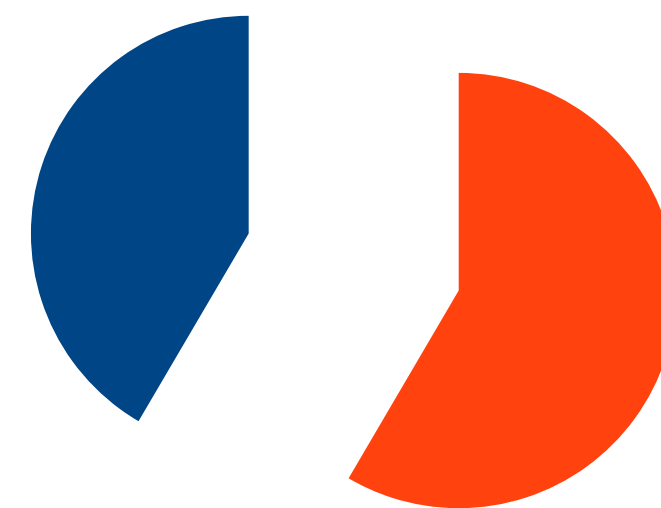
Felix Agner



## 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

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

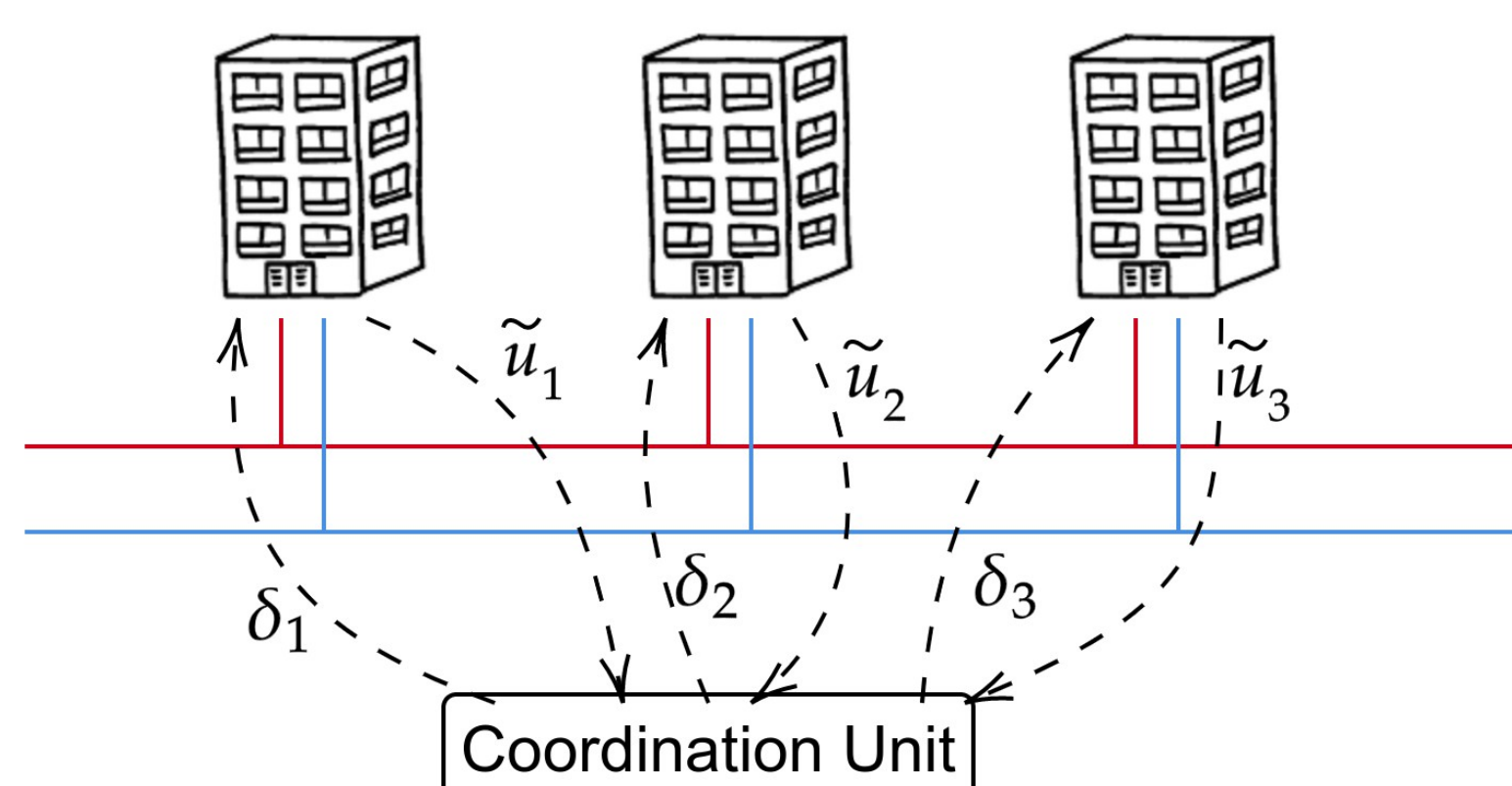
### Indirect Load Control

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

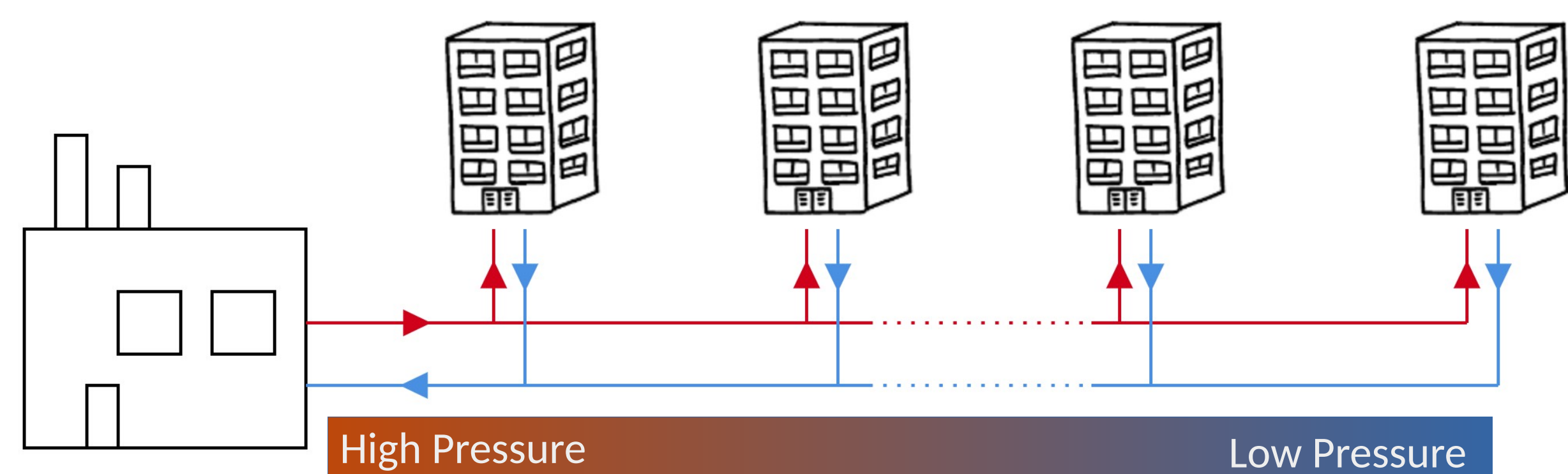
+Scalable and distributed

- 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.

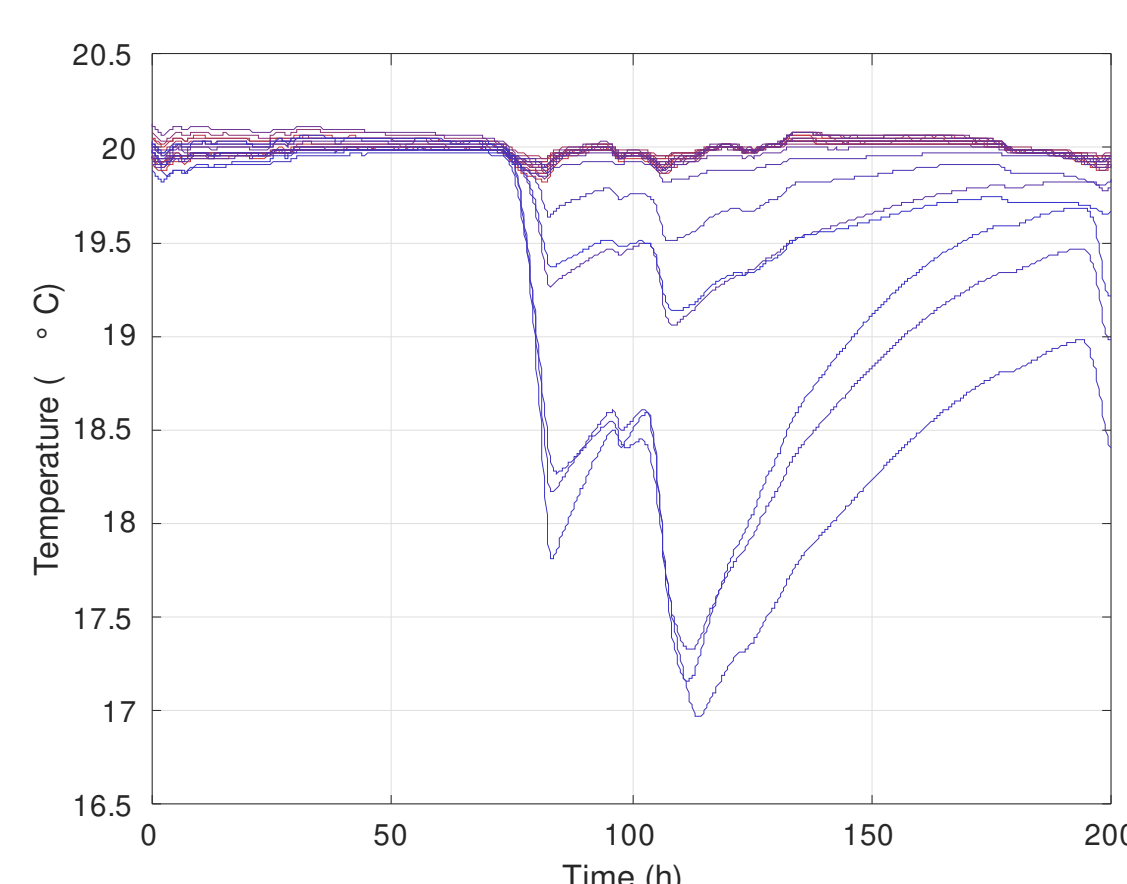


## Tackling Bottlenecks Using Load Control



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

