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A study on the integration of upgraded weather forecast in a predictive control of building cooling systems

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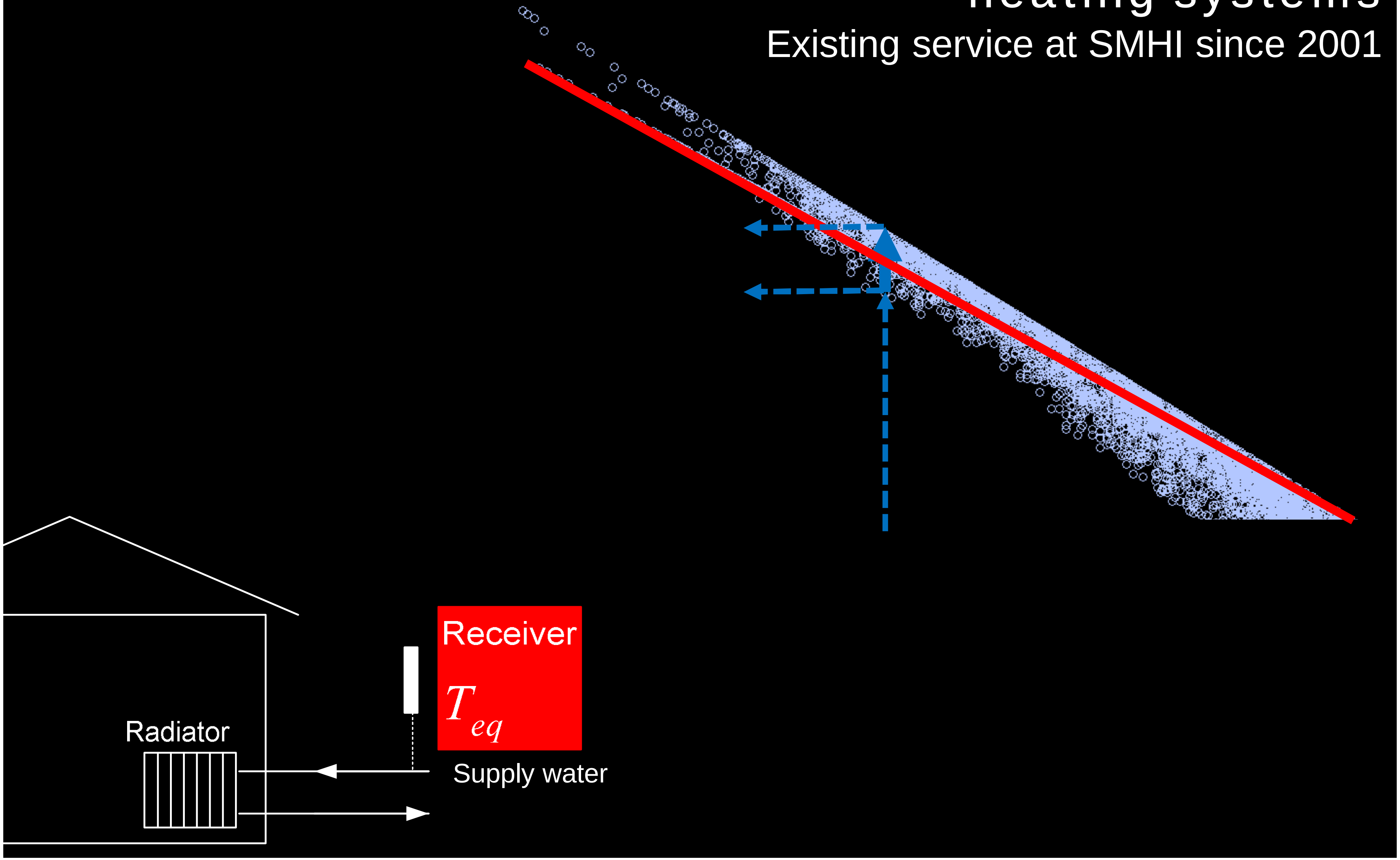
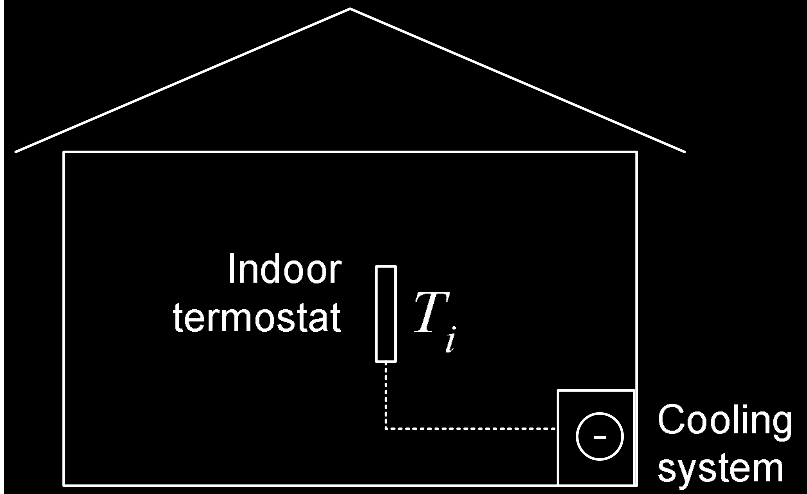
Upgraded control of heating systems

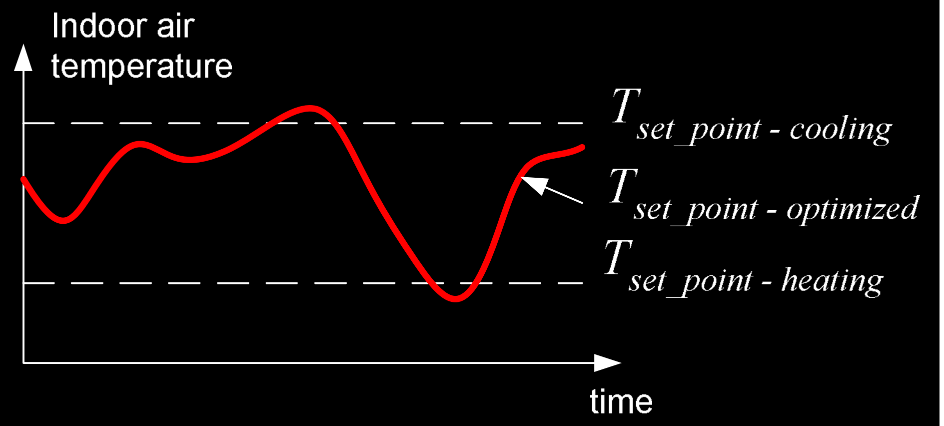
Existing service at SMHI since 2001



Upgraded control of cooling systems

An attempt for extended service





Upgraded control of cooling systems

- Control in real time
  - Following the weather forecast
  - Efficient energy balance model

- Targets:
  - Redistribution of peak cooling loads
  - Decreased cooling demand
  - Decreased total cost of air conditioning

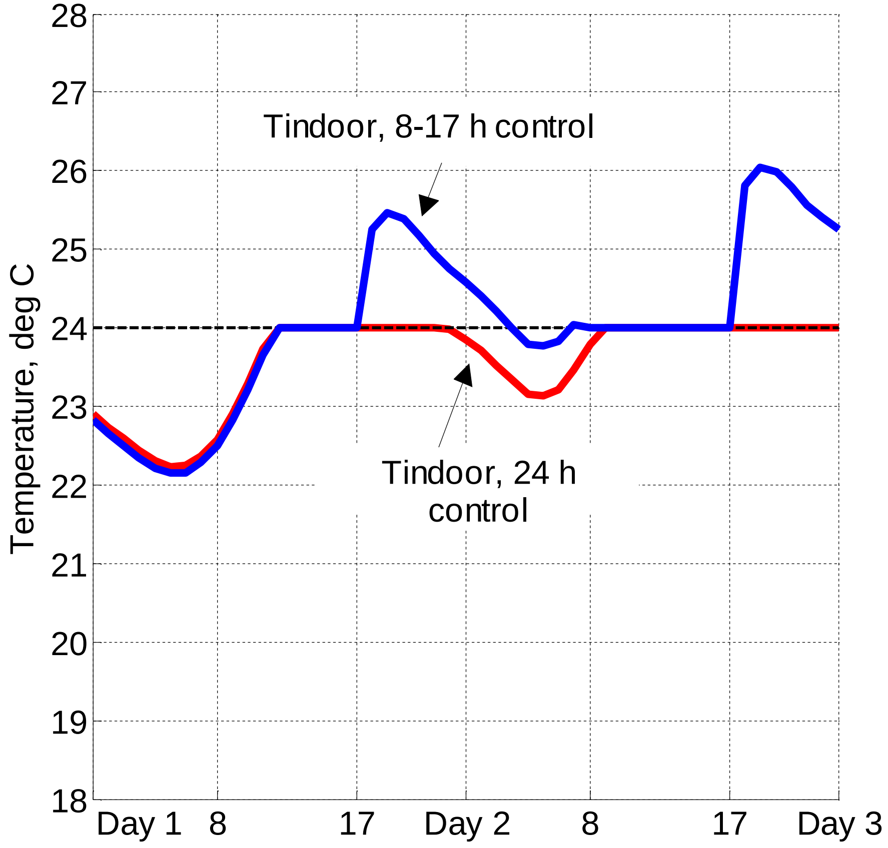
- This work:
  - Decreased total energy demand for cooling

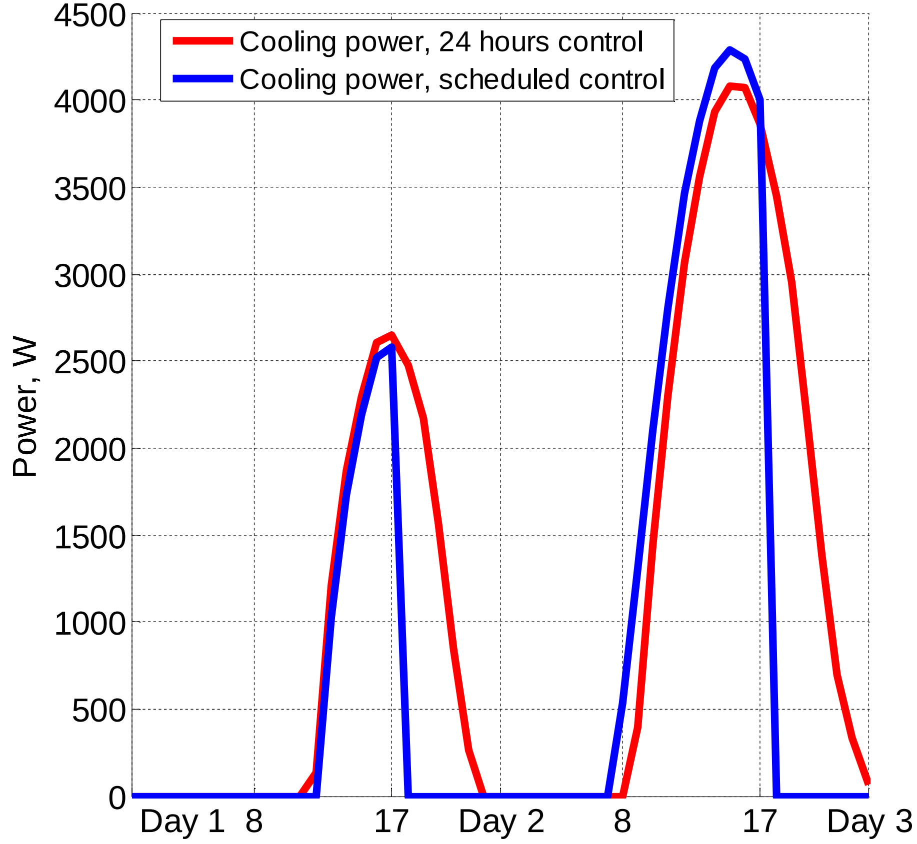
Modelling approach

- Dynamic thermal model of a building
  - Dynamic thermal networks (response function method)
  - Instantaneous cooling load expressed by algebraic equations

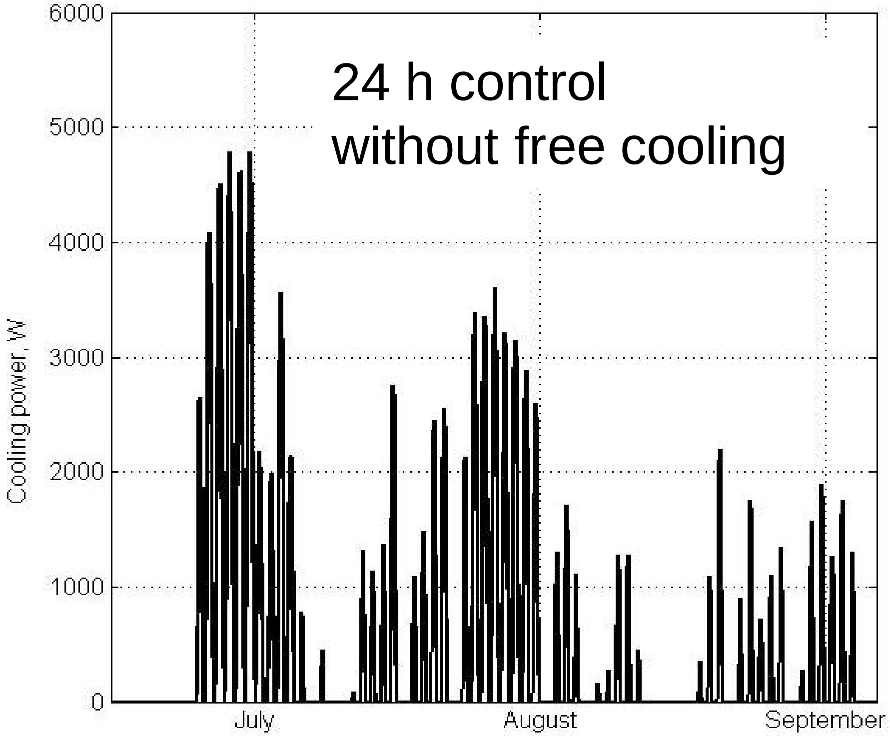
- (Optimization) Forcing algorithm
  - Use free cooling, i.e. maximize ventilation by outdoor air whenever colder outside than inside and $T_{in}(t) > T_{set-point}$

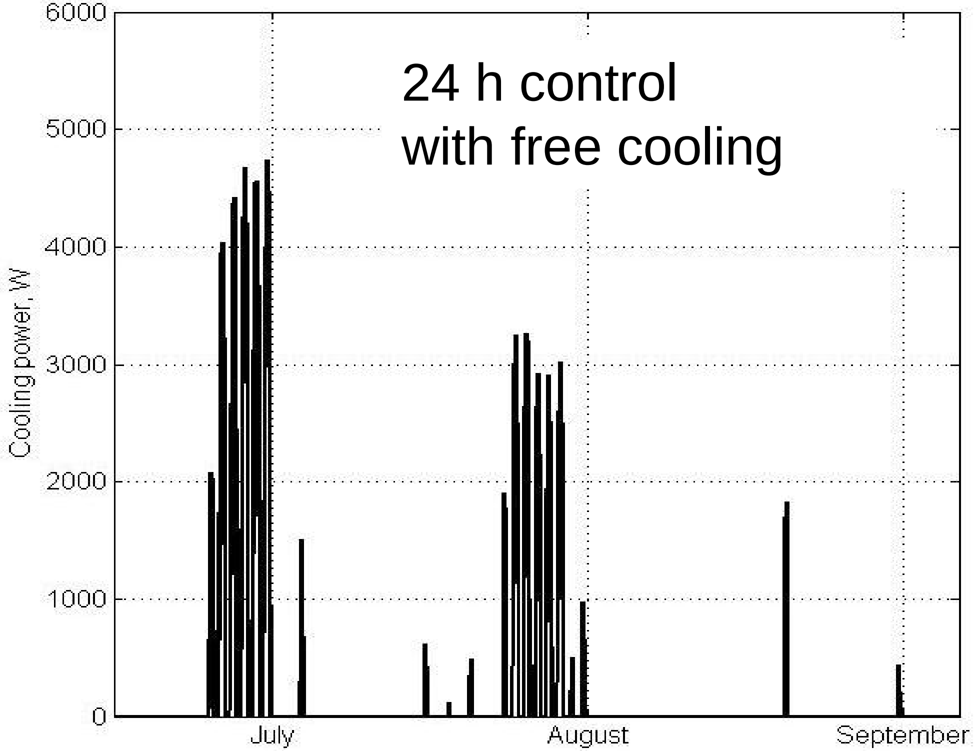
Indoor air temperature and cooling demand without free cooling





Example of results – with free cooling





<u>Results – savings in terms of cooling energy</u>

- 53 % at 24 h control
- 36 % at intermittent control

Total energy demand

- Sum of
  - Electricity for the cooling plant (COP=3)
  - Electricity for the ventilation fans

    SFP=1.5 or 2 kWh/(m^3/s)

- Air change rates of the fan limited to 1-5 ACH/h

Results – maximum savings of total energy demand

- 1.5 % at 24 h control
- 3.5 % at intermittent control

Conclusions March 2011

- High potential of free cooling in reducing the cooling loads
- Analyzis should be done for total energy demand

Since than ...

- A generic optimization algorithm developed
- Total energy savings 10 % if SFP=1, 3-5 % if SFP=2