Neighborhood Heat Control
Comfort Control and Peak Load Reduction

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Presentation Outline

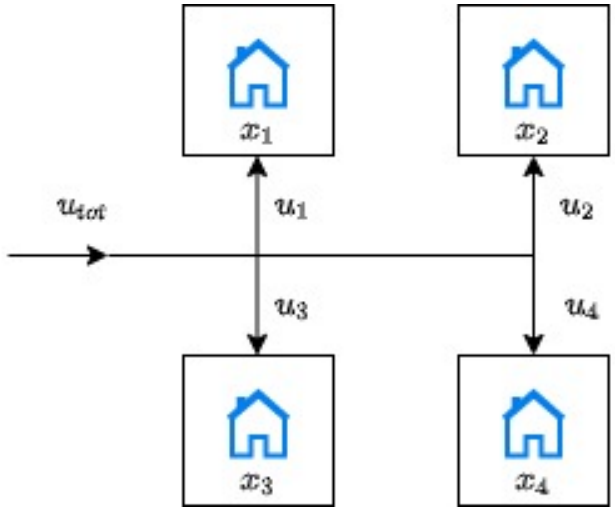
Problem: Control indoor temperature and peak electricity consumption in domestic buildings

- Problem formulation
- Results
- Discussion and simulink playtime

Neighborhood

Here's a neighborhood of 4 houses with

- Indoor temperatures x_i
- Individual electrical loads u_i



$$C_i \dot{x}_i = a_i(T_{out} - x_i) + b_i u_i^h \tag{1}$$

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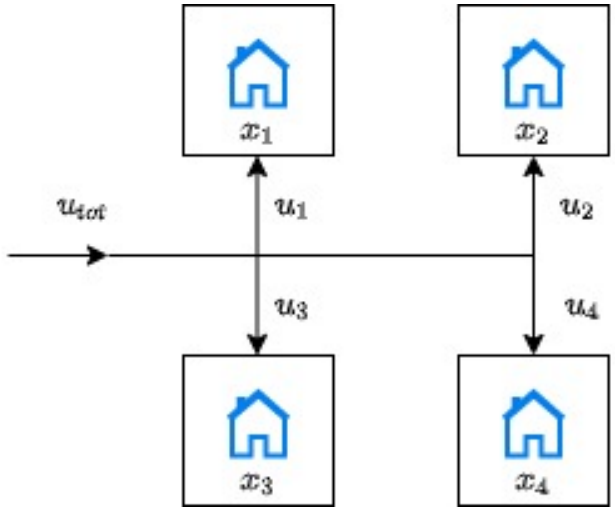
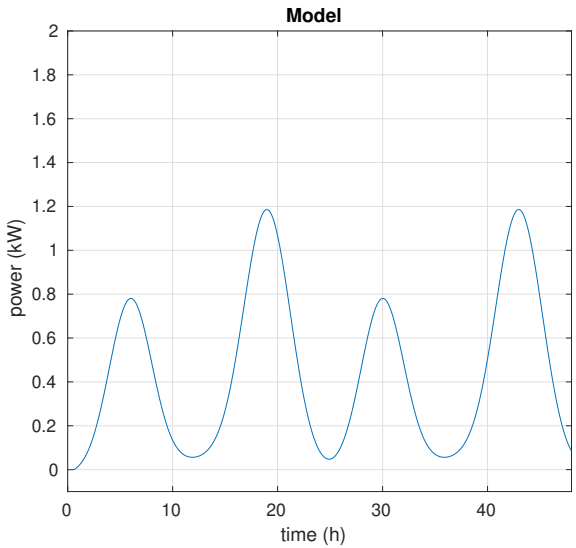


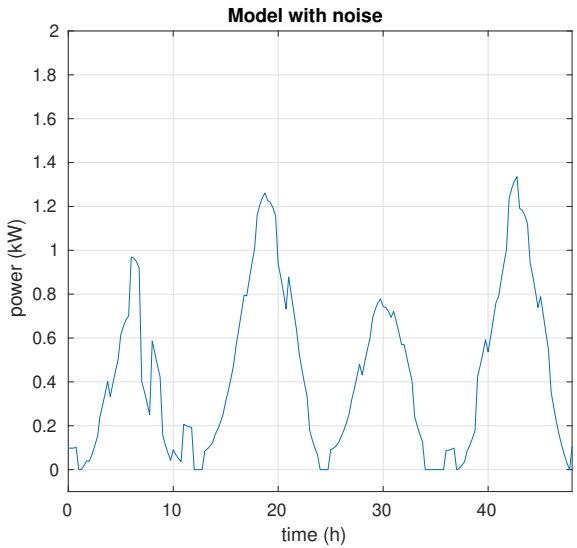
$$C_i \dot{x}_i = a_i(T_{out} - x_i) + b_i u_i^h \tag{1}$$

Goal: Construct controller to minimize peak load u_{tot} while keeping x_i in comfort zone $\pm 0.5^\circ C$.

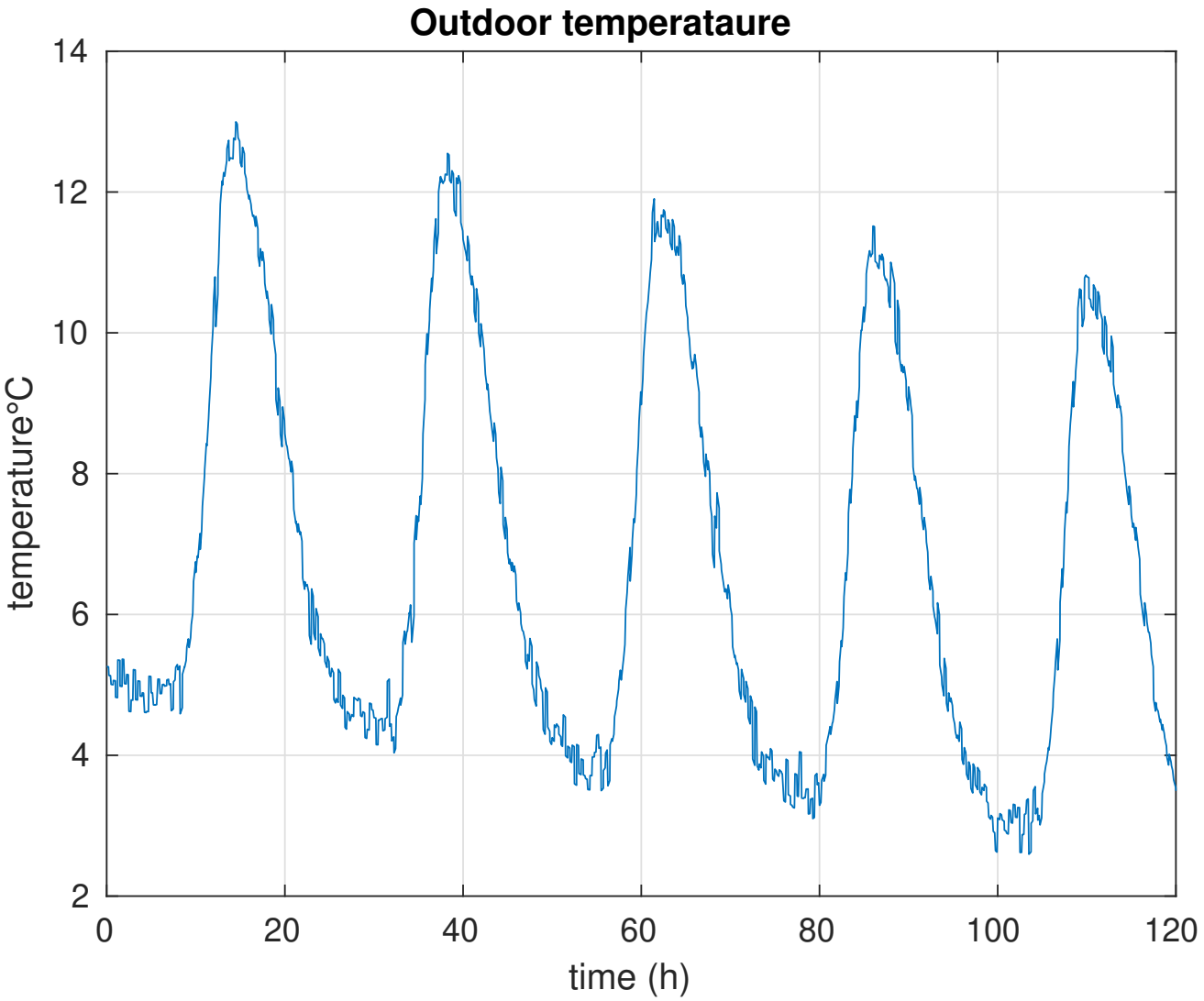
Total Building Load

$$u_i^{tot} = u_i^{other} + u_i^h \tag{2}$$



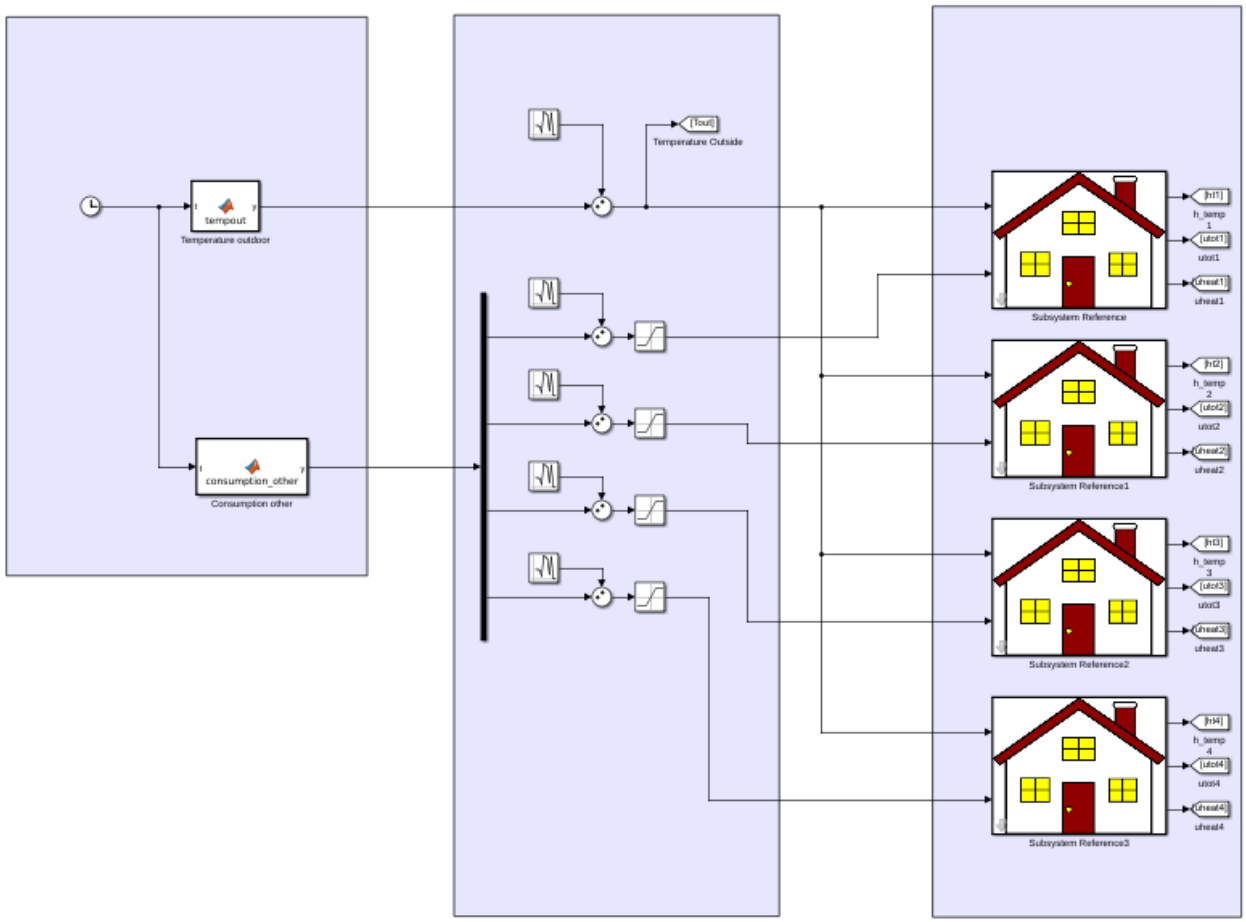


Outdoor Temperature



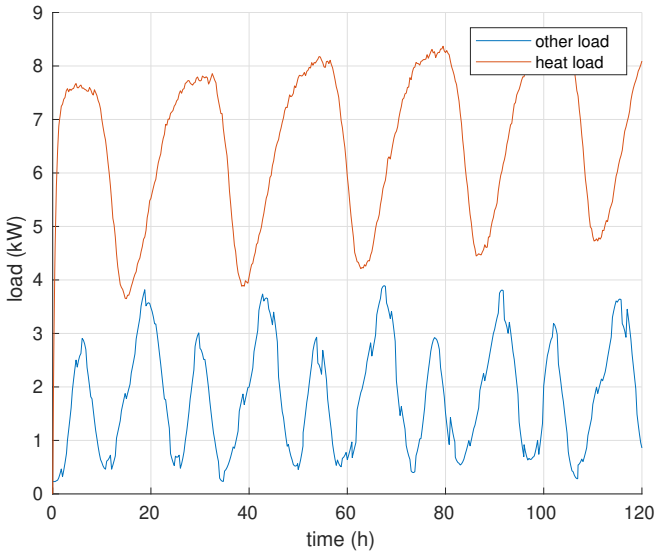
Control Approaches

- Non-coordinated PI(D)'s
- Temperature feed-forward and PI(D)'s
- MPC

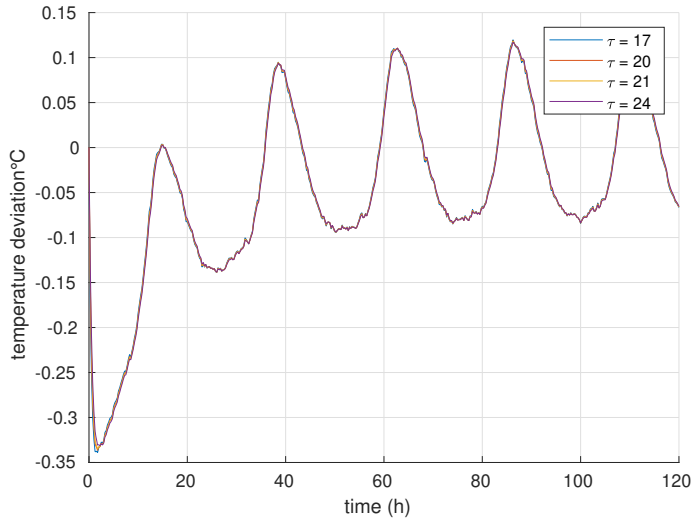


PI(D) Results

Loads



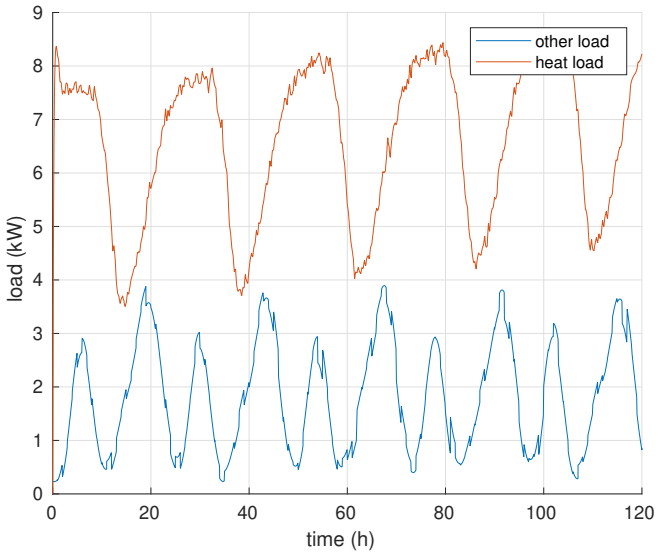
temperatures



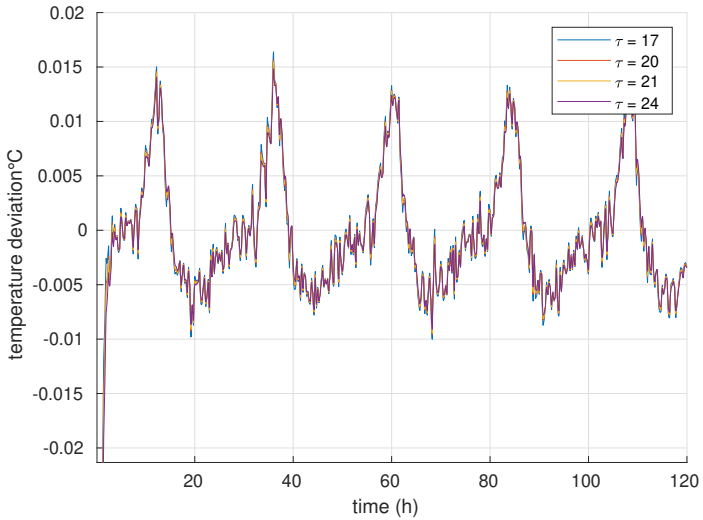
Fluctuations both in temperature and load.

Feed-forward and PI(D) Results

Loads



Temperatures

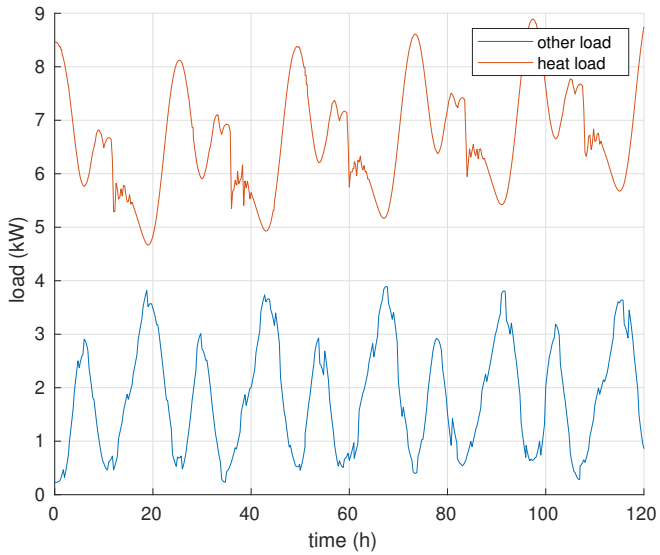


Fluctuations in temperature supressed. Little-to no difference in load.

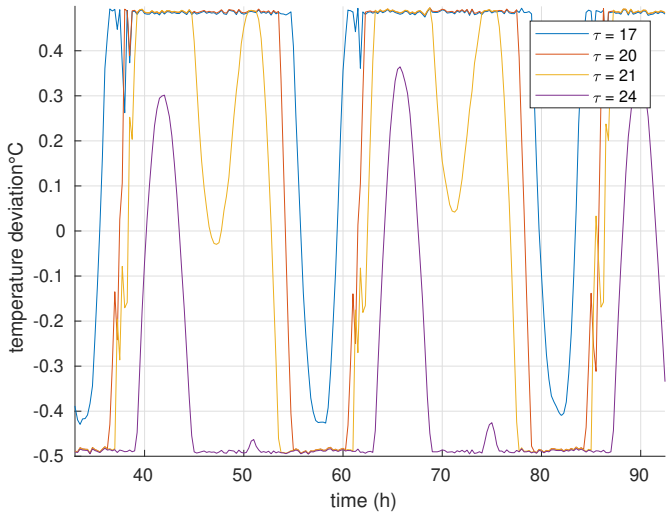
MPC Results

Prediction horizon: 12 hours
Noise level: Low
Model errors: None

Loads



Temperatures



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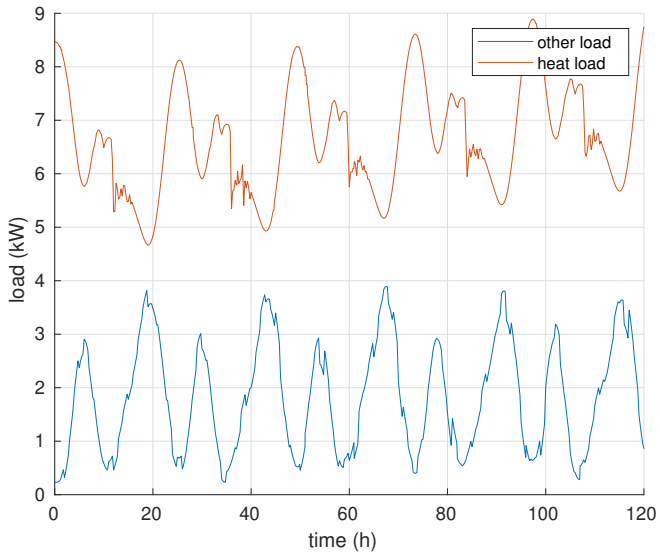

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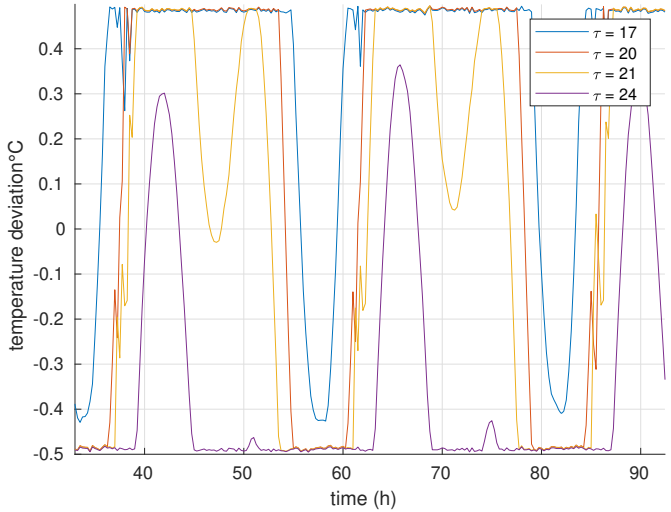
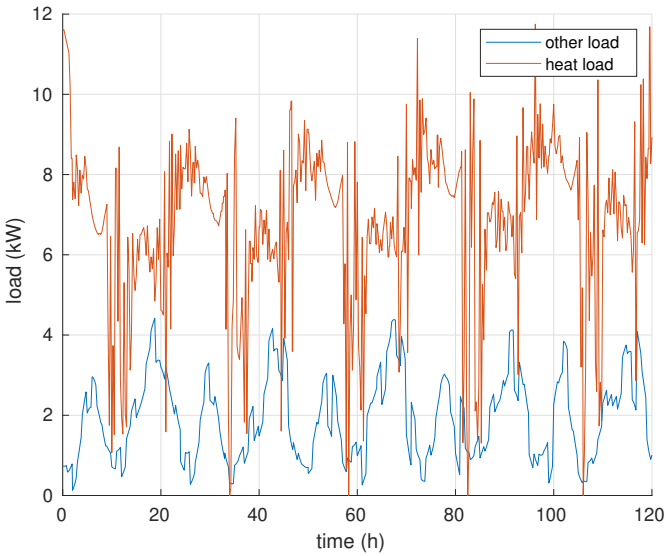


But what if we have more noise, and don't know the system model that well?

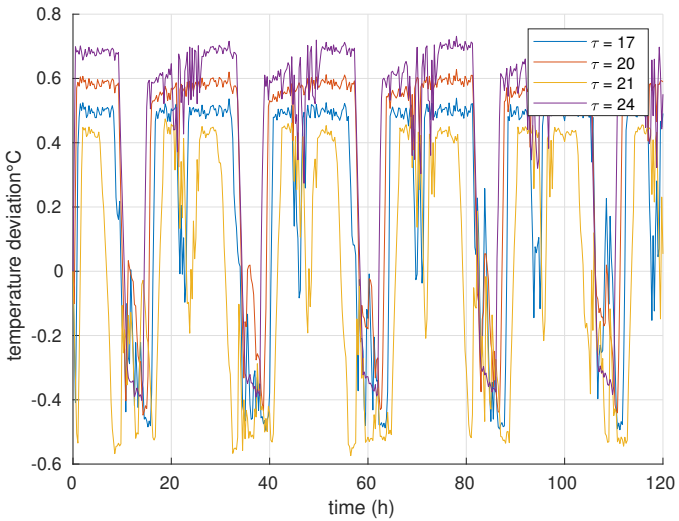
MPC Results

Prediction horizon: 12 hours
Noise level: High
Model errors: Yes

Loads

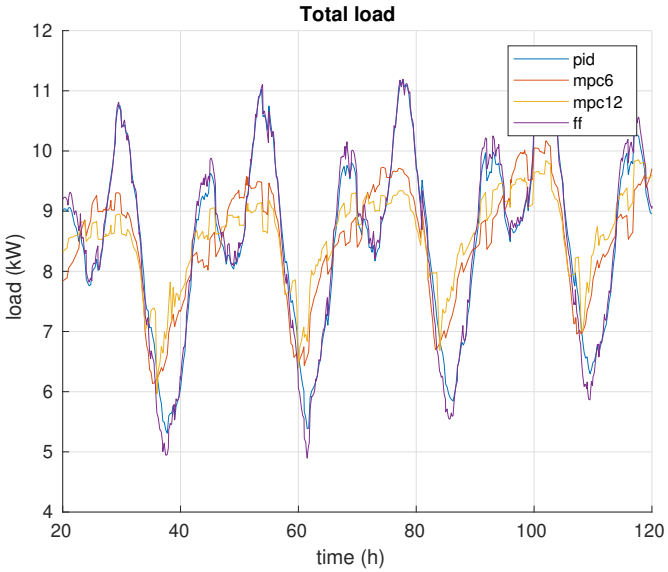


Temperatures

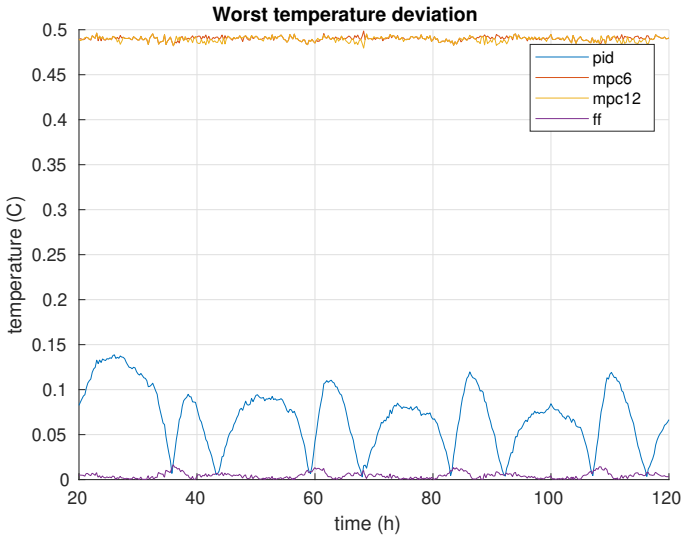


Comparison

Loads



Temperatures



Conclusions

- PI(D)
  - Simple design
  - Some fluctuations in temperature
  - No consideration of total load
- FF and PI(D)
  - Demands outdoor temperature readings
  - Steadier indoor temperature
  - Still no total load consideration
- MPC
  - Demands a lot of communication and data
  - Fluctuating (but constrained) indoor temperature
  - Increased consideration of load
  - Sensitive to model and prediction errors

Questions?

Simulink-playtime!!!