Forecasting of heat load for buildings and refrigeration load for supermarkets

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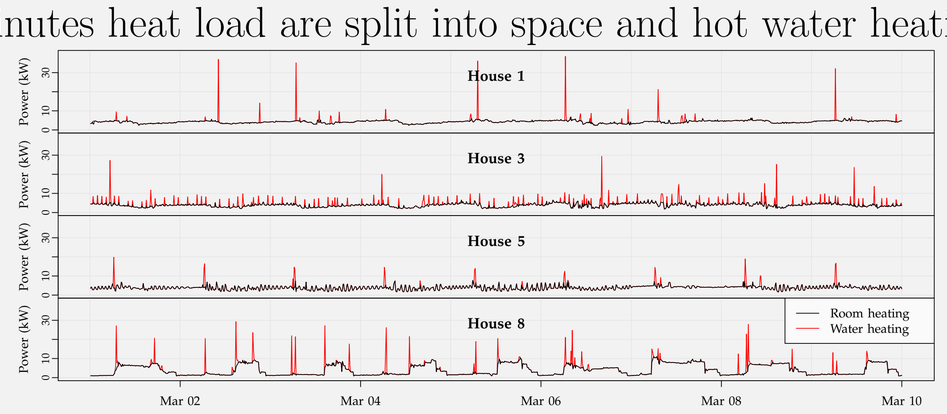
Heat load forecasting for buildings

- **What?**
  Heat load forecasting for buildings (hourly forecasts up to 42 hours ahead)
- **Why?**
  Use for activating flexibility with hot water storage tank and for improved operation of district heating
- **How?**
  Data-driven time-adaptive model using local climate and weather forecasts input

Data

- 10 minutes heat load are split into space and hot water heating:



- Model output: space heating averaged to hourly values Q_t
- Model input: combined measurements and weather forecasts of: temperature $T^{\mathrm{a}}_{t+k|t}$, solar radiation $G_{t+k|t}$ and wind $W^{\mathrm{s}}_{t+k|t}$

Model

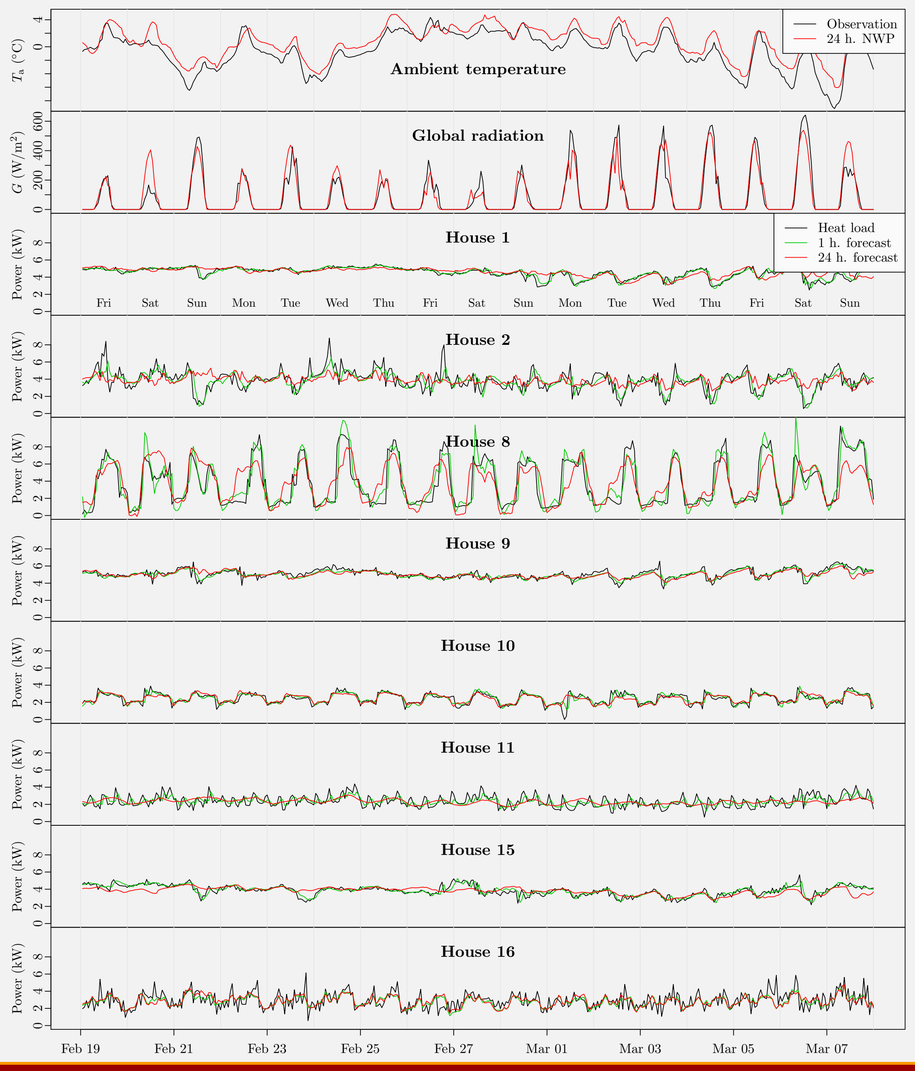
- Selected model

$$\widehat{Q}_{t+k|t} = \alpha_{\mathrm{i}} + \mu(t_{\mathrm{tod}}, \alpha_{\mathrm{diu}}) + \alpha_{\mathrm{a}} H_a(q) T^{\mathrm{a}}_{t+k|t} + \alpha_{\mathrm{g}} H_{\mathrm{g}}(q) G_{t+k|t} + \alpha_{\mathrm{ws}} H_w(q) W^{\mathrm{s}}_{t+k|t}$$

where $\mu(t_{\mathrm{tod}}, \alpha_{\mathrm{diu}})$ is a diurnal curve formed by a Fourier series, α_X is the coefficient for input X and $H_{\mathrm{X}}(q) = \frac{1-a_X}{1-a_X q^{-1}}$ is the first-order transfer function for input X

Results

- Inputs with 1 and 24 hours forecast results for 8 houses with different characteristics:

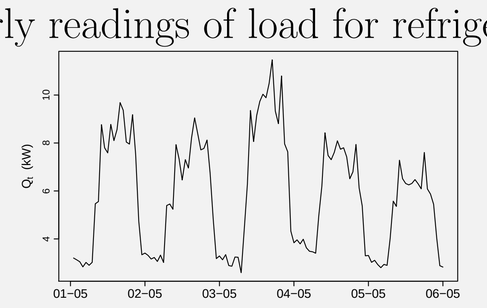


Refrigeration load forecasting for supermarkets

- **What?**
  Refrigeration load forecasting for supermarkets (hourly forecasts up to 42 hours ahead)
- **Why?**
  Use for activating flexibility with ice storage storage
- **How?**
  Data-driven time-adaptive model using local climate and weather forecasts input

Data

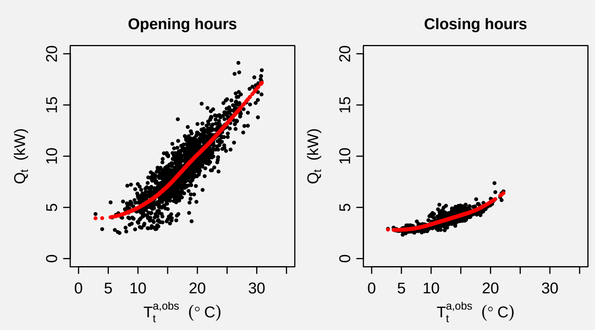
- Model output: hourly readings of load for refrigeration Q_t:



- Model input: combined measurements and weather forecasts of: temperature $T^{\mathrm{a}}_{t+k|t}$, solar radiation $G_{t+k|t}$ and wind $W^{\mathrm{s}}_{t+k|t}$

Model

- Two-regimes identified:



- Selected model

$$\widehat{Q}_{t+k|t} = \mu(t+k, n_{\mathrm{har}}, \boldsymbol{\alpha}_{\mathrm{diu}}) + \alpha_{\mathrm{iop}}\, I^{\mathrm{var}}_{t+k|t} + \alpha_{\mathrm{aop}}\, I^{\mathrm{var}}_{t+k|t} S^{\mathrm{open}}_{t+k|k} + \alpha_{\mathrm{icl}} \left(1 - I^{\mathrm{var}}_{t+k|t}\right) + \alpha_{\mathrm{acl}} \left(1 - I^{\mathrm{var}}_{t+k|t}\right) S^{\mathrm{close}}_{t+k|k}$$

where $\mu(t+k, n_{\mathrm{har}}, \boldsymbol{\alpha}_{\mathrm{diu}})$ is a diurnal curve formed by a Fourier series, α_X is the coefficient for input X, $I^{\mathrm{var}}_{t+k|t}$ is the indicator function switching the regimes and $S^{\mathrm{x}}_{t+k|k}$ is the ambient temperature resolved with base spline functions for regime x

Results

- Plot of:
  - Observations *(load and ambient temperature)*
  - Forecasts *(1 hour ahead)*
  - Input *(after low-pass filtering)*
  - Coefficients *(note the change over time)*