IEA EBC Annex 58
Reliable building energy performance characterisation based on full scale dynamic measurements

Guidelines for data analysis from dynamic experimental campaigns. Statistical Methods

Energy performance assessment of buildings and building components.

Models considered

Focus on the following key methods / models

In general a more advanced model gives more information

- 🟢 Steady state / linear regression models
- 🟢 Transfer function models (ARX)
- 🟢 Grey-box models
  - Linear (RC network model)
  - Nonlinear

Steps in the analysis

Each method is described using the following headings

- Experimental design (incl. Sampling time, PRBS, Sensors, ...)
- Pre-processing (incl. Filtering, Averaging, PCA, ...)
- Model selection
- Post-processing (Model validation)
  - Test of model parameter
  - Test using autocorrelation and accumulated periodogram
  - Test using cross correlation functions
- Methods for deriving the physical parameters from the model
- Examples in R

Model characteristics

Steady State (linear regression) models – some characteristics

- **UA (HLC) and gA – values**

- No information about dynamics

- No information about the internal physical parameter

- Not able to cope with time-varying phenomena

- Not able to deal with nonlinear phenomena

Model characteristics

Transfer function (ARX) models – some characteristics

- **UA and gA – values**

- **Estimation of dynamics (time constants)**

- No information about the internal physical parameter

- Not able to cope with time-varying phenomen

- Not able to deal with nonlinear phenomena (except from nonlinear tranformation of input variables)

Model characteristics

Linear grey-box (RC-network) models – some characteristics

- **UA and gA – values**
- **Estimation of dynamical characteristics (time constants)**
- **Information about the internal physical parameter (R and C)**
- Not able to cope with time-varying phenomen
- Not able to deal with nonlinear phenomena (except from nonlinear tranformation of input variables)

Model characteristics

Nonlinear grey-box models – some characteristics

- **UA and gA – values**

- **Estimation of dynamical characteristics**

- **Information about the internal physical parameter (R and C)**

- **Description of time-varying phenomen (eg. moisture)**

- **Description of nonlinear phenomena (eg. Air leakage)**

MORE PROGRES IS

EXPECTED FROM

FEEDBACK/TESTING

Interpretation of Residuals

- **Residuals with a frequency of 24 hours** are very frequent in insufficient models
- Non negligible correlation between model residuals and solar radiation, could inspire more **detailed description of the solar radiation** in to improve the model.
- **Sometimes better modelling solar radiation is not a solution:** Many variables can have relevant correlation with solar radiation, so **any other effect** depending on them and not properly modelled **can show residuals in the same frequency**. Examples:
  - Ø **Air leakage** that can depend on wind speed and/or outdoor air temperature, both depending on solar radiation
  - Ø **Longwave effects** stressed by high surface temperatures due to solar radiation
  - Ø U depending on **thermal conductivities** depending on temperature of materials that depends on solar radiation
  - Ø **Wrong resampling** disregarding the sampling theorem