EBC

Energy in Buildings and Communities Programme

IEA EBC Annex 71

Quantifying the Thermal Performance of the Building Fabric based on Smart Meter Data

Staf Roels, Christian Struck and Twan Rovers

IEA Technical Collaboration Programme on Energy in Buildings and Communities Webinar
- Reducing the Performance Gap between Design Intent and Real Operation -

Today no operational rating and little measurement based optimisation of buildings

At the same time, we see following trends

Internet of Things | Home automation | Big Data

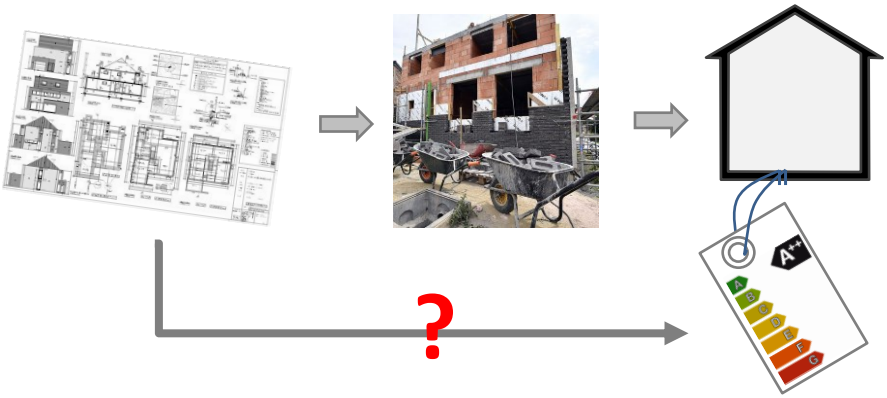
To what extent can we use on board monitored data to assess the energy performance of our buildings?

Quantifying the thermal performance of the building fabric

Today's theoretical approach

Energy performance estimated using simulation software; EPB en EPC

building plans and specifications | building delivery | energy labelling

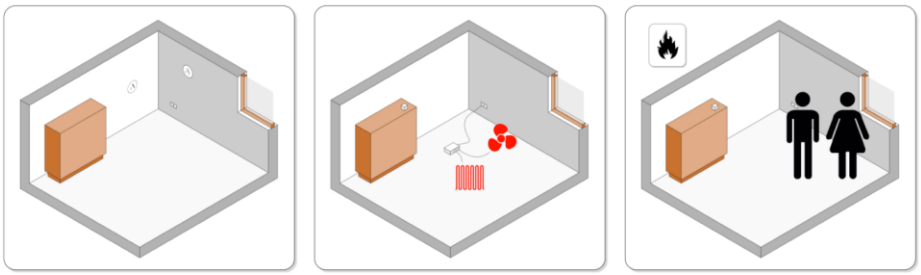


Actual quality/performance often tuns out worse than expected
Missed opportunities to optimise energy efficiency

Quantifying the thermal performance of the building fabric

As-built thermal quality check

Three options



R-value/U-value test
Local thermal performance of building elements

Specific heating test
Thermal performance of whole building envelope

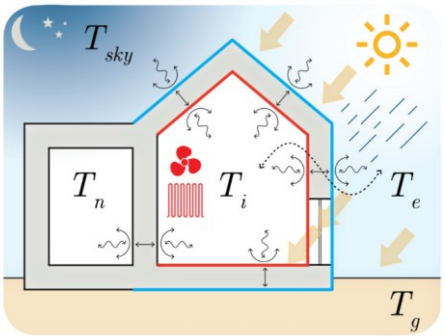
On-board test
Thermal performance of whole building envelope

focus of IEA EBC Annex 58-project

focus of Annex 71-project

Estimate as-built thermal performance of the building fabric, based on measured data during normal operating conditions

$$C_i \frac{\partial \theta_i}{\partial t} = \Phi_h + \Phi_{int} + \Phi_{sol} + \Phi_l + \Phi_{tr} + \Phi_v + \Phi_m$$



HTC ?

$$C_i \frac{\partial \theta_i}{\partial t} = \Phi_h + \Phi_{int} + \Phi_{sol} + \Phi_l + \Phi_{tr} + \Phi_v + \Phi_m$$

$$\Phi_{tr} = \Phi_{tr}^{e} + \Phi_{tr}^{n} + \Phi_{tr}^{adj} + \Phi_{tr}^{g}$$

$$\Phi_{tr}^{e} + \Phi_{tr}^{n} + \Phi_{tr}^{g} \sim HTC$$

Exploration of different statistical methods:

- Averaging method
- Linear regression models
- Energy signature model
- AR(MA)X-models
- grey box models
- …

Investigating the impact of input data:

- solar gains
- heat input (SH vs. DHW)
- weather data
- indoor temperature
- infiltration and ventilation
- …

IEA EBC Annex 71: from extensive monitoring campaigns to smart meter data

extensive monitoring

artificial users

actual users

smart meter data

blind test

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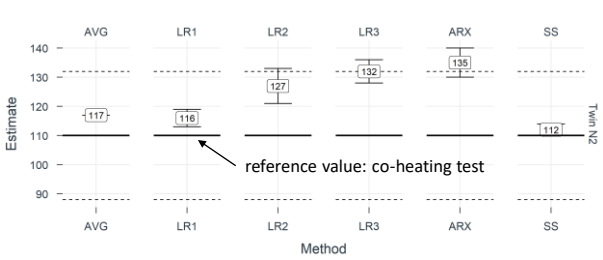
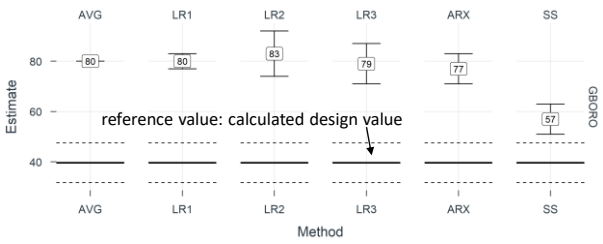
Some results

Twin test houses, Germany
artificial users



Social housing dwelling, UK
actual users



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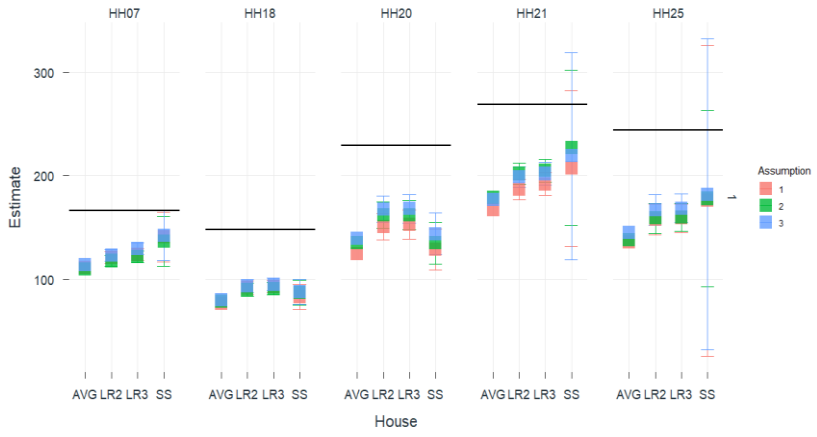
Blind test: SMETER-project, UK

Impact of the different assumptions applied on indoor temperature averaging



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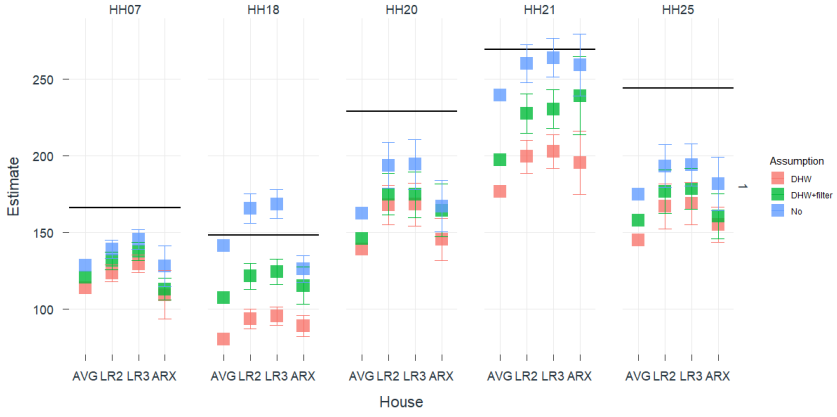
Blind test: SMETER-project, UK

Impact of the different assumptions applied in DHW and SH splitting



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Conclusions

- Statistical tools show promise to determine the building's HTC based on limited on-site monitored data.
- Static methods showed to be more robust in application, but overall both static and dynamic measurements resulted in similar estimates
- Results often in close agreement with the target values (co-heating test results), but for some buildings deviations up to almost 50% were found.
- Assumptions on almost all parameters (measurement time and period, internal heat gains, temperature averaging,…) showed to significantly impact the outcome.
- A further in-depth analysis on more case studies is advisable to turn the methods into reliable tools to be used in actual performance assessment.
- Details can be found in the IEA EBC Annex 71-reports

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Consequences for The Netherlands?

Characterization of as-built energy performance

Source: https://www.bouwwereld.nl/categorie/bouwfouten

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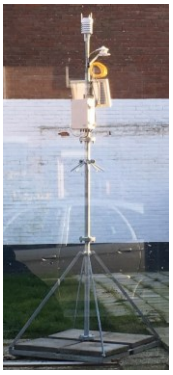
Consequences for The Netherlands?

Characterization of as-built energy performance

In-situ performance assessment of renovation measures, testing and standardization of methods (blowerdoortest, co-heating test, …)



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Consequences for The Netherlands?

Characterization of as-built energy performance using on-board monitoring data.

- More cost-effective and less intrusive than traditional heating experiments
- Quality assurance
- Performance tracking
- Model calibration

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Consequences for The Netherlands?

A number of methods have been developed and described to determine the as-built HLC and HTC.

Future work:

- Improving accuracy / reducing uncertainty
- Automation of methods for large-scale application

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