EBC

Energy in Buildings and Communities Programme

IEA EBC Annex 71

Building energy performance assessment based on in-situ measurements

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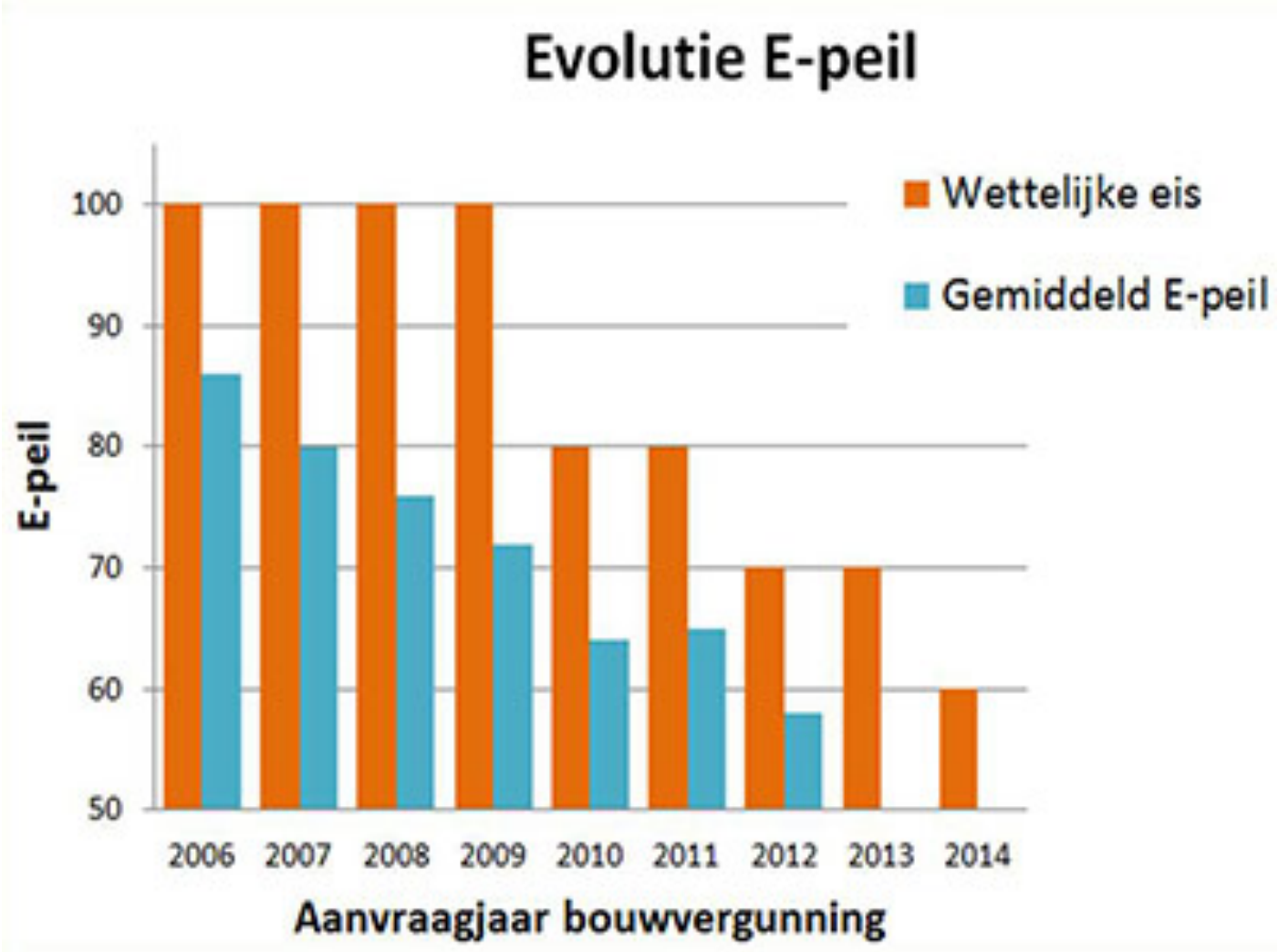
ACE-Workshop 'SMART and SMART-ER: Architecture and Building Performance'
Brussels, Belgium__ June 7, 2018

International collaboration

1. Austria University of Innsbruck
2. Belgium BBRI, BCCA, Energyville, INIVE, Knauf Insulation, KU Leuven, UCL, UGhent, University of Liège
3. Denmark Danish Building Research Institute, DTU
4. France Cerema, CSTB, Ecole des Mines de Douai, ENTPE, Groupe Atlantic, Saint Gobain, Univ. de Savoie Mont-Blanc
5. Germany Fraunhofer Institute, FH Rosenheim
6. Netherlands Saxion Hogeschool, Huygen Ingenieurs&Adviseurs
7. Norway NTNU
8. Spain CIEMAT, CIMNE, Univ. of the Basque Country
9. Switzerland ETH
10. UK Knauf Insulation, Leeds Beckett Univ., Loughborough Univ., UCL, Univ. of Lincoln, Univ. of Salford, Univ. of Strathclyde, Univ. of the West of England, The British Blind and Shutter Ass.

Regulation rapidly grew more strict

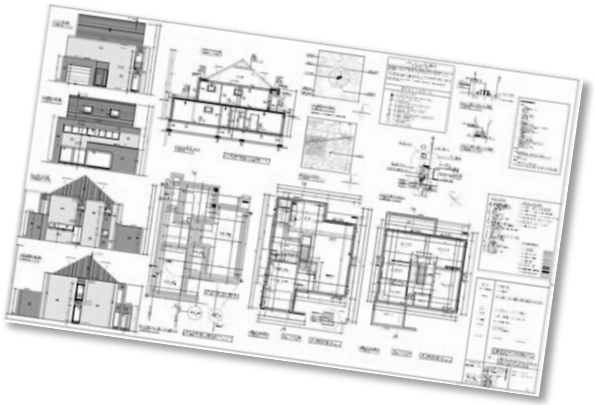


Figuur: www.mijnepb.be/evolutie-e-peil/

Today's theoretical approach

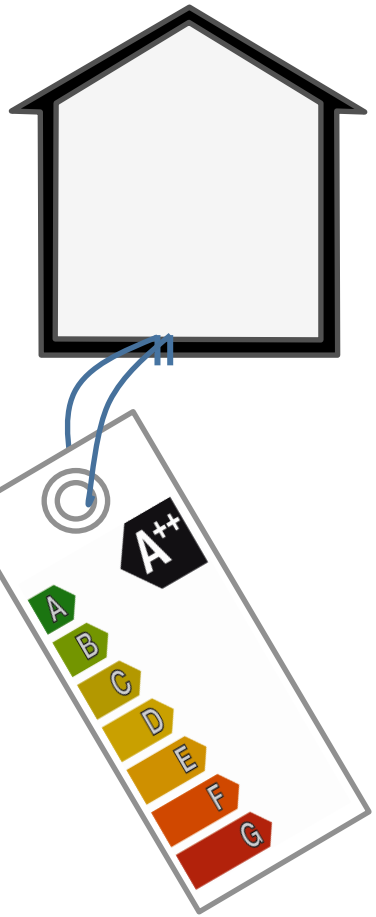
Energy performance estimated using simulation software; EPB en EPC
Actual quality/performance often tuns out worse than expected
Missed opportunities to optimise energy efficiency

building plans and specifications



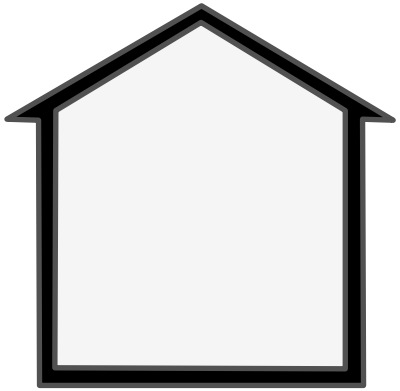
building delivery

energy labelling

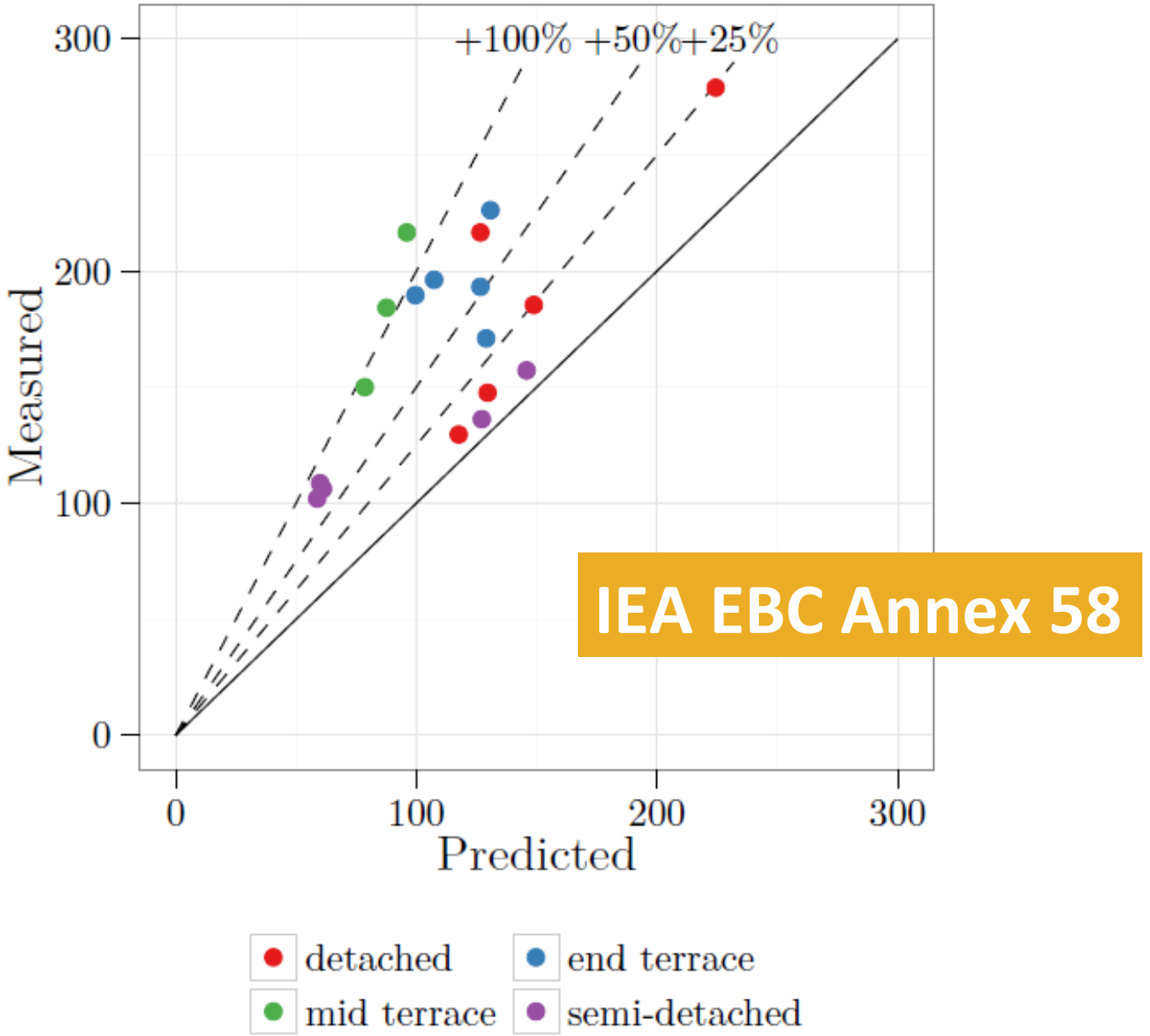


?

designed energy performance < > actual energy performance



designed energy performance < > actual energy performance



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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?

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Main objective:

Support the development of replicable methodologies embedded in a statistical and building physical framework to characterize and assess the actual energy performance of buildings starting from on board monitored data of in-use buildings

Focus on residential dwellings, but both individual as aggregate scale

ANALYSIS ON LEVEL OF INDIVIDUAL DWELLING

ANALYSIS ON LEVEL OF BUILDING DISTRICTS

At both levels the development of characterization methods as well as of quality assurance methods will be explored

CHARACTERIZATION METHODS

- Translate the (dynamic) behaviour of a building into a simplified model
- Simplified model can be used in model predictive control, fault detection, optimisation of district energy systems,…

building behaviour identification

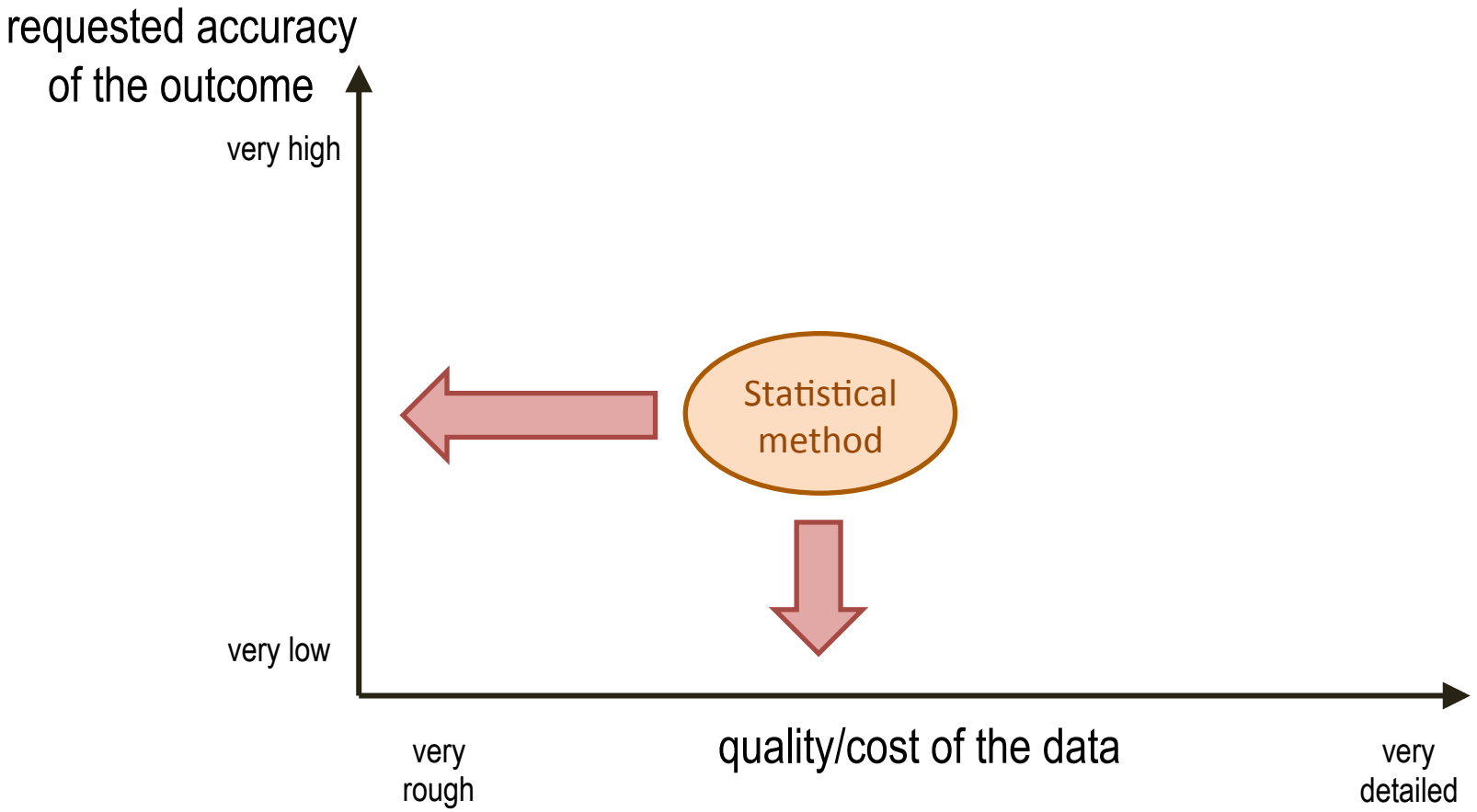
QUALITY ASSURANCE METHODS

- Pinpoint some of the most relevant actual building performances
- For instance: the overall heat loss coefficient of a building, the energy efficiency of the heating (cooling) system, air tightness, solar absorption,…

physical parameter identification

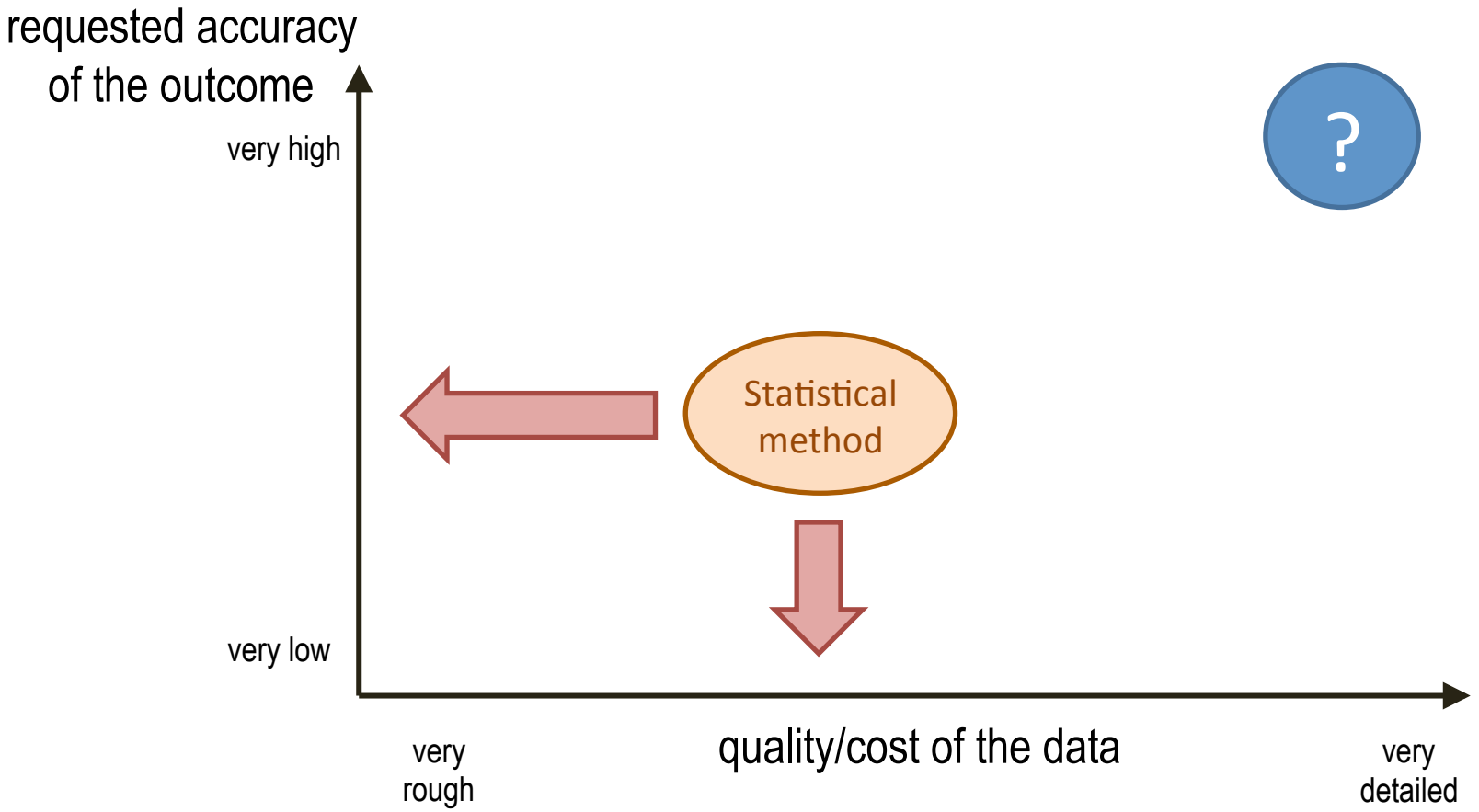
Major outcome

Evaluate methods regarding the requested input and expected outcome



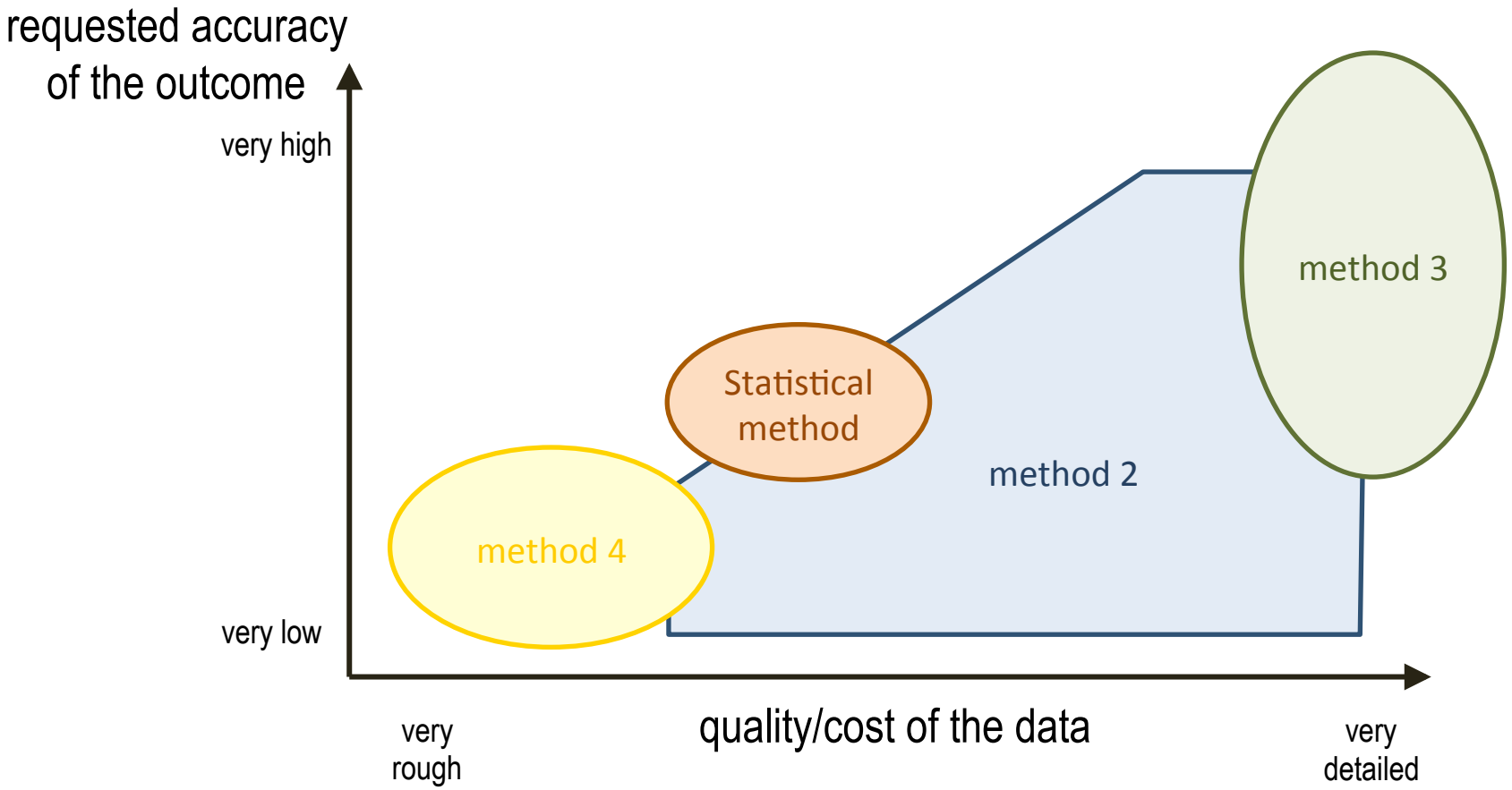
Major outcome

Evaluate methods regarding the requested input and expected outcome



Major outcome

Evaluate methods regarding the requested input and expected outcome



First explorative results

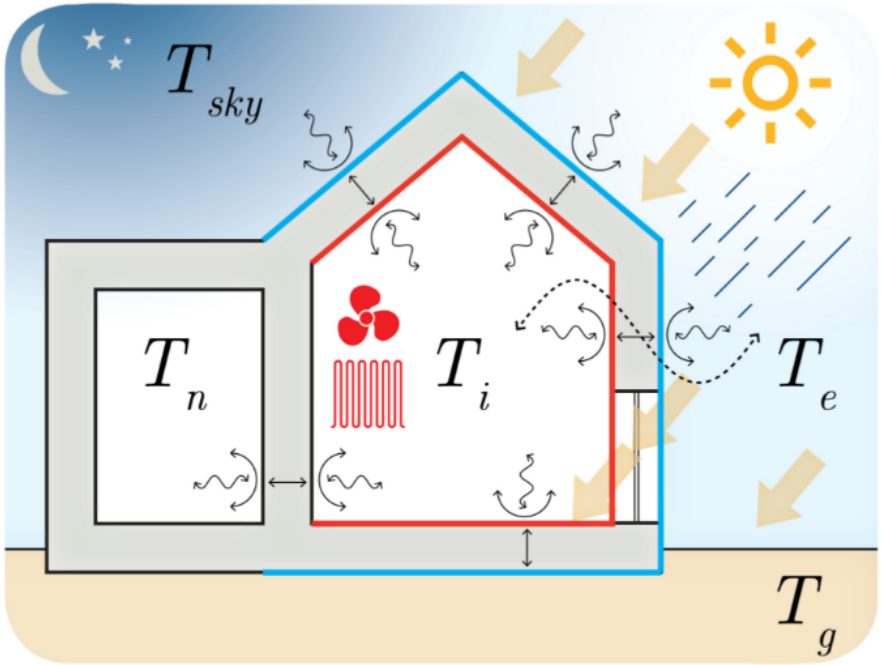
Based on the on-site measured data, participants are requested to:

- develop a model to predict indoor temperature (ST2)
- calculate the overall heat transfer coefficient (ST3)

First explorative results ST3

Estimate global as-built heat transfer coefficient HTC, 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 ?

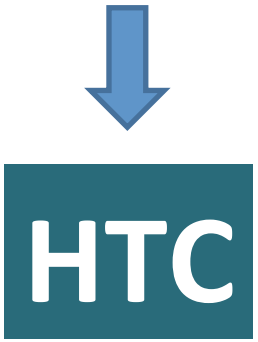
$$C_i \partial\theta_i / \partial t = \Phi_h + \Phi_{int} + \Phi_{sol} + \Phi_l + \Phi_{tr} + \Phi_v + \Phi_m$$

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

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

A needle in a haystack?

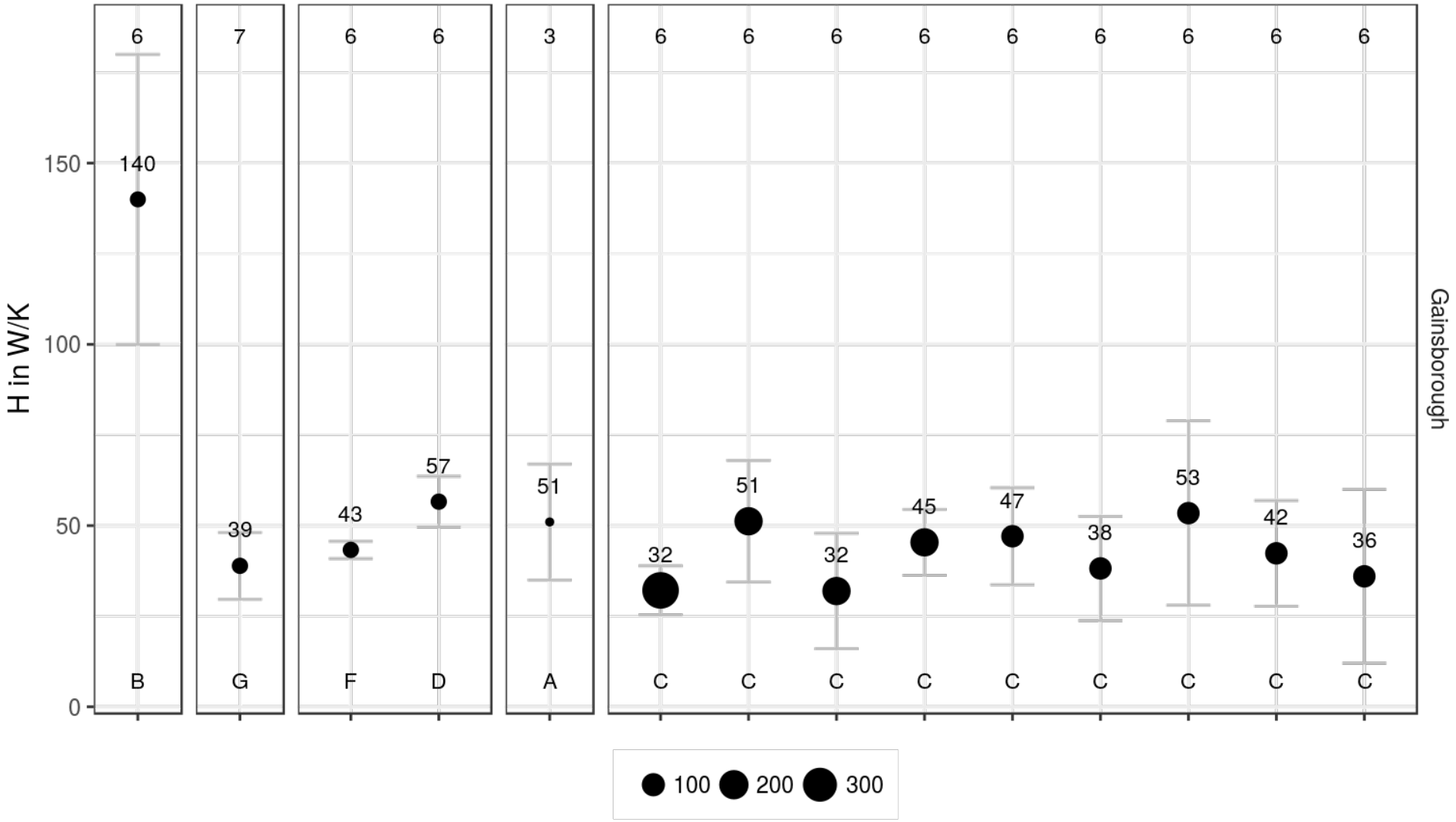
$$C_i \partial\theta_i / \partial t = \Phi_h + \Phi_{int} + \Phi_{sol} + \Phi_l + \Phi_{tr} + \Phi_v + \Phi_m$$



Exploration of different methods:

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

Gainsborough case



A: Bayesian - MCMC, B: BEECHAM, C: Linear regression, D: ARX, E: Average, F: RC (LORD), G: Grey-box (CTSM-R)

Preliminary conclusions

- Different techniques can be applied to assess the operational performance of a building
- Methods differ in input data and accuracy of output data
- Several questions remain to be answered:
  - robustness, reliability and accuracy of the methods
  - required accuracy for different use cases
  - acceptable costs for different use cases
  - ….

More results in due time!

Questions?