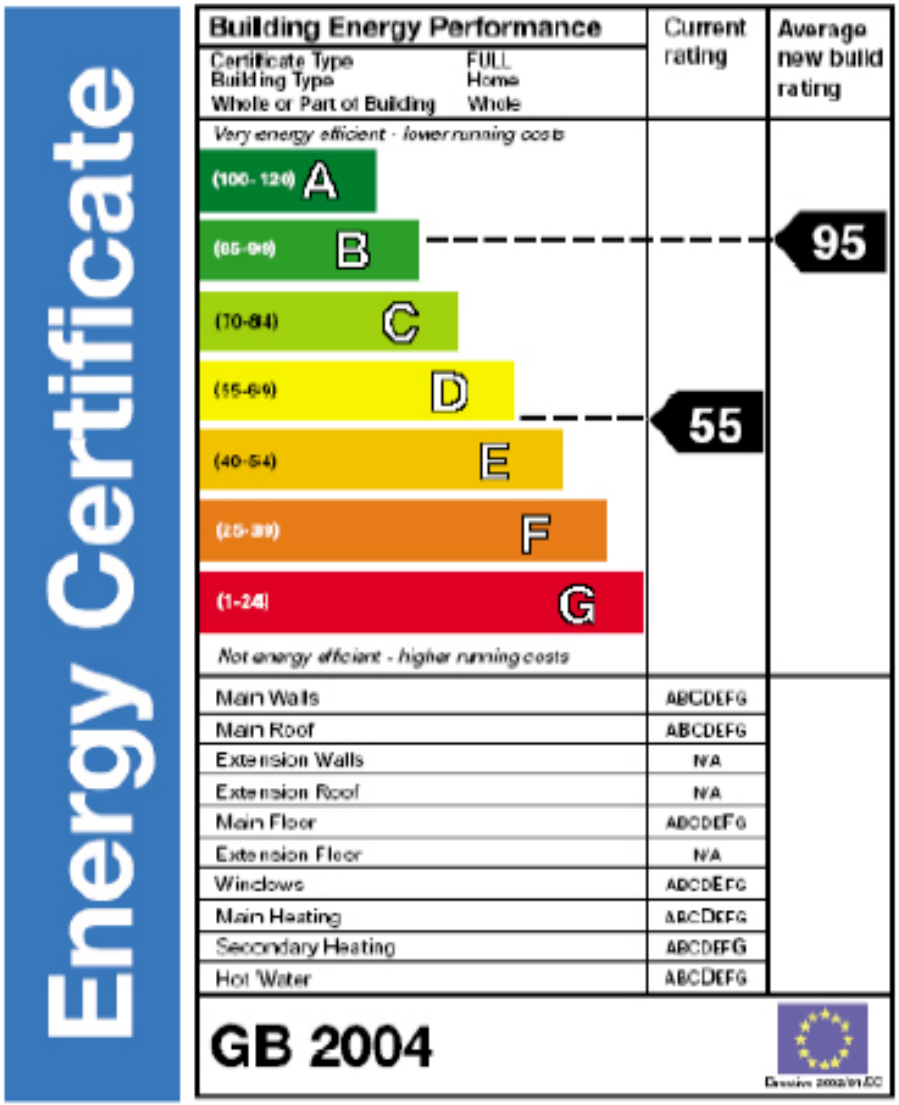
IEA EBC Project Concept

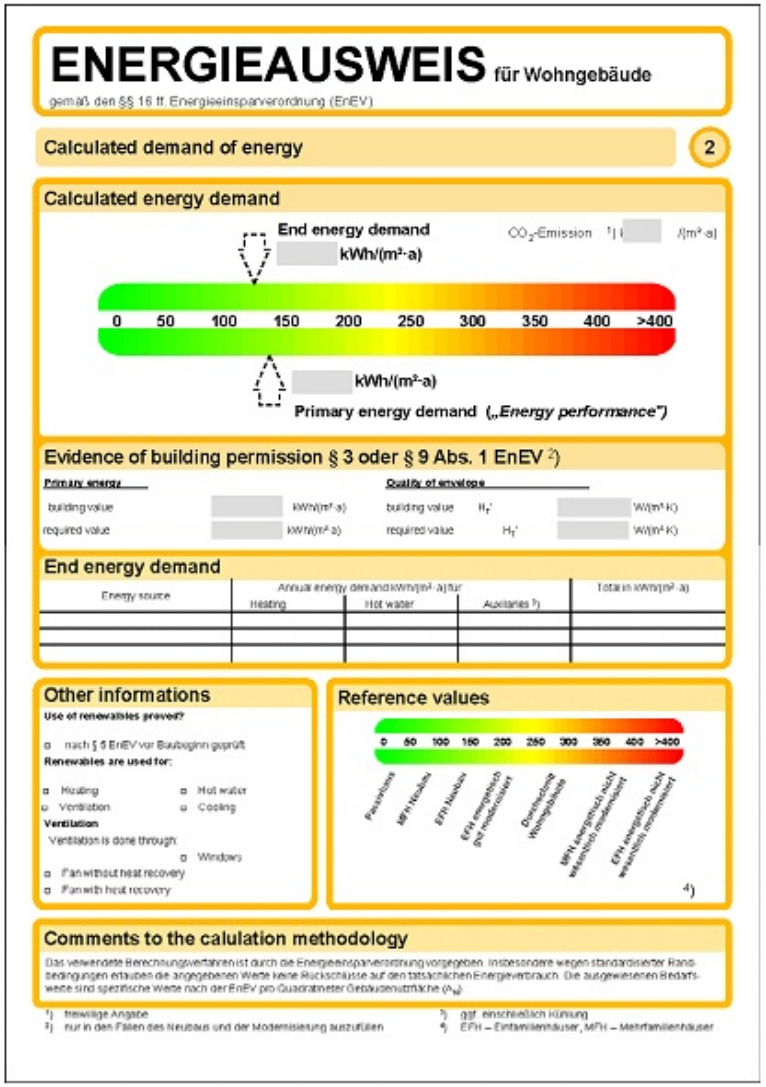
Building energy performance assessment based on optimised in-situ measurements

Staf Roels, KU Leuven Belgium
staf.roels@bwk.kuleuven.be

Workshop in preparation of new IEA EBC Annex project – Brussels April 18-19, 2016

Introduction and background





'As an expert in the field of energy efficiency in new building I find it astonishing that countries, states and cities do not pay more attention to the actual energy consumption of new buildings. How can we be sure of the value of the codes if we don't know how well the new buildings are performing under them? So, I guess large savings could be achieved if more attention was paid to the actual energy performance.'

Jens Laustsen, IEA

Building Energy Quotient Certificate

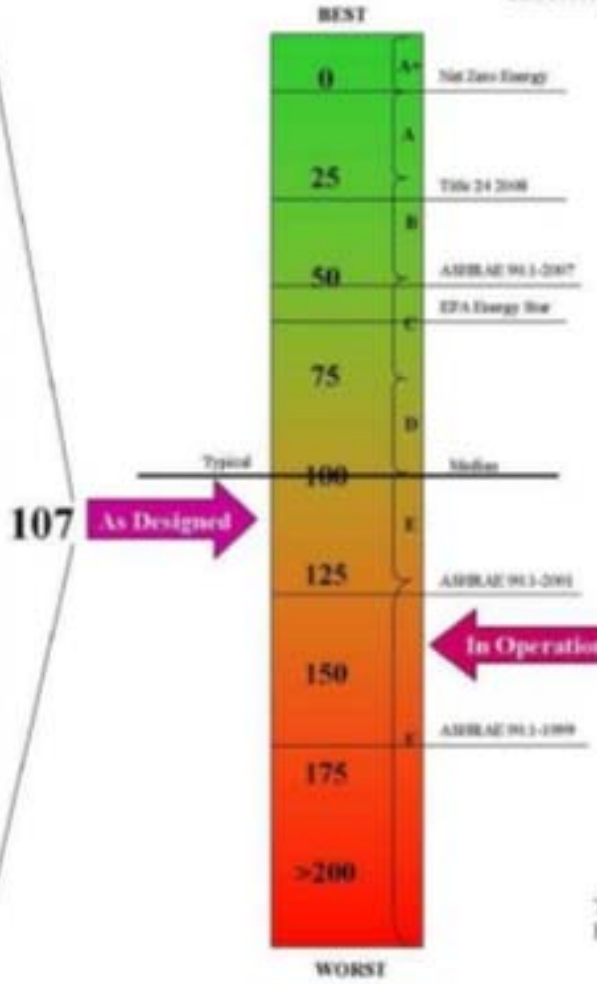
Galt House
100 Louisville St.
Louisville, KY 10000

ID Number: KY00001
Assessor: Jim Smith

Hotel

Assessment Year: 2009

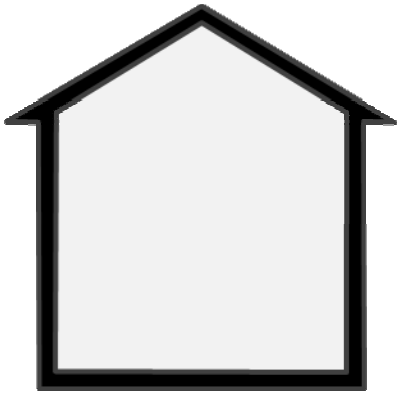
Energy Use Intensity (kBTU/ft2/yr)	225
System EUIs (kBTU/ft2/yr)	HVAC: 100 Lighting: 50 Plug Loads: 75
Target Finder	45
CO2 Emissions (tons/yr)	50
Asset Label Method Software	EPA Target Finder eQuest
Energy Saving Features	Daylighting Increased Envelope Insulation High Efficiency HVAC Cool Roof
Meets IEQ Requirements Thermal Comfort Visual Comfort Acoustical Comfort IAQ	 Yes Yes No Yes
Commissioned	Yes
Asset Rating Year	1999
Designed to meet	USGBC LEED-NC Silver



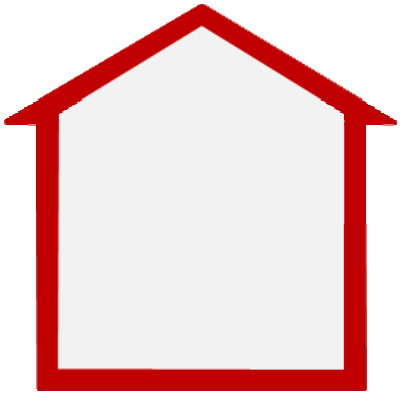
Energy Use Intensity (kBTU/ft2/yr)	350
System EUIs (kBTU/ft2/yr)	HVAC: 200 Lighting: 50 Plug Loads: 100
Portfolio Manager	30
Previous Operational Ratings	150 (2008) 130 (2007)
CO2 Emissions (tons/yr)	75
Operational Label Method	EPA Portfolio Manager
Meets IEQ Requirements Thermal Comfort Visual Comfort Acoustical Comfort IAQ	 Yes Yes No Yes
Commissioned (yr)	1999 2005
Peak kW	100

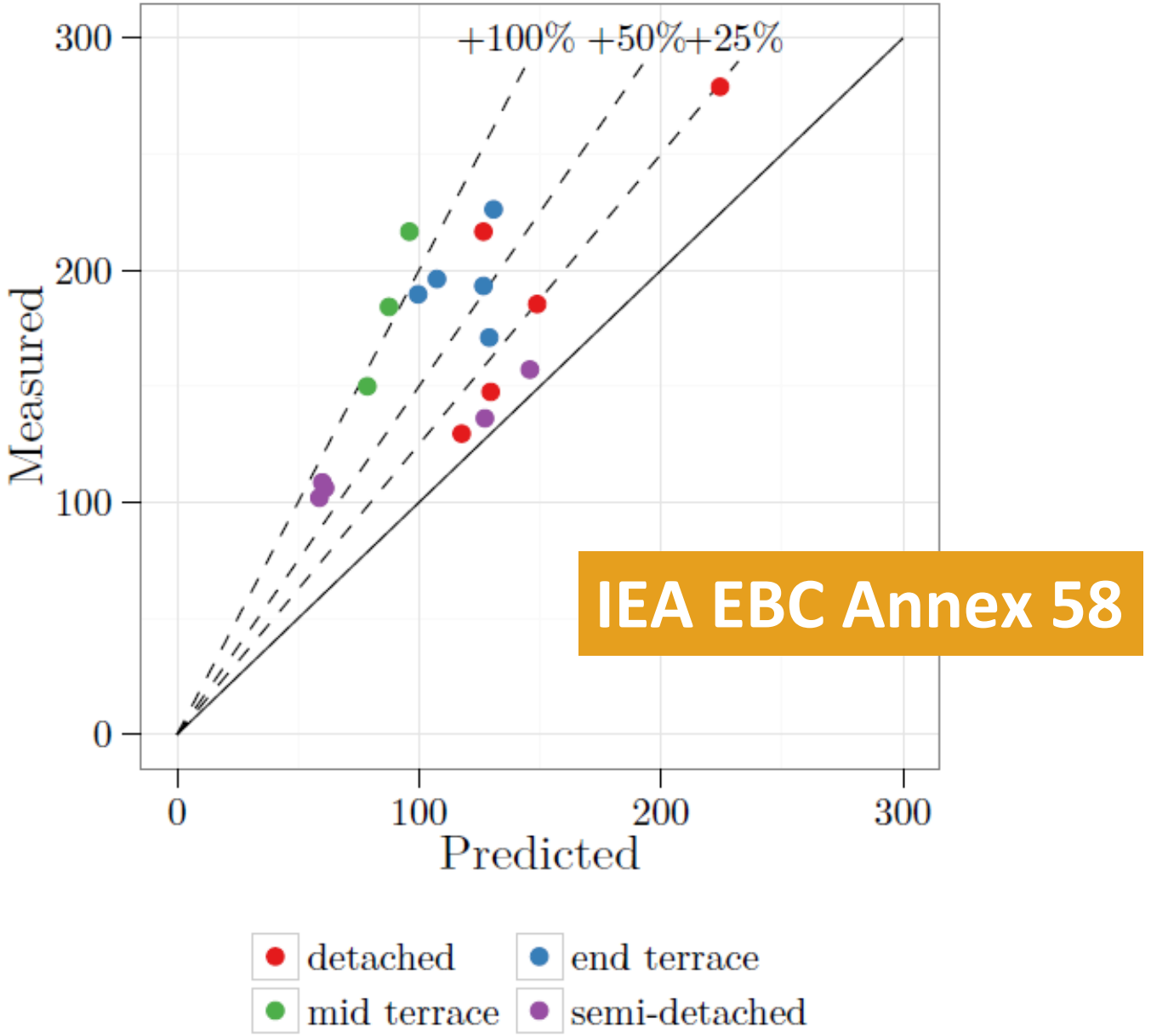
Technical Basis Provided by American Society of Heating, Refrigerating and Air-conditioning Engineers

designed energy performance < > actual energy performance



designed energy performance < > actual energy performance





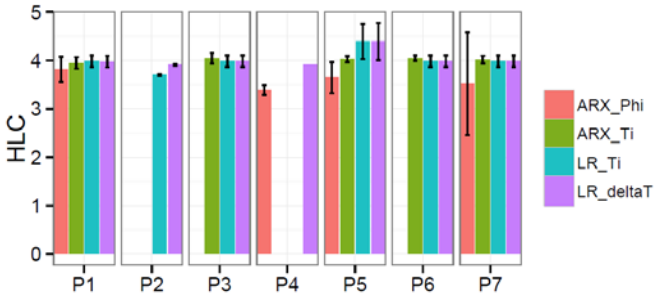
IEA EBC Annex 58

EBC

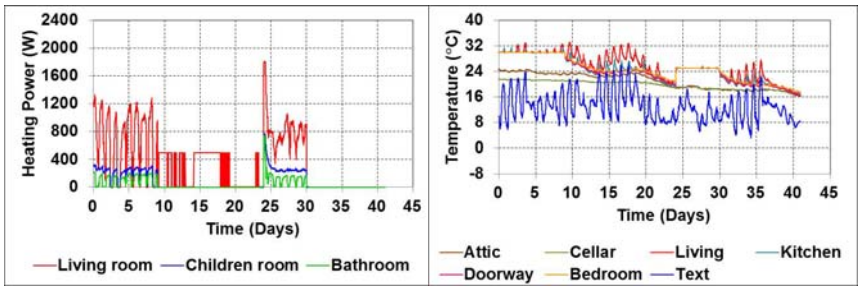
IEA EBC Annex 58

Reliable building energy performance characterisation based on full scale dynamic measurements

CE3-CE4

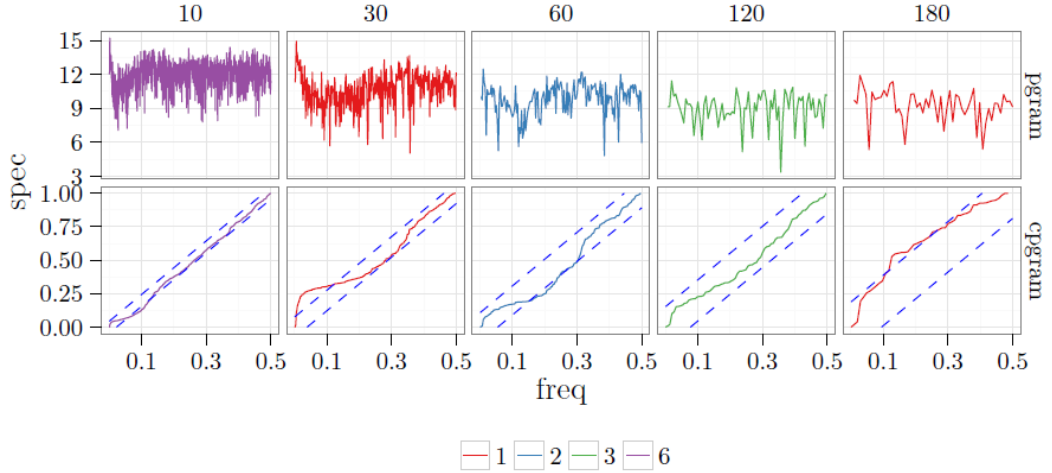


CE5



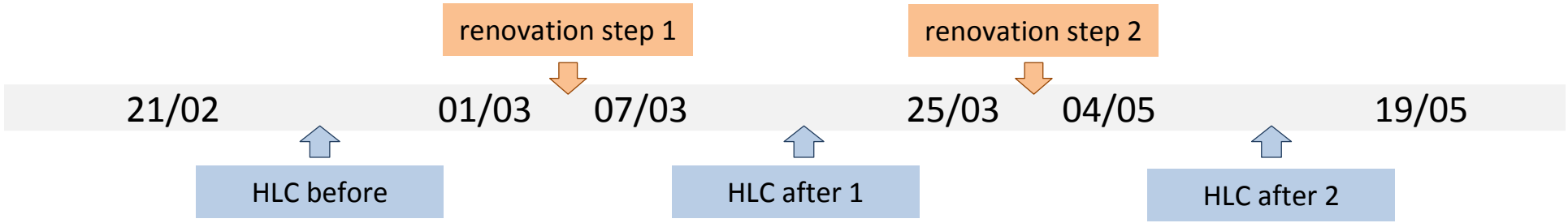
On site assessment of thermal performance of building fabric

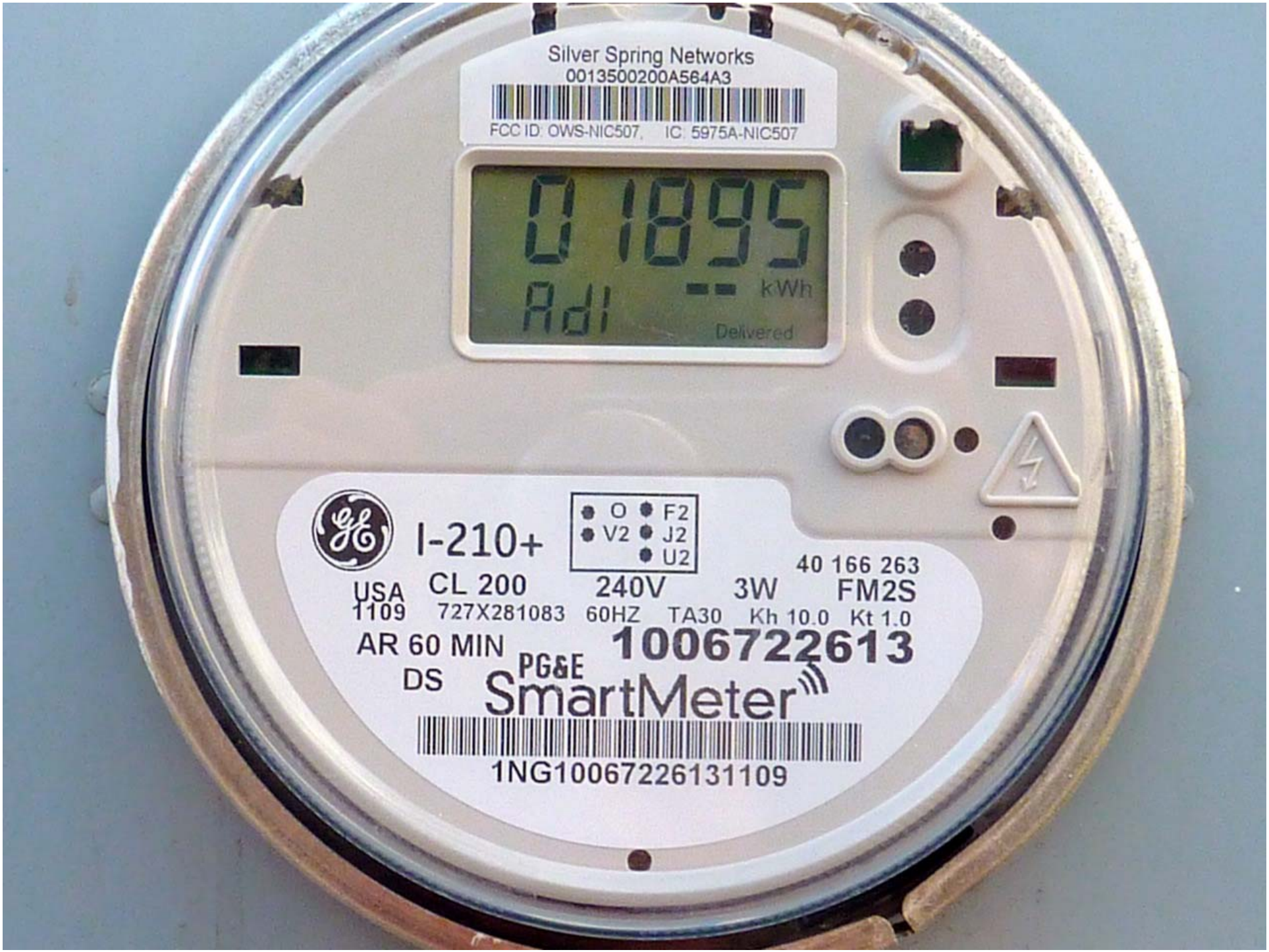
From static co-heating test towards dynamic building performance characterisation



	H_{tr}
Expected	207.2
LR	203.6
ARX	205.2

Analysis based on dedicated intrusive tests




Silver Spring Networks
0013500200A564A3
FCC ID: OWS-NIC507, IC: 5975A-NIC507
01895
Adl
kWh
Delivered
I-210+
O F2
V2 J2
U2
40 166 263
USA CL 200 240V 3W FM2S
1109 727X281083 60HZ TA30 Kh 10.0 Kt 1.0
AR 60 MIN
1006722613
DS
PG&E
SmartMeter
1NG10067226131109


Overview
Power Use
402 W
6.2 kWh
211 kWh
Power Generation
2.48 kW
7.99 kWh
89.25 kWh
Water Use
98 L
307 L
5017 L
Gas Use
0.4 m³
Appliances
50 W
5
2
Cost
£95.21
£37.49
Temperature
21 °C
Eco
1.2 kg
46.8 kg
3.3 kg
111 kg

To what extent can we use smart meter and home automation data instead of going to dedicated intensive measurements?

Objectives of IEA EBC Annex-proposal

Building performance assessment based on optimised in-situ measurements

1. Support the development of replicable methodologies to in situ assess the building energy performances

2. Disaggregate the energy performance to the three main sources: building, systems and users

Focus on residential buildings

Development of characterization and assessment methodologies embedded in a statistical and building physical framework

Challenges:

- Going from intrusive (dedicated) tests towards assessment methods based on on board monitoring

- Elaborate existing methods towards non-linear and time-dependent phenomena

- Develop reliable methodologies to analyse data in a way that the energy performance on site can not only be assessed but that discrepancies between designed and actual performances understood!

- Disaggregate obtained energy performance to users, building fabric and systems

major aim of the Annex-project is a collaboration in the EBC-context, building further on the progress made in previous projects, with the aim

to pave the way for real and reliable quality checks in daily building construction practice to guarantee that designed performances are obtained on site.

The procedures should focus on **buildings in use** and, as much as possible, making use of **on board monitored data**

Annex should answer (at least) the following questions:

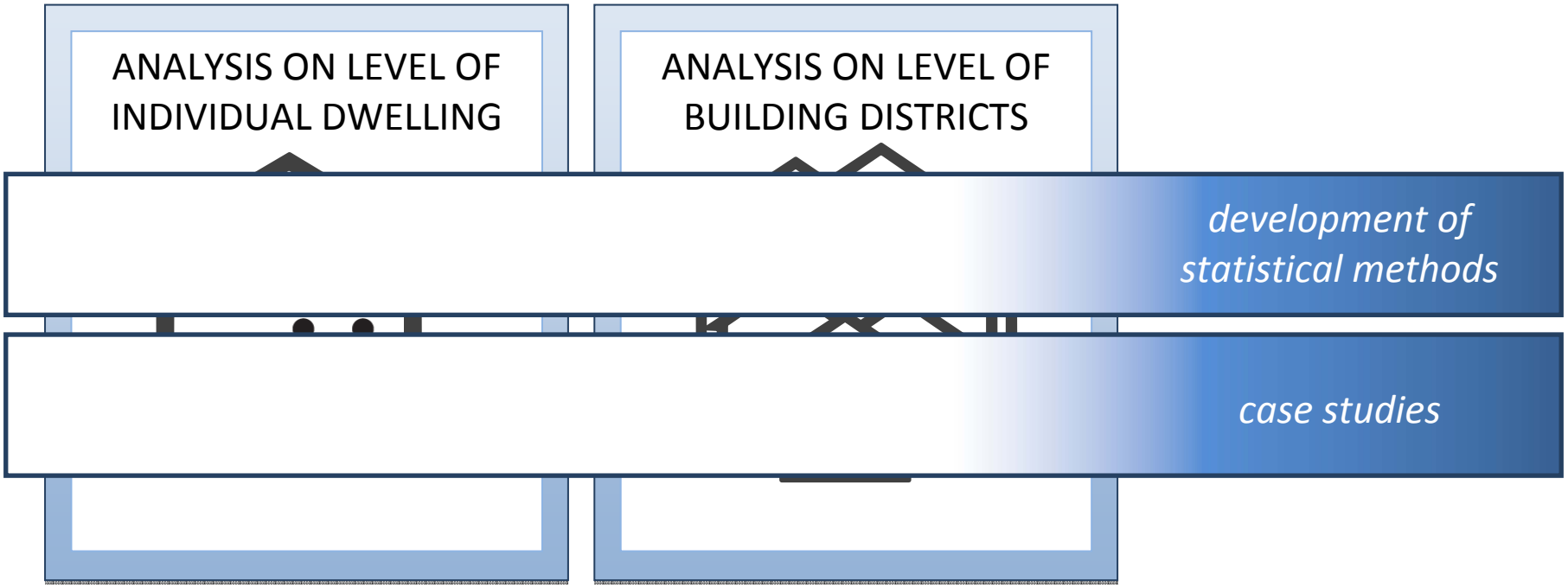
- How to deduce energy performance of the building based on on site measured data
- Characterise the impact of users / fabric / systems on the obtained energy performance ?
- What are the reasons for observed discrepancies?

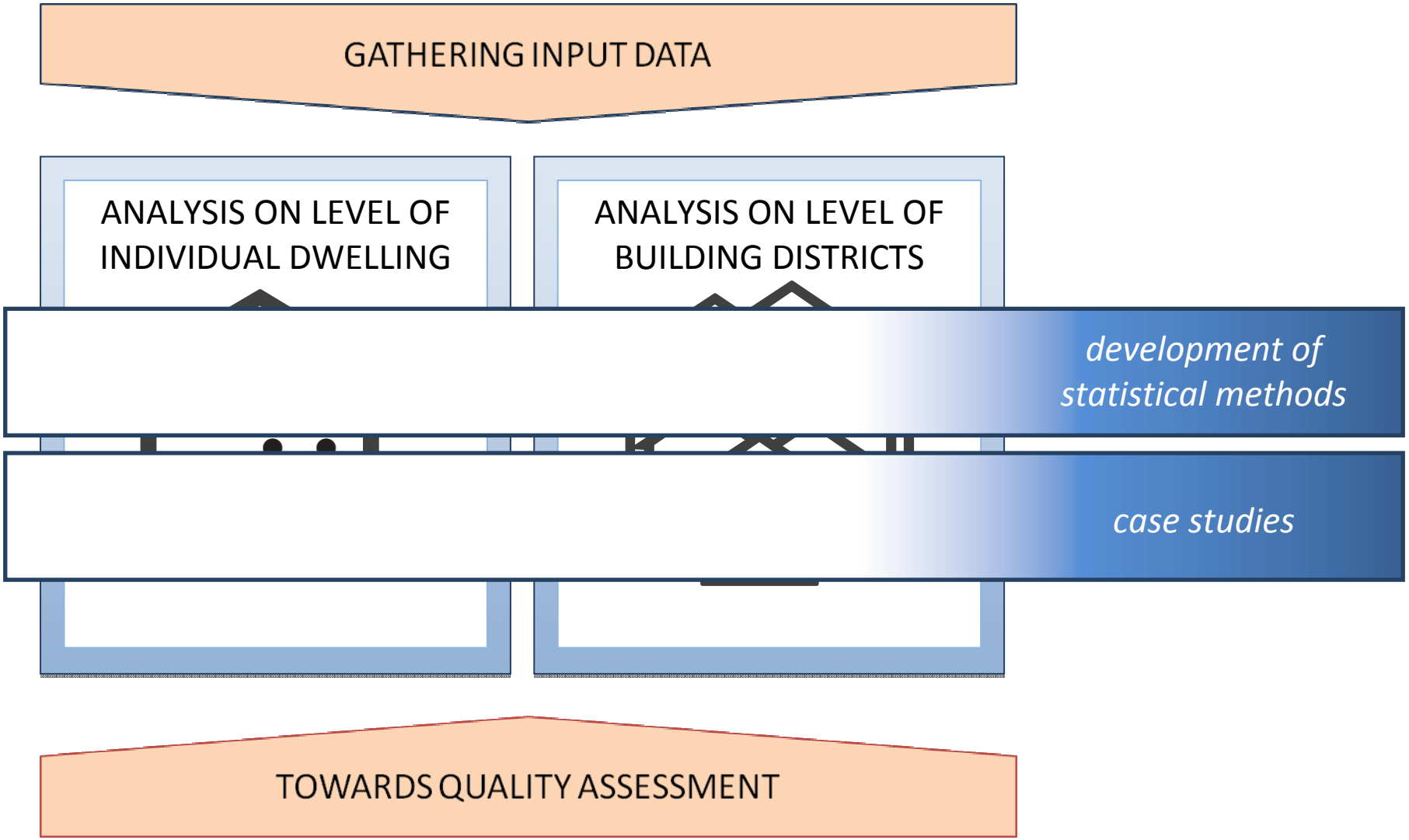
Development of replicable methodologies to quantify the different aspects of the building energy performance

at the same time this annex will continue the '**network of excellence**' on full scale testing and data analysis (DYNASTEE)

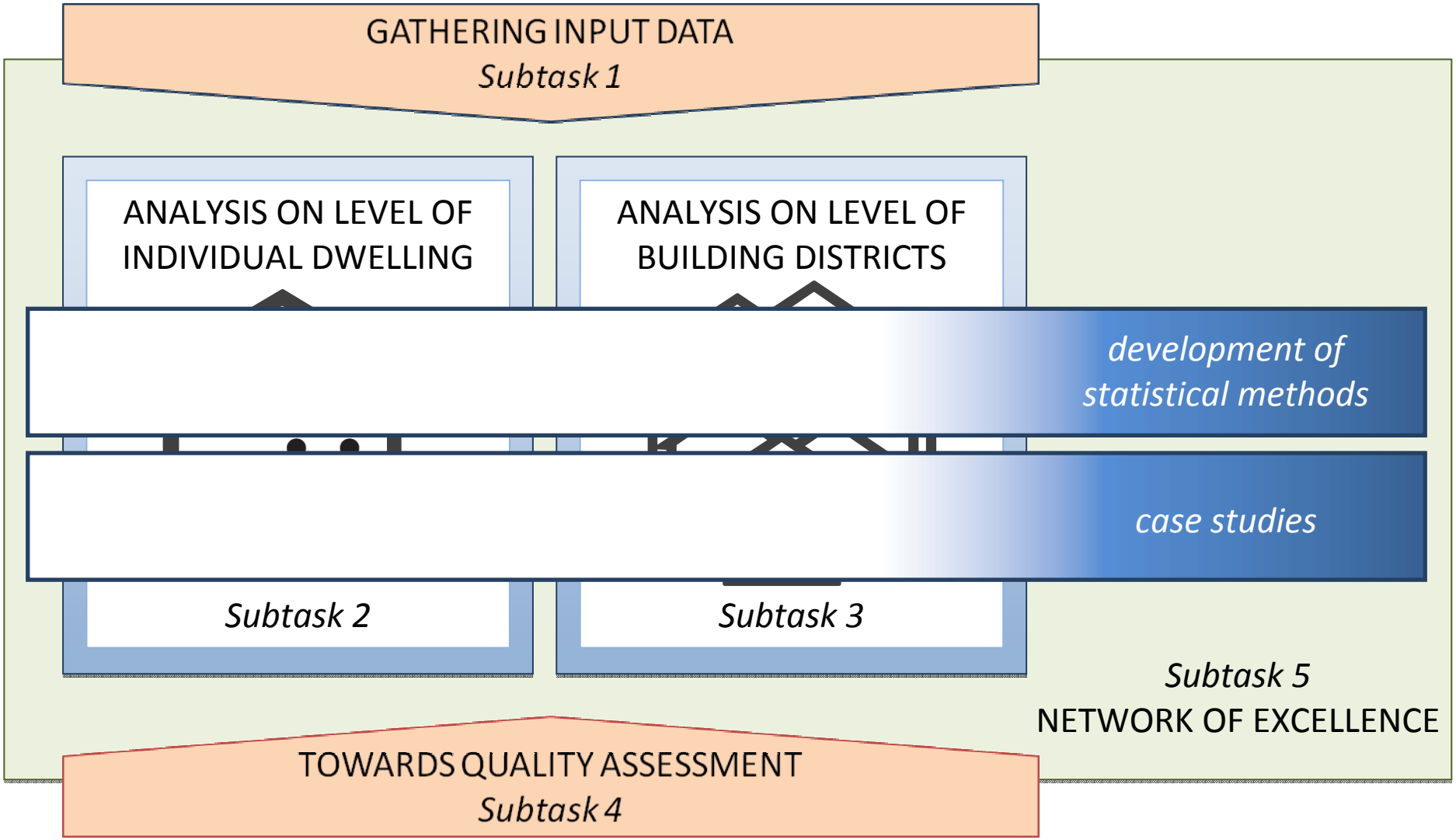
Focus on residential dwellings

But both individual as aggregate scale




GATHERING INPUT DATA
ANALYSIS ON LEVEL OF INDIVIDUAL DWELLING
ANALYSIS ON LEVEL OF BUILDING DISTRICTS
development of statistical methods
case studies
TOWARDS QUALITY ASSESSMENT

Proposed main structure



ST1 *Gathering input data*

Objective: investigate possibilities and limitations of commonly available data

A lot of data is nowadays available, but how useful is this data for our aim?

Where can we get (cheap) input on:

the construction + systems

How to obtain input on geometrical aspects of the dwellings, composition of the building envelopes (can GIS be of help?), link building age – construction type

on site measured data

What do we typically get from smart meters?
How reliable are (standard) (energy) meters – how to transform to net energy?

boundary conditions / users

On site measured weather data versus data from (official) weather station
Input on occupancy behaviour?

ST2 *Analysis on the level of the individual building*

Objective: Development of assessment and characterisation methods applicable on the building scale

Methods should be able to disaggregate between:

- building fabric (energy performance)
- building systems (energy efficiency)
- users (energy consumption)

ST2 *Analysis on the level of the individual building*

Challenges:

• Going from intrusive (dedicated) tests towards assessment methods based on on board monitoring in occupied buildings controlled by building own services.

• Taking dynamic aspect into account (loading/unloading, variable system efficiency, renewable resources,….). This means elaborate existing methods towards non-linear and time-dependent phenomena.

• What data do we need? Trying to come to the minimum data set we need to come to a reliable characterisation.

ST3 *Analysis on district level*

Objective: Development of assessment and characterisation methods applicable on the district scale

District scale to be considered in broad sense:

=

ST3

Analysis on district level

Challenges:

• Often large, but crude data sets are available. How to we deal with missing information (building geometry, system,…)?

• Taking dynamic aspect into account – link with district heating systems, smart energy grids. This means elaborate existing methods towards non-linear and time-dependent phenomena.

• What kind of feedback/assessment do we aim for? Develop guidelines on the data needed for a specific characterisation.

ST4 *Towards a quality assessment*

Objective: Investigate to what extent the developed methodologies can be used in quality assessment

Aim is to make the link between the Annex-participants (building physicists, statisticians,…) and certification bodies, government, practitioners,..

To what extent can the methodologies developed in ST2 and ST3 be used in a quality assessment framework ?

e.g. can we use the methods to determine the overall HLC of a building based on on-site measured date in an easy, cheap and reliable way, so that it can replace the calculated design value in Energy Performance Certifications?

ST4 *Towards a quality assessment*

Challenges:

- What kind of quality assessment is feasible with the developed methods?

- What input data is required / how can we guarantee the quality of the input data?

- How reliable (reproducibility, accuracy,..) are the methods?

- Can we standardise the methods? How to go from '*data analysis by experts*' to reliable and easy-to-use tools?

ST5

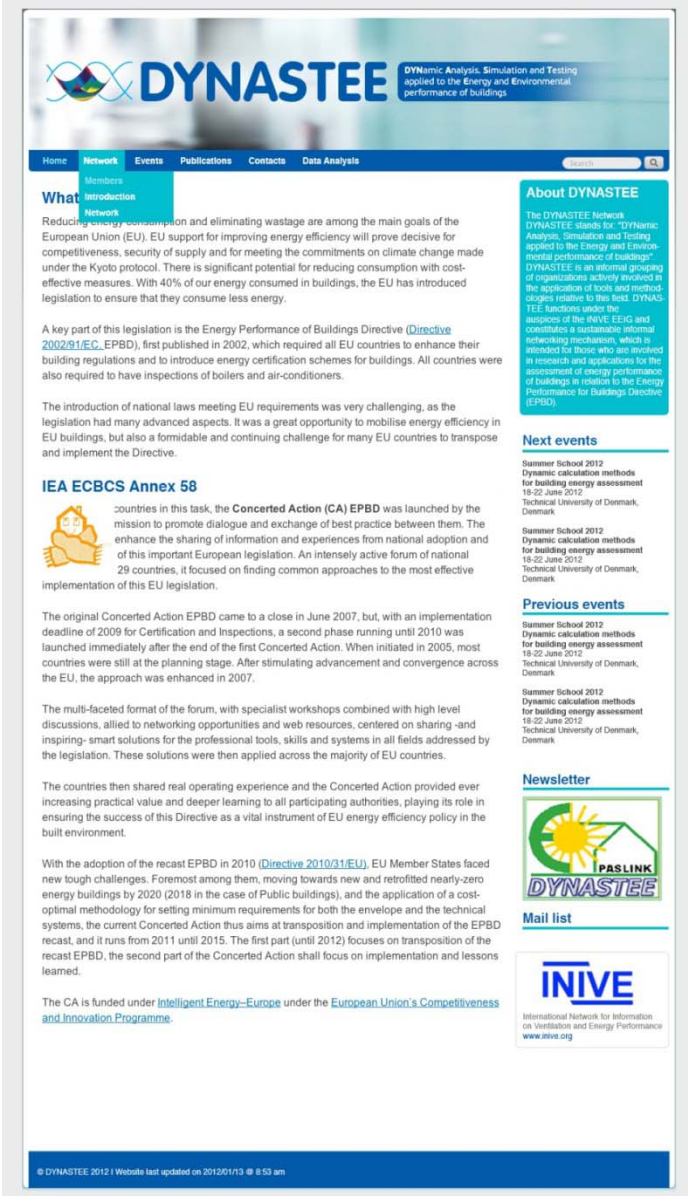
Network of excellence

DYNASTEE

Network of Excellence

www.dynastee.info

Dynamic analysis, simulation and testing applied to the energy and environmental performance of buildings



Deliverables of the project

1. An **internet site** and **Annex newsletter**
2. A few, but well-documented **dynamic data sets** (on different scales: individual building and district level) that can be used for developing dynamic data analysis procedures and for validation purposes
3. The **reports of the different subtasks**, including:
    1. A report on reliabilitiy of input data for on site building performance assessment
    2. A report on dynamic data analysis methods that can be used to disaggregate users/fabric and systems on the building level
    3. A report on example cases on the building level
    4. A report on data analysis methods applicable at the district level
    5. A report on example cases on the district level
    6. A report on guidelines (possibilities and limitations) to apply the methods in quality assessment procedures
4. Further collaboration with Dynastee, the **network of excellence** on full scale testing and dynamic data analysis. This network organises on a regular basis events as international workshops, annual trainings,... and will be of help for interested organisations

Link with other EBC-projects

IEA EBC Annex 58

IEA EBC Annex 58 dealt with full scale testing and dynamic data analysis methods. Main focus was on the characterization of the building fabric (overall HLC, gA-values,…) based on (rather intrusive) on site tests of unoccupied buildings.
The current proposal takes this methodological approach one step further towards occupied buildings and based on on-board monitored data.

IEA EBC Annex 70 on Building Energy Epidemiology

This new proposal looks a large data sets, with the aim to address the performance gap and inform policy makers and industry in the development of low energy / low carbon solutions.
Although there is a distinct different focus with the current proposal (more empirical approach versus statistical and modelling approach), a regular interaction seems logic and advisable.

Proposed time schedule

Next steps:

- Further elaboration of the proposal.

  Annex text to be submitted to ExCo by May 18th

- Presentation at the ExCo-meeting in Oslo, June 9-10.

- If approved the project starts with one year preparation phase (autumn 2016-june 2017)

- Final approval by ExCo (June 2017) of participating partners

- Three years working phase: autumn 2017 – spring 2020

- One year reporting phase: autumn 2020 – spring 2021

Time for discussion