Measuring the in-situ performance of dwellings

Dr Richard Fitton

Applied Buildings and Energy Research Group
Introduction

Who am I?
• Building Physicist
• Lecturer in Energy Efficiency
• Head of Applied Buildings and Energy Research Group
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Energy House
Performance Gap

Performance gap is now well researched:

Measured energy - Modelled energy = Performance gap.
Modelled Data Example
Variations in U values

- ‘Variations in U value of a whole dwelling using infrared thermography’
- Published in Buildings 2018, 8, 46; doi:10.3390/buildings8030046
# Modelling Results

A heat transfer coefficient was determined under steady state modelled conditions.

<table>
<thead>
<tr>
<th></th>
<th>Model using point measurements</th>
<th>Model using Low-resolution IRT</th>
<th>Model using High-resolution IRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTC (W/K)</td>
<td>225 ± 6</td>
<td>233 ± 23</td>
<td>209 ± 26</td>
</tr>
<tr>
<td>Difference from Measured HTC</td>
<td>2.5%</td>
<td>6.1%</td>
<td>-4.8%</td>
</tr>
</tbody>
</table>

Measured HTC = 220 W/K
Modelling Results

Dynamic simulations made predictions of the annual heating consumption and heating cost.

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<tbody>
<tr>
<td>Heating (Gas)</td>
<td>5547 ± 83 kWh</td>
<td>5656 ± 272 kWh</td>
<td>5202 ± 279 kWh</td>
</tr>
<tr>
<td>Consumption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating Cost</td>
<td>£271 ± 4</td>
<td>£277 ± 29</td>
<td>£254 ± 27</td>
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WG13 Work - General

• **Title:** Thermal Insulation – Construction products, building elements and structures – In-situ measurement of thermal performance

**Five documents:**
• Part 1 General Principles,
• Part 2/3 Testing of components or elements
• Part 4 Testing of structures
• Part 5 Testing of Domestic properties
What are we doing?

- It was felt that there was a need for a recognised and ratified standard for the measurement of the “heat loss” of a small building. To include all include all three mechanisms of heat transfer;
  - Convection
  - Conduction
  - Radiation
  - = Global Heat Loss / Heat Transfer Coefficient
What is it?

Heat Transfer Coefficient = \( \frac{Q}{\Delta t} \)

- External Temp (t0)
- Heat input (Q)
- Internal Temp (t1)
Whole building aggregate heat loss test methodology

- The method produces a heat transfer coefficient (HTC) for the dwelling, Watts Per Kelvin (W/K) how many Watts does it take to lift the building’s temp by 1 deg C
- Takes around 1-2 weeks
- The standard also suggests that these may be suitable conditions to carry out airtightness measurements (to allow for a convective heat transfer split) and for U value measurements to be carried out in line with ISO9869
- Home must be vacant
- Late autumn, to early spring acceptable
- Northern EU climates, further south needs consideration.
How are we doing it:

- 11 members covering industry, academia and research organisations throughout the EU.
- Working on a methodology for testing from start to finish. Data Collection, Data Analysis and Reporting.
- Not reinventing the wheel, other methodologies will be incorporated (Leeds Beckett method etc.)
- Results can be used to make comparisons with energy models/predictions
What will the standard contain

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What will the standard contain

Parts:
1. Data collection:
   ✓ Scope, what's in and out
   ✓ Data to be collected
   ✓ Equipment setup, calibration
   ✓ Detailed methodology, duration of test etc
   ✓ Reporting of data
What will the standard contain

2. Steady State Data Analysis:
   ✓ Scope
   ✓ Terms
   ✓ General Principles of Data Analysis
   ✓ Input Data, errors, gaps, filtering and checking
   ✓ Measurement uncertainty
   ✓ Statistical Analysis
   ✓ Standard reporting format
What will the standard contain

3. Dynamic data analysis
   - This standard is currently being defined, to be completed in 2019
   - Inputs from IEA A71 are to be used to assist
   - Monitoring periods to be shorter, more flexible to internal and external conditions
   - As yet largely untested compared to SS method.
What will the standard contain

3. Dynamic data analysis
   • Other dynamic methods exist such as QUB, by Saint Gobain, ISABELE by CSTB
   • Expertise will be drawn from the innovators of these systems to suitable method, or a series of methods that are deemed to be appropriate.
How does this fit with Annex 71

- The dynamic aspects of the data analysis may have overlaps although the data collection will be different.
- The aim of the two groups ultimately is the same; to measure the HTC.
- We understand the closeness of the groups and standards writing group for WG13 has approximately 50% of people who are in A71.
How does this fit with Annex 71

- Aside from shared goal of HTC there are other overlaps
- Uncertainty analysis
- Repeatability
- Sensitivity analysis
- Data handling
- Reporting outputs and other useful metrics such as comfort etc