Building Energy Performance Gap: A Way Forward

Building Better Buildings: 50 years of Environmental Design and Engineering at The Bartlett
Building Performance Evaluation – Understanding the Performance Gap
15 February 2016

Esfand Burman
Research Associate, UCL Institute for Environmental Design and Engineering
Outline

• Performance gap: various perspectives

• What BPE projects really tell us?

• The way forward
“SBEM is an energy calculation tool for the purpose of assessing and demonstrating compliance with Building Regulations and to produce Energy Performance Certificates and Building Energy Ratings. Although the data produced by the tool may be of use in the design process, **SBEM is not intended as a building design tool.**”

“The basis on a comparison minimises argument about how well the absolute carbon emissions are predicted by different NCM-compliant methods, because both the proposed and notional buildings are subject to the same calculation approach. Instead it concentrates on achieving improvements compared with the previous regulations.”

Actual vs. ‘design’ comparison: absolute values

Different baselines
(EPC: self-reference modelling
DEC: statistical benchmarking)

Equipment load excluded from EPC rating; included in DEC

Fuel CO₂ conversion factors different

Different scaling factors

Ratings are therefore not directly comparable
And yet, in the absence of robust design predictions, there is a tendency among some practitioners to compare these ratings as ‘proxy’ for the performance gap!

This points to the shortcomings of the existing frameworks and rating schemes to determine the performance gap with reasonable accuracy.
Inspired by the EPBD certification schemes, and reflecting on them, ASHRAE bEQ is an example of design and operational rating schemes developed in tandem.

Source: www.buildingenergyquotient.org
• Generally, there is lack of robust baselines / reference points to measure the true extent of the performance gap

• Very few projects attempt to predict performance in-use. Fewer projects share and publicise this data.

• The outcomes of the Building Regulations compliance calculations and Energy Performance Certificates must be applied with caution!

• These ‘reference’ points neutralise the effect of occupant behaviour by using standardised profiles and assumptions.

• This is understandable in the regulatory context. However, an important part of a building context is lost in this process.

• Building context must be taken into account in the debate about the performance gap.

• The energy performance gap is an ill-defined problem in the UK/EU as there is currently no requirement to verify performance in-use in reference to design predictions in the EPBD.

• We can have insights but the true extent of the gap can only be determined if we move towards performance in-use assessment & verification.
Actual vs. design comparison: how could it work?

- 18 design-phase models for LEED Canada certification
- Subject to partial-calibration post-occupancy
- Adding the unregulated loads
- Revising the process loads
- Weather correction
- Updating a minimal number of other inputs
- The performance gap reduced from 45% to 24%
- In most cases designers’ assumptions significantly under predicted energy (and led to more LEED credits!)

What BPE projects tell us? From BER to total performance

- 30 BPE buildings with EPC data and measured performance
- Building Emission Rate (BER) does not take into account equipment load
- Fuel CO$_2$ conversion factors are also different
- Measured performance is 2-3 times the BER

- Allowance for equipment load (NCM allowance)
- Identical fuel CO$_2$ conversion factors
- Measured performance is around 50% higher than the calculated performance
- Valid if building operation broadly follows the NCM standardised operation of the respective building category
Schools and seasonal buildings pose a particular problem for this type of analysis:

- The standardised profiles used in the National Calculation Methodology assume building is not in use during half-term breaks and school holidays.
- In practice buildings services across the whole building are operational even if only part of the building is used during these periods!
- This combination leads to higher performance gap compared to other building categories.
What BPE projects tell us? Space-time utilisation is key!

- HVAC zoning arrangement
- Poor lighting control

Optimum space-time utilisation is key to approach the NCM calculated performance!
- Heating performance gap lower than electrical performance gap; however, there are significant improvement opportunities.
- NCM calculated performance allows for designed U values and air tightness and therefore can set better performance benchmarks than the benchmarks derived from the existing building stock.
- It is important to include the equipment load in the analysis; NCM heating & cooling loads are dependent on the default equipment load allowed for different activity types. Why exclude this from the analysis?!
BPE buildings with mechanical ventilation show higher energy performance gap than naturally ventilated buildings.

Operational risks of MV systems not fully understood and mitigated at design stages and in-operation!
• Higher specific fan powers than design targets in almost all cases!
• Poor system control (demand-control ventilation not fully enabled)
• Poor maintenance can further increase the energy performance gap and also compromise the indoor air quality.
Buildings that were subject to DSM analysis show higher performance gap than buildings that used SBEM!

Does not necessarily tell us which calculation method is better.

Buildings that used DSM are generally larger and more complex.
The energy performance gap in D&B procured buildings is ‘slightly’ higher than traditionally procured buildings.

However, this analysis is skewed by an outlier!
National Composite Centre

Conclusions

• We do not have robust baselines to determine the performance gap with reasonable accuracy thanks to the existing regulatory framework and lack of data!

• Methods to address this issue:
  - Move towards assessment of total energy performance in-use (e.g. CIBSE TM54 & ASHRAE 90.1 protocols)
  - Allow for a period of fine-tuning after building handover
  - Calibrate the energy performance models with actual operation and determine the performance gap under identical operating conditions
  - Disclose, share and publicise this data and root causes of underperformance

• Who will facilitate this? What are the drivers? Where are the incentives?!

• Innovate UK projects uncovered significant improvement opportunities and point to an urgent need to review the existing frameworks, methods, and tools used to procure ‘low carbon’ buildings.
Thank you for your attention!

Contact: esfandiar.burman.10@ucl.ac.uk