Minimising the Energy Performance Gap (EPG) in Australia's Commercial Buildings

Noni Nuriani
Principal Consultant – Kani Quest Pty Ltd
PhD Candidate UNSW

CIBSE ANZ Seminar Series 2022 – Day 5, 27th of September 2022

n.nuriani@kaniquest.com.au
n.nuriani@unsw.edu.au

What is Energy Performance Gap (EPG)

Do we really deliver on our promise of energy efficient and high performing buildings?

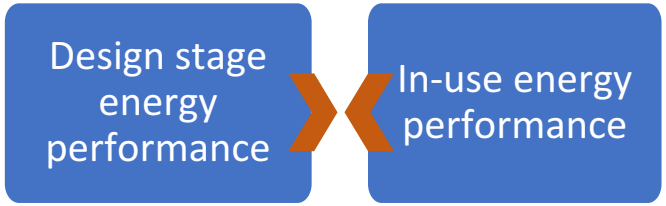
How much of an issue is it in Australia?

How can we minimize it?

Going from Great to Good: Non premium office and other commercial building sectors?

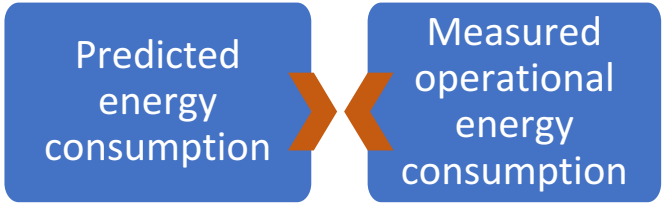
CIBSE KANI QUEST n.nuriani@kaniquest.com.au n.nuriani@unsw.edu.au UNSW SYDNEY

Energy Performance Gap is the gap between:



What are we actually comparing?

Two sets of energy figures:



Scope/ coverage:

What are the coverage of the energy consumption?

Sources of the figures

For the source of the predicted figure, we need to understand:

- The basis of the estimate
- The stage of the project
- Types of energy modelling

Predicted Energy:
Energy Modelling + Manual Calculation

Compliance based

- JV3 modelling
- Green Star energy modelling

are comparative based:

Reference building

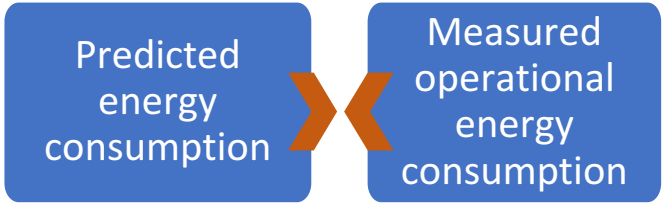
Proposed building

How much is the proposed building energy model, aimed at representing the building in operation?

Performance based

- Carbon Neutral, Net Zero
- NABERS energy modelling
- NABERS energy modelling for Commitment Agreement IDR
- Calibrated NABERS Energy model (after 12-month monitoring)

Two sets of energy figures:



Scope/ coverage:

What are the coverage of the energy consumption?

Sources of the figures

For the source for the predicted figure, we need to understand:

- The basis of the estimate
- The stage of the project
- Types of energy modelling

For the source of measured operational energy:

- Monthly/Quarterly bill(s) – only one incoming? Or several bills? where these bills sit on the SLD? – tenants, BB, specific area or equipment?
- Do we have non-utility sub-metering?
- Quality of the Energy Metering System (EMS)

Energy Metering System

Energy Coverage

- Aligned with allocation of responsibilities set in the benchmarking tool (NABERS): e.g. base building rating, tenant rating or whole building rating.
- Aligned with the grouping of energy end-uses from the energy modelling report.
- Separation between energy end uses by centralized services for building infrastructure operations (Base Building) and energy due to activities (tenant's lighting and power, process equipment, hospital equipment.
- Impact of the unpredictability of tenant equipment can be minimized if tenant equipment is separately metered

Granularity

ENERGY END USE	ENERGY SOURCE
Cooling (kWh)	Electricity
Heating - gas (MJ)	Gas
Heating - electricity (kWh)	Electricity
Fan (kWh)	Electricity
Pumps (kWh)	Electricity
Heat rejections (kWh)	Electricity
Tenant heat rejections (kWh)	Electricity
Misc. ventilation (kWh)	Electricity
Base building lighting (kWh)	Electricity
External lighting (kWh)	Electricity
Vertical transport (kWh)	Electricity
Domestic hot water (MJ)	Gas
Hot water circulators (kWh)	Electricity
Cold water pumps (kWh)	Electricity
Communication equipment (kWh)	Electricity
Fire protection (kWh)	Electricity
Fire Protection (L)	Diesel
Standby generator (L)	Diesel
Standby generator (kWh)	Electricity
Photovoltaic (kWh)	Electricity

Energy Metering System

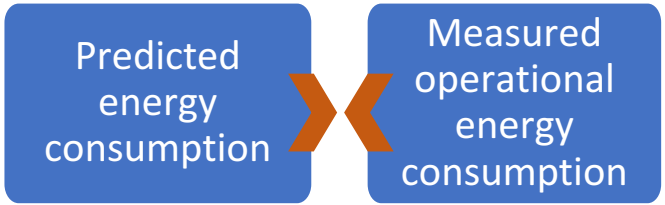
Calibrated and Validated

- As per the NABERS Rules Metering and Consumption
  - The physical meters are validated
    - CT meters: meter multipliers to match CT ratios
    - No CT meter wiring issues
  - The remote meter reading system is validated
- (plus sum of all downstream meter corresponds with the upstream meter above them. No un-metered CBs to allow for summation check)

Monitored

- Continuous benchmarking and monitoring of energy consumption

Two sets of energy figures:



Scope/ coverage:
What are the coverage of the energy consumption?

Sources of the figures

For the source for the predicted figure, we need to understand:

- The **basis** of the estimate
- The stage of the project
- Types of energy modelling

For the source of measured operational energy:

- Monthly/Quarterly bill(s) – only one incoming? Or several bills? where these bills sit on the SLD? – or equipment?
- -metering?
- ering System (EMS)

How about changes in operational parameters?

Operational Paramaters

- Additional floors maybe added or reduced due to fitouts
- Buildings maybe utilized more than previously predicted
- Tenants may require central services during after hours and weekends

NABERS rating parameters:
rated hours, rated NLA,
provides sets of new threshold/
max energy consumption

Scenarios in Energy Modelling

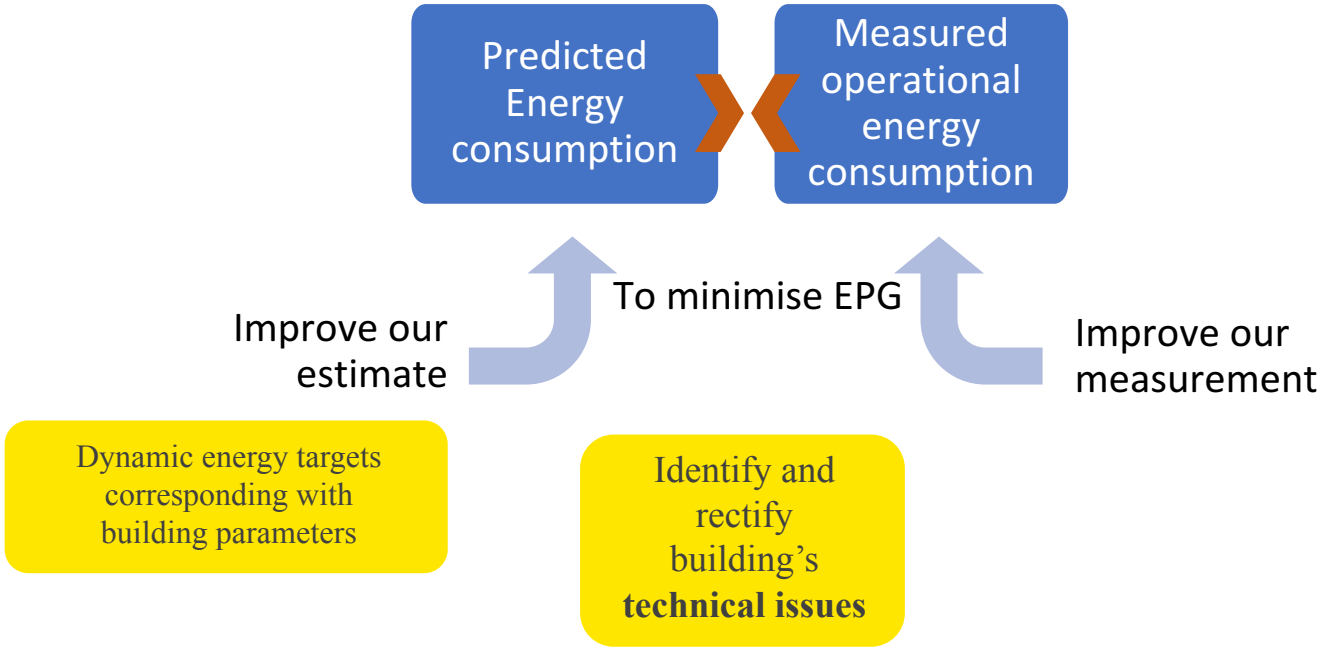
- Energy modelling needs to generate various scenarios of operation (e.g., 75% leased, 50% leased, 60 hours/wk) for monitoring
- (in addition to off axis scenarios)

Building Management System

BMS/ building logs to record building parameters affecting building energy:

- Building and spaces operating hours
- Conditioned area of actual building in operation
- Occupancy density
- Outside air requirement
- Lighting density
- Equipment heat load density
- Achieved internal temperature of conditioned spaces

Energy Performance Gap is the gap between:



Issues causing EPG

Design Stage

- Design details are left unspecified (Difficulty in completing information collection)
- Energy modelers were not engaged in the construction and commissioning process to update and develop an operational energy model
- Inefficient or oversized systems
- Lack of communication within the design team (design teams working in silos)
- Energy modeling software issues
- Inappropriate modeling techniques and assumptions
- Limited understanding of building operational stage (including expectation on occupant and their behaviors)
- Energy Metering Systems are not set up properly (meter calibration issues, no separation between base building and tenant uses, inadequate sub-metering by energy end-uses)

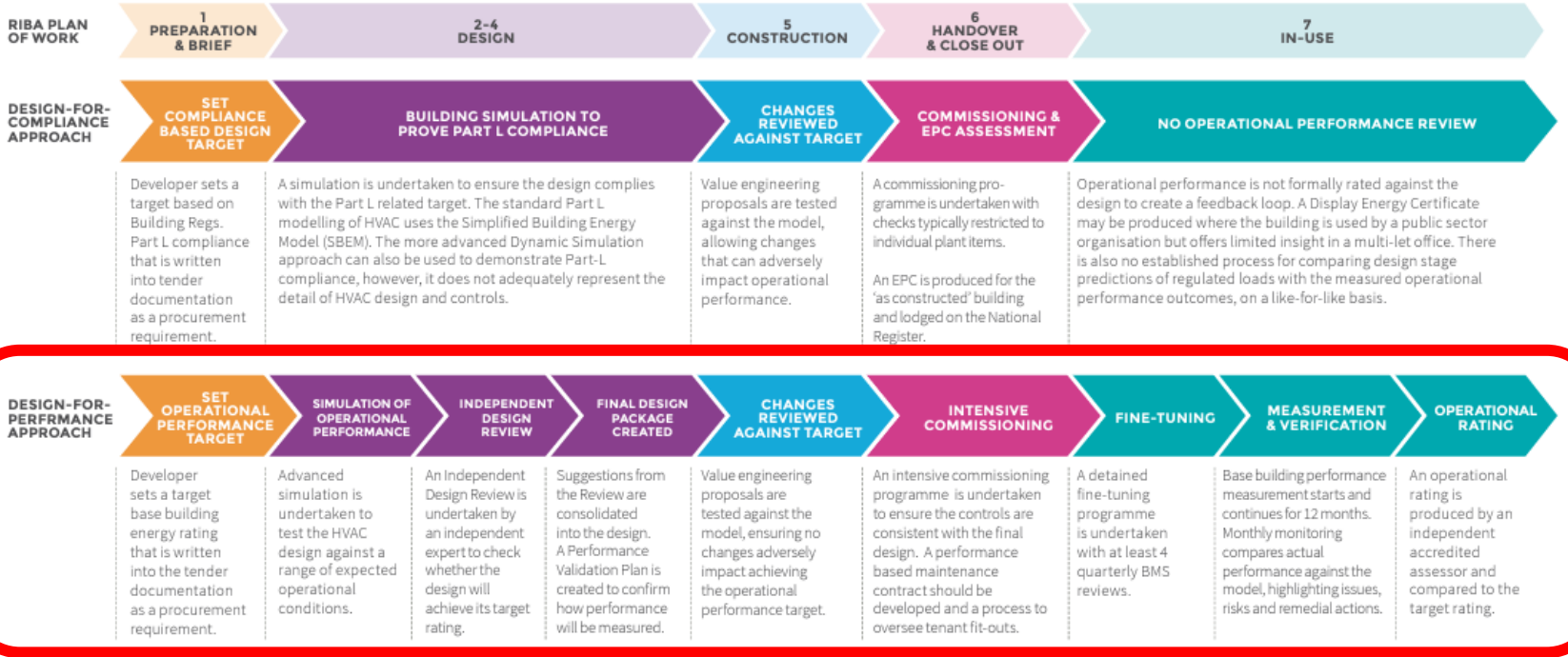
Construction stage

- Change orders
- Poor workmanship
- Improper construction techniques, poor sequencing
- Lack of attention to buildability and simplicity of construction)

If the UK is to mirror the NABERS Commitment Agreement framework, a new approach to the design and delivery of office buildings is needed. One that moves away from the current design-for-compliance approach to one that embraces a design-for-performance approach.

Figure 3 below summarises what a design-for-performance approach would involve compared to the current design-for-compliance approach, set against the stages of the RIBA Plan of Work.

Figure 3 A comparison of the key elements of a design-for-performance approach to the current design-for-compliance approach, set against the stages of the RIBA Plan of Work.



Set target

Simulate

Review

Adjust

Re-simulate

Change: Re-simulate

Do intensive Commissioning

Fine tune

12 month-monitoring

EPG – International and Australia

International look:

- Turner (2008): 112 LEED New Construction (NC) buildings analysed, over half deviated by more than **25%** from design projections in terms of energy use intensity
- UK's Carbon Buzz (2012): on average, buildings consume between **1.5 and 2.5 times** their predicted energy use.
- The UK's Innovation agency (2016): 50 leading edge-nondomestic buildings analysed, on average consumed **3.6 times higher** energy compared to their design estimate.
- Van Dronkelaar et al. (2016): 62 buildings, the average discrepancy between compliance and performance modelling is **more than 34%.**

In Australia:

- **88.1%** of the Green Star-rated office buildings in the sample achieved their NABERS rating or were within 0.5 stars. (GBCA 2021).
- **93%** of NABERS CA buildings achieved their target ratings.
- EPG has been narrowed in premium office buildings in Australia. However, this represents just **14% of** commercial office sectors.

Can we replicate best practice measures the industry has been doing in the premium office sectors, to non-premium office buildings and the rest of the commercial building sectors?

What we know so far

Premium Office Buildings

- Designed to have a clear demarcation of energy consumption responsibility between base building and tenant. Unpredictability of tenant impact is minimized and managed
- Widespread use of detailed dynamic energy modelling to guide design decisions, followed by minimum 12-month energy benchmarking during
- Independent Design Review (IDR) identifies risks to operational performance.

Non-premium Office and the Rest of Commercial Building Types

- Higher portion of tenant and process loads
- Less installation of non-utility energy sub-metering
- New buildings rarely required to achieve an operational energy performance.
- Tenant could be managing the whole building.
- Less driver to manage buildings efficiently: Process focused
- NO MANDATORY DISCLOSURE of operational performance
- Less operational experience in managing energy efficiency performance
- Less energy modelling experience

CIBSE KANI QUEST n.nuriani@kaniquest.com.au n.nuriani@unsw.edu.au UNSW SYDNEY

EPG – Further Research

How widespread is the use of energy modelling to achieve operational performance, across various building types? What drives the modelling works? Policies, corporate strategies?

For design team energy modeller

- How much experience we have in the industry in predicting energy performance of various commercial buildings?
- What are the most challenging aspects in predicting energy consumption?
- How much operational experience energy modellers have?

JOIN THE EPG Research!!

For operational team:

- What are the challenges in achieving energy performance target in non-premium office building and the rest of the commercial building sectors?
- How often they occur in managing the operational energy performance?

CIBSE KANI QUEST n.nuriani@kaniquest.com.au n.nuriani@unsw.edu.au UNSW SYDNEY

JOIN THE EPG Research!!

- We need to document the industry's voice to drive changes.
- We need to know the area we are still lacking so that we can prioritise area for improvement
- We need to create feedback loop where lessons from completed projects can be shared across the industry

Interest to:

- Fill the survey
- Have buildings for case studies
- Interviews/ Focus group meeting

CIBSE KANI QUEST n.nuriani@kaniquest.com.au n.nuriani@unsw.edu.au UNSW SYDNEY

UNSW SYDNEY | Australia's Global University

Faculty of Arts, Design & Architecture
School of Built Environment

Invitation to Survey on Energy Performance Gap in Australia's commercial building sector

- Research team: Noni Nuriani (PhD Candidate)
  Associate Professor Philip Oldfield
  Professor Deo Prasad
  PC Thomas (Team Catalyst)

- For further information, contact: n.nuriani@unsw.edu.au

- The next step of this research involves case study analysis of commercial buildings with interviews/ focus groups.
- Members of design team and operational team of completed projects are encouraged to reach out.