

UK trends in improving building performance to achieve net-zero carbon

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Associate





- Building performance analyst – specialising in energy analysis and occupant surveys of non-domestic buildings
- Runs the MSc Post-Occupancy Evaluation (POE) module at UCL IEDE
- Co-author of the *Soft Landings Framework* (2014)
- Author of *CIBSE TM62 (2020): Operational Performance - Surveying Occupant Satisfaction*
- Author of the *Operational Energy and Carbon Reporting Framework* (2021)
<https://constructioninnovationhub.org.uk/news/new-energy-and-carbon-reporting-framework/>
- Co-Author of BCO report *The Future of UK Office Densities* (Sept 2022)
- Co-author of BCO report *Operational and Embodied Net-Zero Carbon in the Workplace* (in progress – due December 2022)

A talk in four parts

1. Introduction to UK construction industry net-zero ambitions*
2. Challenges to achieving those ambitions
3. The future for post-occupancy evaluation and operational energy tracking
4. Achieving net-zero while protecting occupant comfort – can it be done?

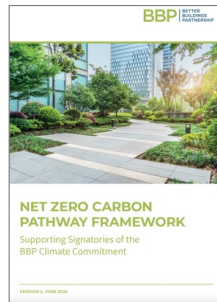
Some conclusions and concerns

**NB: I'm not talking about Nabers UK – new and unproven in UK, and base-build offices only at present*

UK Greenhouse gas emissions from buildings

- Non-domestic buildings in the UK account for 12% of greenhouse gas emissions (17% of UK energy consumption)
- Residential buildings account for 23% of greenhouse gas emissions
- Overall the built environment contributes around 40% of the UK's total carbon footprint
- 1-2% of the UK building stock is replaced each year. Therefore 80% of the buildings that will exist in 2050 have already been built
- Retrofit of the existing building stock is now the name of the game
- **What construction professionals have got used to is maybe not what they're entitled to**

No shortage of net-zero guidance and reports




UKGBC Net-zero energy performance targets for all offices (2019)

Table 1: Energy performance targets for buildings targeting net zero carbon for operational energy

Scope	Metric	Interim Targets			Paris Proof Target
		2020-2025	2025-2030	2030-2035	2035-2050
Whole building energy	kWh _e /m ² (NLA) / year	160	115	90	70
	kWh _e /m ² (GIA) / year	130	90	70	55
	DEC rating	D90	C65	B50	B40
Base building energy	kWh _e /m ² (NLA) / year	90	70	55	35
	kWh _e /m ² (GIA) / year	70	55	45	30
	NABERS UK star rating	4.5	5	5.5	6
Tenant energy	kWh _e /m ² (NLA) / year	70	45	35	35

NLA = net lettable area

GIA = gross internal area



Hardly stretching

RIBA 2030 Climate Challenge: non-domestic building targets

RIBA sustainable outcome metrics	Current benchmarks	2020 Targets	2025 Targets	2030 Targets	Notes
Operational energy	225 kWh/m ² per annum DEC D rating (CIBSE <i>TM46</i> benchmark)	< 170 kWh/m ² per annum DEC C rating	< 110 kWh/m ² per annum DEC B rating	< 0 to 55 kWh/m ² per annum DEC A rating	UKGBC Net Zero Framework 1. Fabric First 2. Efficient services, and low-carbon heat 3. Maximise onsite renewables 4. Minimum offsetting using UK schemes
Embodied carbon	1100 kgCO ₂ e/m ² (M4i benchmark)	< 800 kgCO ₂ e/m ²	< 650 kgCO ₂ e/m ²	< 500 kgCO ₂ e/m ²	RICS Whole Life Carbon (A-C exc. B6, B7) 1. Whole life carbon analysis 2. Using circular economy strategies 3. Minimum offsetting using UK schemes
Potable water use	> 16 litres per person/day (CIRIA <i>W11</i> benchmark)	< 16 litres per person/day	< 13 litres per person/day	< 10 litres per person/day	Using CIBSE <i>Guide G</i>

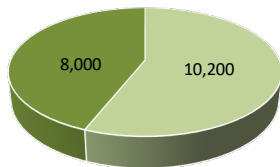
Best practice health metrics	Values	References
Overheating	25-28°C maximum for 1% of occupied hours	<i>CIBSE TM52, CIBSE TM59</i>
Daylighting	≥2% average daylight factor, 0.4 uniformity	<i>CIBSE LG10</i>
CO ₂ levels	<900 ppm	<i>CIBSE TM40</i>
Total VOCs	<0.3 mg/m ³	<i>Approved Document F</i>
Formaldehyde	<0.1 mg/m ³	BREEM

RIBA Whole-life carbon targets for a typical office

Notional 10,000 m² GIA building and 30 year life span using 0.2 electricity carbon factor

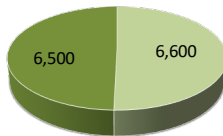
- Operational tCO₂ emissions
- Embodied tCO₂ emissions

RIBA 2020 target



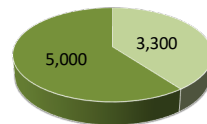
Total whole-life carbon:
18,200 tonnes CO₂

RIBA 2025 target



Total whole-life carbon:
13,100 tonnes CO₂

RIBA 2030 target



Total whole-life carbon:
8300 tonnes CO₂

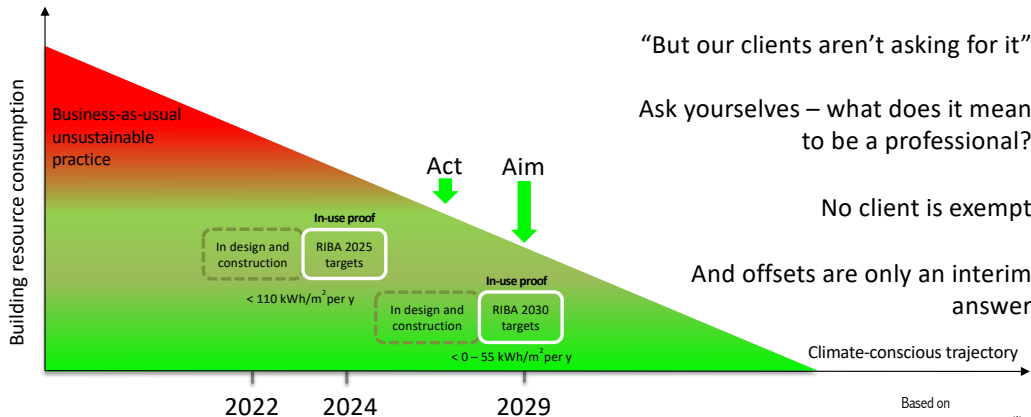
46% cut

A talk in four parts

1. Introduction to UK construction industry net-zero ambitions
2. **Challenges to achieving those ambitions**
3. The future for post-occupancy evaluation and operational energy tracking
4. Achieving net-zero while protecting occupant comfort – can it be done?

Some conclusions and concerns

RIBA 2030 climate challenge trajectory – operational



“But our clients aren’t asking for it”

Ask yourselves – what does it mean to be a professional?

No client is exempt

And offsets are only an interim answer

A building needs at least a year in operation before you should measure and judge anything

Based on

ARB requirements, 2021

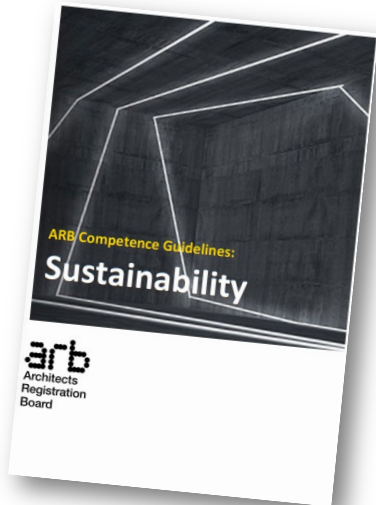
Competence guidelines on sustainable practice

A. ETHICS AND PROFESSIONALISM

C. ENVIRONMENTAL & BUILDING PHYSICS

You should:

- SC1. Understand the environmental science relating to temperature, humidity, sound and lighting
- SC2. Understand the principles of human comfort and indoor air quality in relation to energy use
- SC3. Be able to calculate predicted operational and embodied energy use and carbon emissions
- SC4. Be able to carry out Post Occupancy Evaluations / Building Performance Evaluations to understand performance gaps and inform future projects



New research coming on net-zero uptake in UK offices

Funded by the British Council for Offices (BCO), conducted by UCL

Delivering Net Zero Carbon in the Workplace

Thank you for your participation in this survey!

This survey is carried out by UCL Consultants (UCLC) for The British Council for Offices (BCO).

Achieving Net Zero carbon emissions is now featuring as a key component of Environmental and Social Governance (ESG) in the commercial real estate sector.

Tackling Net Zero carbon will be a challenge facing the built environment over the next few decades. With buildings accounting for 40% of carbon emissions, real estate and workplace teams have a critical role to play in the transition to a Net Zero carbon economy.

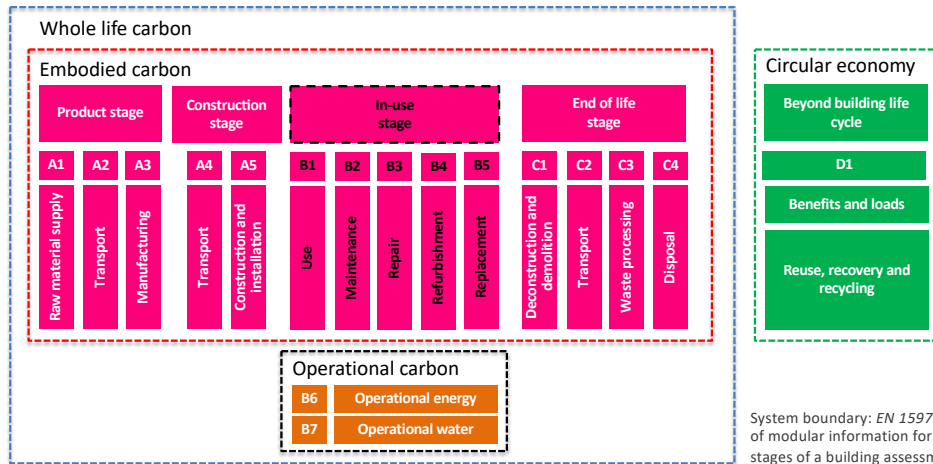
The aim of this survey is to seek feedback from you to examine where the opportunities lie and how organisations can navigate the demands of regulators and other stakeholders, as well as identifying the barriers that businesses face as they strive to pursue a path to Net Zero carbon emissions in the commercial real estate sector.

1. Market analysis by UCL Consultants
2. Review of institutional, commercial, and academic guidance and literature
3. Interviews with key property owners, developers and designers
4. Industry survey of owners and occupiers

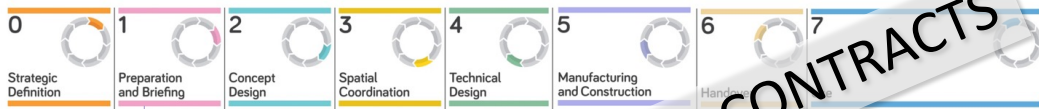
Report publication ~December 2022

People think their own company is doing OK, but the property and construction industry is not

LETI map of whole-life carbon and embodied carbon, 2021



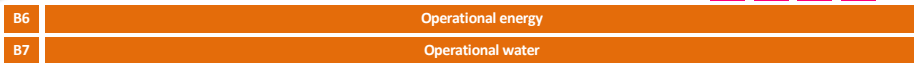
2020 RIBA Plan of Work



2018 Government Soft Landings



2021 LETI embodied carbon stages



NEEDS TO BE BOLTED INTO ALL CONTRACTS

What about Government....?



- **Tangible progress is lagging the policy ambition.** With an emissions path set for the UK and the Net Zero Strategy published, greater emphasis and focus must be placed on delivery.



Jacob Rees-Mogg
Secretary of State for Business
Sept 7, 2022

“We need to be thinking about exploiting every last cubic inch of gas from the North Sea. We are not going for net zero tomorrow – 2050 is a long way off.”

Jacob Rees-Mogg, April 2022



If not sorted out, the Performance Credibility Gap will persist

The 'Performance Gap' describes differences found between design predictions and outturn performance measured in a POE

- Design shortcomings, but also in construction decisions that compromise design efficiencies, poor commissioning of systems, and deficiencies in building management practices
- Consequently, gaps of three times the design expectations (usually expressed in operational energy and CO₂) found in year 1, but up to 10x found in some studies
- Reticence to conduct POE due to insurance, cost, and professional risk reasons
- UK *Building Regulations* on energy conservation lagging way behind

A talk in four parts

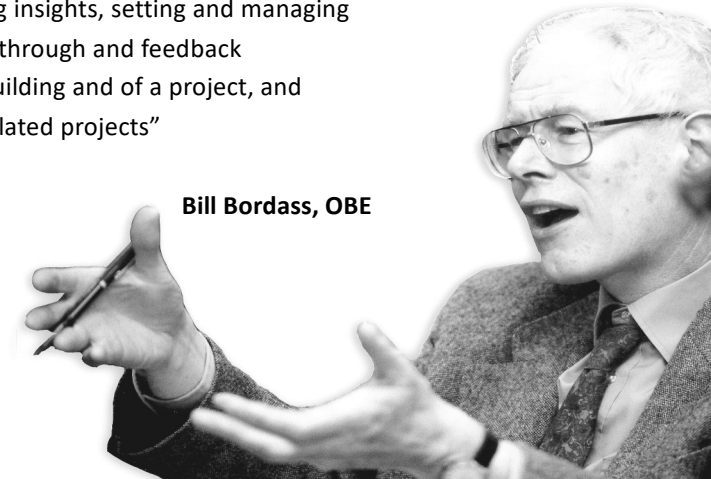
1. Introduction to UK construction industry net-zero ambitions
2. Challenges to achieving net-zero ambitions
 - Lack of consistency between institutional net-zero guidance
 - Almost total lack of central government leadership beyond broad targets
 - Unambitious UK *Building Regulations*
 - Outturn performance historically below ambitions and expectations
 - Contracts, budgets, and programmes largely still business-as-usual

A talk in four parts

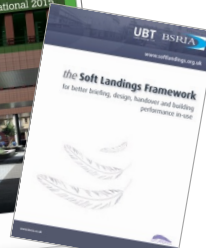
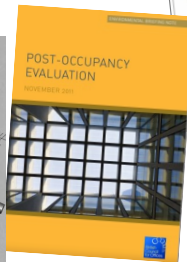
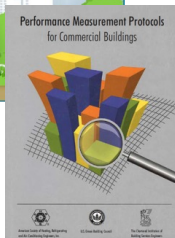
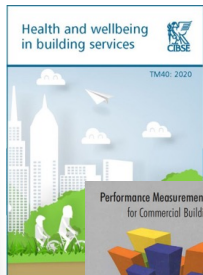
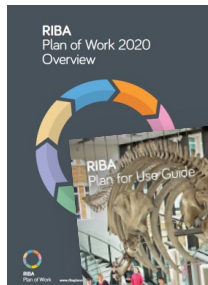
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“POE should be part of a continuous improvement process....a broad framework of developing insights, setting and managing expectations, providing follow-through and feedback throughout the lifecycle of a building and of a project, and informing and learning from related projects”

Bill Bordass, OBE

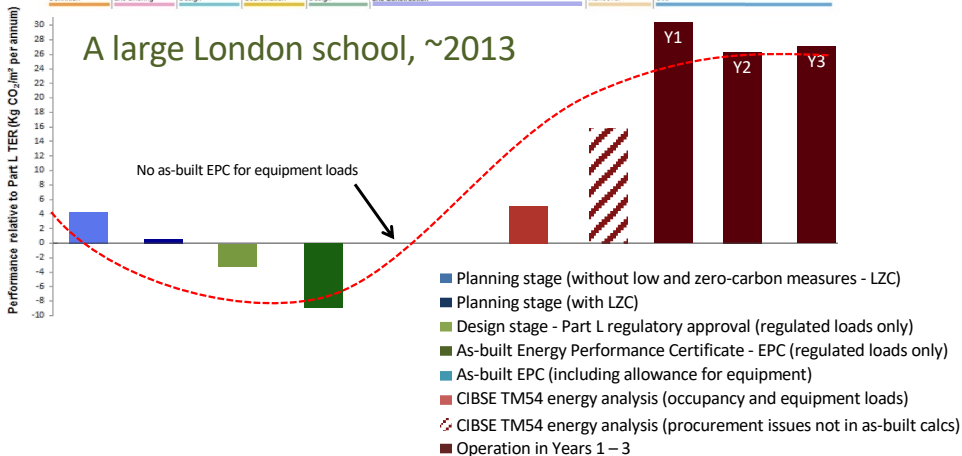


BPE and POE advice is everywhere



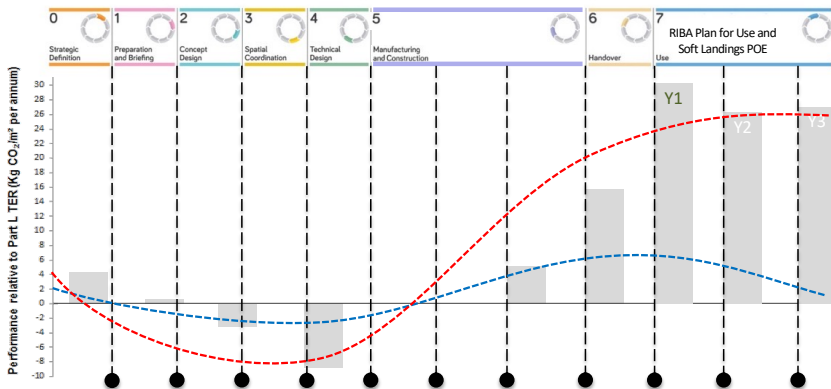


A large London school, ~2013



The big question Can we visualise the gap to control it?

Verifiable proof of likely performance outcomes required...

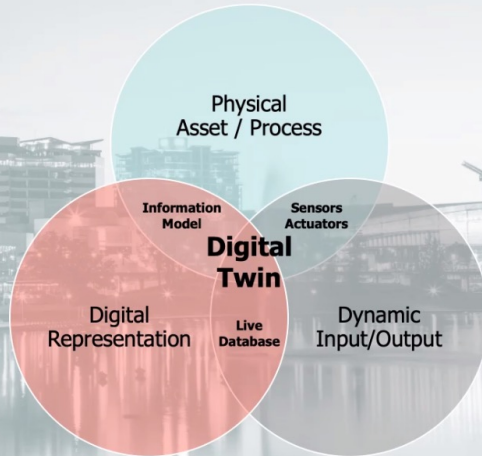


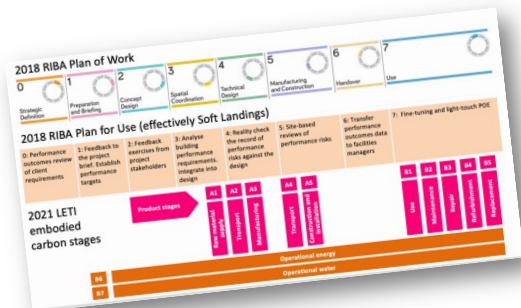
Data drops with validated evidence (BIM Net-Zero Digital Twin) Performance probability penalties can apply at each gateway

What is a Digital Twin?

digital twin

realistic digital representation of assets, processes or systems in the built or natural environment
[SOURCE: Gemini Principles]



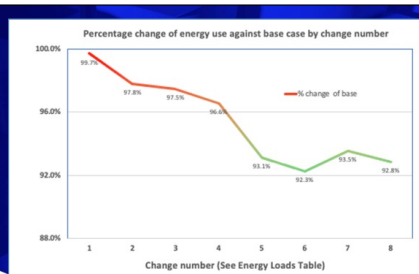
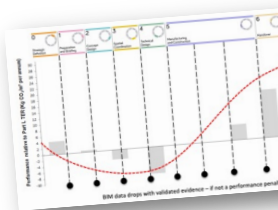


But what value is a POE if construction team members work to different agendas?

It just becomes a post-mortem

A common framework with shared responsibilities is needed to effect improvement

Devising universal data-drop procedures



Energy and Carbon Reporting Framework

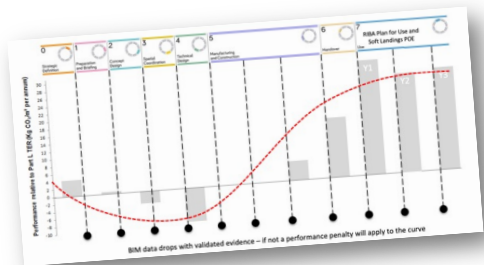
Operational Energy and Carbon Information Exchanges for Government Soft Landings

October 2021

www.cdbb.cam.ac.uk/news/new-energy-and-carbon-reporting-framework

Visualising operational energy and emissions using S-curve trajectories

A prototype project visualisation tool



Jamie Bull MSc MRes

Roderic Bunn BA (Hons) EngD

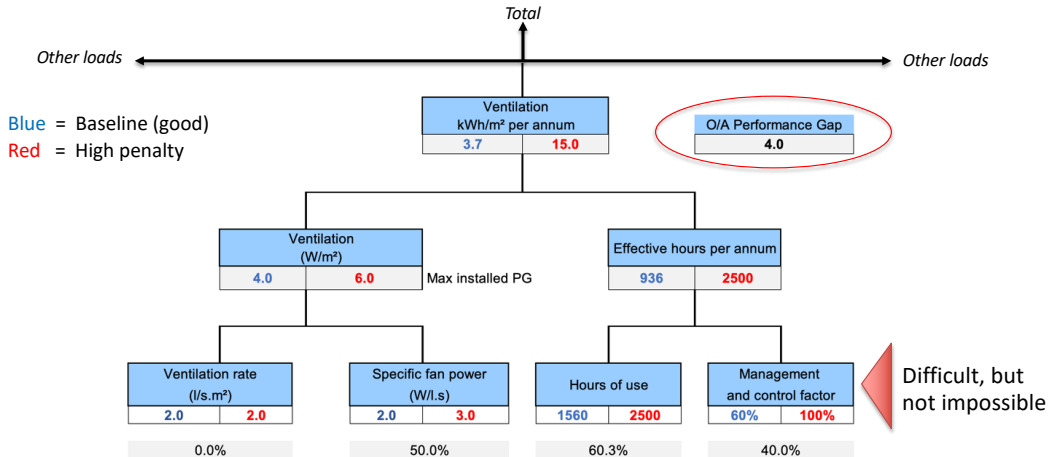
Esfandiar Burman EngD MCIBSE MASHRAE

John Field CEng FCIBSE MEI MINSTP

Paper in BSER&T Special Issue, Summer 2023

Project funded by

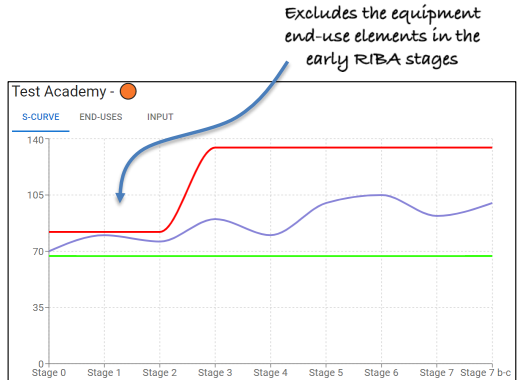
Example performance gap factors: powered ventilation



The prototype operational energy visualisation (work in progress)

Three visualisation curves

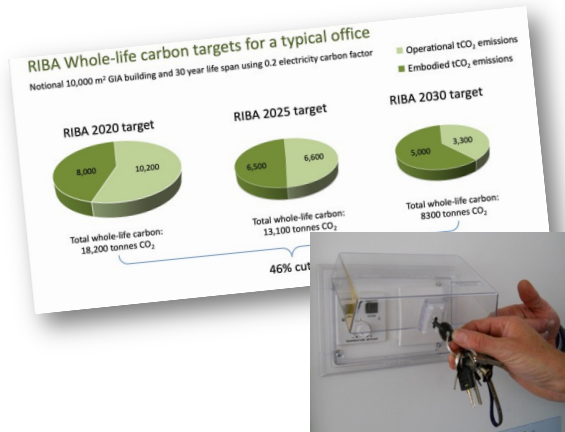
- A **Target Curve** represents sector best practice (initially schools and offices)
- A **High Risk Curve** based on the Target Curve multiplied by performance gap factors
- A **Project S-Curve** Based on the Target Curve, multiplied by the performance gap factors, with a user's QA'd input data and evidence overriding the calculated values and reducing the performance gap multipliers



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Buildings are for people not for MEP efficiency



We have to achieve net-zero carbon while ensuring occupants remain comfortable, healthy, and productive

The two objectives can be in mutual support, but in conflict where system optimisation is placed before human need

Think energy sufficiency rather than maximised efficiency

Plan to avoid health-related unintended consequences by

- Reviewing appropriate standards and promoting adaptive comfort
- Controlling draughts, air movement, and radiant heat gains and losses
- Considering local and personal heating and cooling systems
- Having accessible responsive and user-friendly controls
- Where possible, adding thermal refuges, both hot and cold, local and communal
- (Occupants also need to wear the right clothing and have suitable furniture)

Courtesy Bill Bordass 'Beyond Heating and Cooling', Climate at the Extremes Conference, Edinburgh, 2022 (get via www.usablebuildings.co.uk)

Occupants as measuring devices

Benefits

- There are many of us – far more than you have instruments – and we are spatially distributed
- We are walking, talking, multi-sensory devices
- We are intelligent, and we can be interrogated

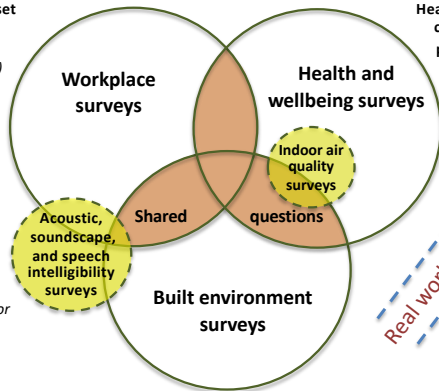
Limitations

- We are impressionable, contrary, opinionated, and physiologically and emotionally diverse
- We are somewhat loosely calibrated



End-user surveys need to become the norm to inform net-zero decisions

Interior designers, space planners, asset managers, workplace psychologists
(Organisation and work culture, interior architecture, space planning)



Specialist surveys
(Often difficult and/or invasive)

Health professionals of various kinds: clinicians, chemists, behavioural psychologists, academic medics
(human studies: dry eyes, stuffy noses and sore throats)

Real world credibility gap

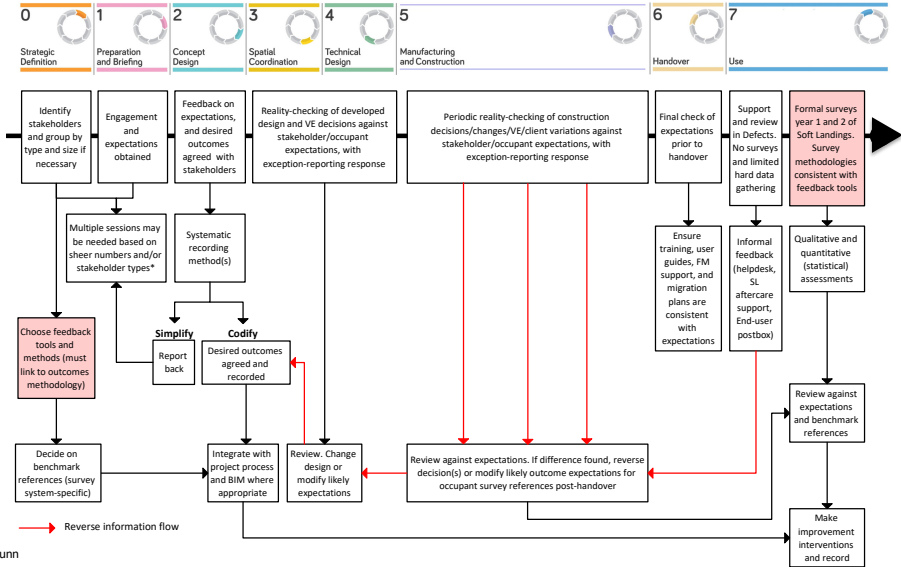
Academics and research scientists

Physiological and cognitive tests under different conditions

Construction professionals, building physicists, facilities managers
(Thermal comfort, lighting, ventilation, acoustics)

Surveys conducted in climate chambers
(Human response to temperature, RH, CO₂ & concentrations of volatile organic compounds)

A flowchart for managing expectations in net-zero procurement



A talk in four parts

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4. Driving down energy use while protecting occupant comfort – can it be done?

Some conclusions and concerns

BUT Architecture Awards still resisting proof of performance

Entries are open

Deadline extended
21 September

Architecture Today Awards 2022

Buildings that stand the test of time

With 3 weeks to enter the *Architecture Today Awards*, we answer your questions on the entry requirements.

Do I need a Post Occupant Evaluation (POE) to enter?

Absolutely not! We would like to stress that post-occupancy evaluation data is NOT a prerequisite for entry. While a key driver behind these awards was the desire to reflect – and to celebrate – changes in the way we understand architectural value and the concurrent focus on long-term performance, we are all too aware that POE has only become widespread practice in the last few years, and that it would be unreasonable, unrealistic and unwise to expect it to be available for buildings completed some years ago. Where appropriate, shortlisted schemes will have an opportunity to bolster their presentations with anecdotal or quantitative feedback at the live presentations on 7 November.

Persistent credibility gap

CIBSE BUILDING PERFORMANCE AWARDS 2023

ENTER NOW

Entry deadline
Wednesday 14 September 2022

How can you write a winning entry for the CIBSE Building Performance Awards 2023?

Here are the five top tips from our judges:

1 - Start early

If you enter before the deadline your entry can be reviewed allowing us to flag up any further requirements prior to judging day

2 - Provide evidence of user satisfaction

How did you meet and exceed client expectations?

3 - Include measured data

Quantify, quantify, quantify

4 - Sell the people/project/product

What is the biggest achievement or unique selling point? Bring out the winning points.

5 - Include supporting photos

Think about which images bring your entry to life

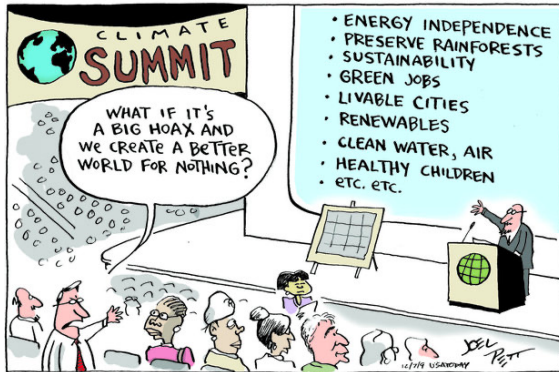
What will hold back the industry from achieving net-zero in practice is not dishonesty or wilful deception, but 'business as usual' motivations

If people don't have to do it, they won't do it

Therefore:

Regulatory certification on performance outcomes





“No industry that owns capital equipment of a similar cost to buildings could survive unless it had more data on performance”

Thomas Markus
Strathclyde University
Building Performance, 1972



Contact me for further information. PDF available.

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