University College London
22 January 2026

Building Performance Evaluation AND Post-Occupancy Evaluation

PAST, PRESENT AND FUTURE

Bill Bordass

USABLE BUILDINGS
www.usablebuildings.co.uk

OUTLINE

1. Building performance in use: *The great unknown?*
2. Some strategic lessons from BPE and POE
3. Why aren't we better tuned in to outcomes?
4. Implications for professional practice
5. The value routine POE can bring
6. Case Study – Feeding forward between projects

PART 1

BUILDING PERFORMANCE IN USE:
THE GREAT UNKNOWN?

Better building performance in use is in the public interest

- Buildings last a long time, well beyond the time horizons of their creators, with many players involved in different roles.
- As building users, the whole population has an interest in buildings and the built environment working better in every respect.

- **Now we want to improve the performance of the new, and particularly the existing stock,** *especially (but by no means only) in terms of energy and carbon.* ***BUT …***
- feedback loops from performance in use to design, building and policymaking are poorly closed, *a disastrous oversight.*

SO DO WE REALLY UNDERSTAND WHAT WE ARE DOING?

Post-Occupancy Evaluation
or Building Performance Evaluation?

Post-Occupancy Evaluation

- Exposes a construction industry perspective,
  with handover seen as the end, not the beginning!
- Too often regarded as academic and mostly about perceptions
  in fact, multiple methods, combining "soft" and "hard" data, can often lead to more valuable insights.

Building Performance Evaluation

- *A more general term.*
- *It can cover any type of investigation, at any depth, at any time.*

I and colleagues now prefer to restrict the POE term to:

Packages of BPE activities that are well-integrated into a client, design + building team's work programmes for procuring or changing a building.

Getting building teams started on POE:
it's not that difficult !

Adopt a drill-down approach where practicable:

1. BASIC: *the wet finger*
2. INTERMEDIATE: *get some useful data*
3. ADVANCED: *deeper investigation.*

None is academic research in the traditional sense: *I call that Level 4.*

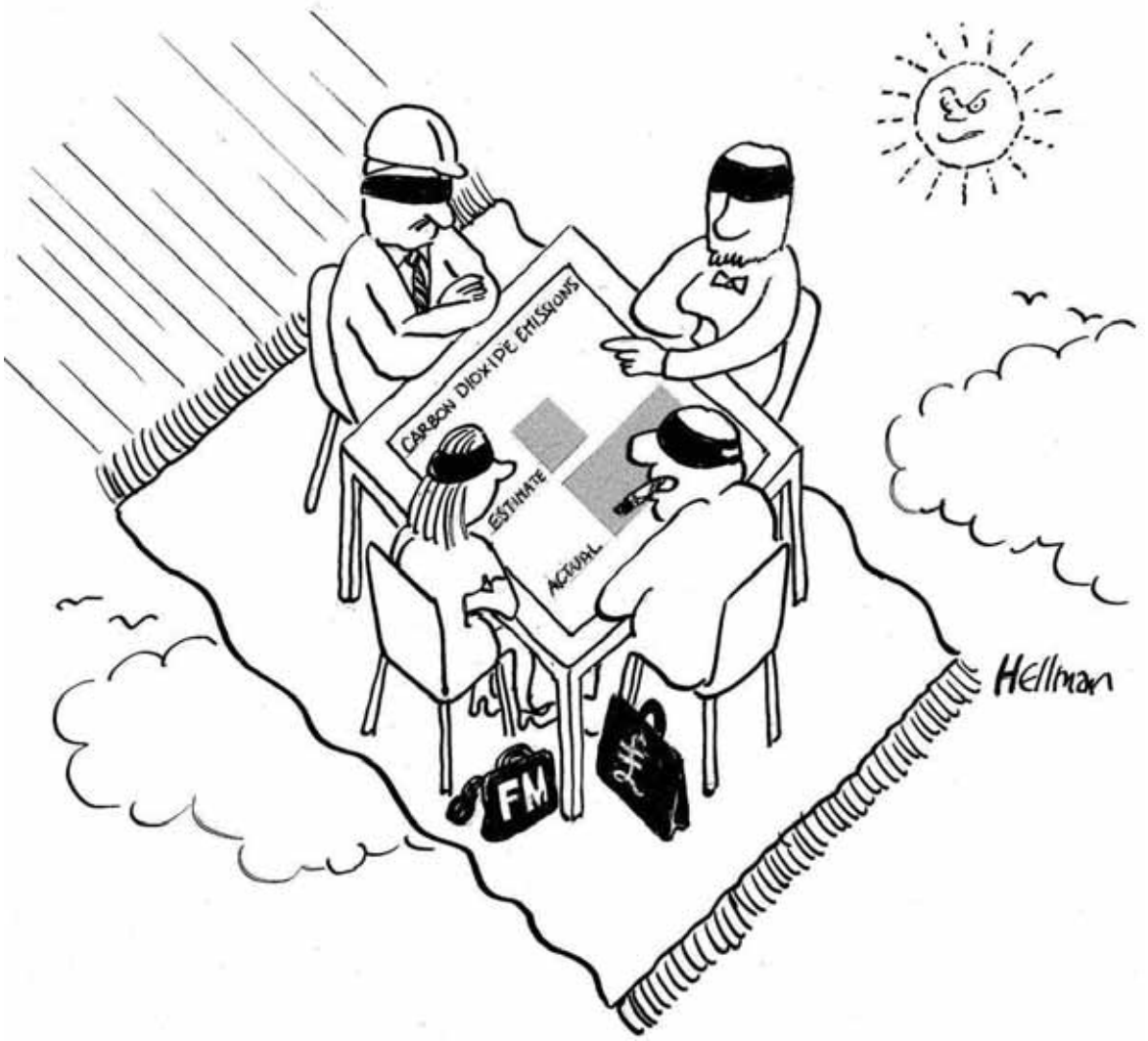
Use mixed methods, combining qualitative and quantitative approaches.
***The stories are often the more powerful**, but need backing up by data.*

Ideally, work should be both:

- ***Separated*** from the client, design and building team:
  this helps provide objectivity and a wider view.
  It can involve a mentor, consultants, or academic input.
- ***Connected**,* so the individuals directly involved in a building project to learn through personal experience and take this back into their organisations and to the wider world.

SOURCE: The three-level classification follow that in the ASHRAE *Performance Measurement Protocols* Guide (2010).

But 25 years after I commissioned this, *many players remain ignorant of the true outcomes of their projects*



SOURCE: by Louis Hellman for cover of W Bordass, *Flying Blind,* Association for the Conservation of Energy, London, (2001).

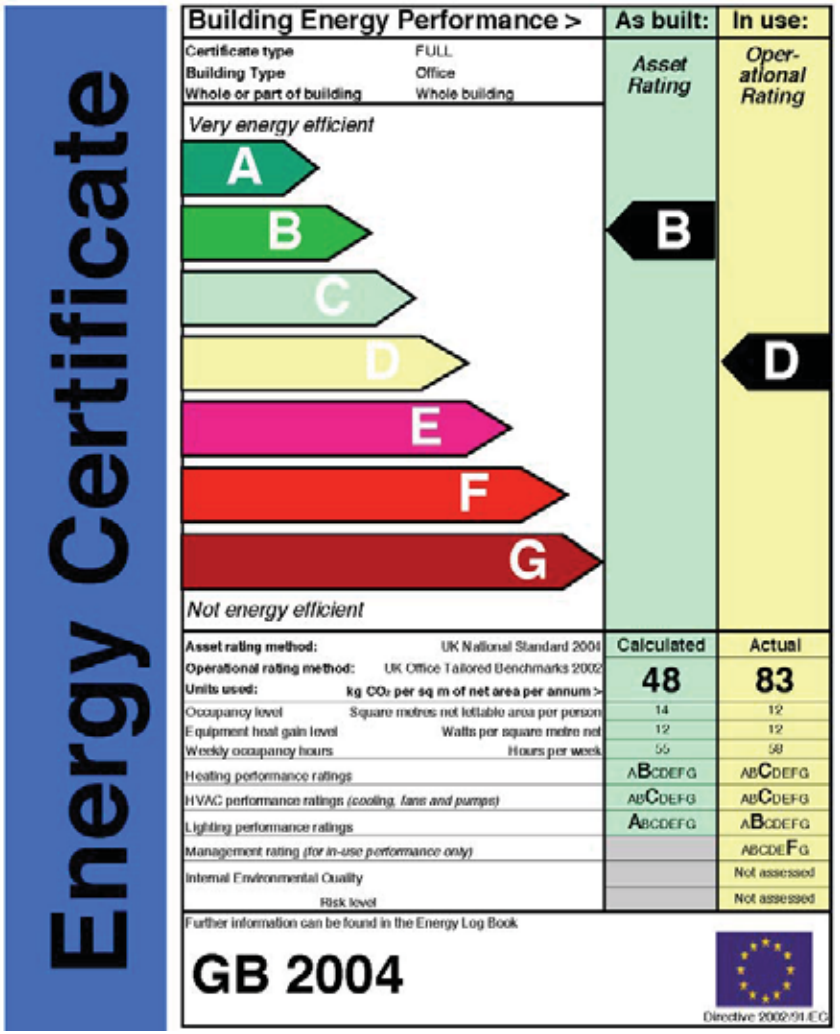
It might have been very different
had government taken energy certificates seriously

Ambitions of Europrosper research project 2000-04:

Display energy certificates based on actual energy use, not theoretical.
Achieved for public buildings only, but not supported.

Transparency between design expectations and in-use performance outcomes.
Not supported.

Multiple performance indicators
But benchmarking not supported.



B Bordass et al, *Energy Performance of Non-Domestic Buildings: Closing the Credibility Gap,* IEECB (2004). See usablebuildings.co.uk

Academics and policymakers often ignore Case Studies, *saying they are anecdotal:* ***THEY ARE NOT!***

FIVE MISUNDERSTANDINGS *(after Flyvbjerg)*

1. General knowledge is better than context-specific knowledge.
   WRONG: *They complement each other.*
2. You can't begin to generalise from a single case.
   WRONG: *Individual cases and outliers can be bellwethers.*
3. They might help you make hypotheses, but other methods are better for hypothesis-testing and theory-building.
   WRONG: *They can also test hypotheses, using multiple methods.*
4. They have a bias to confirming the investigator's bias.
   NOT REALLY: *They often provide new and richer insights,*
   BUT *they need to be done with a degree of independence.*
5. They do not let one develop general propositions and theories.
   BUT: *They do help us develop coherent strategies for the future.*

Why do people so often ignore advance warning signals - the dead canary in the coal mine? **SEEKING MORE DATA IS TOO OFTEN A DELAYING TACTIC.**

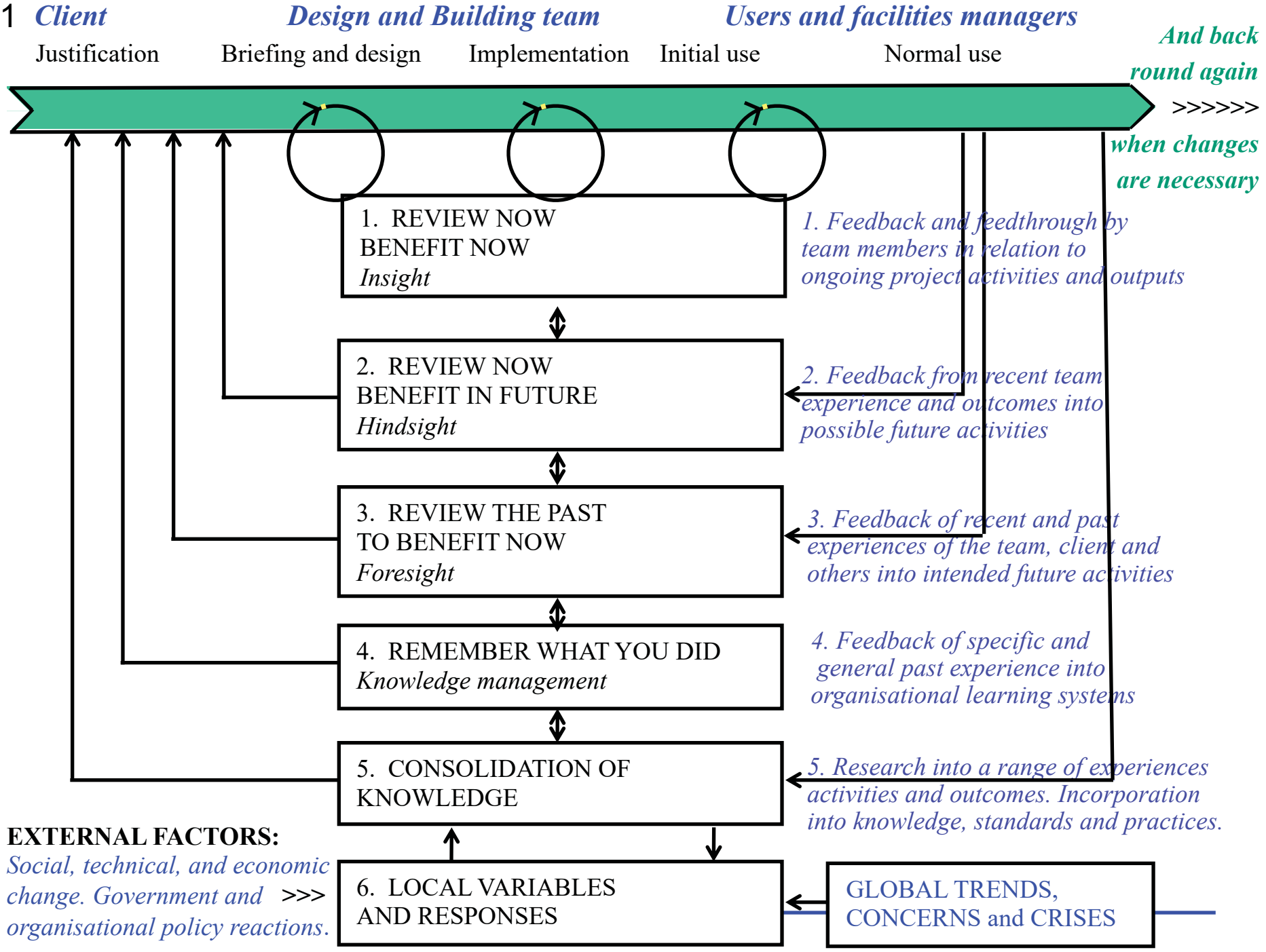
REFERENCE: B Flyvbjerg, *Five misunderstandings about case study research,* Qualitative Enquiry ***12***, 219-245 (2006),

"Any building without a feedback system is stupid. It will continue to make the same dumb old mistakes, rather than interesting new ones."

AMORY LOVINS
Rocky Mountain Institute

Feedback processes occur at many levels

SEE NEXT SLIDE


Client
Design and Building team
Users and facilities managers
Justification
Briefing and design
Implementation
Initial use
Normal use
And back round again >>>>>>
when changes are necessary
1. REVIEW NOW BENEFIT NOW
Insight
1. Feedback and feedthrough by team members in relation to ongoing project activities and outputs
2. REVIEW NOW BENEFIT IN FUTURE
Hindsight
2. Feedback from recent team experience and outcomes into possible future activities
3. REVIEW THE PAST TO BENEFIT NOW
Foresight
3. Feedback of recent and past experiences of the team, client and others into intended future activities
4. REMEMBER WHAT YOU DID
Knowledge management
4. Feedback of specific and general past experience into organisational learning systems
5. CONSOLIDATION OF KNOWLEDGE
5. Research into a range of experiences activities and outcomes. Incorporation into knowledge, standards and practices.
EXTERNAL FACTORS:
Social, technical, and economic change. Government and >>> organisational policy reactions.
6. LOCAL VARIABLES AND RESPONSES
GLOBAL TRENDS, CONCERNS and CRISES

You can't tell how good your building is
… *unless you find out how it is working*

Elizabeth Fry building has the last laugh

The story of the Elizabeth Fry building (AJ 23.4.98) contains a number of ironies. My favourite is that it didn't even make the shortlist of the Green Building of the Year Award in 1996.

DR ROBERT LOWE
Leeds Metropolitan University

LETTER TO ARCHITECTS' JOURNAL

The good performers don't necessarily impress the judges

The original Elizabeth Fry Probe paper was published in *Building Services Journal,* 37-41 (April 1998).

It was the practice, not just the product

"Soft" factors for success at the Elizabeth Fry Building, UEA

But only the technical features were mentioned when a Royal Commission used it an exemplar

- A good client
- A good brief *incorporating the client's previous experience.*
- A good team *(worked together before on the site).*
- Specialist support *(especially on insulation and airtightness).*

- A good, robust design, efficiently serviced *(mostly).*
- Enough time and money *(but to a normal budget).*
- An appropriate specification *(and not too clever).*
- An interested contractor *(with a traditional contract and CoW).*

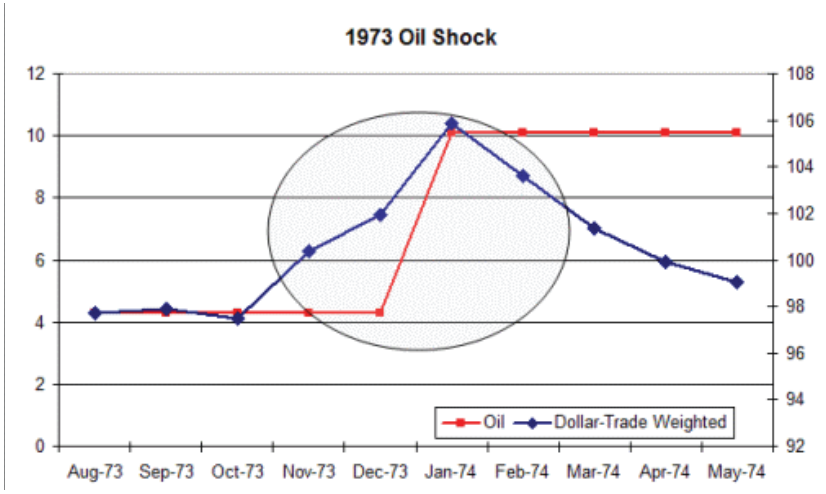
- Well-built *(attention to detail, but still room for improvement).*
- Well controlled *(but only eventually, after monitoring and refit).*
- Post-handover support *(triggered by independent monitoring).*
- Management vigilance *but could it be sustained?*

SOURCE: W Bordass et al, *Assessing building performance in use 5*, BR&I **29** (2), 144-157 (March-April 2001), Figure 6.

PART 2

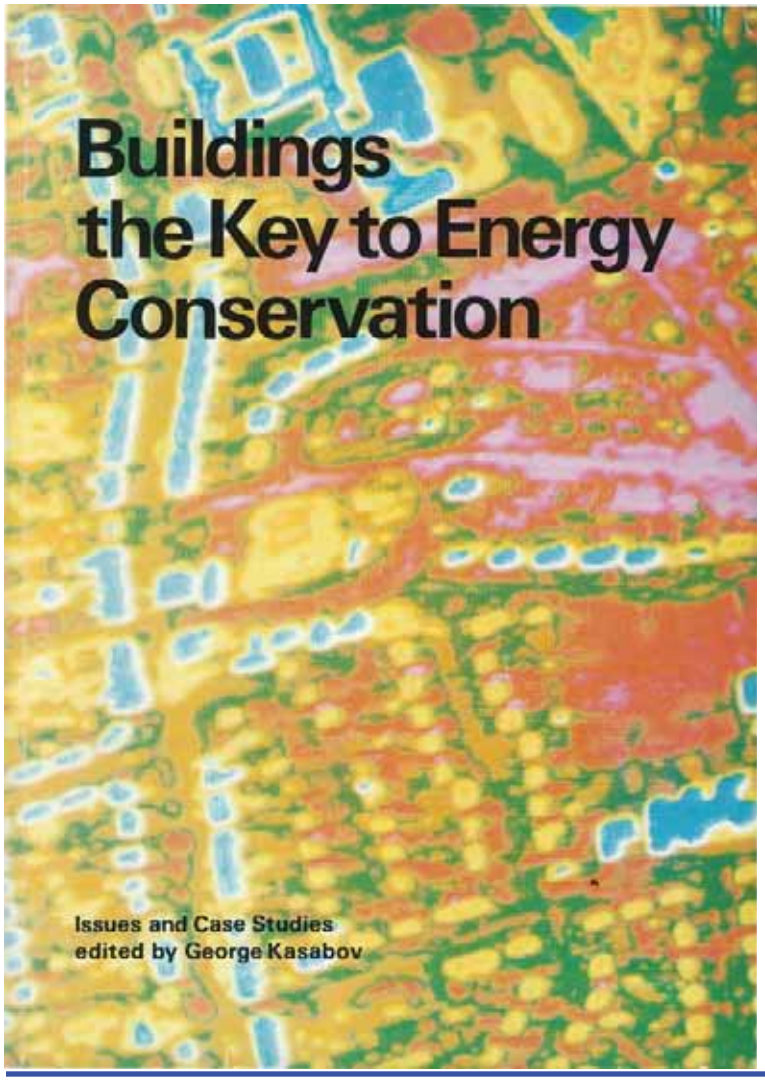
STRATEGIC LESSONS FROM PERFORMANCE EVALUATIONS OF BUILDINGS IN USE

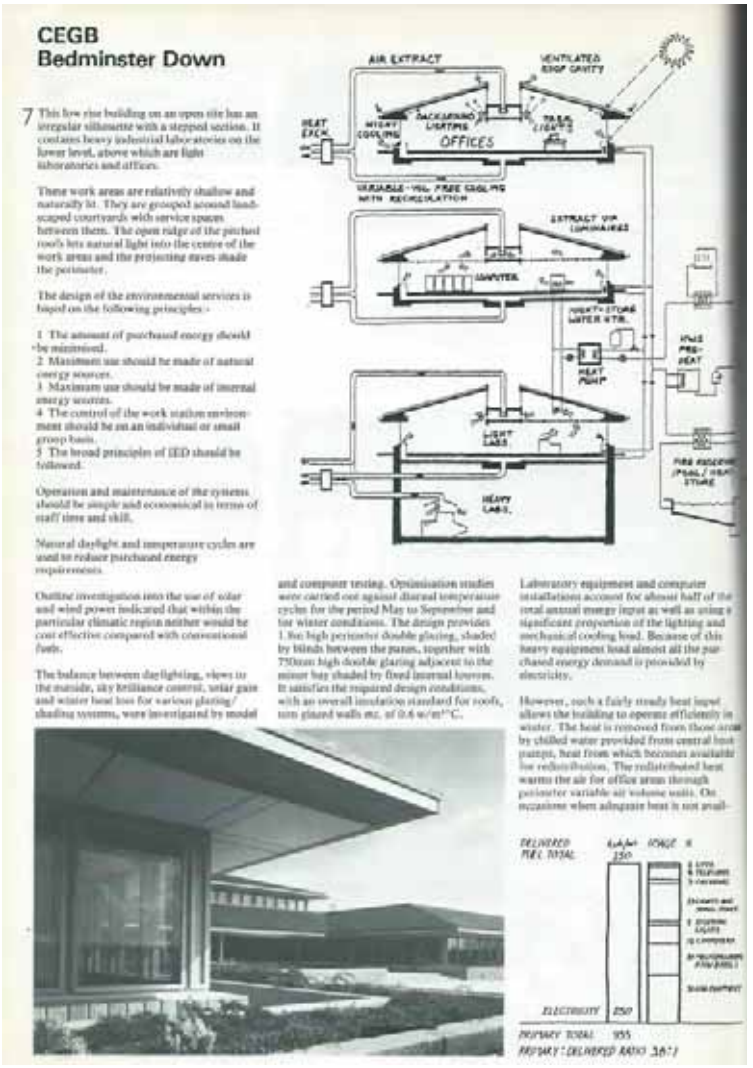
At the end of 1973, we had the oil crisis



In 1974, coal supplies also ran short in the UK, through trade union action, bringing on the 3-day week and bringing down the Tory Government …

RIBA Energy Group 1979 – *8 papers on issues, 50 Case Studies of low-energy buildings, with data*





SOURCE: G Kasabov (ed), *Buildings, the Key to Energy Conservation,* RIBA Energy Group, 1979, 96 pages.

Building-related ill-health also joined the agenda

The WHO recognised Sick Building Syndrome in 1982

Also identified as Tight Building Syndrome in the USA

Source of diagram optipura.com

Ten years later, energy performance gaps were emerging in the UK – *in other countries too*

Tales of the unexpected

Office buildings claimed to be energy efficient, in reality often fall short of their quoted performance because of simple calculation errors and unknown energy-consuming extras. Matthew Coomber *reports.*

BUILDING owners beware – your energy-efficient building may not be as efficient as you have been led to believe.

Bill Bordass, an independent energy consultant and something of a guru in the field of energy efficient design, claims many offices are touted as energy efficient, but turn out not to be on closer examination.

He is helping to prepare a series of case studies of energy use in offices as part of the Energy Efficiency Office's Best Practice programme.

The studies detail energy usage and cost figures for each energy consumption elements missing or had recorded building areas much larger than that actually serviced," he says.

Errors in calculation had arisen either through mismeasurement of floor area or a failure to understand what constitutes the treated area, that is, the area of a building that consumes energy, in whatever form.

"We found that energy researchers have a tendency to look in great detail at where the energy goes, but will often ask somebody else for a building area." Usually rounded up or

Bordass says some people measure energy consumption by the whole building, some by building services only, and some by landlord's building services only. "This can produce great discrepancies when you come to measure the floor area and the devices properly," Bordass notes.

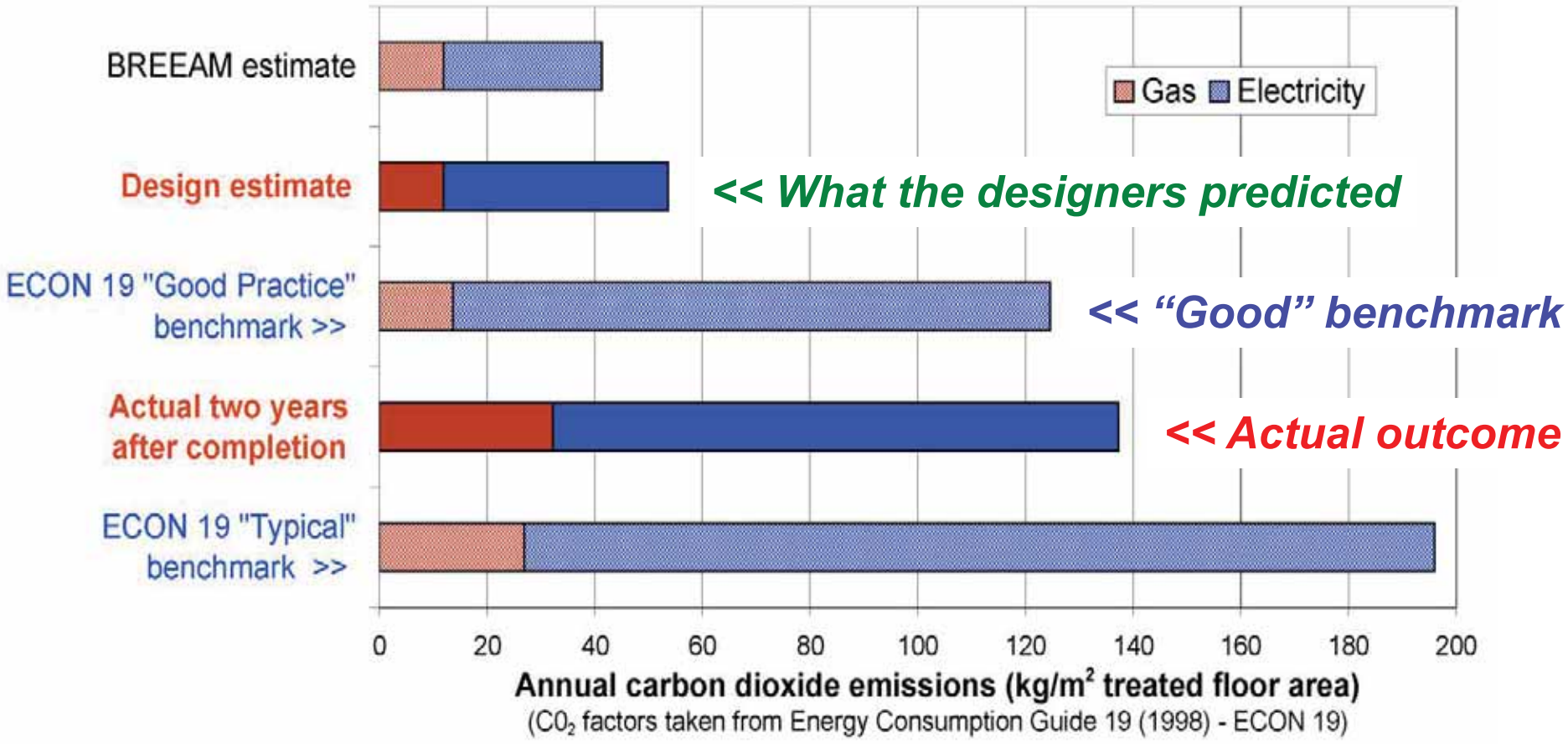
In addition, tenants can be confused about who pays for services, resulting in the doubling-up or omission of important elements of the energy bill.

The next problem concerns the assumptions that the people

SOURCE: M Coomber, *Tales of the Unexpected,* Building Magazine 38-39 (17 August 1990).

BREEAM for offices was also introduced in 1990, *but performance gaps persisted…*

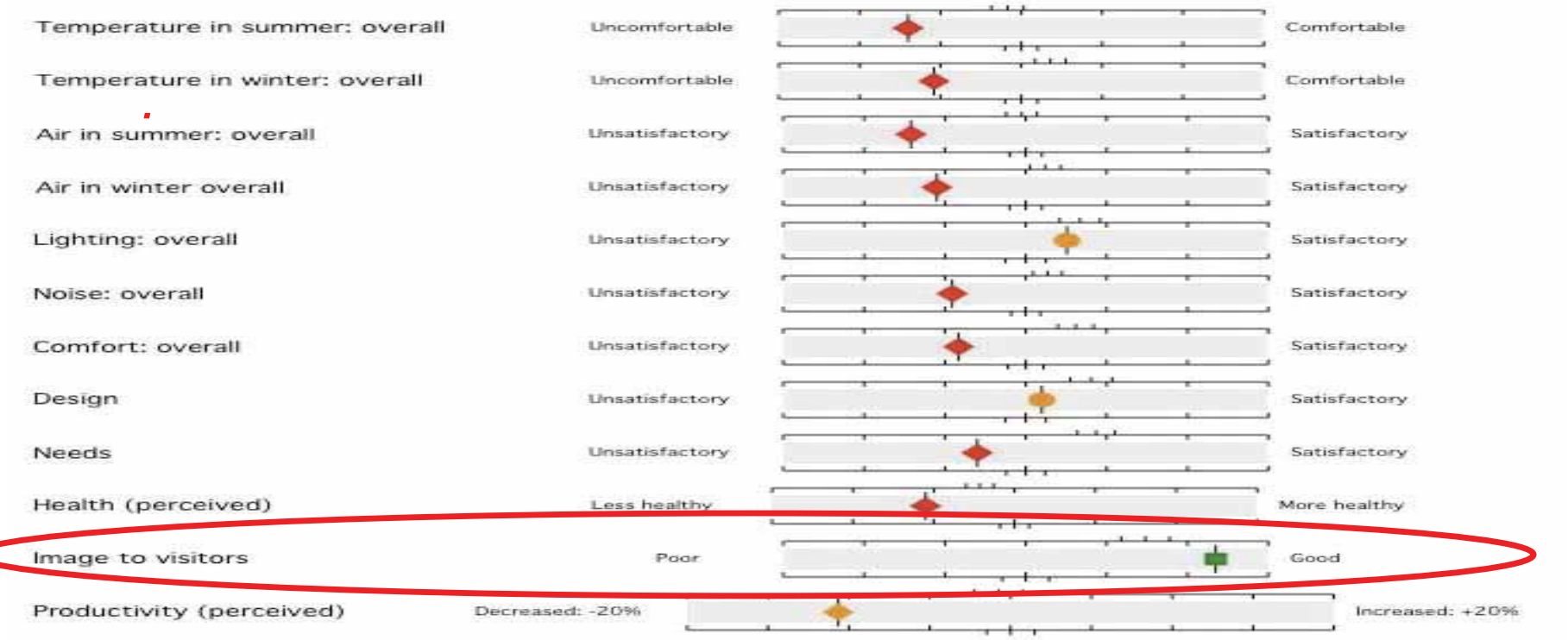
Data from the winner of the Green Building of the Year Award 1996



SOURCE: see discussion in S Curwell et al, *Green Building Challenge in the UK,* Building Research+Information **27**(4/5) 286 (1999).

Performance gaps are not just for energy:
occupant survey, multi-award-winning school

RED: below average; AMBER: Average; GREEN: Above average



" … the architecture showed next to no sense. It leaked in the rain and was intolerably hot in sunlight. Pretty perhaps, sustainable maybe, but practical it is not." … STUDENT

SOURCE: BUS Method survey of a building services engineering award-winning Academy school in South East England, 2009

New non-domestic buildings:

Some strategic implications from the Probe project's findings

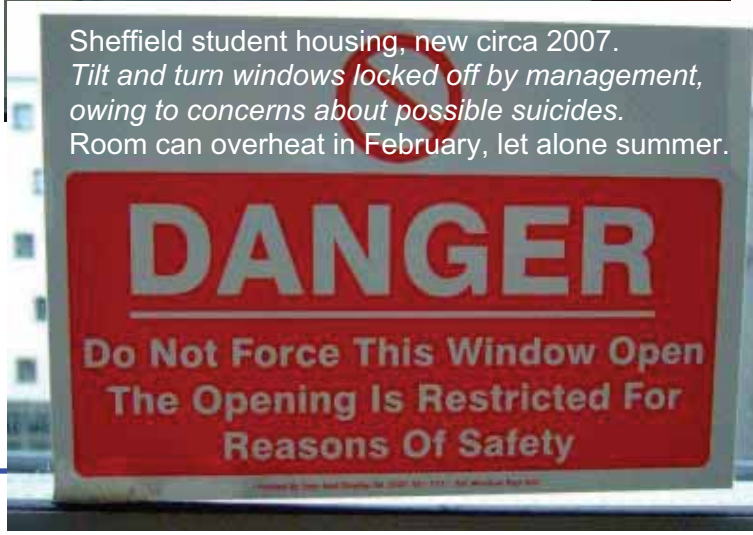
- They often perform much worse than anticipated, *especially for energy and carbon, often for occupants, and with high running costs, and sometimes technical risks.*
- Design intent is not communicated well through the process. **SO …** *Understand how buildings work in use, follow through after handover, and learn from the experience.*
- **Unmanageable complication: the enemy of good performance**. **SO …** *Stop making buildings complicated in the name of sustainability and get the simple things right.*
- Buildings are seldom tuned-up and controls are a muddle. **SO** … *Design to enhance usability and manageability.*
- Modern procurement systems make it difficult to pay attention to critical detail. **SO** … *Change the processes.*
- **AND THEREFORE**… **Focus on in-use performance, communicate it clearly and manage it properly.**

SOURCE: For more information, go the Probe section of www.usablebuildings.co.uk

Simple dysfunctions in recent buildings:
Poor window design, leading to overheating

Cambridge sheltered housing, opened 2011. *No secure, fine control ventilation available: could easily have been small windows in the panel between the doors. Doors need two hands to operate: not clever if you have arthritis!*

Sheffield student housing, new circa 2007.
Tilt and turn windows locked off by management, owing to concerns about possible suicides.
Room can overheat in February, let alone summer.



… and widely dysfunctional controls

BCIA
Building Controls Industry Association

Controls for End Users

Usability criteria	Ranking (controller as supplied) Poor	Excellent
Clarity of purpose	●	
Intuitive switching	●	
Labelling and annotation	●	
Ease of use	▬	
Indication of system response	▬▬	
Degree of fine control	●	

This control for lighting has clear switching with four settings clearly illuminated, plus an off setting. The numbers by the setting are arbitrary.

Apart from the numbering, the switch is not labelled as to what it does. The red light for setting 1 is on the far left of its button, hinting that there be more than one stage for each setting. Is the off button for system off, or does it apply to each of the four stages in turn? Does the vertical button to the right raise or lower the lighting generally, or on each setting? In the absence of clear annotation, the user is forced to experiment.

Usability criteria	Ranking (controller as supplied) Poor	Excellent
Clarity of purpose	▬	
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Labelling and annotation	▬	
Ease of use	▬▬	
Indication of system response	●	
Degree of fine control	▬	

This controller is clearly a control device for ventilation. The knob at the lower left appears to offer control over a setpoint (presumably for temperature), against an arbitrary scale of plus or minus. In the absence of controller feedback, the user would need to learn the settings by experimentation. The function of the knob on the right is clearer, with three fan speed-settings, but is it for room ventilation or a fan in a heating/cooling unit? Probably the latter, as experience has forced the facilities manager to append a label telling users not to switch off the fan.

"we sell dreams and install nightmares"
– CONTROLS SUPPLIER

SOURCE: www.usablebuildings.co.uk/Pages/Publications/UBPubsControlsForEndUsers.html and BSRIA

Technology - management interactions:

Conclusions from the Probe POE studies of public and commercial buildings. Confirmed by later work

		Technological complexity	
		More	**Less**
Building management input	**More**	*Type A* Effective, but often costly	*Type D* Rare, not replicable?
	Less	Risky with performance penalties *Type C*	Effective, but often small-scale *Type B*

Diagram first appeared in: *Probe 19: Designer Feedback,* Building Services, the CIBSE Journal, page E21 (March 1999).

Technology - management interactions:

Conclusions from the Probe POE studies of public and commercial buildings. Confirmed by later work

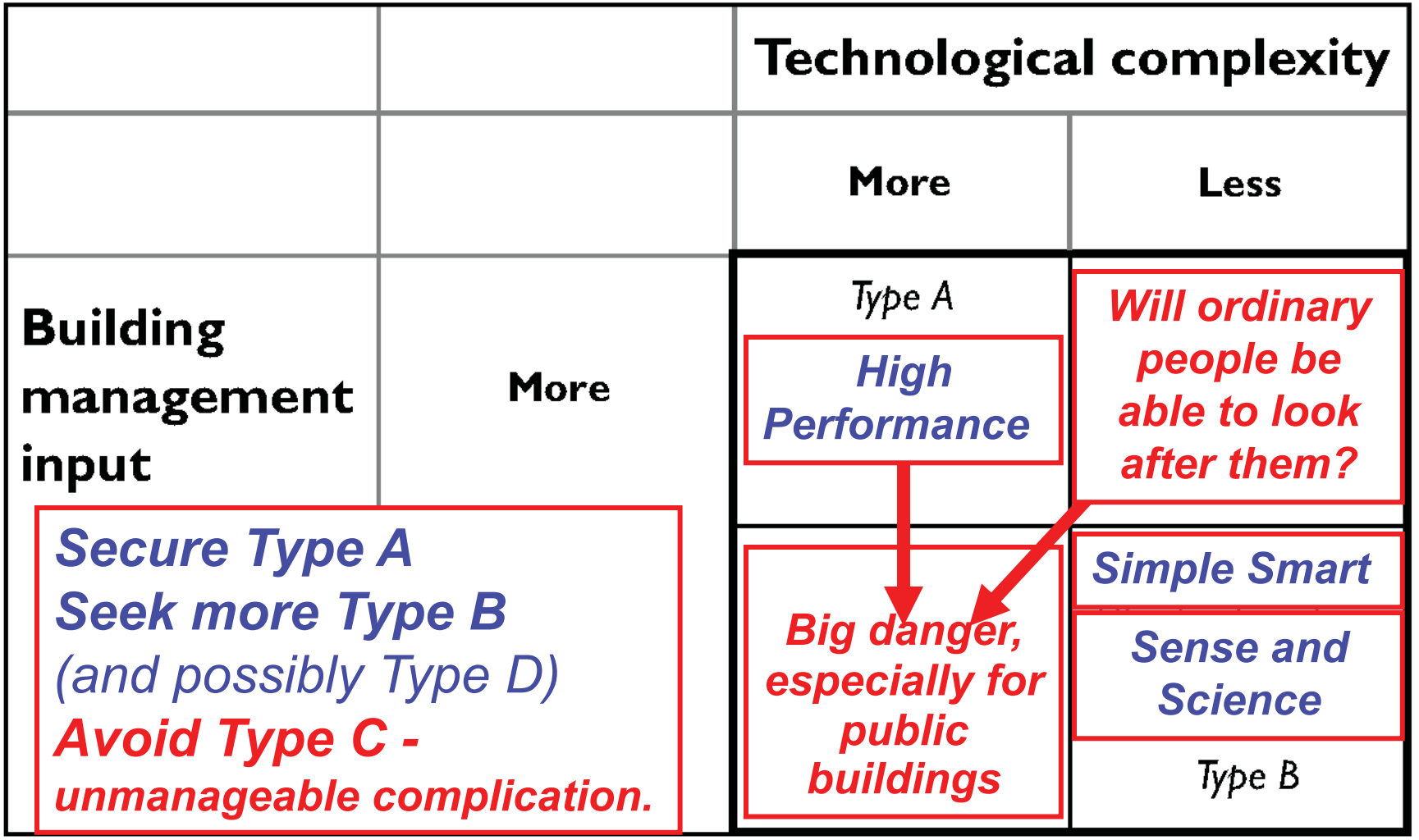


Diagram first appeared in: *Probe 19: Designer Feedback,* Building Services, the CIBSE Journal, page E21 (March 1999).

In spite of these insights from the 1990s, *complication has burgeoned this century*

- Technical complication
- Legislative complication
- Contractual complication
- Bureaucratic complication
- Tick-box procedures: feature creep
- Complication for building users and managers


5 vans on callout at Sustainable Homes Code 5 sheltered housing in Cambridge

So less money to spend on basics

And the complication disease has spread to housing too!

NOTHING JOINS UP PROPERLY!

"Complexity is profitable, [it] makes people believe you understand it."
JON DANIELSSON

F Stevenson et al,: *The usability of control interfaces in low-carbon housing,* Architectural Science Review, 1-13 (2013).

And yet again ... *Some conclusions from TSB-IUK Building Performance Evaluation programme 2010-14*

Significant problems with integrating new technologies,
especially configuring and optimising BMSs.
Insufficient thought given to how occupants will use them.

"Controls are something of a minefield."
Tendency to make control of heating, lighting and renewable energy systems over-complicated. The one air source heat pump had operational issues in cold weather.

Problems with automatic window controls.

Multiple systems fighting each other *e.g.* cooling vs heating, different heating systems jockeying for control.

Maintenance, control & metering problems,
especially with biomass boilers, PVs and solar heating.

AND ON IT GOES ...

SOURCE: J Palmer & P Armitage, BPE Programme, Early findings from non-domestic projects, Innovate UK (Nov 2014)

PART 3

WHY AREN'T CLIENTS, DESIGNERS, BUILDERS, MANAGERS and GOVERNMENT BETTER TUNED IN TO PROJECT OUTCOMES?

Over 60 years ago, RIBA put a feedback stage in its **Plan of Work (1963): STAGE M**

PURPOSE

To analyse the management, construction and performance of the project.

TASKS TO BE DONE

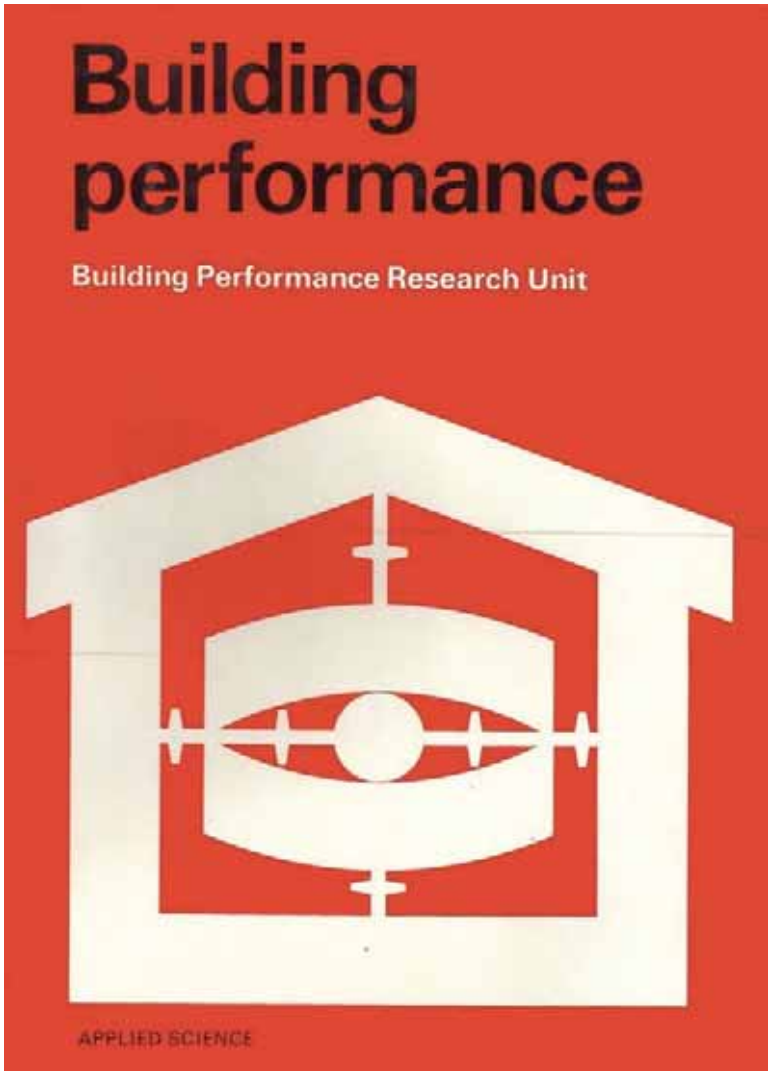
Analysis of job records.
Inspections of completed building.
Studies of building in use.

PEOPLE DIRECTLY INVOLVED

Architect, engineers, QS, contractor, client.

SO WHY ISN'T BPE ROUTINE FOR DESIGNERS TODAY?

Building performance evaluation started in some universities in the 1960s



Pioneers included the University of California, Berkeley and the Building Performance Research Unit at Strathclyde (BPRU).

However, after BPRU's seminal book (1972), the subject failed to gather momentum, as it did not fit well with academic criteria, or get sustained client, government or industry support.

"*Unfortunately, interdisciplinary subjects have a way of escaping from any discipline whatever.*" …
ERIC DREXLER

In the very same year, 1972
the RIBA removed **Stage M: Feedback**
from its publication ***Architect's Appointment.***

Half a century later, and in spite of numerous efforts, "finish, hand over and go away" is still deeply embedded in many government, client and industry procedures and contracts.

REFERENCE: T Markus et al, *Building Performance,* Applied Science Publishers (1972)

The tide also turned in government …

- Widespread disruption and disillusionment in the 1970s.
- Ascendancy of ideas about free markets, competition and choice; a *de facto* inefficient public sector, and *"no such thing as society".*
- Professionals began to be seen as an elitist conspiracy against the public, and were treated by government as just another business.
- In 1972, the Rothschild Report advocated a customer-contractor relationship for government-sponsored applied research, *followed by:*
- Outsourcing and privatisation of professional skills and research capabilities from government *e.g. the Building Research Establishment.*
- Dismemberment of the Department of the Environment 1997-2002.
- *This all eroded Rothchild's idea of an intelligent government customer.*

SO WHERE IS GOVERNMENT'S INSTITUTIONAL MEMORY TODAY?

Nobody else (e.g. professional institutions), has helped fill a growing gap effectively and provide continuity over the years – "the forgetting curve".

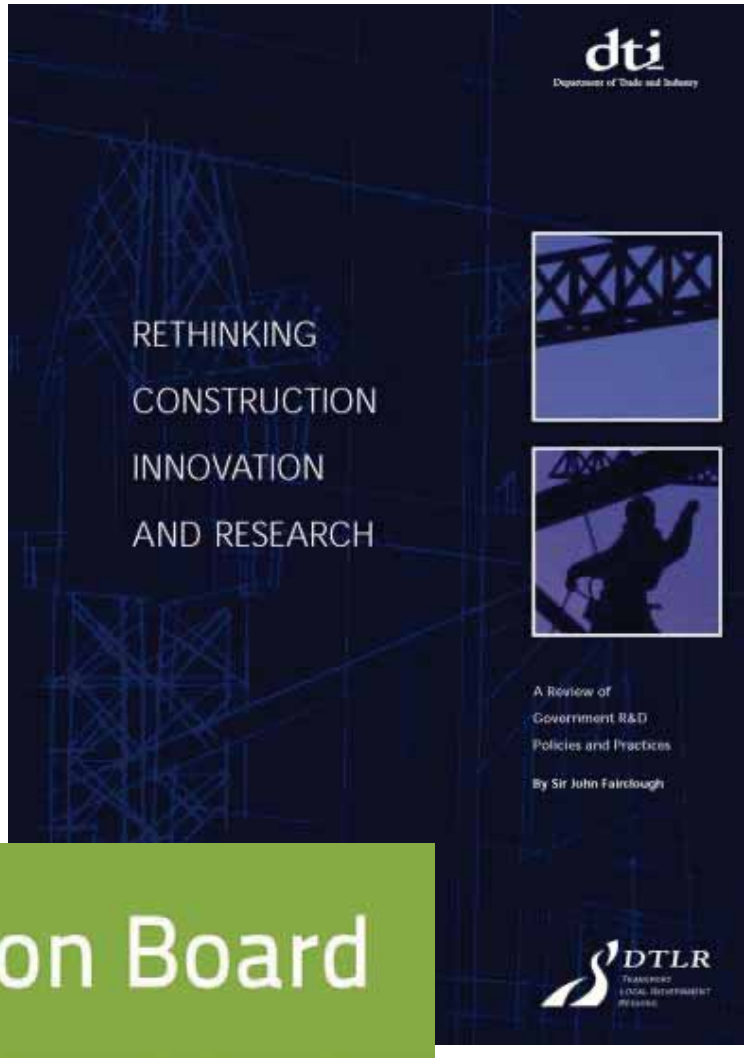
As a result, policy relies too much on hope, predictions and lobbies; and less on lived experience of what works and what really needs attending to.

Instead of responding to early signals, often it only reacts to crises.

… and UK buildings policy is usually focused on construction, *not performance in use …*

RETHINKING CONSTRUCTION

ORT OF THE CONSTRUCTION TASK FORCE

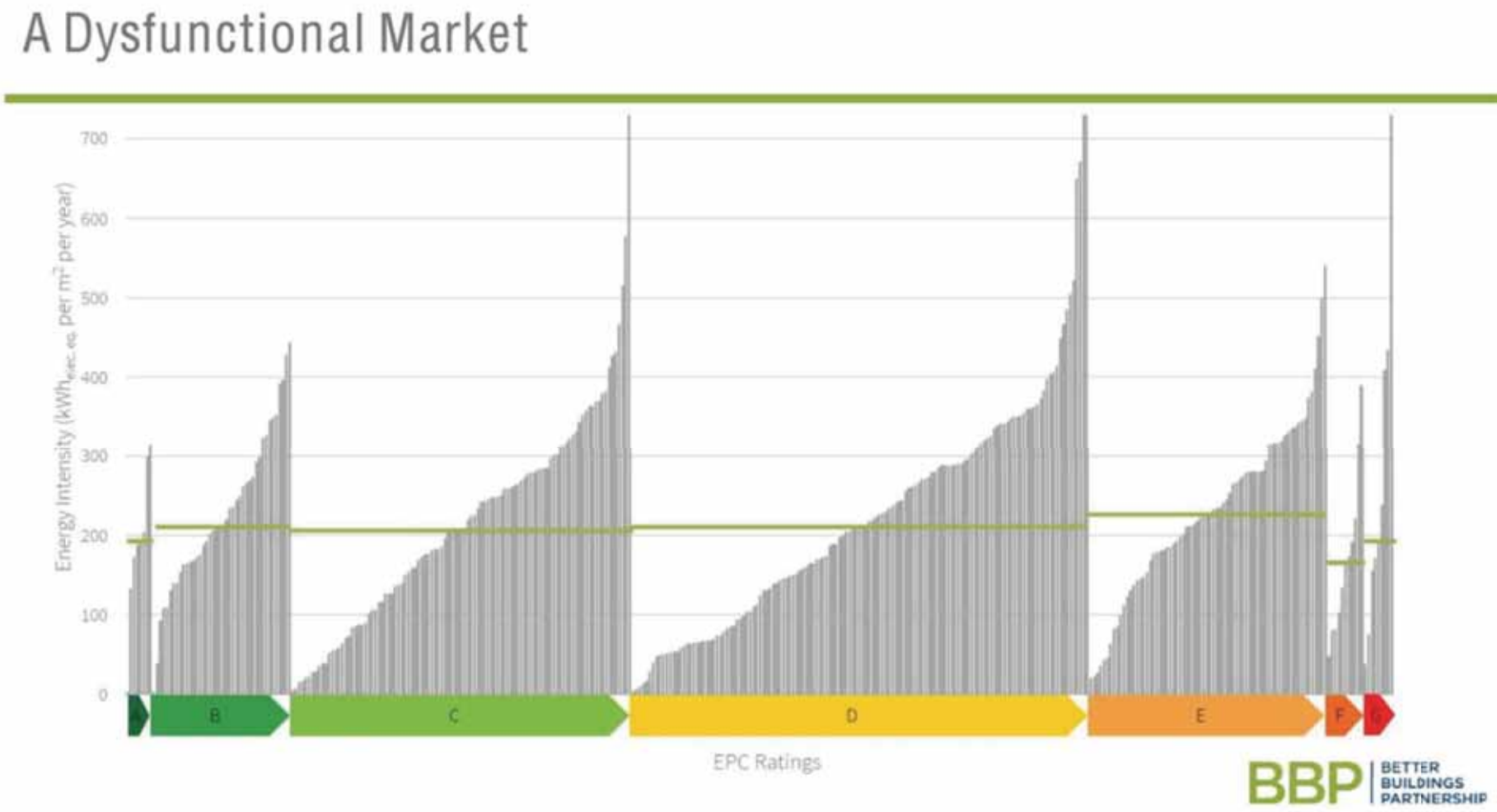


The Green Construction Board

REFERENCES: The Egan Report (DTI, 1998), the Fairclough Report (DTI and DTLR, 2002)

Are the tools we use sometimes merely rituals?

Office actual energy use/m² NLA vs. EPC Grade



FOR MORE SEE: www.betterbuildingspartnership.co.uk/our-priorities/measuring-reporting/design-performance

Are the tools we use sometimes merely rituals?

National Audit Office report on wall insulation, Oct 2025

Department for Energy Security & Net Zero

Ofgem

"92% of EWI and 27% of IWI non-compliant
6% of EWI and 3% of IWI risk occupant health"

Research and analysis

Solid wall insulation installed under ECO4 and GBIS: Statistical audit results

Published 13 October 2025

Applies to England, Scotland and Wales

Contents

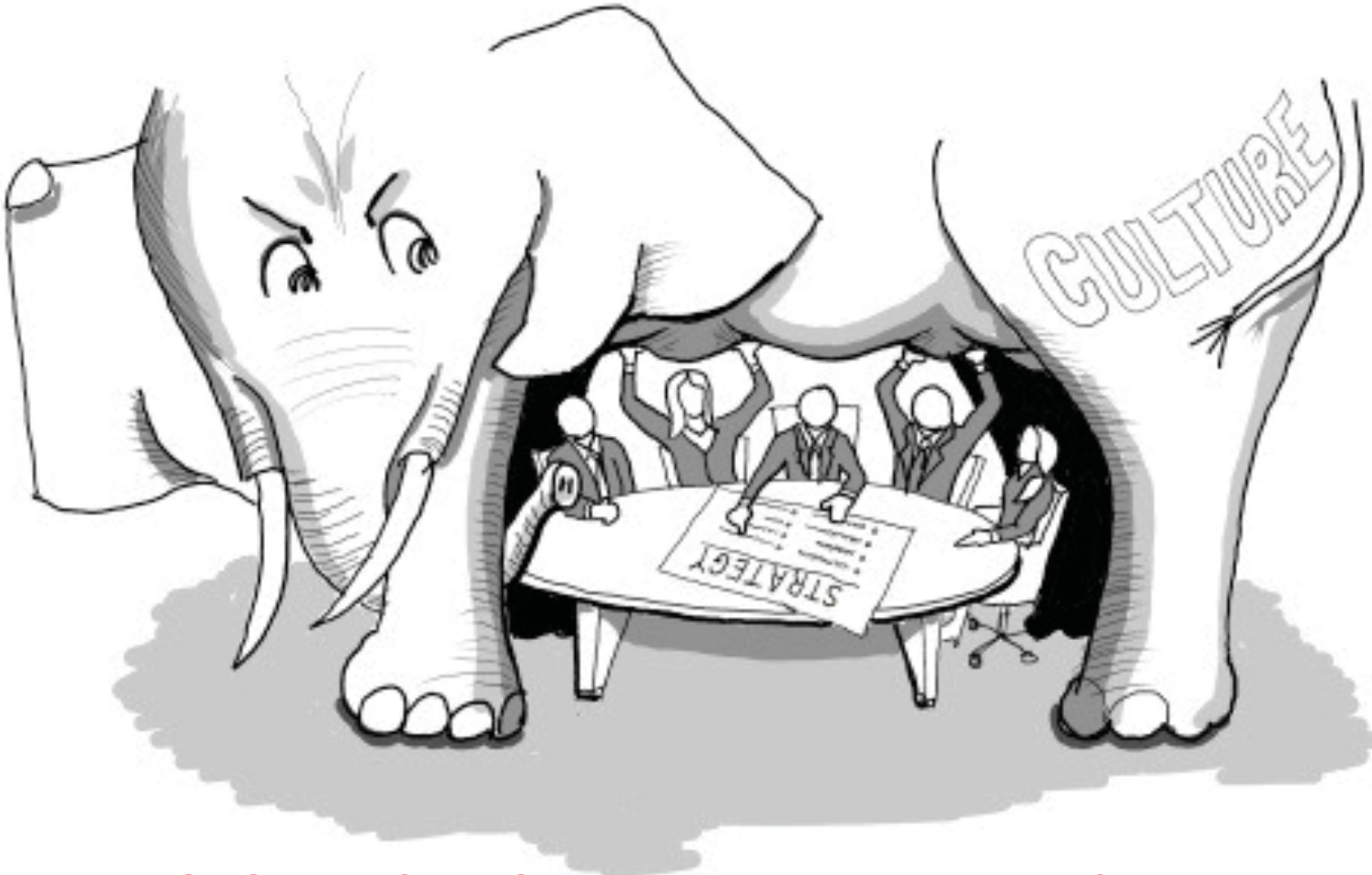
Print this page

This report summarises the results of the randomised samples of audits which were commissioned by Ofgem on behalf of DESNZ in order to understand the extent of non-compliance in Solid Wall Insulation (SWI) measures installed under the fourth iteration of the Energy Company Obligation (ECO4), and the Great British Insulation Scheme (GBIS).

The results showed that a majority (92%) of External Wall Insulation (EWI) installations and a large minority (27%) of Internal Wall Insulation (IWI) installations under these schemes were found to have at least one major technical non-compliance, which will affect the performance of the system. In addition, a small percentage of installations (6% of EWI and 3% of IWI installations) were found to have health and safety risks to the occupants.

SOURCE: www.gov.uk/government/publications/solid-wall-insulation-installed-under-eco4-and-gbis-statistical-audit-results/solid-wall-insulation-installed-under-eco4-and-gbis-statistical-audit-results

The elephant isn't in the room, *IT IS THE ROOM!*



WE HAVE A SYSTEMIC PROBLEM: Blindness to performance in use

It's not just the construction industry, it's the way we all go about things

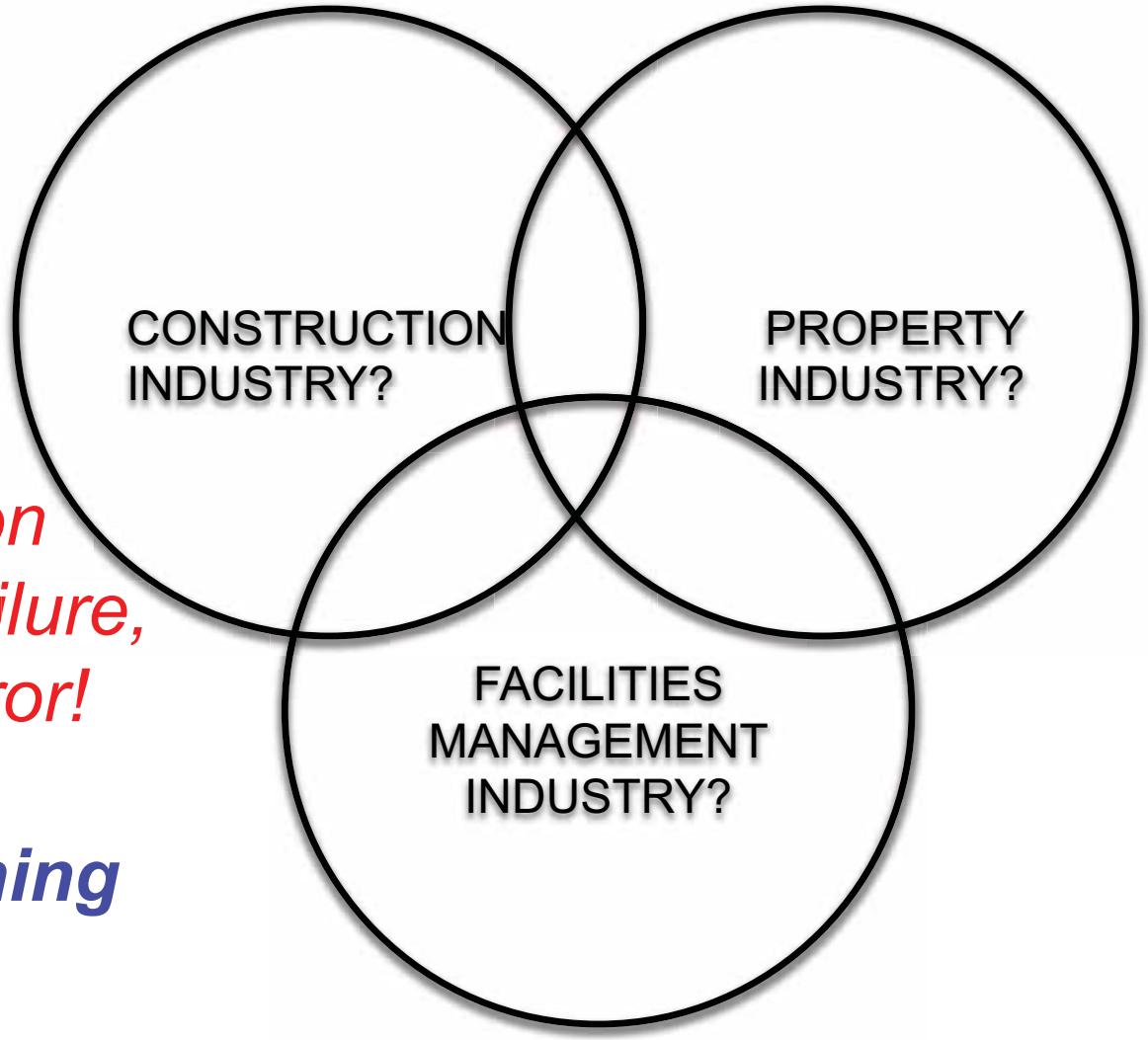
SOURCE: Bruce Flye, 2012, www.bruceflye.com/concept-graphics/illustrations/4092610

Which industry and market is really responsible for building performance in use?

None of these: it's much more complicated than that.

The lack of traction is not a market failure, but a category error!

We need something more …



Our proposed sticky interventions:
seeding things with potential to snowball over time

Cultural adaptations, not just technical "solutions".
To create virtuous circles of continuous improvement.

MAKE IN-USE PERFORMANCE CLEARLY VISIBLE

In a way that motivates people to strive to improve it.
This needs a well-informed technical infrastructure to help the plethora of different systems to converge, particularly for energy and carbon.

CONSOLIDATE THE KNOWLEDGE DOMAIN OF BUILDINGS IN USE

Develop building performance as an independent knowledge domain, to gain the evidence and authority to inform practice and policymaking.

REVIEW PROFESSIONAL ETHICS AND PRACTICES

A shared vision for building-related professionals to work in the public interest and engage properly with outcomes: *NEW PROFESSIONALISM*

SEE ALSO: Bill Bordass, George Henderson Memorial Lecture, University College London (12 June 2013).

A glimmer of hope: Stage M came back!
as Stage 7 in the RIBA Plan of Work 2013 and 2020

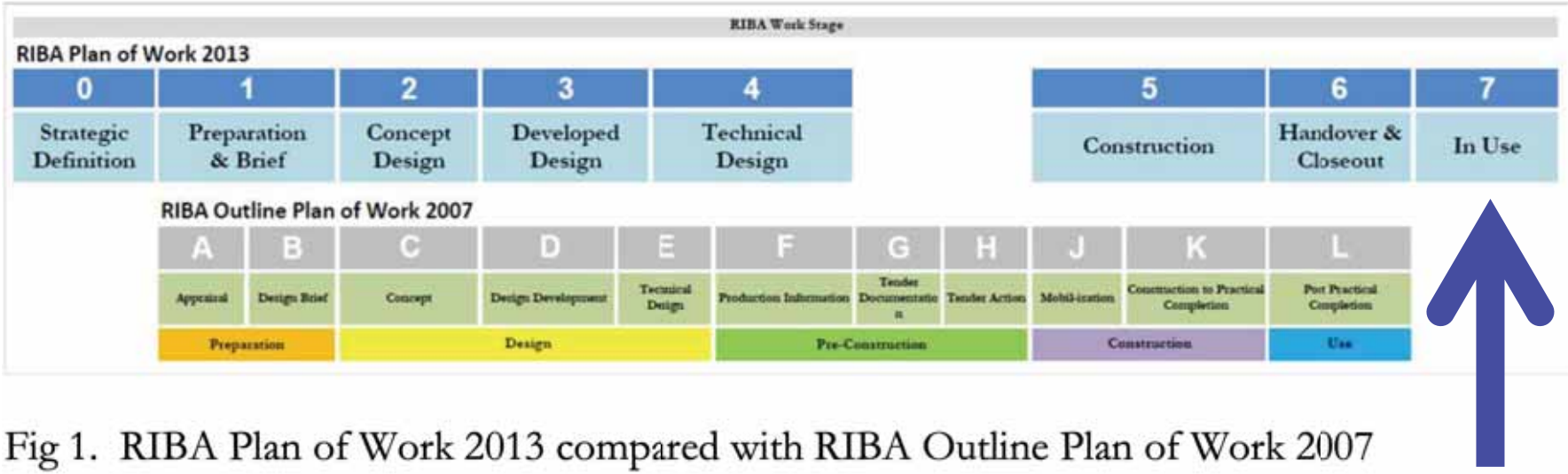


Fig 1. RIBA Plan of Work 2013 compared with RIBA Outline Plan of Work 2007

And some universities are becoming more active – but many still not.

Most design professionals *(particularly those in the larger firms)* get little exposure to how their buildings actually work.

"We design to the rules, not for good outcomes" - ENGINEER

SOURCE: RIBA Plan of Work overview (March 2013). See also www.architecture.com/planofwork

This should have woken everybody up …

but I fear it has been interpreted far too narrowly

Government response has been onerous safety regulation and control, *not culture change per se*

Learn about the new Building Safety Regulator (BSR)

"The government is proposing changes to building safety law. These will protect people who live in high rise buildings and give new duties to the people who are responsible for the safety …."

SOURCE: HSE video at www.youtube.com/watch?v=YyOnPjkVyU8

The need for culture change is now becoming explicit *including from the head of the first Grenfell inquiry*

In a recent lecture, Dame Judith Hackitt called on construction professionals and industry leaders to take their building safety responsibilities more seriously amidst an "*appalling attitude [that] continues to prevail*"

Speaking at the annual Sir James Wates lecture in late 2024, Dame Judith Hackitt said: "*I feel strongly that it is time for us to name and shame those who continue to try to game the new system.*"....The "*sobering speech*" titled 'In Search of the Leaders' saw Dame Judith share her concerns about the current direction of building safety. She noted that even with the recommendations of the Grenfell Tower Inquiry report and the implementation of the Building Safety Act (BSA) in 2022, there remained limited evidence of any kind of behavioural change within the industry.

"*Let us remind ourselves what regulation is actually there for. It is to drive different behaviours. I have seen and have been part of other industries who have found themselves in similar positions, in the wake of a tragic or catastrophic event. The difference is that they have chosen to come together to demonstrate collective leadership and responsible behaviour, to be part of the solution, rather than continuing to be perceived as the problem.*"

Built environment governance and professionalism: the end of *laissez-faire* (again)

SIMON FOXELL

ABSTRACT

The regulation of the built environment depends upon a combination of governmental regulation, robust professional practice and market forces. The balance between these varies over time and different jurisdictions. This essay considers the recurrent rise and fall of the principle of *laissez-faire*. The growth and public purpose objectives of the professional institutions are examined, as is their decline under the ascendency of neoliberalism in the UK, though the analysis is relevant to other countries. A reconsideration of professional attitudes and attitudes to the professions resulting from the catastrophic fire in the UK's Grenfell Tower residential block in 2017 is currently underway. A return to the founding objectives of the institutions is recommended if they are to equip themselves with renewed purpose and to avoid over-restrictive regulation by government. Any such renewal needs to include a focus on behaviour, ethics, competence, research-based evidence and, above all, a transformation in the governance of the professions.

POLICY RELEVANCE

The recent history and current public purpose obligations of governmental and non-governmental organisations are considered to ensure that built environment professionals under their jurisdiction have the competence, authority and freedom of action to make reasonably certain that those obligations are fulfilled effectively. An approach to appropriate organisational governance and policy following several high-profile building failures, including the Grenfell Tower fire, as well as future environmental challenges, is described and discussed. A coordinated system of governance involving both market regulation and professionalism (guided by robust institutions) have an essential role to play in making an equitable and rules-based economy work and delivering both short- and long-term objectives.

BUILDINGS & CITIES

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KEYWORDS:
built environment; professionalism; professional institutes; governance; duty of care; caring; accountability; competence; UK

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SOURCES: https://www.thefpa.co.uk/news/dame-judith-hackitt-frustrated-by-lack-of-construction-industry-progress *and* https://doi.org/10.5334/bc.713

The need for culture change is now becoming explicit
triggered by the Grenfell public inquiry

Share your views on CABE's Future Professional consultation, a roadmap for evolving the standards, values and practices of the building engineering profession.

The events at Grenfell Tower, the subsequent public inquiry and ongoing programme of regulatory reform have highlighted the urgent need for stronger professional oversight, greater transparency and a cultural change within the construction sector.

Future Professional sets out CABE's proposals for how the Association will meet these challenges, laying the foundations for long-term development. The consultation forms a vital part of CABE's ongoing commitment to ensuring that CABE Members, and the wider construction and built environment community, are equipped to meet the highest expectations of competence, ethics, and accountability.

CONSULTATION ENDS 15 FEBRUARY 2026

SOURCE: CABE: Future Professional consultation (Nov 2025) https://cbuilde.com/page/futureprofessional

PART 4

IMPLICATIONS FOR PROFESSIONS and PRACTICE

Sustainability raises challenging moral and ethical dilemmas

- Work ‘after us’ and for ‘the other’.
- Intergenerational equity.
- Deferred impacts over long periods.
- Differential geographical and social impacts.
- Growing levels of uncertainty and unpredictability.

It needs vision, imagination, reflection and commitment

“[it] does not tempt us to be less moral than we might otherwise be; it invites us to be more moral than we could ever have imagined.” … MALCOLM BULL

RIBA Plan of Work 2013 let sustainability checkpoints be switched on and off ! *Fortunately the 2020 Plan doesn’t.*

SOURCES: S Hill, Edge debate, New Professionalism, 20 Feb 2013, M Bull, London Review of Books, 3-6, 24 May 2012

If you wanted to improve building performance in use, *what would you do …*

A. Focus on building performance in use?

OR

B. Do lots of other things and hope that performance will improve …?

Why have we been barking up the wrong tree?

Why has actual performance not been the target?

BPE as real-world research
(after Robson, 1993)

Solving problems **NOT** Just gaining knowledge

Predicting effects **NOT** Just finding causes

Robust results, actionable factors **NOT** Only statistical relationships

Developing & testing services **NOT** Developing & testing theories

Field **NOT** Laboratory

Outside organisation **NOT** Research institution

Strict time and cost constraints **NOT** R&D environment

Researchers with wide-ranging skills **NOT** Highly specific skills

Multiple methods **NOT** Single method

Oriented to client **NOT** Oriented to academic peers

Viewed as dubious by some academics **NOT** High academic prestige

Large samples are not necessary, if you understand the context.

Case studies of individual buildings tell stories

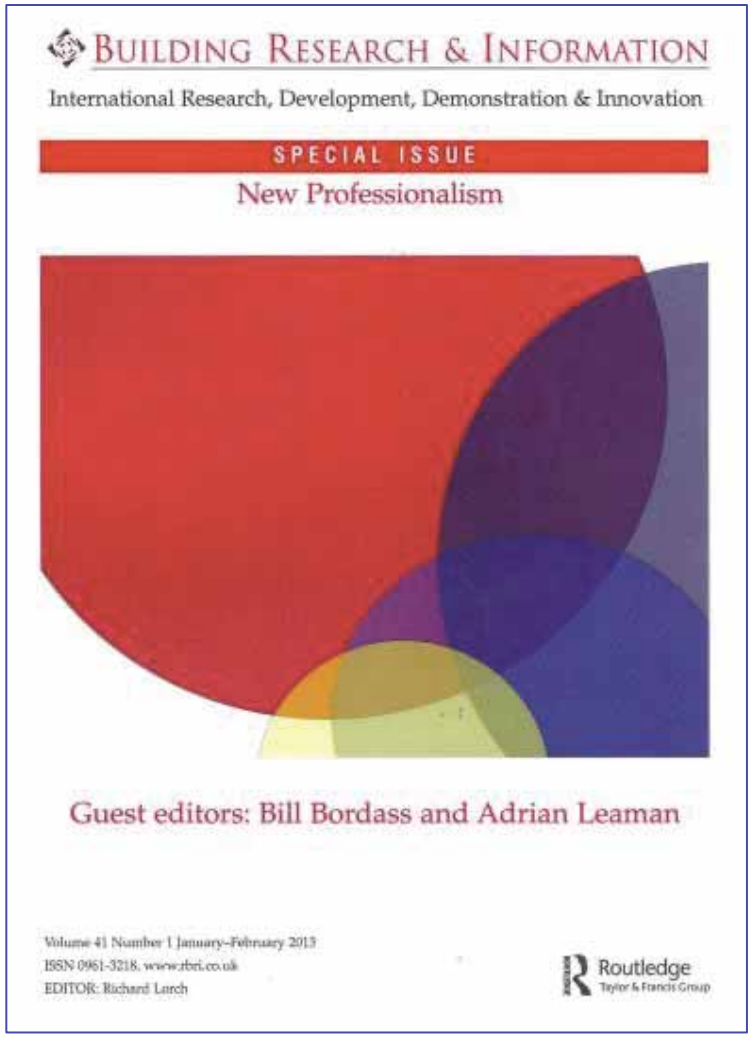
and can establish hypotheses that can be tested elsewhere.

SOURCE: After H Robson, *Real-World Research* (Butterworth-Heinemann, 1993), 5th Edition (2023).

Changing the way we do things

- Many construction-related institutions require their members to understand and practice sustainable development.
- How can members do this unless they understand the consequences of their actions? *The real outcomes.*
- If they don't, they are working outside their region of competence …
- **or in other words, not acting in a fit manner for a professional !**

New Professionalism: getting started
Principles anyone can adopt tomorrow



PROVISIONAL LIST DEVELOPED WITH THE EDGE

ETHICS AND CONDUCT:

1. Be a steward of the community, its resources, and the planet. Take a broad view.
2. Do the right thing, beyond your obligation to whoever pays your fee.
3. Develop trusting relationships, with open and honest collaboration.

ENGAGEMENT WITH OUTCOMES:

4. Bridge between design, project implementation, and use. Concentrate on the outcomes.
5. Don't walk away.
   Provide follow-through and aftercare.
6. Evaluate and reflect upon the performance in use of your work. Feed back the findings.
7. Learn from your actions and admit your mistakes. Share your understanding openly.

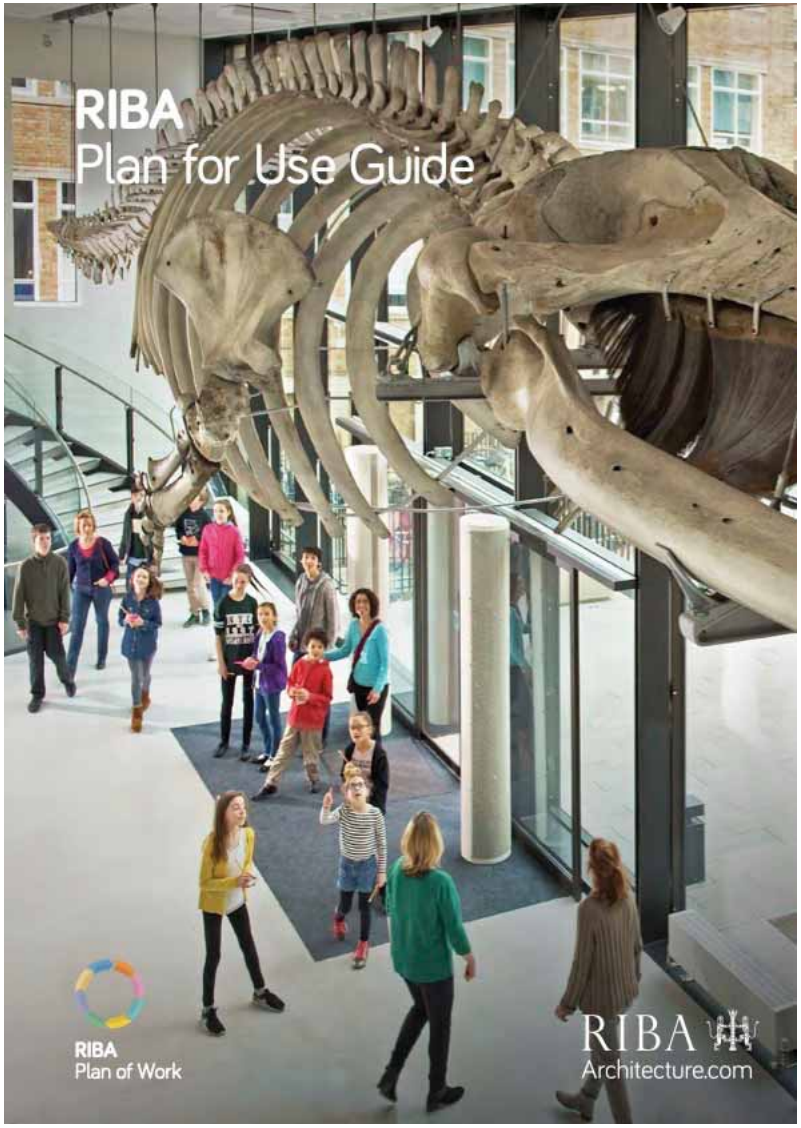
THE WIDER CONTEXT:

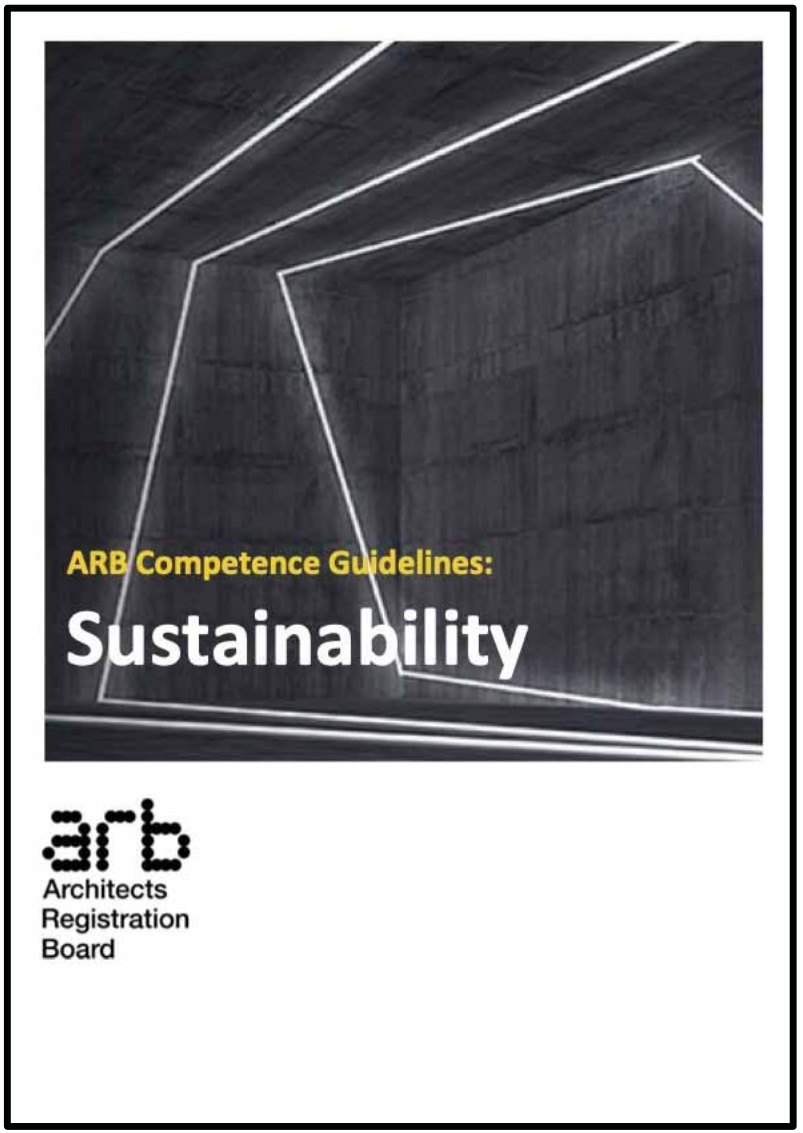
8. Seek to bring together practice, industry, education, research and policymaking.
9. Challenge assumptions and standards. Be honest about what you don't know.
10. Understand contexts and constraints. Create lasting value. Keep options open for the future.

SOURCE: The Editorial of BR&I **41**(1), Jan-Feb 2013 can be downloaded at www.tandfonline.com/toc/rbri20/41/1

Recent architectural responses: *Apr+Aug 2021*

Preceded by the RIBA Sustainable Outcomes Guide (2019)





SOURCE of RIBA's Plan for Use and related material: riba.org/work/insights-and-resources/plan-for-use-guide/

ARB – Architects Registration Board
Sustainability Competence Requirements 2021

A. ETHICS AND PROFESSIONALISM:
SA1. Climate science; SA2. Resilience, mitigation, adaptation;
SA3. Sustainable regenerative solutions and ethical sourcing;
SA4. Maintain knowledge of key legislation; **SA5. Share building performance data**.

B. SUSTAINABLE DESIGN PRINCIPLES:
SB1. Relationships between buildings, settlements, communities, climate. Design LZC;
SB2. Social sustainability and value; SB3. Biodiversity, access to green infrastructure;
SB4. • Retrofit and Fabric First • Passive Design • Daylight • Renewables • LCA and LCC • WLC and Low embodied carbon design • Water cycle, demand, supply, and reduction.

C. ENVIRONMENTAL AND BUILDING PHYSICS.
SC1. Temperature, humidity, sound & light; SC2. Comfort, IAQ & energy; SC3. Calculate operational and embodied energy and carbon **SC4. Do POE/BPE and understand gaps.**

D. CONSTRUCTION TECHNOLOGY.
SD1. Embodied carbon: resource & **performance** implications; SD2. Airtightness, thermal integrity; **SD3. Performance of energy systems**; SD4. Circular economy principles.

SOURCE: arb.org.uk/wp-content/uploads/ARB-Competence-Guidelines_-Sustainability.pdf

Achieving projects that work better in use: ***Soft Landings*** *antecedent to RIBA* ***Plan for Use***

Augments the duties of the design and building team, *(and of client representatives),* especially:

- During the critical briefing stage.
- With closer forecasting of building performance.
- With greater involvement with users before and after handover, and on-site presence during settling-in; and
- including monitoring and review for the first 3 years of use.

Soft Landings can:

- *Be used on any project, in any country, with any procurement route.*
- *Provide a fast track to raising building performance.*
- *Help to provide more customer focus for the industry.*
- *Improve client relationships and user satisfaction.*
- *Build recognition that some debugging is to be expected.*

It is primarily about a change in attitude.
It needs champions to take it forward - The new professionals: YOU!

Soft Landings: providing the "golden thread"
Key findings from its application 2009-2022

STAGE 1 – INCEPTION AND BRIEFING

Client leadership is key.
Champions need to be designated.

STAGE 2 – DESIGN AND CONSTRUCTION

A question of **attitude** – no additional costs.
Regular reality-checking is essential.
Clients must not drift off – too often they do.

STAGE 3 – PREPARATION FOR HANDOVER

Dialogue with occupiers+operators **needs more care**.

STAGE 4 – INITIAL AFTERCARE *typically Year 1*

Difficult for **contractors** not to **revert to type**.
Helps to have a **client budget** for fixing things quickly.

STAGE 5 – LONGER TERM AFTERCARE *Years 2+3*

Needs some **independent, disinterested input**.
Needs **funding outside the building contract**.

Published July 2009, minor revisions 2014, downloadable from www.usablebuidings.co.uk and www.softlandings.org.uk

Soft Landings and routine POE:
Everybody can win

- Better communication, proper expectations management, *fewer nasty surprises.*
- More effective building readiness. *Less rework.*
- Natural route for feedback and Post-occupancy evaluation, *to improve the product and its performance in use.*
- Teams can develop reputations for customer service and performance delivery, *build relationships, retain customers, improve commercial advantage.*
- Vital if we are to progress towards more sustainable, low-energy, low-carbon, well-liked buildings and refurbishments, *closing the credibility gaps.*

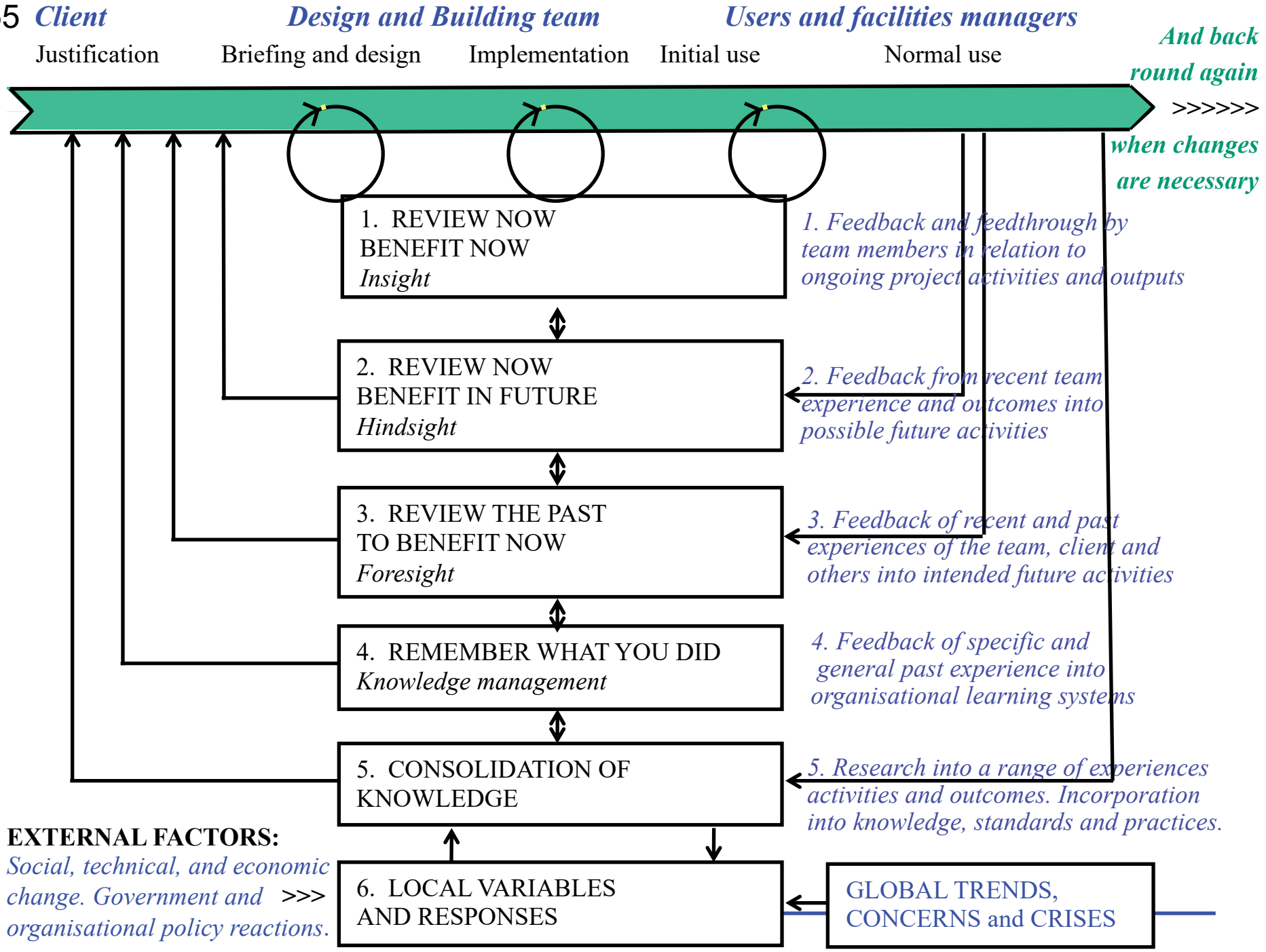
SO WHAT'S STOPPING US?

- ***ATTITUDES**: Everybody needs to be committed, starting with the client - perhaps the biggest obstacle. The "golden thread" needs to be put in place.*
- ***PROCESSES**: There is a learning curve to pay for (perhaps best from marketing budgets). The feedback information also has to be managed.*
- ***CAPACITY**: We need facilitators, investigators, troubleshooters and fixers.*
- ***MONEY**: Ringfenced budget for POE, tune-up etc. after practical completion.*
- ***IMAGINATION**: Often constrained by burgeoning bureaucracy!*

PART 5

THE VALUE ROUTINE
POE and BPE CAN BRING

at all six levels


Client
Design and Building team
Users and facilities managers
Justification
Briefing and design
Implementation
Initial use
Normal use
And back round again >>>>>>
when changes are necessary
1. REVIEW NOW BENEFIT NOW Insight
1. Feedback and feedthrough by team members in relation to ongoing project activities and outputs
2. REVIEW NOW BENEFIT IN FUTURE Hindsight
2. Feedback from recent team experience and outcomes into possible future activities
3. REVIEW THE PAST TO BENEFIT NOW Foresight
3. Feedback of recent and past experiences of the team, client and others into intended future activities
4. REMEMBER WHAT YOU DID Knowledge management
4. Feedback of specific and general past experience into organisational learning systems
5. CONSOLIDATION OF KNOWLEDGE
5. Research into a range of experiences activities and outcomes. Incorporation into knowledge, standards and practices.
EXTERNAL FACTORS:
Social, technical, and economic change. Government and >>> organisational policy reactions.
6. LOCAL VARIABLES AND RESPONSES
GLOBAL TRENDS, CONCERNS and CRISES

Examples of using BPE data and insights to improve any building-related project

FORESIGHT *(while developing the brief and approach)*

- Review published information *(reports, papers, articles etc.)*
- Review experience of your organisation and your wider team *(who to talk to, not and just what might have been recorded)*
- Visit and evaluate buildings and items of relevance *(this can also provide valuable team-bonding experiences).*

INSIGHT *(while a project is underway).* As above, and:

- Undertake pilot projects, build and evaluate mock-ups.
- Pitstops and reality checks.

HINDSIGHT *(once the project has been handed over).*

- Aftercare, troubleshooting and fine tuning
- Post-occupancy evaluation, *ideally repeated at intervals – dream on!*
- Record and share the data, insights and experience gained.

Benefits of POE Hindsights

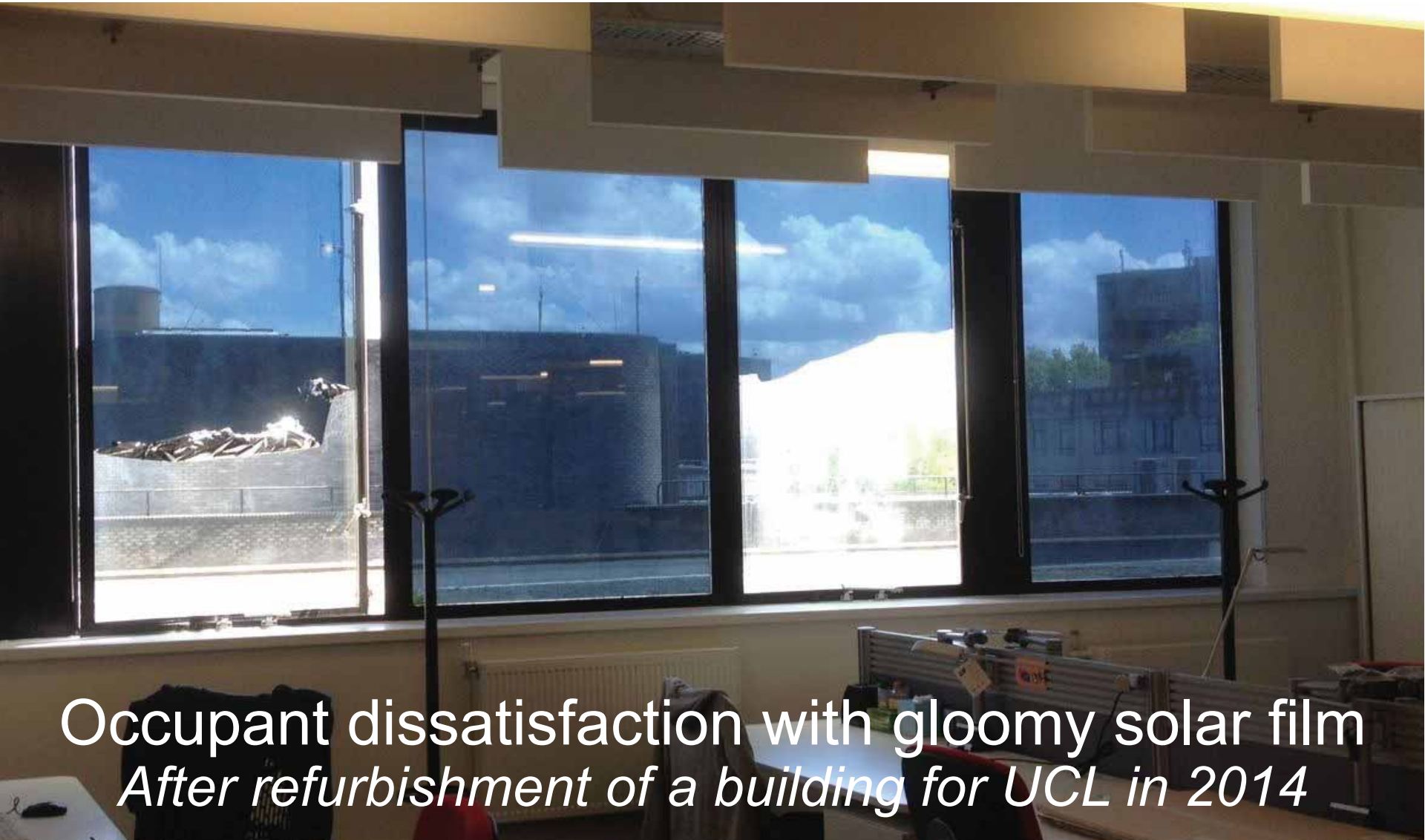
Clients too often claim POE benefits the next project not theirs, so why should they pay for it?

POE does incur costs *(best budgeted & managed separately from the building contract in our experience).*

But it usually more than pays for itself in terms of:

- More effective use of the building
- Better appreciation of design intent and potential
- Greater occupant satisfaction & productivity
- Lower energy costs – Payback often very fast
- Detecting and dealing with hidden problems
- Mutual education of occupiers, managers and designers.

Without aftercare, designers may never learn from unintended consequences



Occupant dissatisfaction with gloomy solar film

After refurbishment of a building for UCL in 2014

SOFT LANDINGS FOR SCHOOLS

Case Studies

Feedback from use of the Soft Landings Framework in new schools

Edited by Mike Buckley, Bill Bordass and Roderic Bunn

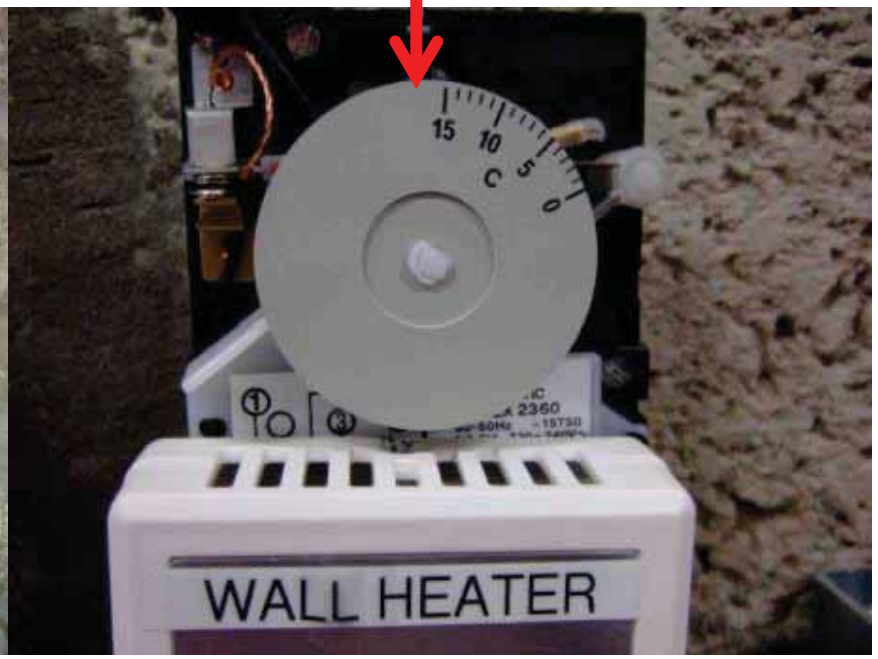
BSRIA BG 9/2010

SOFT LANDINGS

Research funded by **Technology Strategy Board**

Downloadable free from www.usablebuildings.co.uk .

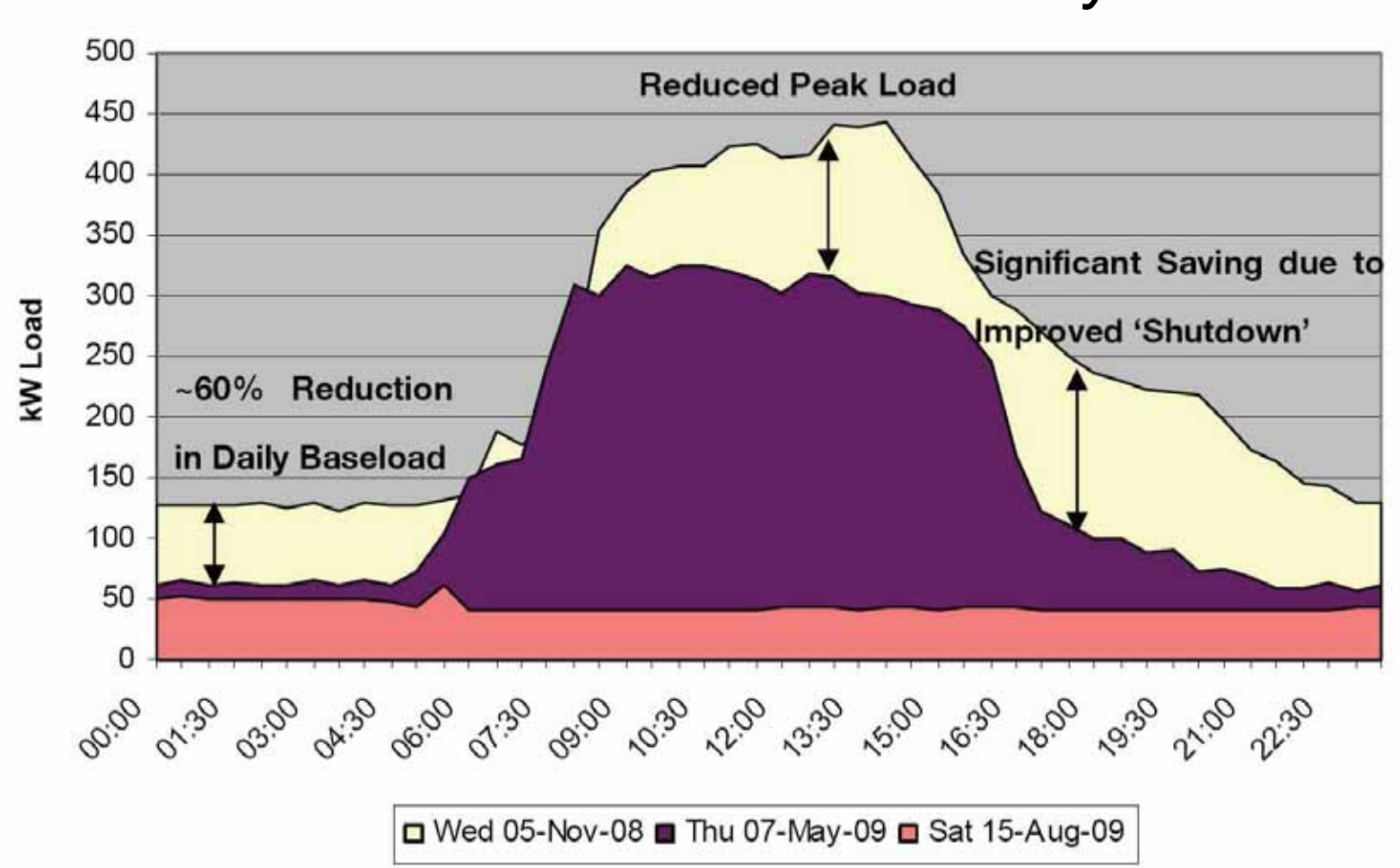
Aftercare can trap unintended consequences:
Example: sprinkler frost protection in a primary school



In 2008-09, this “tamperproof frost thermostat *(improperly set at 17° C)* energised the wall heater in the sprinkler pump room. Over a year, this wasted more electricity than the wind generator *(intended to offset the entire building’s annual heating energy use)* produced.

Aftercare management will often pay for itself

Intervention in a new secondary school



Saving over £ 50,000 p.a. in electricity bills: avoid default to ON

SOURCE: Buro Happold Engineers, *Soft Landings Trials* (2009).

Feeding forward in phased projects:

Window control improvements at Cambridge Maths building

PHASE 1 **>>>**

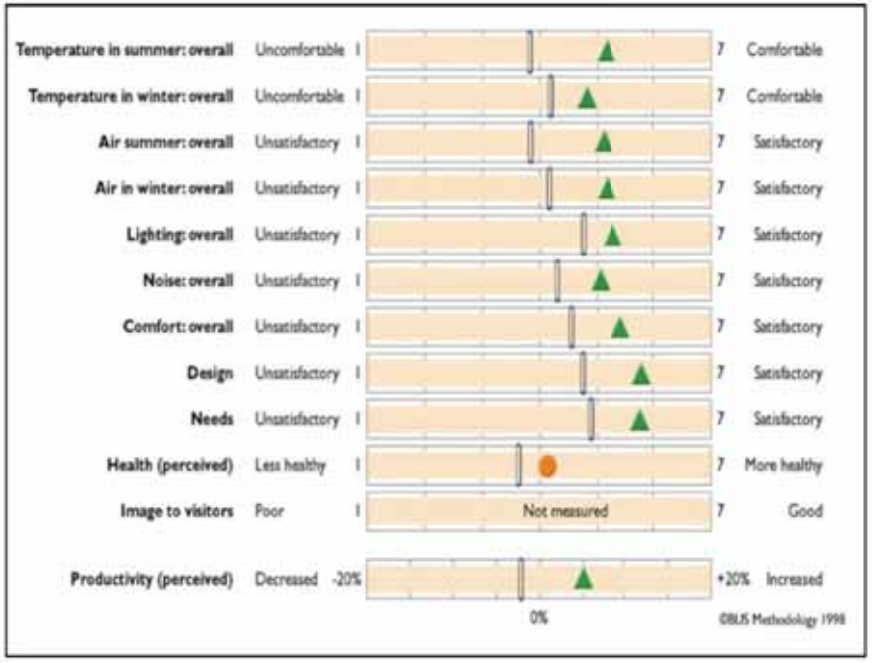
- Difficult to understand
- Some poorly located
- Remote control problems

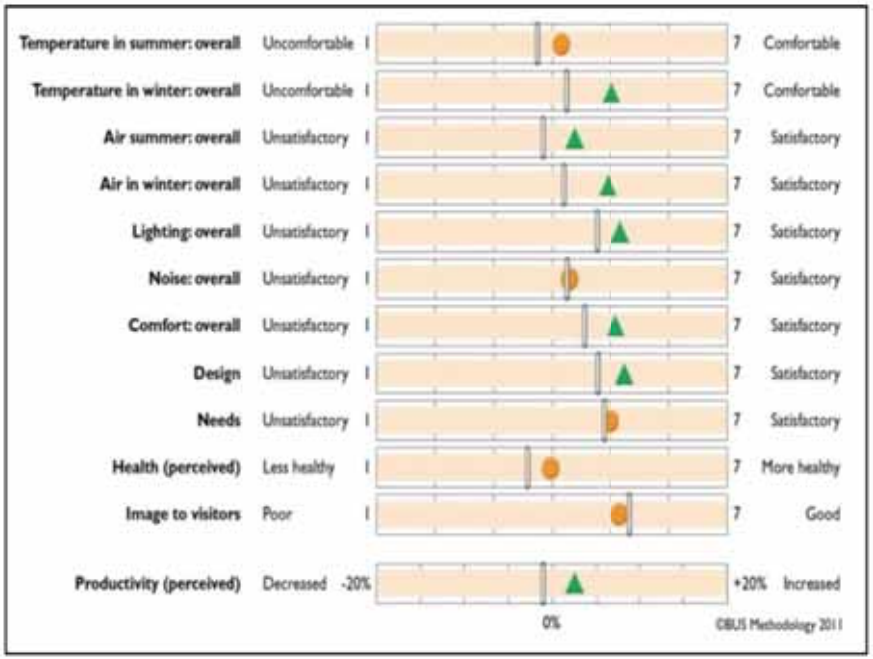
PHASE 2

- Improved, custom design
- Better located
- Not yet perfect

Revisiting projects: *Longitudinal surveys*

1998 *BUS Occupant questionnaire* ***2011***





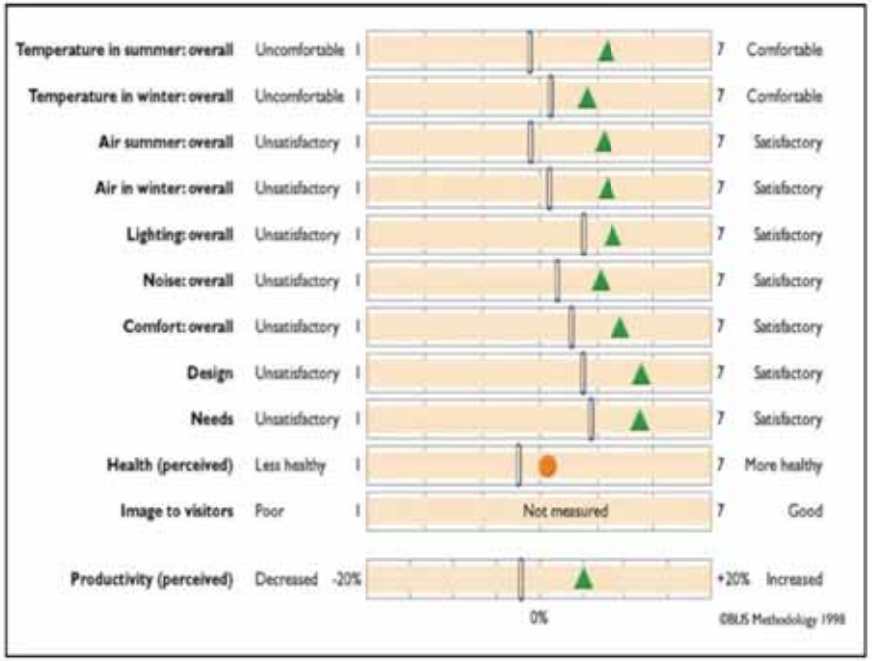
Average scores from BUS occupant survey questionnaire:
Vertical bars = benchmark medians from similar buildings.
Green triangles = significantly better than benchmark.
Orange circles = indistinguishable from benchmark, Red squares = worse

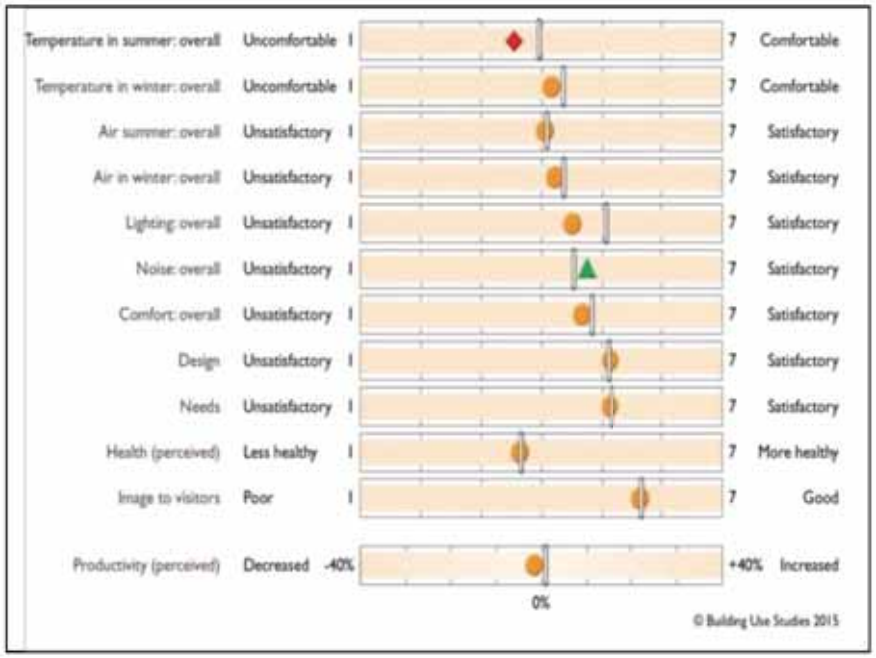
Some degradation over the years, but recognisably similar

SOURCE: W Bordass and A Leaman, *The Elizabeth Fry Building revisited,* Building Services Journal, 30-36, (March 2012).

Revisiting projects: *Longitudinal surveys*

1998 *BUS Occupant questionnaire* ***2015***





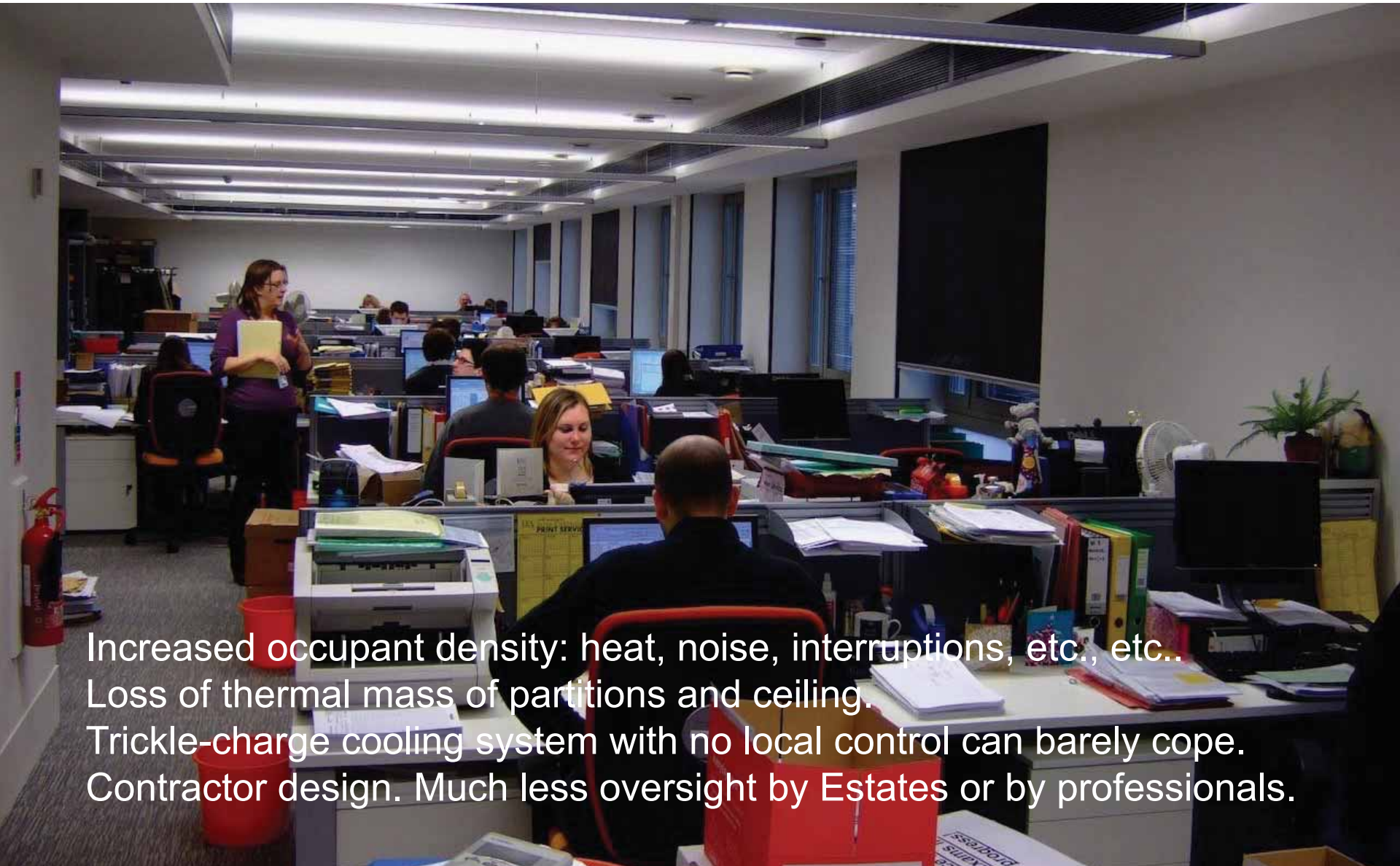
Average scores from BUS occupant survey questionnaire:
Vertical bars = benchmark medians from similar buildings.
Green triangle = significantly better than benchmark.
Orange circle = indistinguishable from benchmark, Red diamond = worse.

Now very much average – *WHAT HAPPENED ?*

SOURCE: R Bunn and L Marjanovich, *Occupant satisfaction signatures: Longitudinal studies,* CIBSE Symposium (April 2016).

The building and its use was altered

particularly ca. 2012: this was once four seminar rooms



IN FUTURE: Moving from design for compliance to *Design for Performance*

BBP | BETTER BUILDINGS PARTNERSHIP | OUR RESOURCES | OUR MEMBERS

Design for Performance

The Design for Performance Project is an industry initiative led by Verco and including BSRIA, Arup and the Usable Buildings Trust (UBT), and supported by the BBP, which aims to change the way we design new office developments in the UK. The project looks abroad to the hugely successful Australian NABERS Commitment Agreement and explores the applicability and opportunity of developing and testing such a framework in the UK.

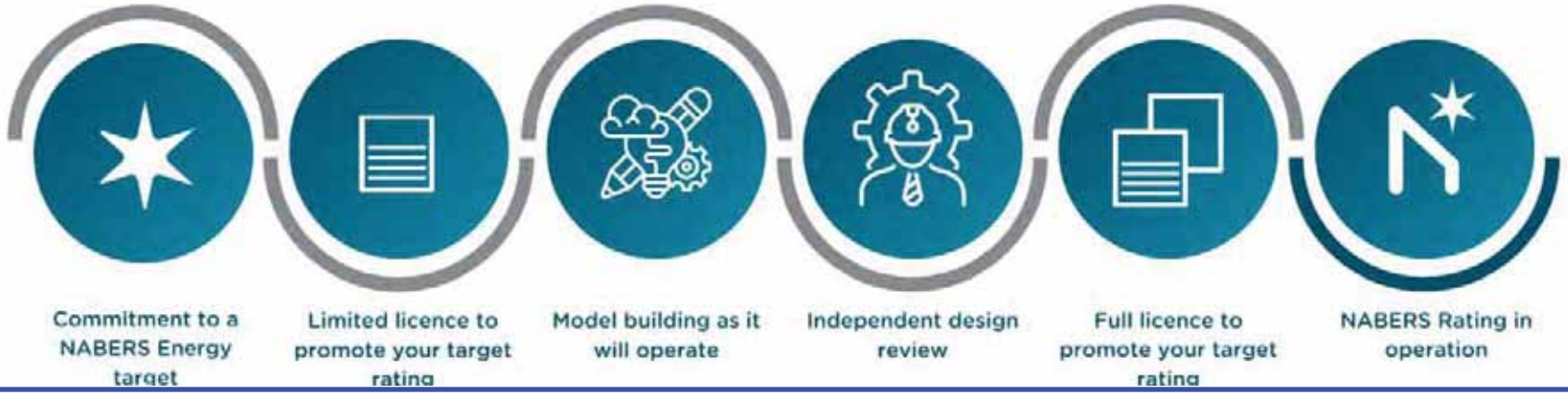
The energy efficiency of new offices in the UK is subject to Building Regulations Part L and represented in market transactions by Energy Performance Certificates (EPCs). Developers, owners and occupiers of new and refurbished buildings might reasonably expect that these mechanisms will produce a building that is energy efficient in operation. However, both focus on design and technology that improves predicted building performance, not on achieving directly measureable improvements in performance in-use.

The consequence has been a *design-for-compliance* culture, and a disconnect between the regulatory framework and the influence it has on the energy use and associated carbon emissions it is supposed to be limiting – the so-called 'Performance Gap'. Voluntary

FOR THE LATEST INFORMATION GO TO: www.betterbuildingspartnership.co.uk/node/360

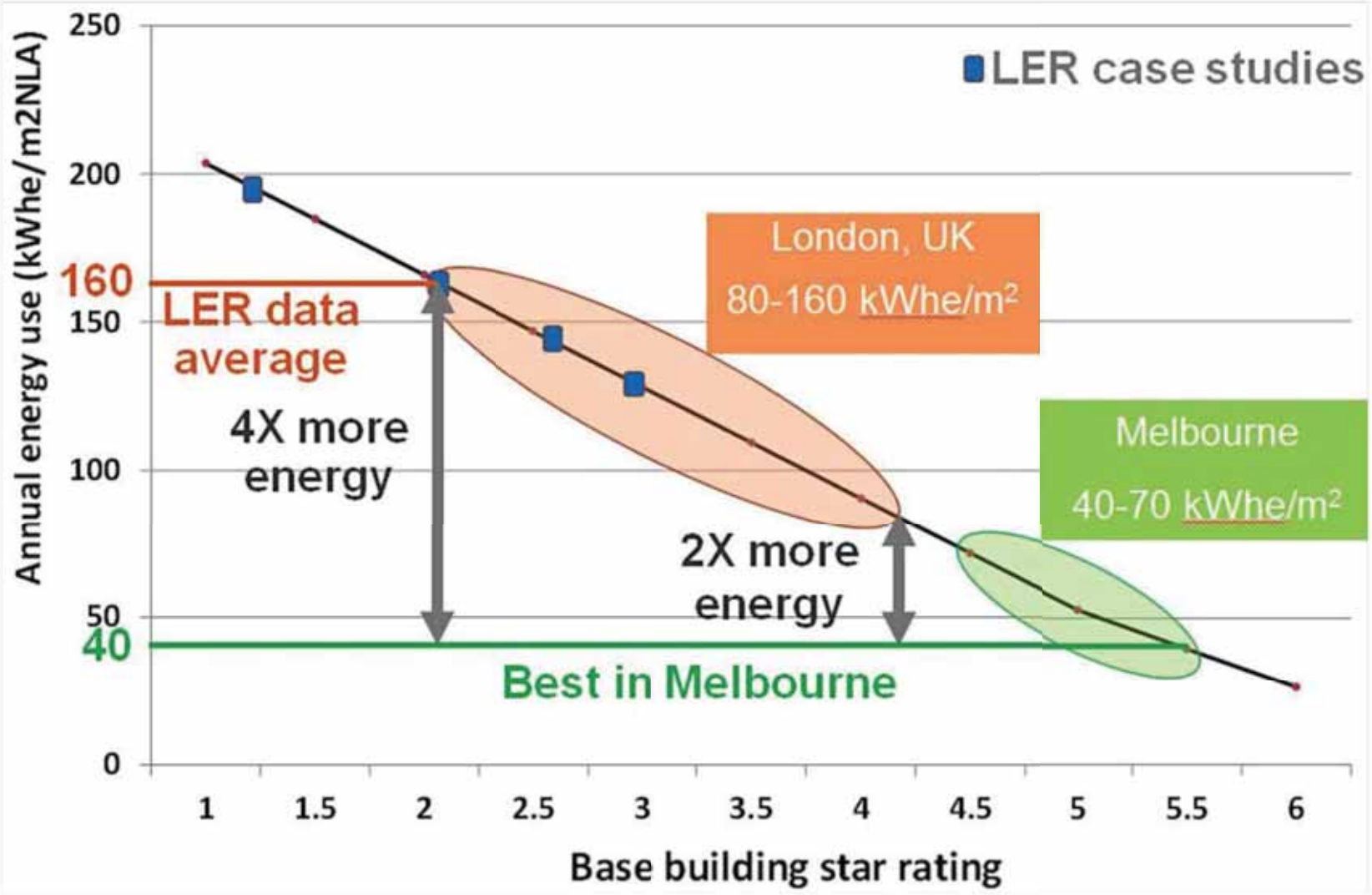
Design for Performance CAs - *Commitment Agreements, as developed by NABERS in Australia*

- Developer signs up to provide guaranteed in-use energy performance for the "Base Building" – *the landlord's areas and services.*
- All new members of the design, construction and management team sign up to a *Commitment Agreement.*
- Modelling *includes assessment of controls and "off-axis" scenarios.*
- Design and Model reviewed by *independent assessors.*
- Metering systems allow *outcomes* to be reviewed.
- The completed building is *fine-tuned* as necessary.
- Results are *benchmarked and reported.*



SEE: www.betterbuildingspartnership.co.uk/resources?topic=24 and www.cibse.org/nabers-uk

Potential reward in landlord annual energy use:
London (without CAs) & Melbourne (with CAs)



SOURCE: R Cohen, P Bannister, B Bordass, *NZE buildings in reality, not just in theory,* REHVA Journal, 56-59 (May 2016).

Might we be starting to get there? **Nov 2025**

Far too late: *we could have had integrated certification*

Leeds office achieves 5-Star NABERS UK Energy Rating

The 11&12 Wellington Place office development in Leeds has made history by becoming the first new building in the UK to achieve a 5-star NABERS UK energy rating. For the engineering team, it's just the beginning, as they push for even greater efficiencies to future-proof the investment

Posted in October 2025

'Five stars is excellent, but that's just the starting point for us. We see this building as having a lot more to give,' says Brad McHale, principal mechanical engineer at Arup. McHale is talking about the speculative office building 11&12 Wellington Place, Leeds, which has made history by becoming the first new building in the UK to achieve a NABERS UK 5* Energy Rating.

cibse Journal

Don't miss an issue

Sign up to the CIBSE Journal newsletters

The first UK office with measured in-use operational performance that matches its declared design intent.

SOURCE: *Aiming for the Stars,* CIBSE Journal, 22-26 (November 2025).

PART 6

CASE STUDY:
Feeding forward between projects

Feeding forward between projects:

National Trust *to* *Woodland Trust*

For further reading, see B Bordass et al, *Trees of Knowledge,* CIBSE Journal 20-26 (Oct 2014). Download at usablebuildings.co.uk

National Trust Heelis HQ Building
Outline of project, completed 2005

Offices, catering for staff and public, central IT servers, shop.

Client and design intent for a sustainable building, including:

- Deep plan (with courtyards) for good communications.
- Low rise (2 storey) with rooflights for natural light and ventilation.
- Automatic natural ventilation with low energy mechanical backup.
- Low energy aspirations. Large PV array added: big grant available.
- Expectations managed using a matrix of features vs. aspirations.

Procured as a pre-let:

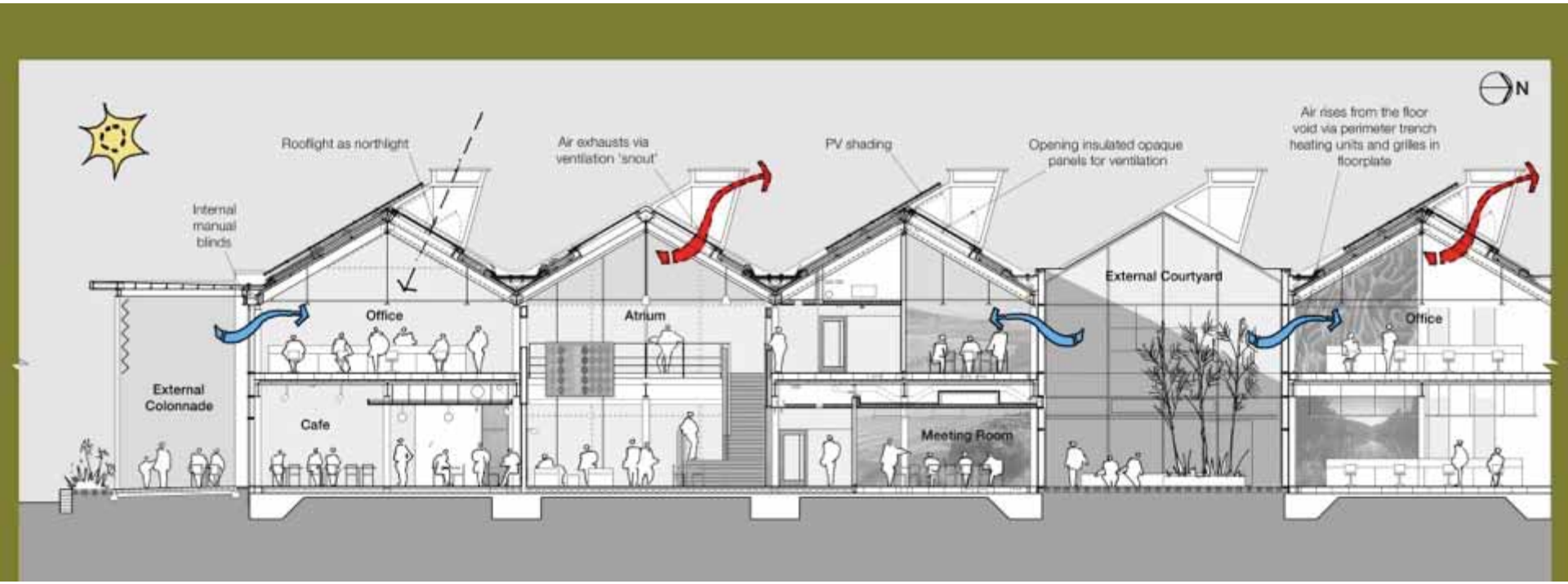
- Scheme design by Feilden Clegg Bradley (FCBS, architects), Max Fordham (building services), Adams Kara Taylor (structural).
- Then novated to: Aim Investments (investor), Kier Ventures (developer), Moss Construction (contractor).

Awards 2006: *BCO Innovation, Civic Trust Sustainability, RIBA Sustainability.*

FCBS spent the RIBA prize money on the POE, plus a bit for a party!

Heelis cross-section *(south to the left)*

Aim was good daylight on both floors



My lifetime ambition: *"Buildings with no heating, no cooling, and no artificial lighting while the sun is above the horizon."*

MAX FORDHAM, Principal, Max Fordham and Partners.


Main (south) facade to the rignt >>>

Heelis entrance south facade

Heelis atrium

Heelis office interior

Heelis: some environmental systems

Heelis was a Soft Landings pioneer

Its architects and engineers were on its research team

1. Inception and Briefing
   Appropriate processes.
   Assigned responsibilities.
   Well-informed targets.
2. Design development
   and expectations management.
3. Preparation for handover
   better operational readiness.
4. Initial aftercare
   Information, troubleshooting,
   fine tuning, training.
5. Longer-term aftercare
   monitoring, review, independent
   POE, feedback and feedforward.

Design intent to reality: *if expectations are not constantly reviewed, credibility gaps will open up*

e.g. for energy and carbon performance

DESIGN ESTIMATES NOT SET CLEARLY OR REALISTICALLY:

- Little or no transparency between design estimates and in-use outcomes.
- Not everything is counted: *only normal "regulated" services in typical spaces.*
- Estimates are too optimistic, e.g. *no night loads, perfect control.*
- A policy concentration on carbon has drawn a veil over underlying energy performance.

SLIPPAGE DURING DESIGN AND CONSTRUCTION:

- Design does not get into areas of critical detail, or understand the users.
- Changes to design and client requirements, *vandal "Value Engineering".*
- Changes during construction and commissioning: *negotiations, substitutions, build quality, systems, deployment of controls, delays.*

SLIPPAGE AFTER COMPLETION:

- No follow-through, initial aftercare, fine-tuning, monitoring, or feedback.
- Fitout changes and clashes.
- Spilt responsibilities: *developer/owner, landlord/manager/tenant, outsourcing. Principal/agent problems. Procurement of controls and FM services.*
- Unintended consequences and revenge effects, *technical and management shortcomings, controls problems, poor user interfaces, default to ON.*

DESIGN INTENT NEEDS MANAGING THROUGH THE PROCESS AND ON INTO USE

Soft Landings Stage 2 components: *The sustainability matrix at Heelis*

Architect and engineer were on the Soft Landings research team

1. Key attributes rated on a scale

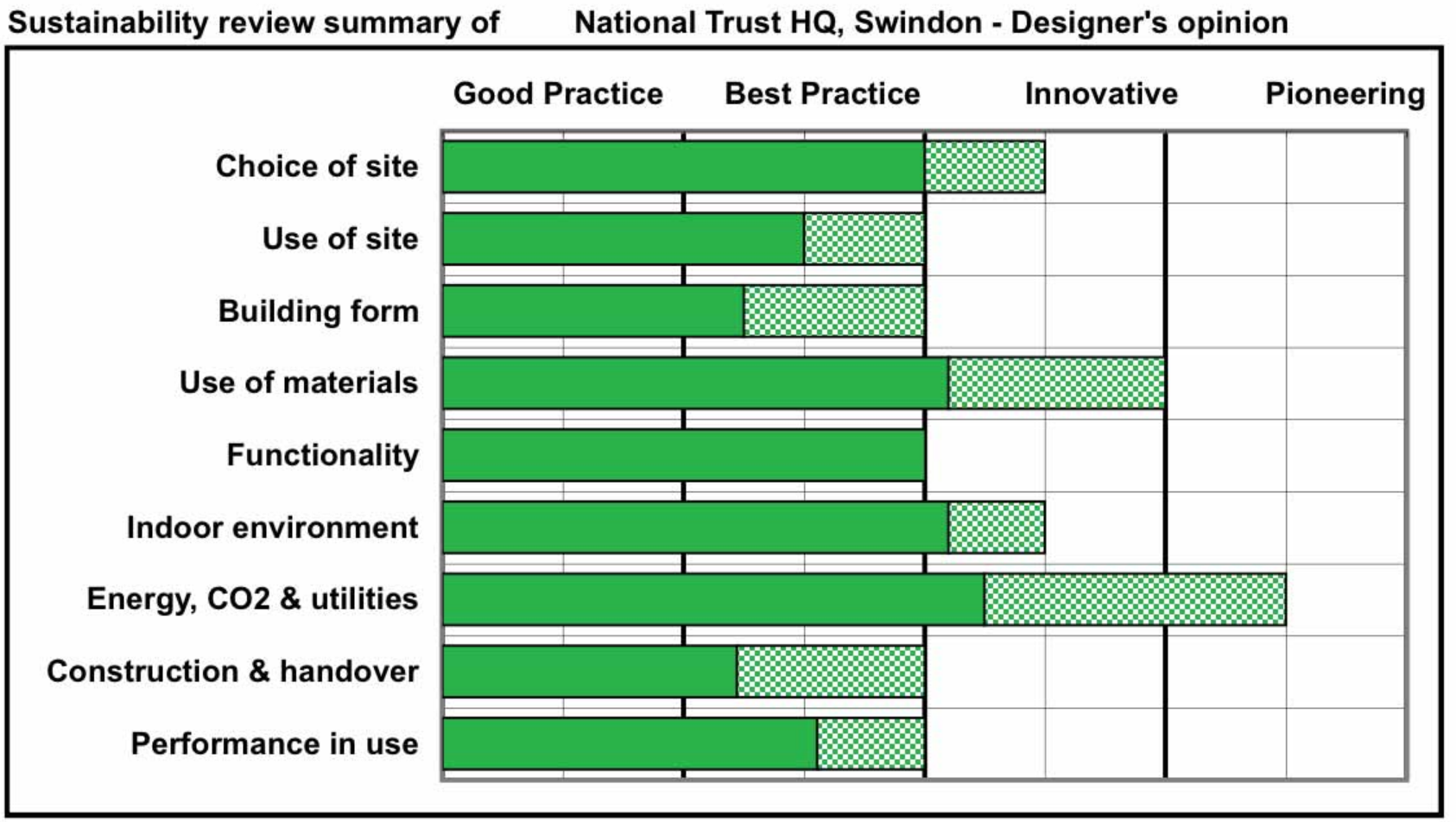
- Pioneering
- Innovative
- Best practice
- Good practice
- *… and added later to generalise:* Standard *and* Sub-standard *because there will always be constraints (e.g. location)*

2. Attributes calibrated and used in progress reviews

- Client/design team discussion of appropriate qualitative standard.
- Appropriate targets identified.
- Data, techniques and costs reviewed, and targets confirmed.
- Matrix used for management review and cost checks.

REF: W Gething & W Bordass, *A rapid assessment checklist for sustainable buildings,* BR&I **34**(4), 416-426 (2006).

Soft Landings Stage 2 components:
Simplified sustainability matrix for Heelis



KEY: ***Solid bars = on average, Hatched = best component***

REF: W Gething & W Bordass, *A rapid assessment checklist for sustainable buildings,* BR&I **34**(4), 416-426 (2006).

Managing expectations with Soft Landings:

Snapshot from the matrix used to manage Heelis design

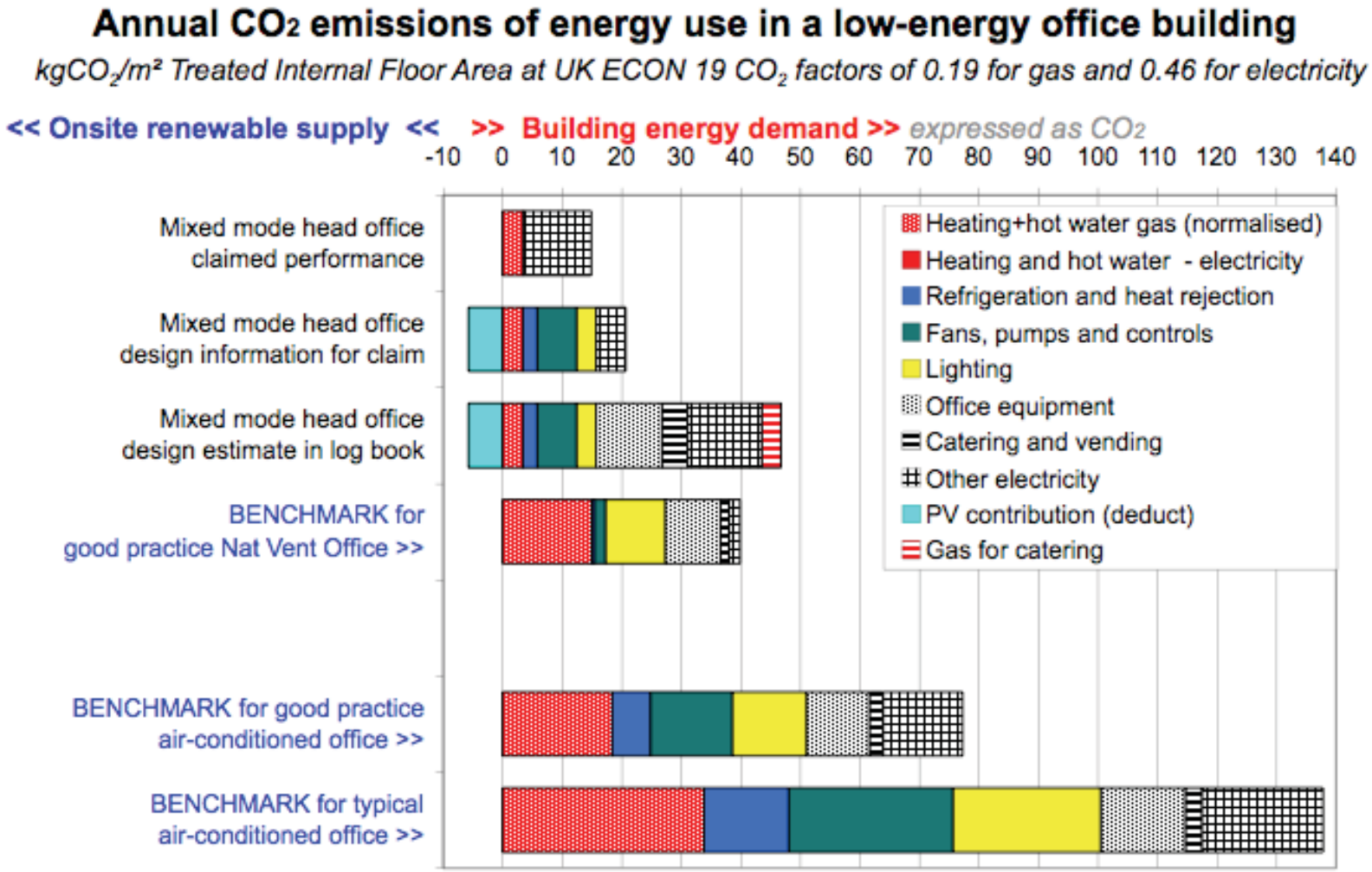
Sustainability Matrix: Offices **Feilden Clegg Bradley Architects LLP ©**

Operational Energy Consumption and CO^2 Emissions

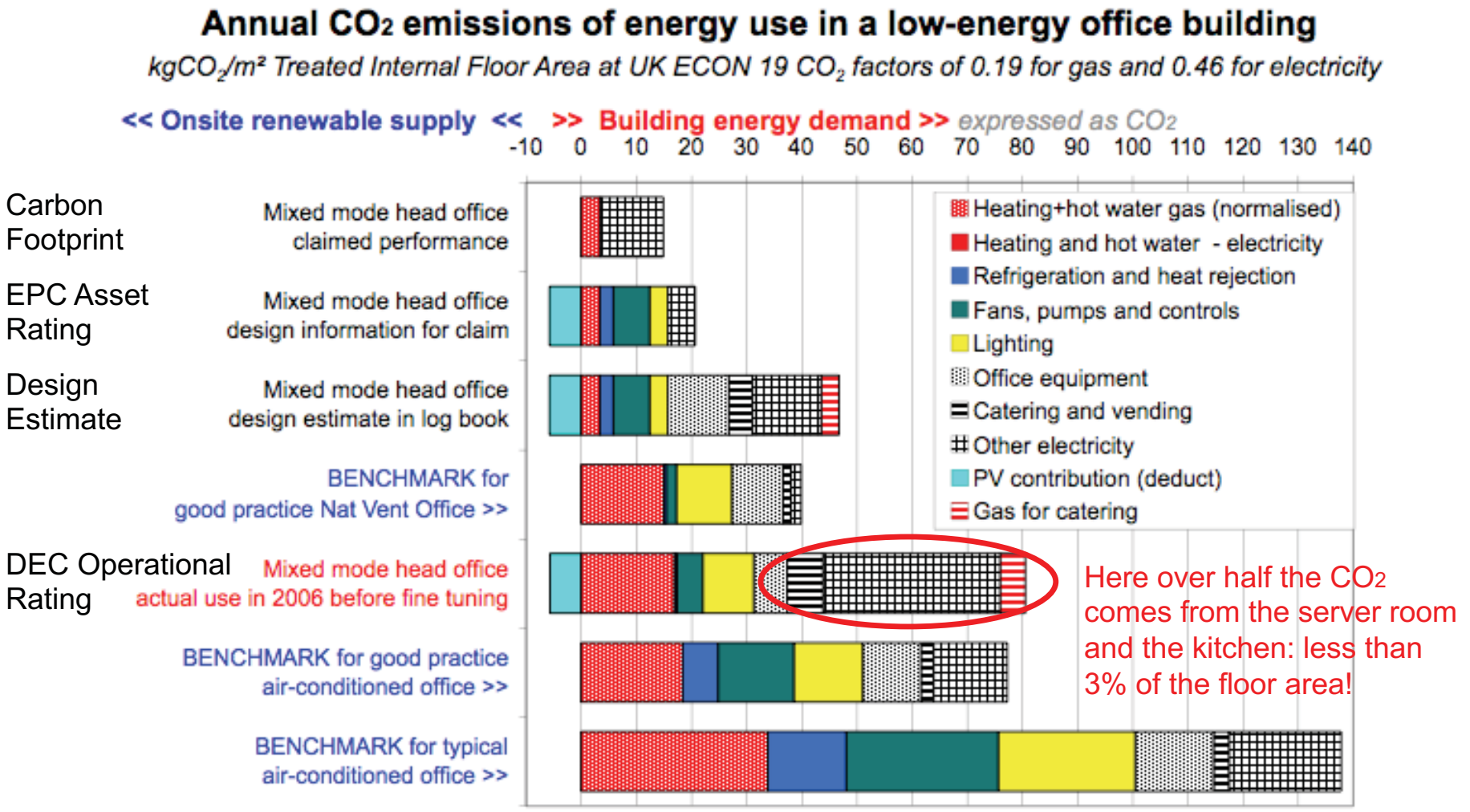
	1. GOOD PRACTICE	2. BEST PRACTICE	3. INNOVATIVE	4. PIONEERING	NOTES
1. CO^2 Emission Target	40kgCO^2/m²/yr	30kgCO^2/m²/yr	15kgCO^2/m³/yr	"Carbon neutral" 0kgCO^2/m	Industry standard EEO targets
2. Heating Load Target	79kWhr/m²/yr	47kWhr/m²/yr	30kWhr/m²/yr	20kWhr/m²/yr	Industry standard EEO targets
3. Electrical Load Target	54kWhr/m²/yr	43kWhr/m²/yr	35kWhr/m²/yr	25kWhr/m²/yr	Industry standard EEO targets
4. U Values: Wall	0.35	0.25	0.2	0.1	good practice=current building regulations pioneering=Bedzed values
Average Window	2.2	1.8	1.4	0.9	
Roof	0.2	0.18	0.15	0.1	
Ground Floor	0.25	0.22	0.2	0.1	
5. Airtightness	<10m³/hr/m²	<8m³/hr/m²	<5m³/hr/m²	<3m³/hr/m²	All measures require careful attention to details and monitoring construction.
6. Ventilation	Natural ventilation where possible. Mechanical ventilation where not.	Designed natural ventilation with automatic openers, mechanical ventilation to WCs etc.	Mechanical ventilation with heat reclaim in winter and BMS controlled natural ventilation in summer.		BMS with manual overrides preferable on all windows.
7. On Site Energy Generation		Solar domestic water heating to WCs.	Solar domestic water heating to WC cores. Cost effective PV installation using PVs to shade rooflights. Gas fired CHP installation.	Solar water heating to kitchens. Maximum PV installation using most efficient PVs. Wood/waste fired CHP.	Potential 50% grant available from DTI for wolar water heating, up to 65% for PV installation.
8. Daylighting	"Reasonable" to BS8206 part 2. A 2% daylight factor.	80% office space daylit to meet criteria of BS8206: part 2.	100% of office space daylit to BS8206 part 2		Ensure prevention of solar heat gain/glare by building form/shading systems
9. Artificial Lighting Controls	PIR detectors in WCs etc. Low energy fittings throughout.	Luminance and presence detectors throughout building. No dimming.	Luminance and presence detection at all fittings with dimming to zero and BMS override.		Personalised controls strongly recommended by Rob Jarman
10. Cooling Systems/Sources	Zero ozone depletion refrigerants in high efficiency comfort cooling/air conditioning systems.	Night time structural cooling with automatic window vents.	Evaporative cooling to rooms with high internal heat gains.	Borehole/ground water cooling to rooms with high internal heat gains.	Need to provide for areas where cooling is required and provide upgrade path for entire building.
11. Embodied Energy in Structural Materials	Steel and concrete frame engineered to minimise mass of materials.	Use of cement replacements eg GGBFS in concrete. Use recycled steel.	Timber structure in lieu of steel or concrete but retaining concrete floors. Use of recycled aggregates in structural concrete.	All timber structure with thermal mass provided using minimum amount of concrete.	NB. Rob Jarman particularly keen on use of timber for low embodied energy

REF: W Gething & W Bordass, *A rapid assessment checklist for sustainable buildings,* BR&I **34**(4), 416-426 (2006).

Heelis design energy data
expressed as CO_2 emissions (factors at the time)

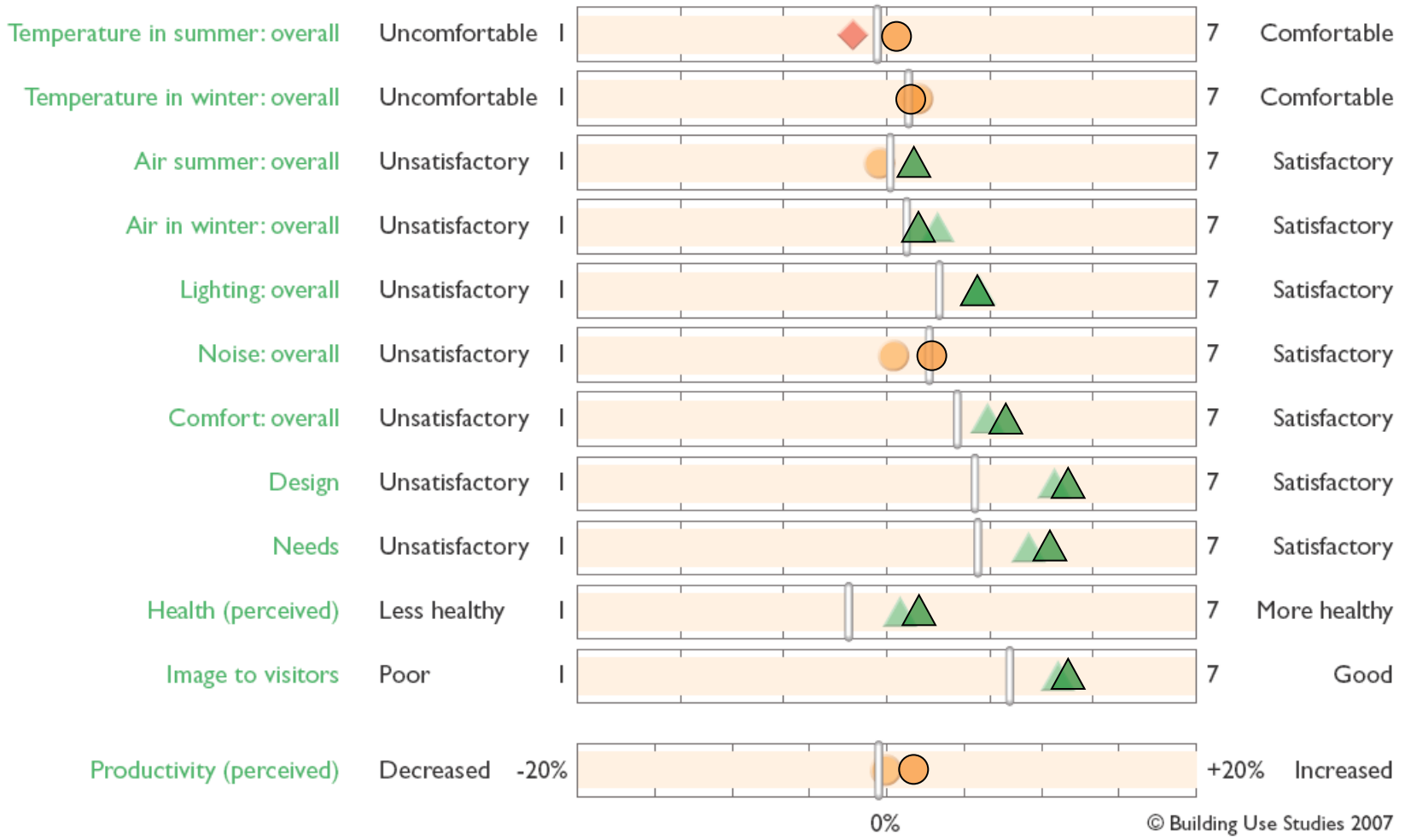


Heelis POE: metered performance 2006
expressed as CO_2 emissions (factors at the time)



Heelis occupant satisfaction 2006 & 2007

some items from BUS questionnaire survey



Heelis POE: main conclusions *on energy and internal environment*

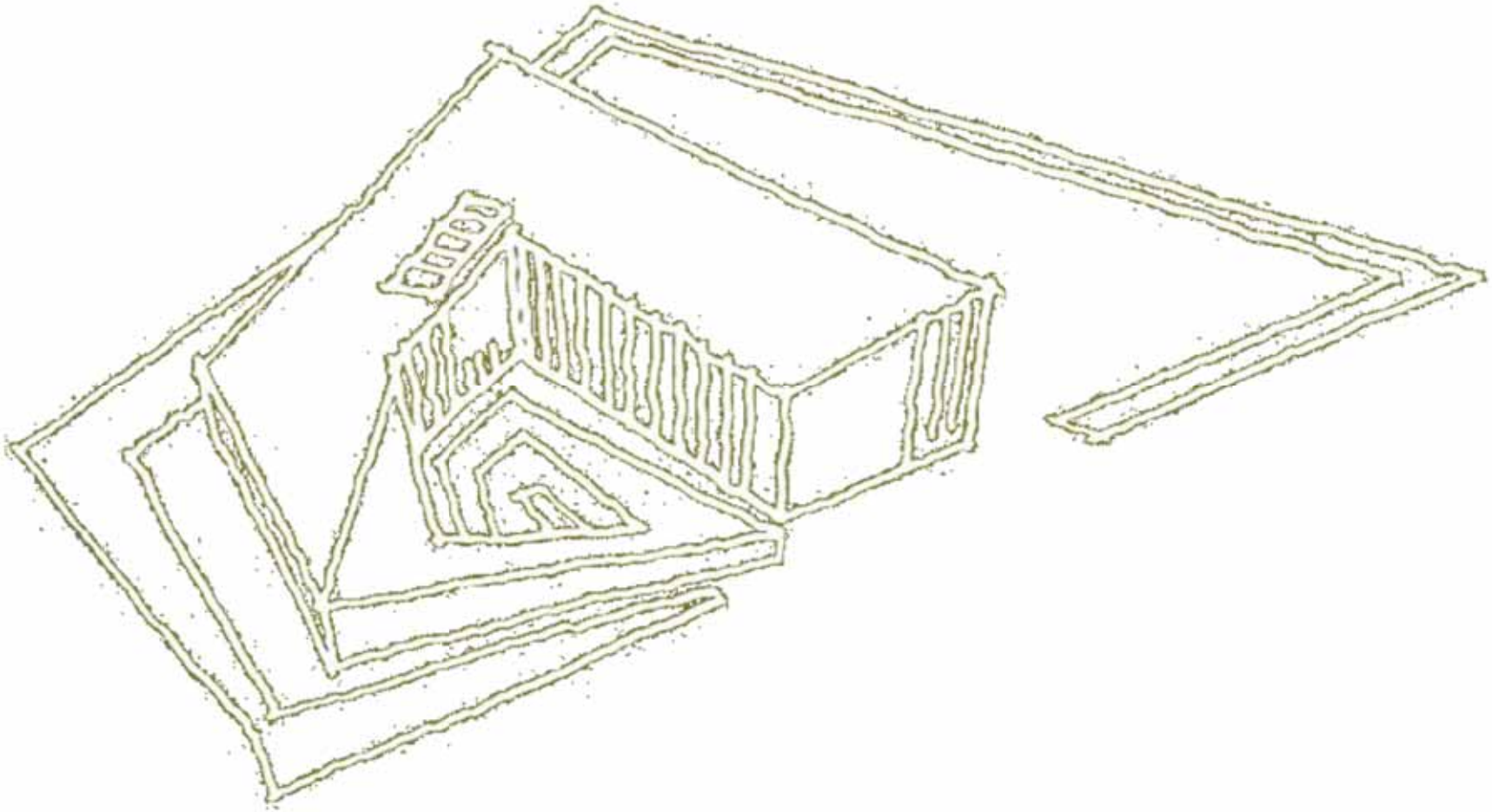
- **DAYLIGHT:** design needs to take account of indoor appearance, not just desktop illuminance. *Added wall washing would save lighting energy.*
- **SPECIAL AREAS:** Energy use in server room and kitchen creates more than half the CO_2 emissions. *Need more design & management attention.*
- **METERING & MONITORING:** *More attention needed to work well.*
- **HEATING & HOT WATER:** *Performance disappointing.*
- **ENERGY MANAGEMENT:** Improved in 2007. *But scope for more savings, including reduction in night loads. User interfaces leave a lot to be desired.*
- **SUMMER COMFORT:** Occupant survey shows better satisfaction in 2007, owing to cooler weather, better control and management. *Control strategy might seek better balance between temperature and air movement.*
- **WINTER COMFORT:** Improved. Window controls have been fine-tuned.
- **OCCUPANT SATISFACTION:** Heelis (2007) had the best overall score in the BUS database for “green” buildings with deep floorplates *(but simpler, shallow buildings tend to perform better, with more perceived control).*

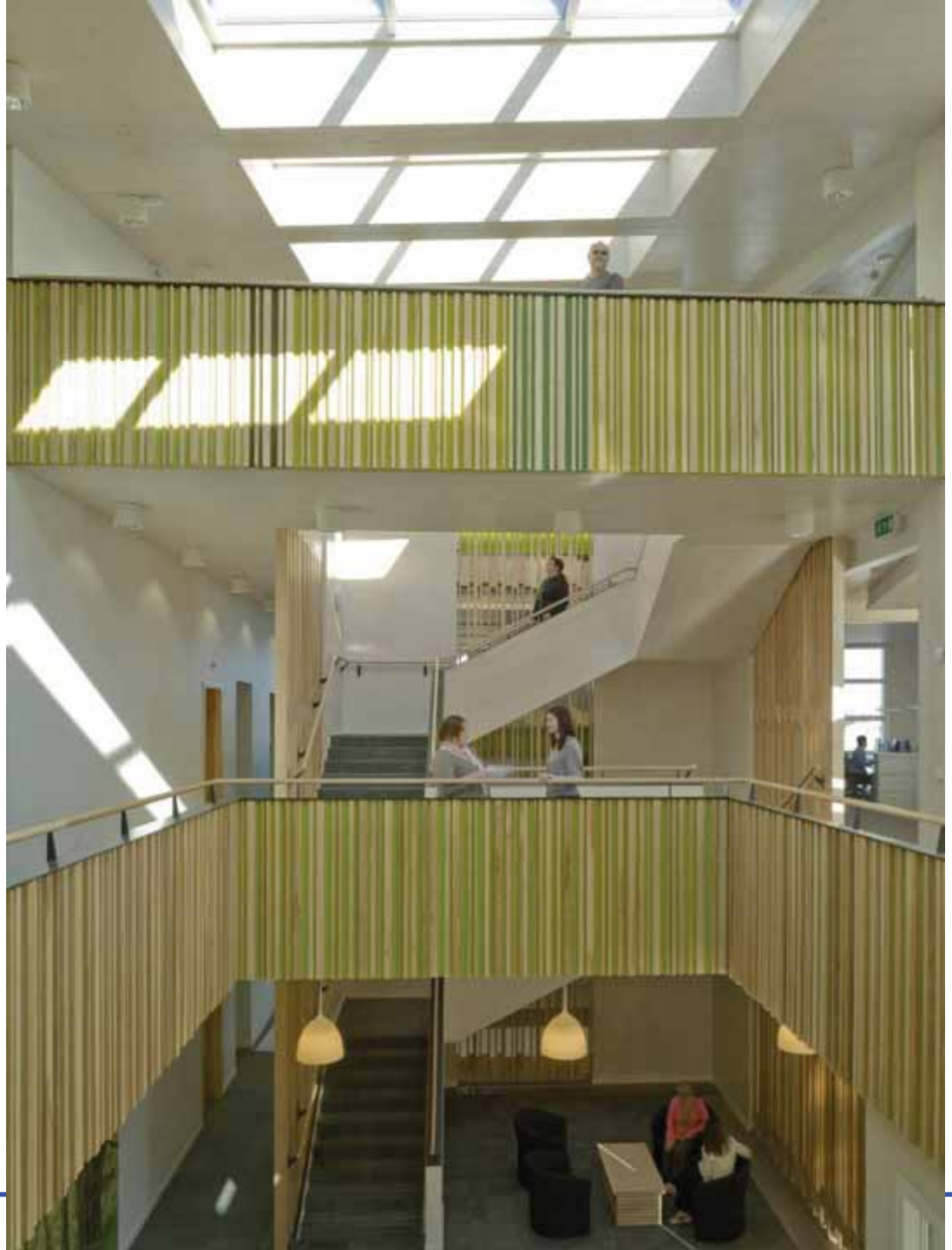
LEARNING FROM THE HEELIS POE
at the Woodland Trust HQ, Grantham

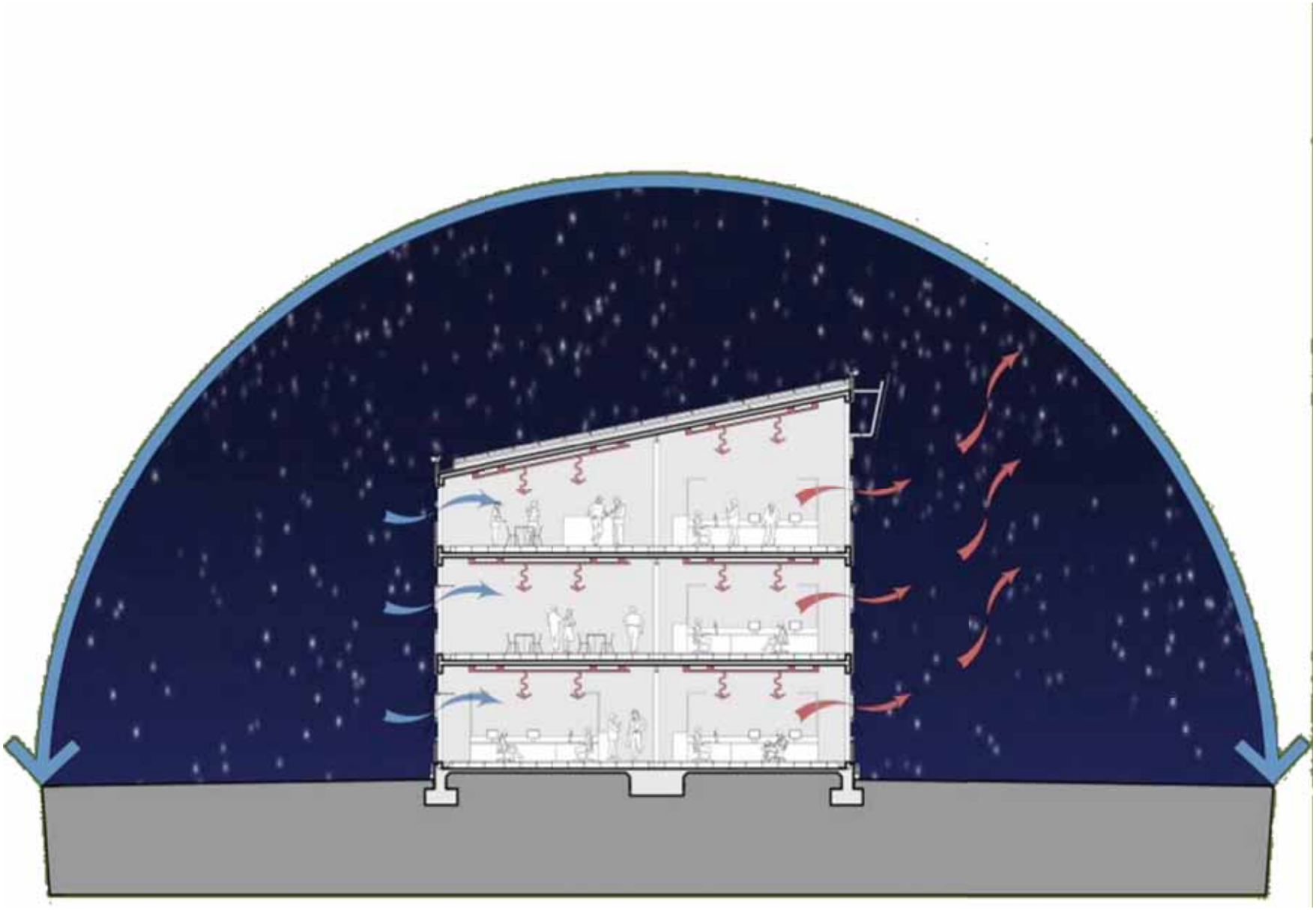
The same architects (FCBS) & services engineers (Max Fordham).
The CEO of the Woodland Trust also joined from the National Trust.

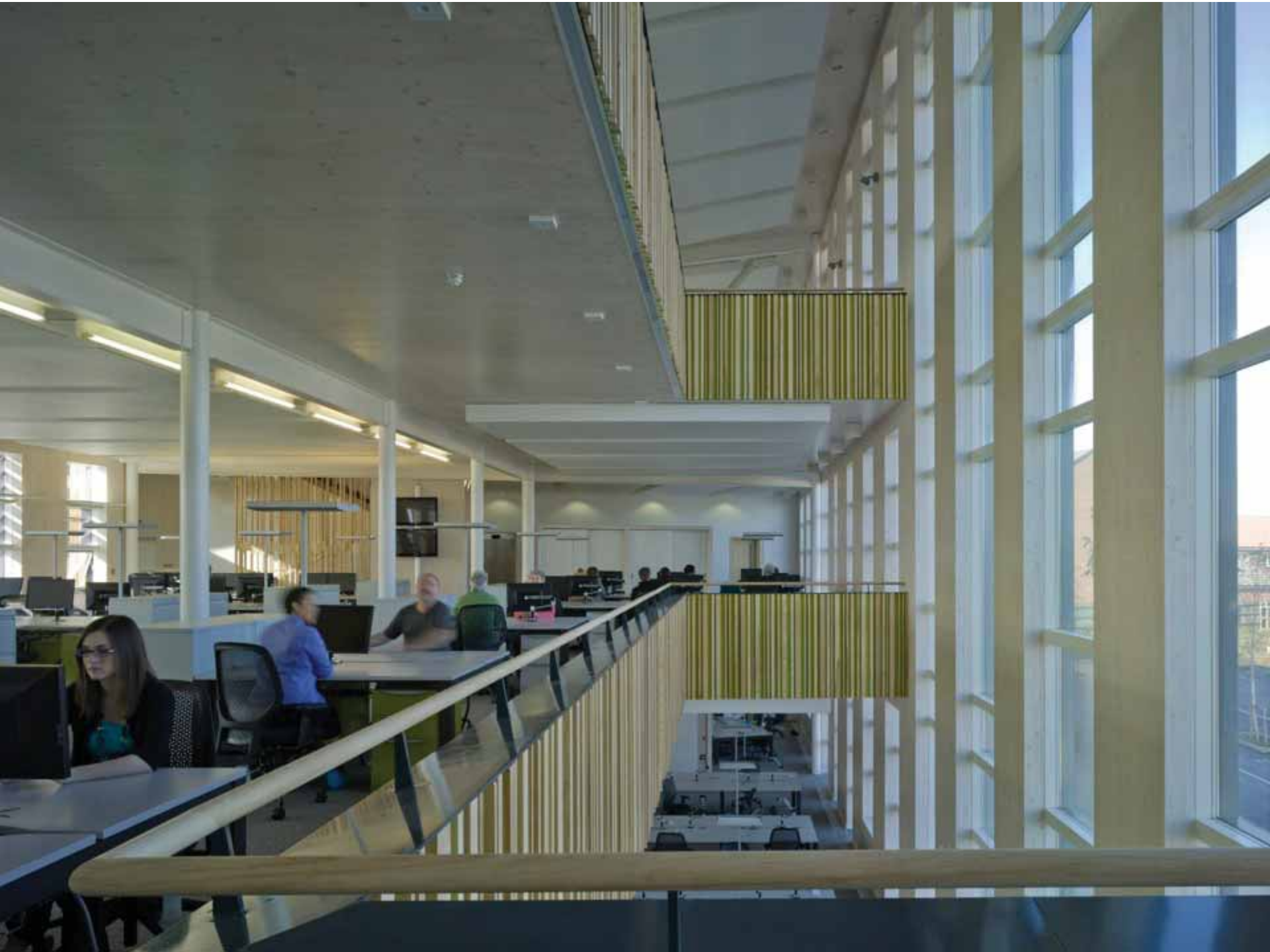
SOME LESSONS INCORPORATED IN THE DESIGN:

- Make it simpler: *controls, shallow plan, naturally ventilated*
- Task-ambient lighting, *including wall-washing.*
- More energy-efficient ICT, *with thin clients.*
- Soft Landings, *but less rigorously applied than at Heelis.*
- Early appointment of Facilities Manager.
- Managed move-in process, *with newsletters from the FM.*
- Follow-through, *including a successful bid to the Technology Strategy Board (now called Innovate UK) for a detailed POE.*









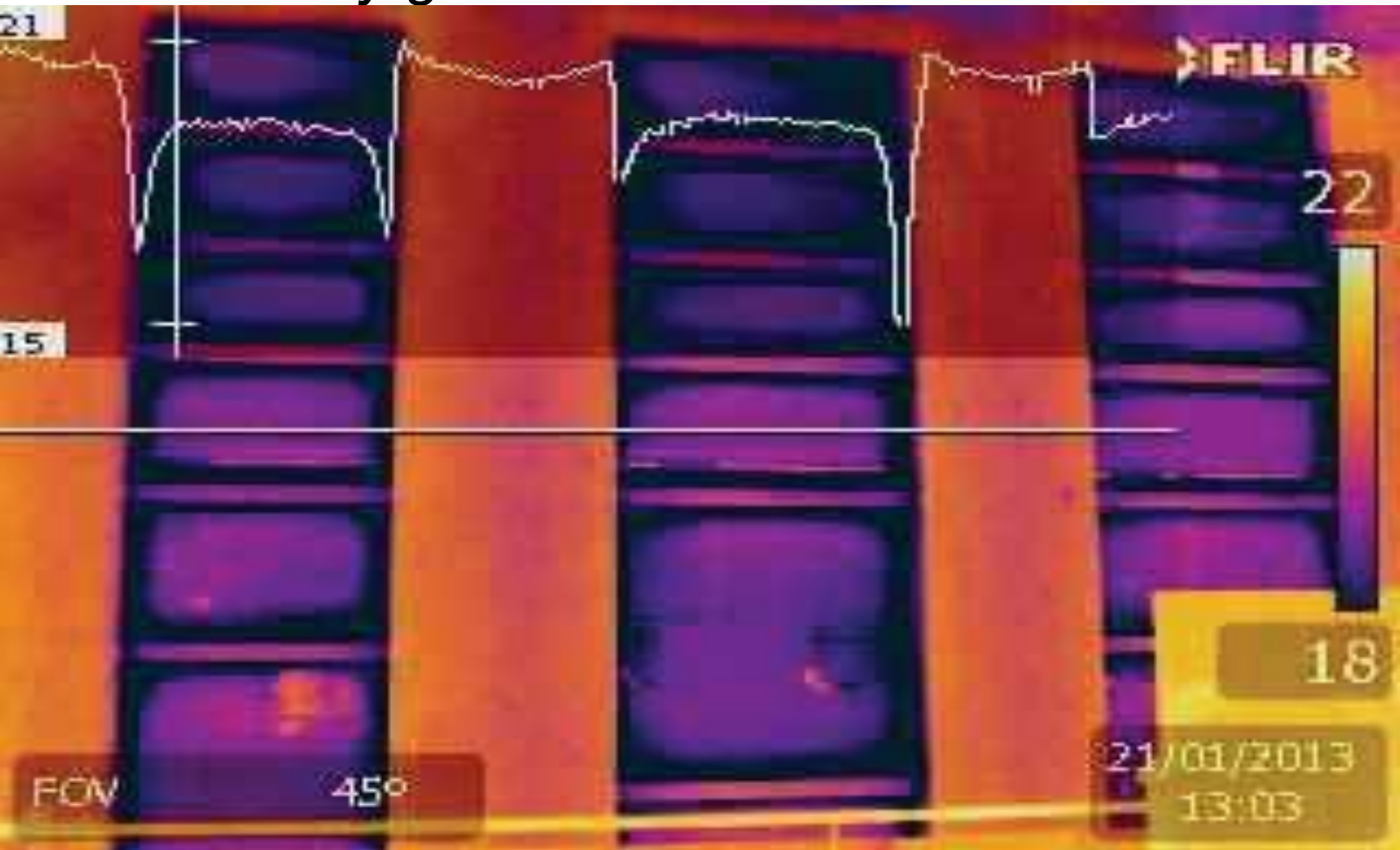
Final round funding for
new build domestic projects only
Register by noon 16 May 2012
http://goo.gl/y9lZe

Technology Strategy Board

Building Performance Evaluation Programme

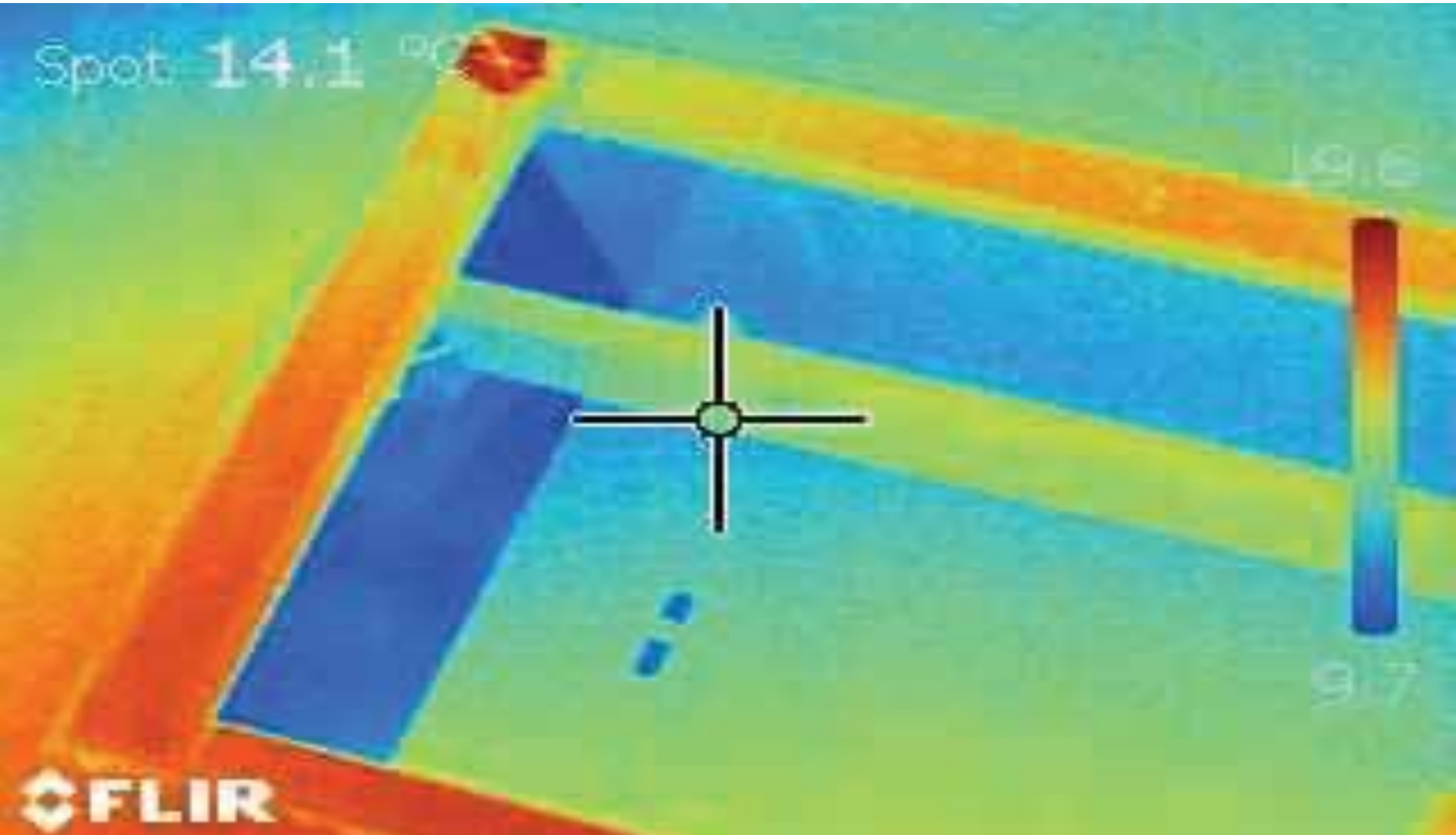
Woodland Trust Fabric

Generally good. Windows could be better



Woodland Trust Fabric

Don’t leave ends of trench heaters open



Woodland Trust energy overview

Low gas consumption *(34 kWh/m^2 p.a.)*
- but hot water was still somewhat wasteful

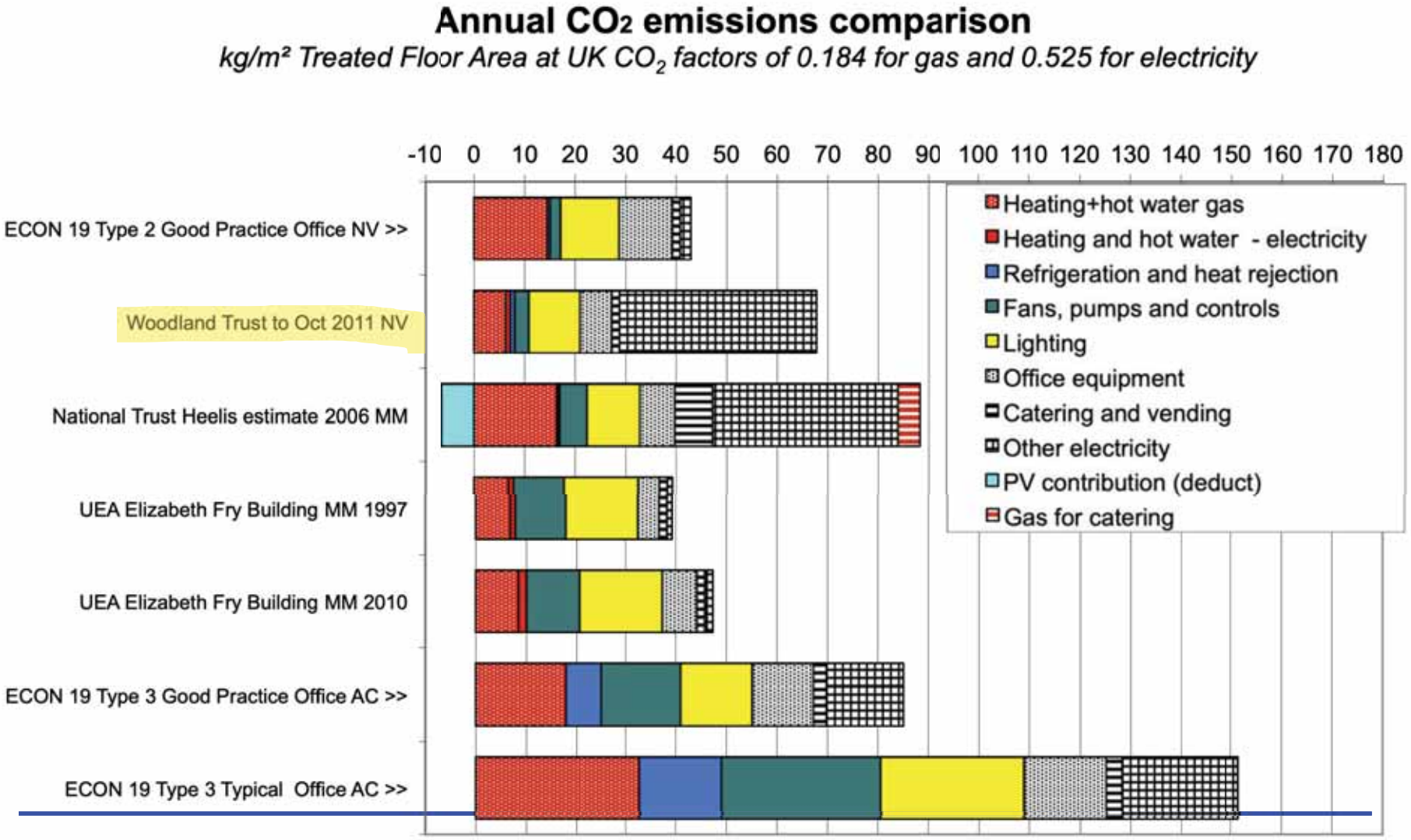
Interior lighting better than benchmark –
but only just: scope for better efficiency and control

Modest office equipment load due to thin clients –
but they and the phones shouldn't stay on 24/7

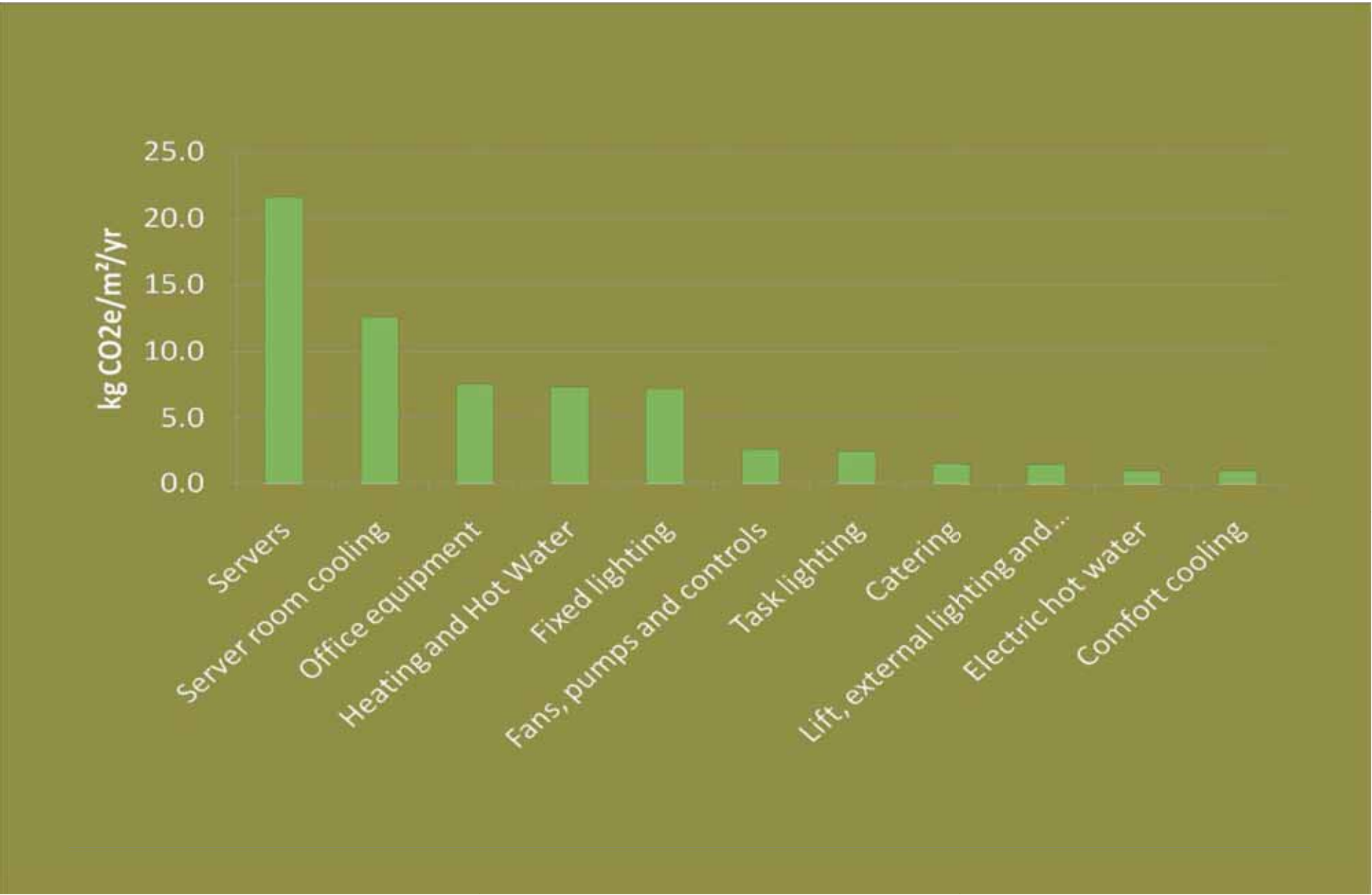
Large use resulting from server room and its cooling – *in hindsight may have been over-specified. Waterside free cooling over-elaborate*

Woodland Trust energy performance

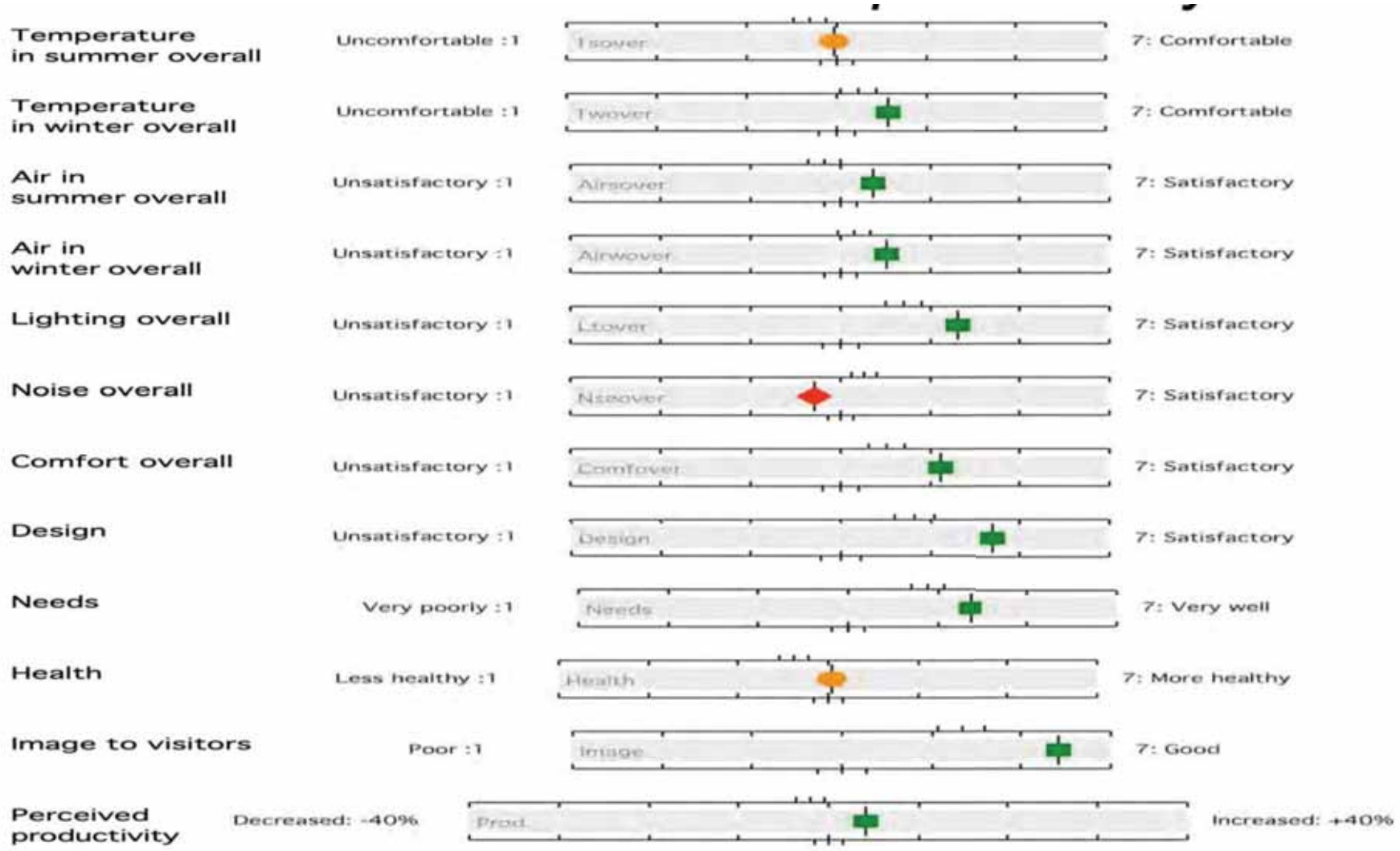
expressed as annual CO_2 emission (factors at the time)



Woodland Trust: CO_2 emissions by end use



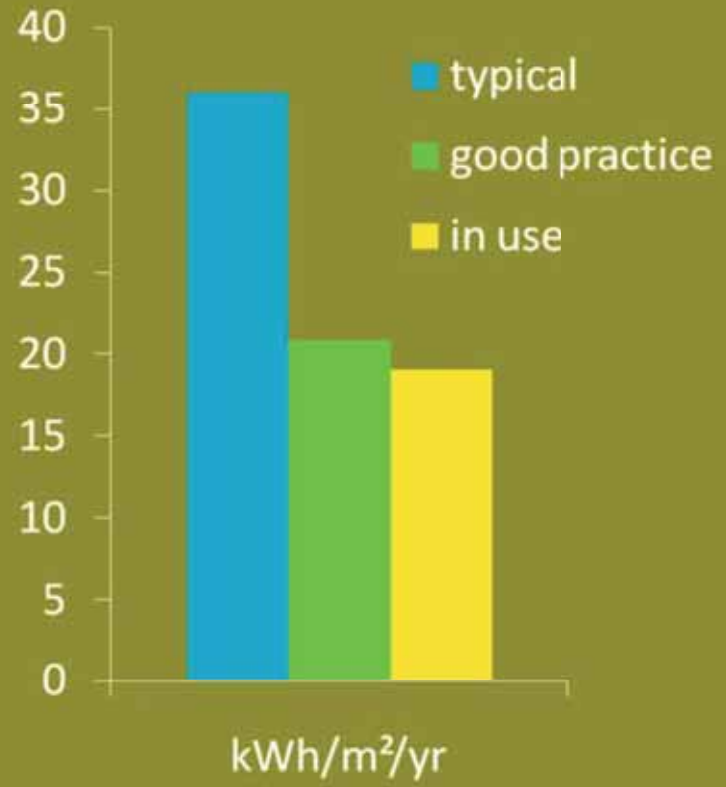
Woodland Trust – *BUS Occupant survey 2012*



Lighting in context *(modest use of task lighting, even on a dark winter evening)*

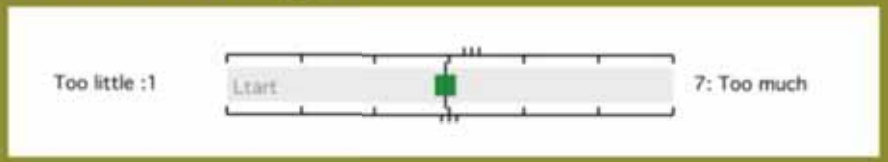
Key success: Lighting
but could be still better

Energy use

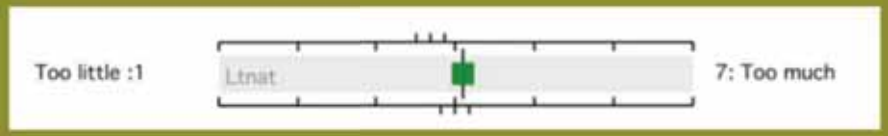


User experience

Artificial light



Natural light



Overall

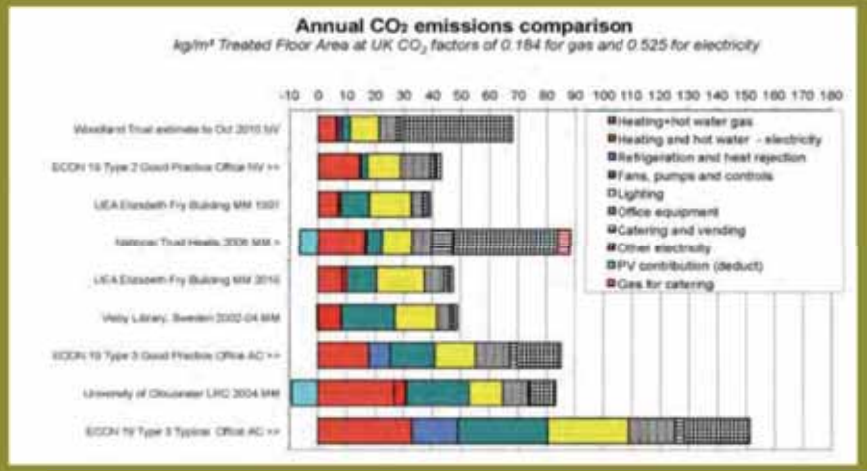
Glare can come from surprising places
here reflected up from car windows

Time control of ambient lighting poor

don't leave the ergonomics to the contractor!

Key issue: ICT energy use

little different from Heelis after all the effort



Over 50 per cent of emissions from server and its cooling

Thin client accentuates this

A future in cloud computing will push this load upstream

Contrast this with the push for energy supply to move downstream having headed upstream during its rise

Try to make things simpler and to do them better

"The Woodland Trust are lucky to have got less complication than most. It is difficult enough to cope with the complication we have got."

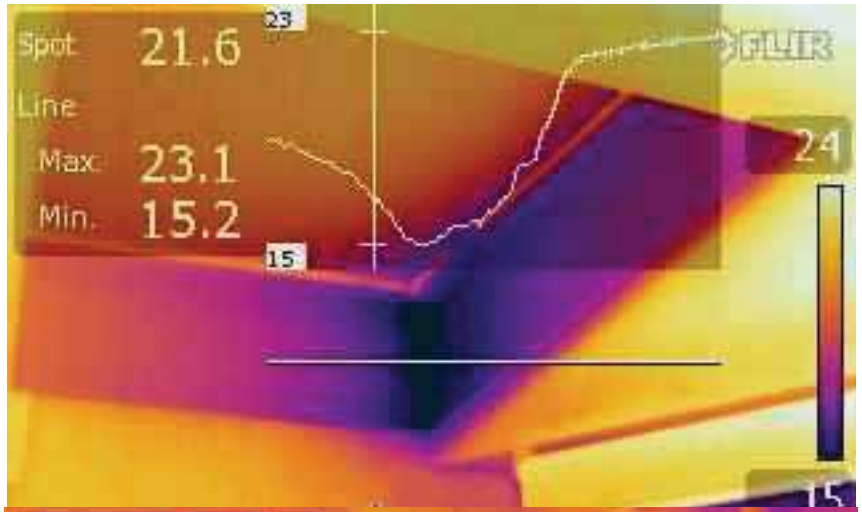
MANDY LOOSE
Facilities Manager

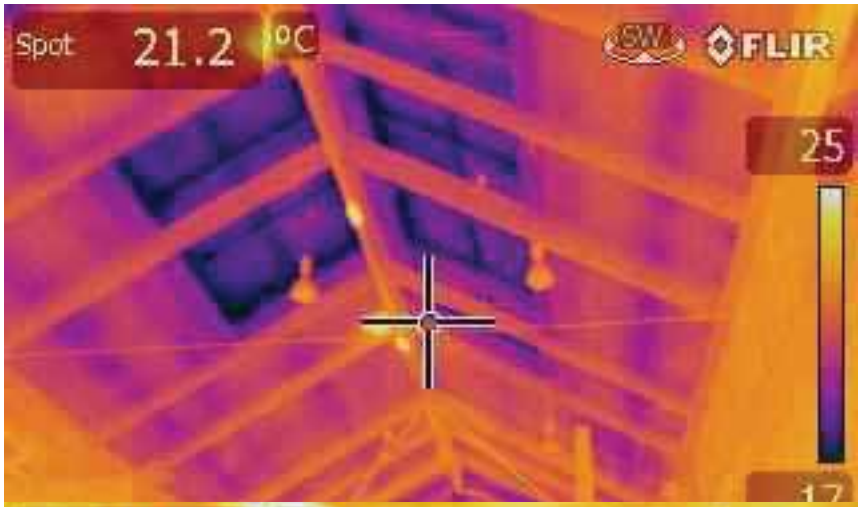
TIMES CHANGE: Heelis revisit

January 2013 and more recently

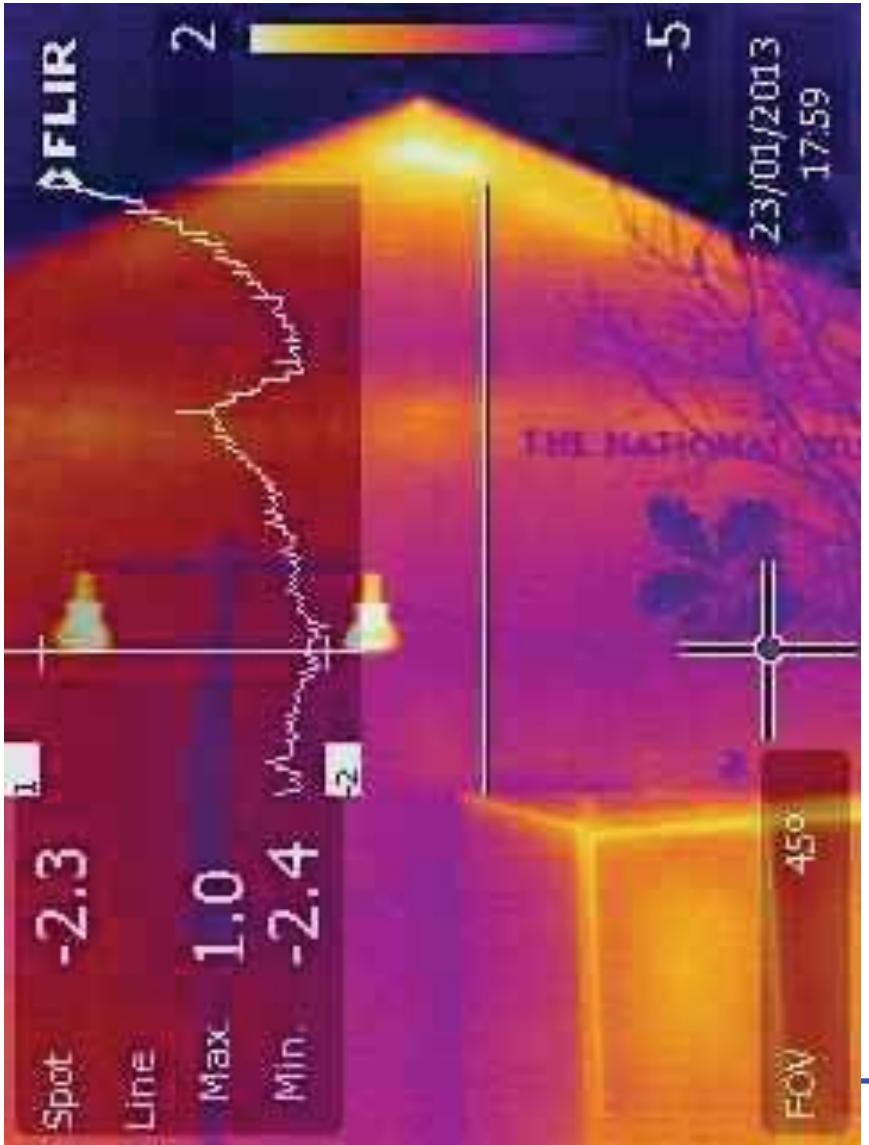
- USE: More intensively occupied in 2013. **Much less so today, post Covid.**
- TECHNICAL PERFORMANCE: Engineering systems were neglected in the 2008-11 recession. Then improved and some original shortcomings tackled, including missing valves and poorly located temperature sensors.
- METERING: Recalibrated and now read automatically – *in 2006 the meters were not fully commissioned and were not being read.*
- CONTROLS: Remain poorly integrated, but improvements undertaken.
- AUTOMATED NATURAL VENTILATION: Upgraded 2012. Every window has its individual IP address and can be individually controlled.
- ENERGY PERFORMANCE: Deteriorated substantially 2008-2011. Now back under control, 2013 similar to 2006.
- OCCUPANT SATISFACTION. No budget for a new survey, but anecdotally thought to have improved following the system alterations.
- CATERING KITCHEN. Intensity of use had increased in 2013 and the wasteful tunnel dishwasher was being replaced.
- SERVER ROOM: Free cooling had failed. Working again in 2013.

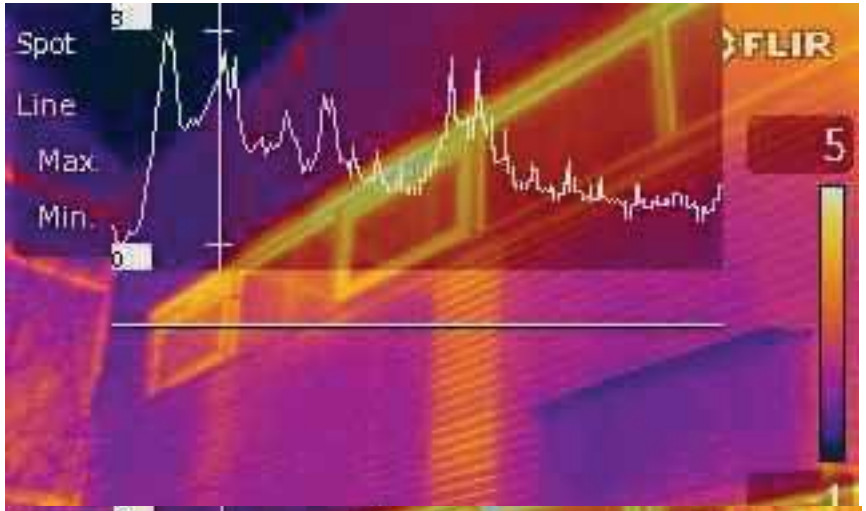
Heelis infra-red photos 2013
revealed many thermal bridges - inside

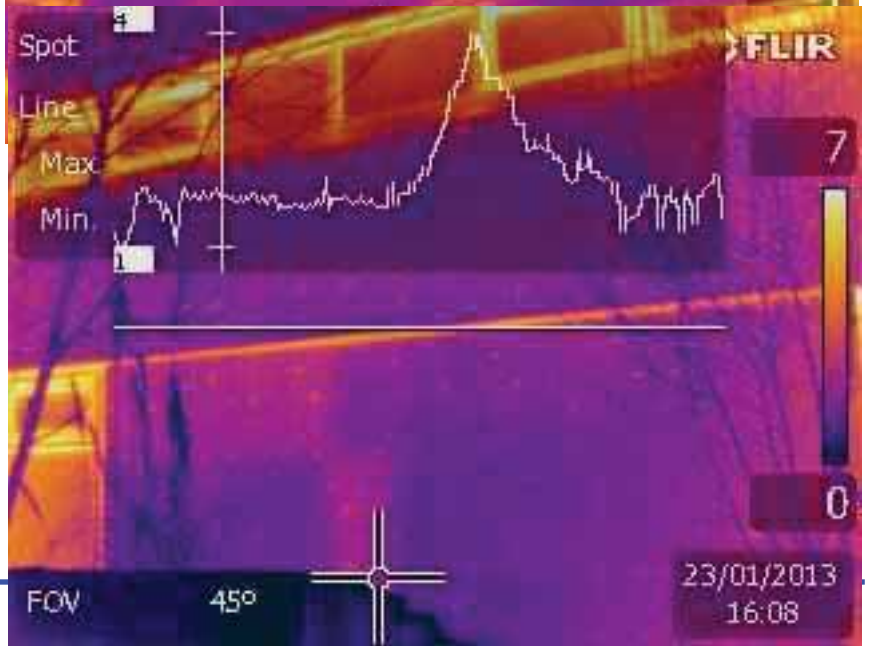




Heelis infra-red photos 2013
revealed many thermal bridges – outside

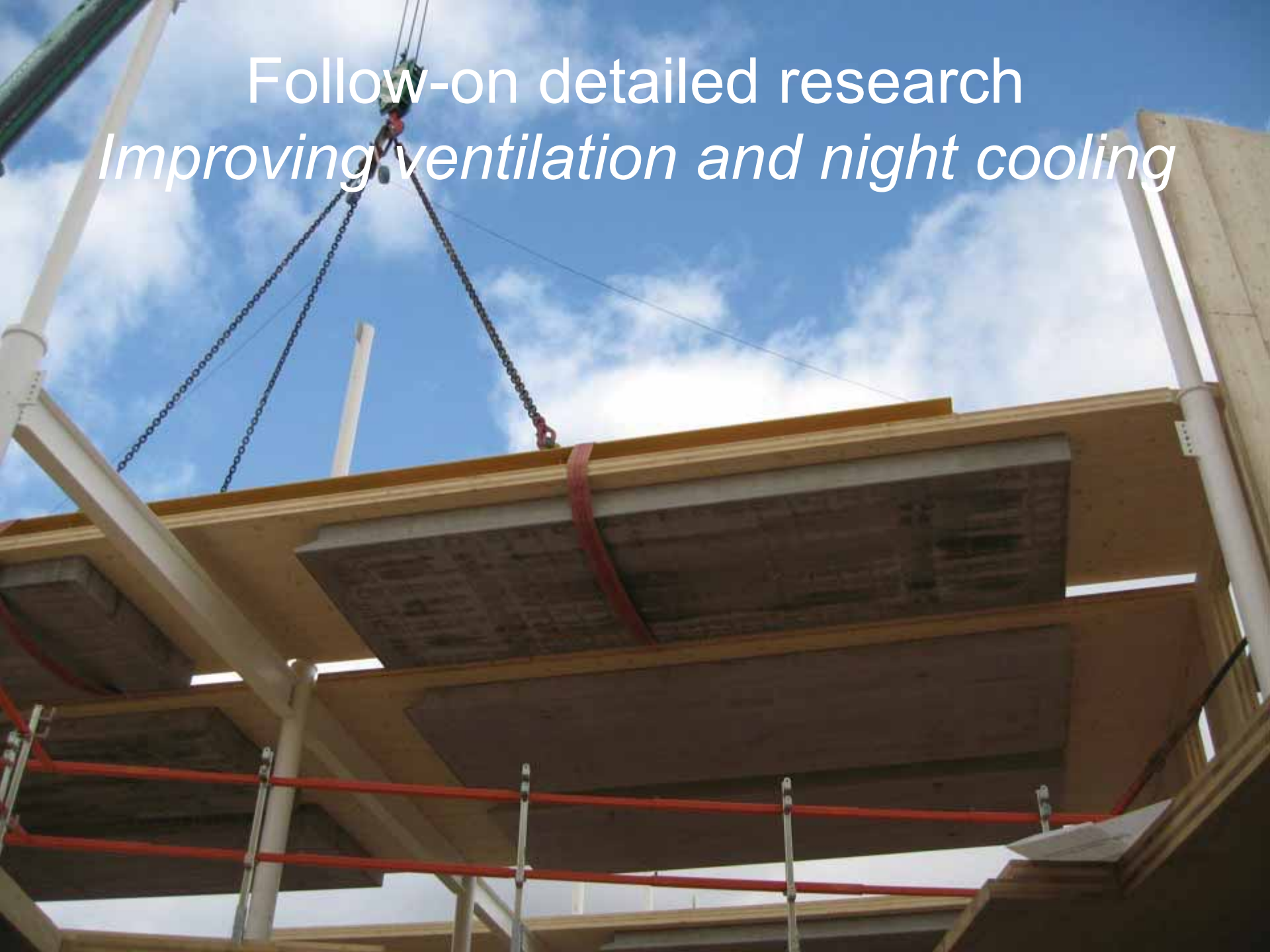






Some things learnt
from Heelis and the Woodland Trust

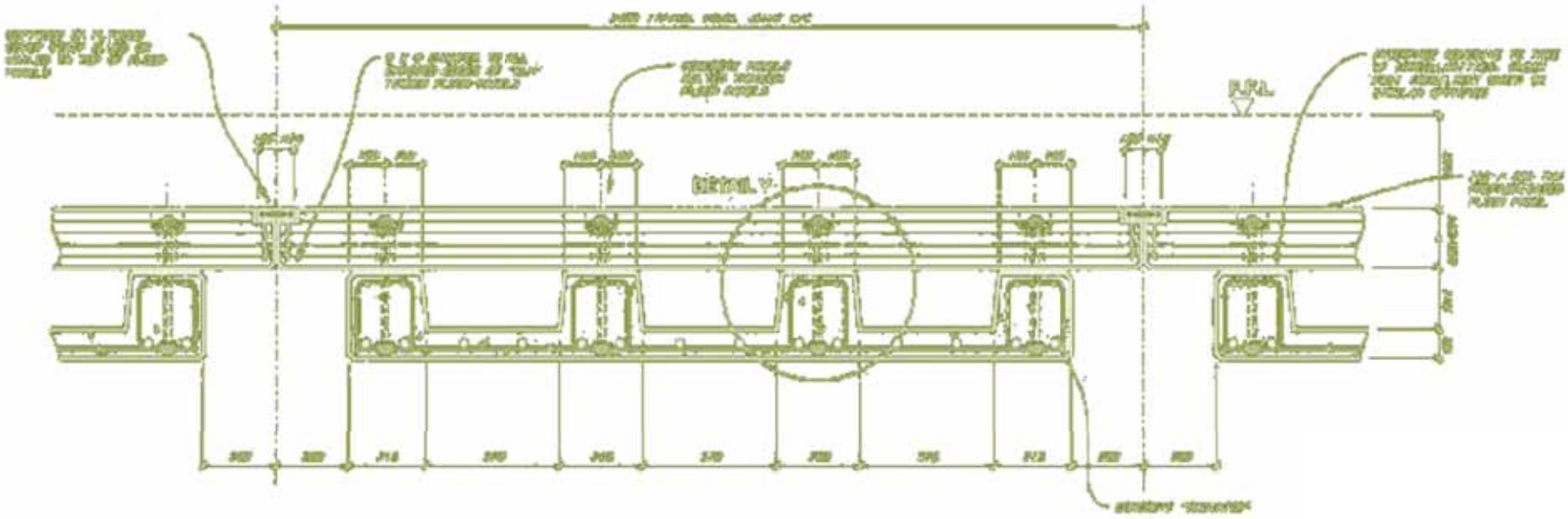
- **SIMPLER BUILDINGS and KIT:** Considerable potential, but needs care.
- **FINE TUNING IN THE FIRST YEAR OF OCCUPATION.** Requires very different priorities from normal practices during the defects liability period.
- **NATURAL LIGHTING:** Good, but glare can come from unexpected places.
- **ELECTRIC LIGHTING:** Not just about desktop illuminance. More finesse required with controls, together with more efficient lighting generally.
- **HEATING:** Woodland Trust uses much less gas. Further improvements planned. *Hot tap water generation may well be better separate from heating?*
- **CONTROLS AND BMS**: Still in need of much more attention to detail.
- **WINTER VENTILATION:** Tricky to introduce controlled quantities in winter at the Woodland Trust. Heelis mixed mode mechanical background more robust.
- **SUMMER VENTILATION AND COOLING:** Optimisation required at the Woodland Trust, owing to control issues and security concerns.
- **WORKSTATION PLANNING:** Needs flexibility. One size doesn't fit all.
- **ICT SYSTEMS:** In spite of major efforts, ICT and the associated HVAC still dominates electricity use. Some tuning now happening, with specialist advice.



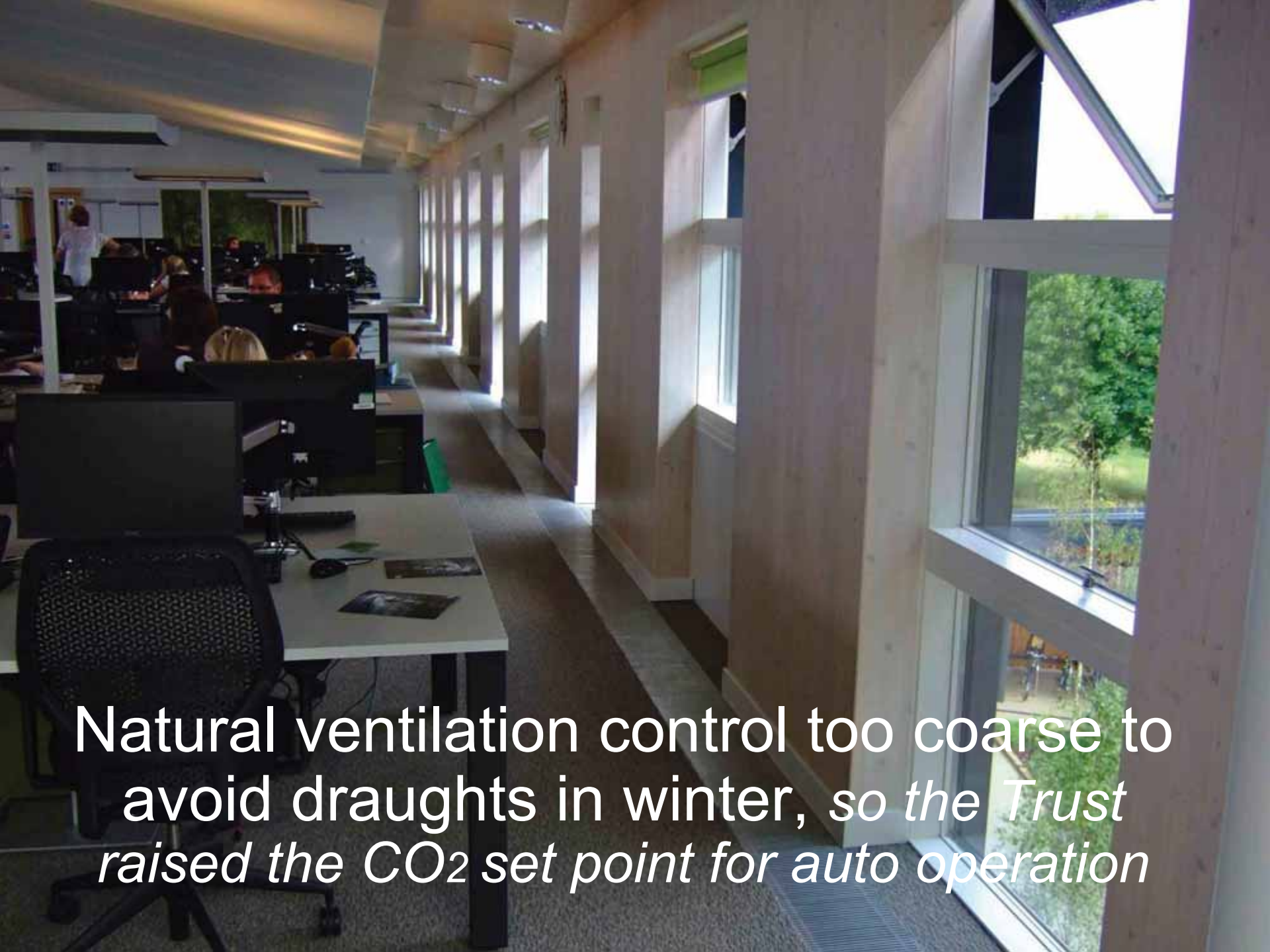
Follow-on detailed research

Improving ventilation and night cooling

Thermal performance of the "concrete radiators" at the Woodland Trust

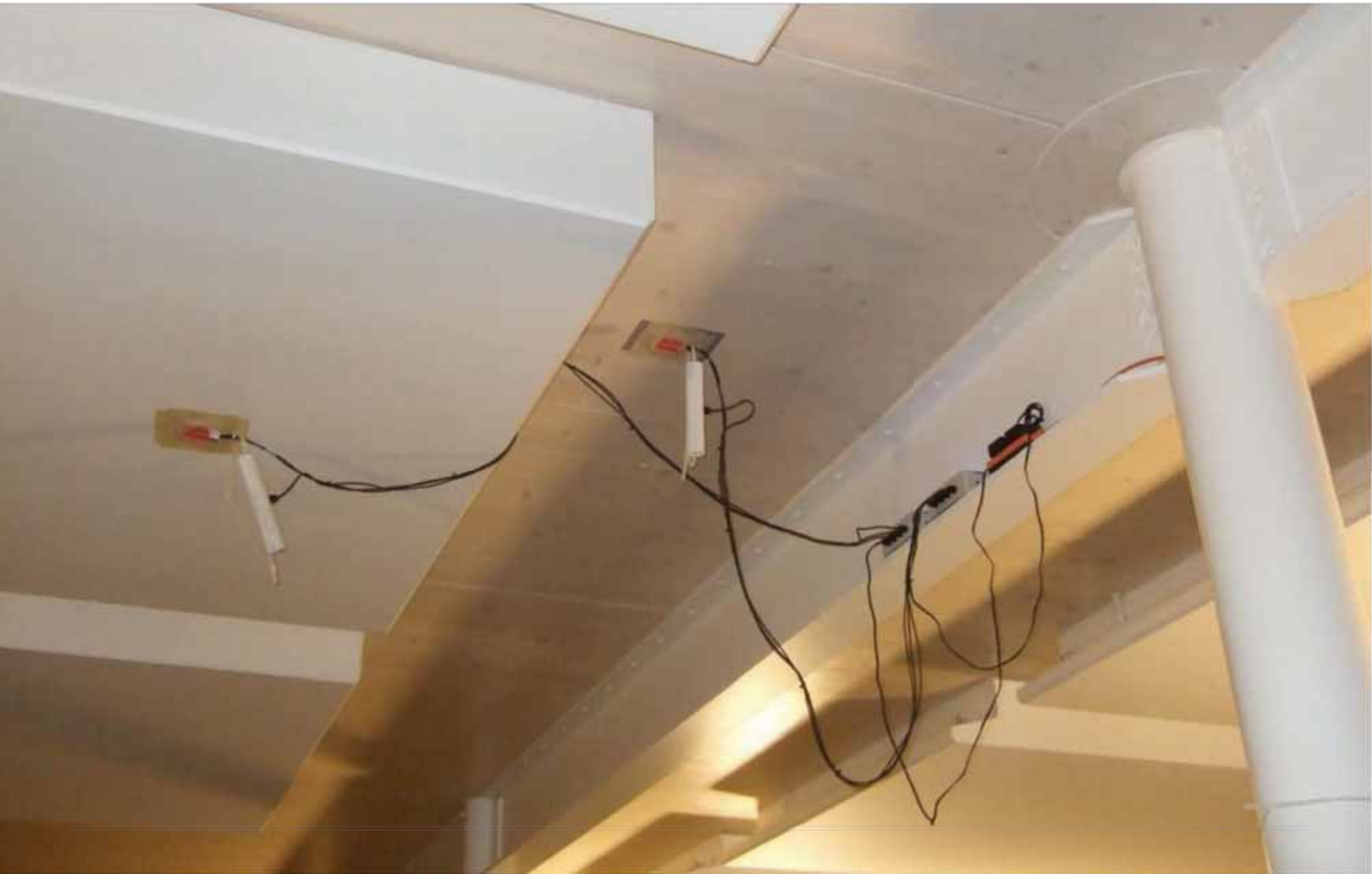


These concrete panels stiffen the cross-laminated timber floor structure and provide additional thermal capacity to smooth indoor temperature fluctuations and limit summer overheating.



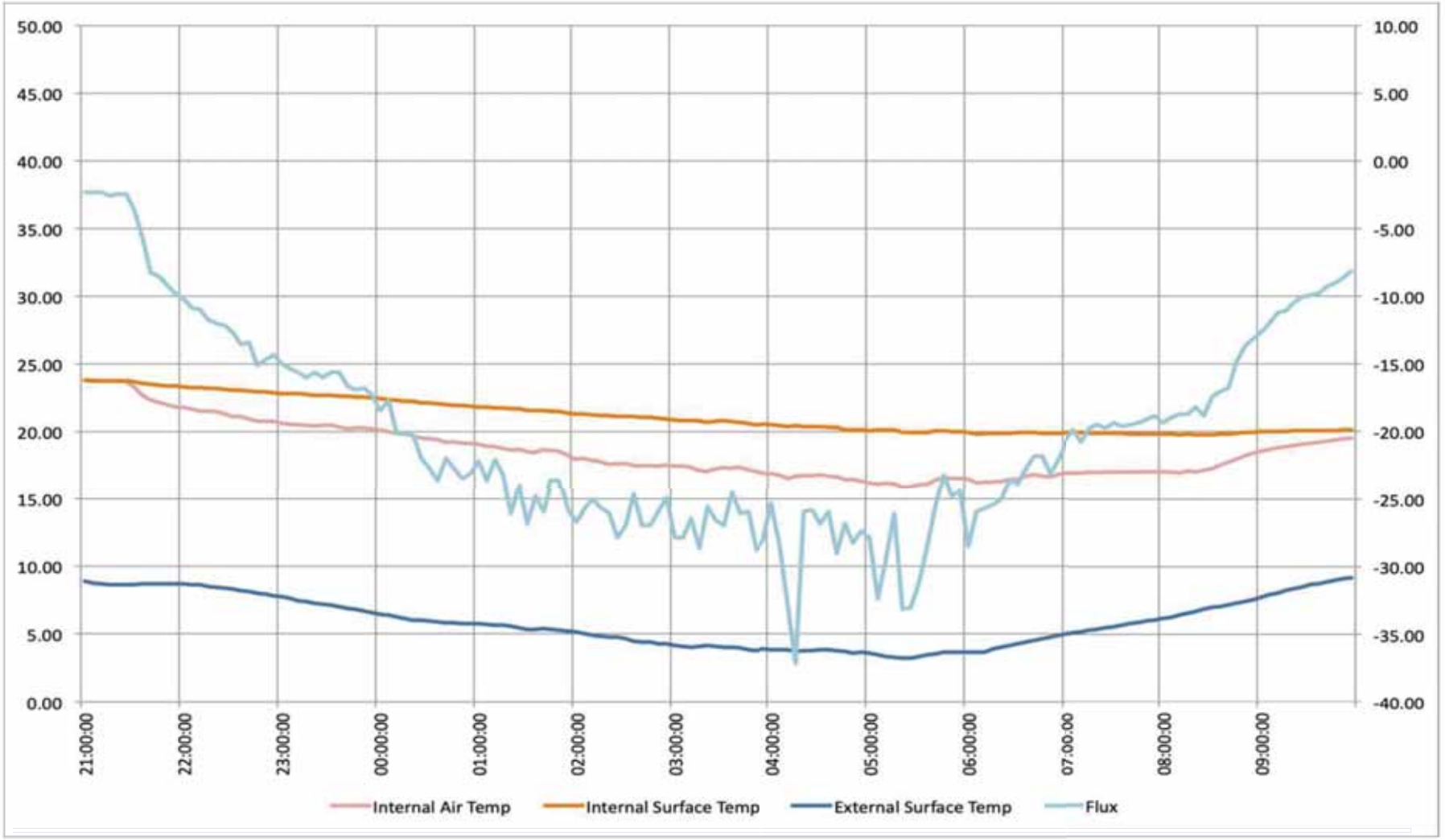
Natural ventilation control too coarse to avoid draughts in winter, *so the Trust raised the CO_2 set point for auto operation*

Heat flux monitoring



Heat flux monitoring results

Heat transfer coefficient approx 7.5 W/m²K



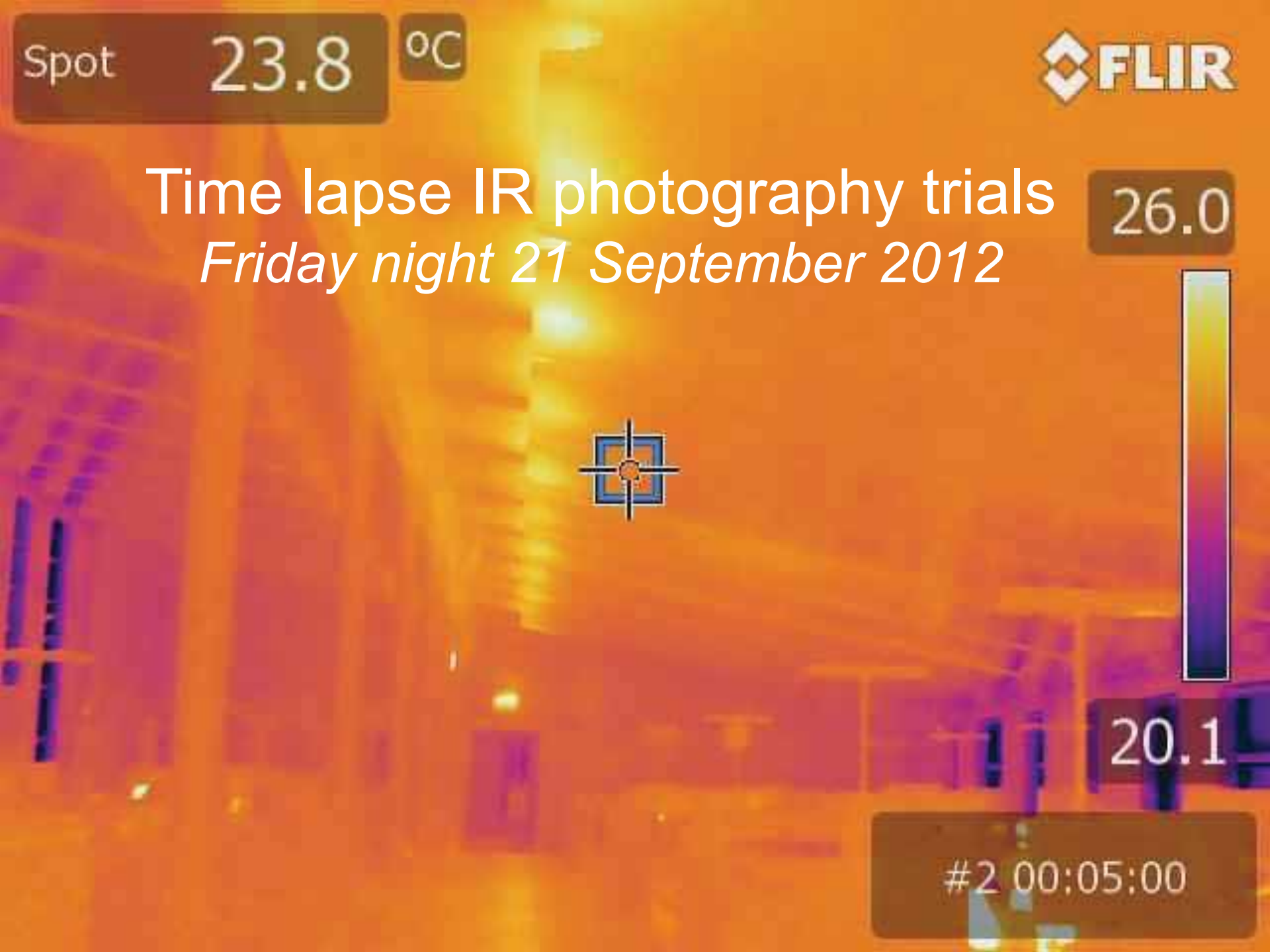
Findings from heat flux follow-on research

- Heat passed into and out of the concrete radiators 3.5 times as fast as to the timber. *Heat transfer through the concrete sides added about 20% to their effective area*.
- On mild days, the average rate of heat absorption was about 5 W/m^2, raising the temperature of the concrete by 1° C. On warm days, the figure doubled.
- In hot weather, night ventilation removed heat at typically 5-8 W/m^2, making weekend cooling essential to restore indoor temperatures for the following week.
- When the windows were open, there was little stratification within the three floors of offices, with changes in concrete radiator temperature very similar for all locations.
- Air and mean radiant temperatures were very similar.

Findings from ventilation control and night cooling follow-on research

MAIN REASONS FOR UNDER-PERFORMANCE

- Reduced opening of high level automated windows for night cooling: *change of mind by insurance company.*
- FM *(unnecessarily)* added restrictors to low level windows.
- BMS outdoor temperature sensor could get much hotter than ambient air: *relocated to a better shaded position.*
- Night cooling algorithm too complicated: *much simplified, with more authority given to the building manager.*
- Space could be too cold immediately after night cooling, which in turn reduced the ability of management to run it : *so auto windows now close 1-2 hours before occupancy.*


Spot 23.8 °C
FLIR
Time lapse IR photography trials
Friday night 21 September 2012
26.0
20.1
#2 00:05:00

Time lapse IR photography trials

Saturday Morning 22 September 2012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- Understand what is needed — *strategic briefing*
- Make their overall expectations and intentions clear — *strategic design*
- Are ambitious, but realistic — *question assumptions, understand user needs*
- Confirm that things will work — *technical feasibility, usability and manageability*
- Tell others what is expected — *specify not just what, but why and how*
- Follow things right through the whole process — *e.g. using Soft Landings*
- Collaborate to get things done well — *communicate, train, inspect*
- Reflect on progress — *manage expectations, undertake reality checks*
- Finish things off — *commission, operational readiness, handover, dialogue*
- Help users to understand and take ownership — *provide aftercare support*
- Review performance in use — *including **POE and BPE***
- Work with occupiers to improve things — *monitoring, review and fine tuning*
- Anticipate and spot unintended consequences — *revenge effects*
- Learn from it all — ***and share their experiences***

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