Ecobuild, 5 March 2013
Mind the Gap:
Why does energy use fall so short of predictions?

Time to get real about building energy performance

Bill Bordass

the **USABLE BUILDINGS TRUST**
www.usablebuildings.co.uk

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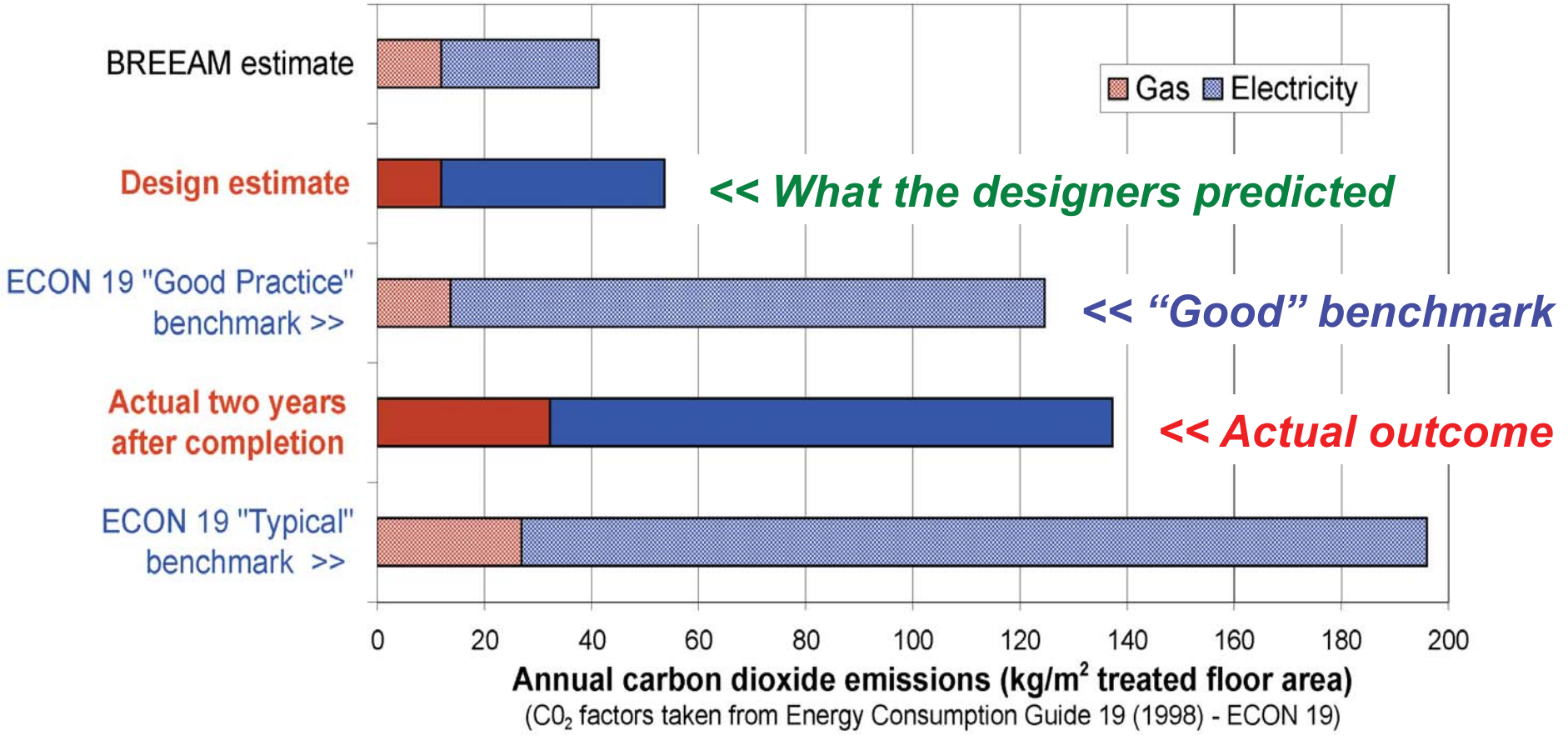
THE PEFORMANCE GAP:

SOME FUNDAMENTAL REASONS and AN EXAMPLE

The Design-Performance Gap:
Identified in the 1990s

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).

We're much better at improving performance in the virtual world than the real one. **WHY?**

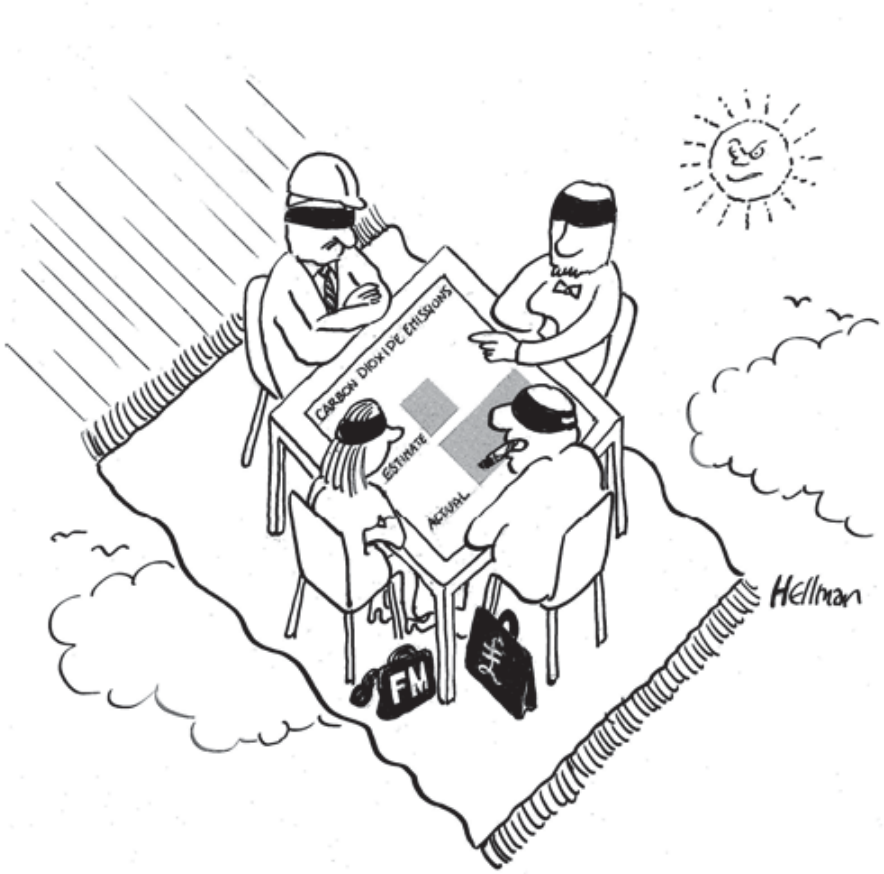
1. We don't count everything, or have a dialogue about it. *Designers tend to concentrate on "regulated loads" only – a term I hate!*
2. Models and policy assumes more technical and operational complication improves performance. *Usually it doesn't.*
3. Our procurement systems aren't fit for purpose: *they salami-slice the design intent.*
4. We don't pay nearly enough attention to detail, *particularly for usablilty and manageability.*
5. Commissioning and handover are often rushed, *perhaps inevitably, but why don't we plan to follow through?*
6. The industry hands over the keys and runs away, *so buildings are seldom tuned-up and we don't understand how they work, or trap the unintended consequences.*
7. With outsourcing and privatisation, government no longer closes the feedback loop routinely, a*nd nothing else has replaced it.*

For most of the construction and property industry, *building performance in use has been another country …*

"designers seldom get feedback, and only notice problems when asked to investigate a failure."
ALASTAIR BLYTH
CRISP Commission 00/02

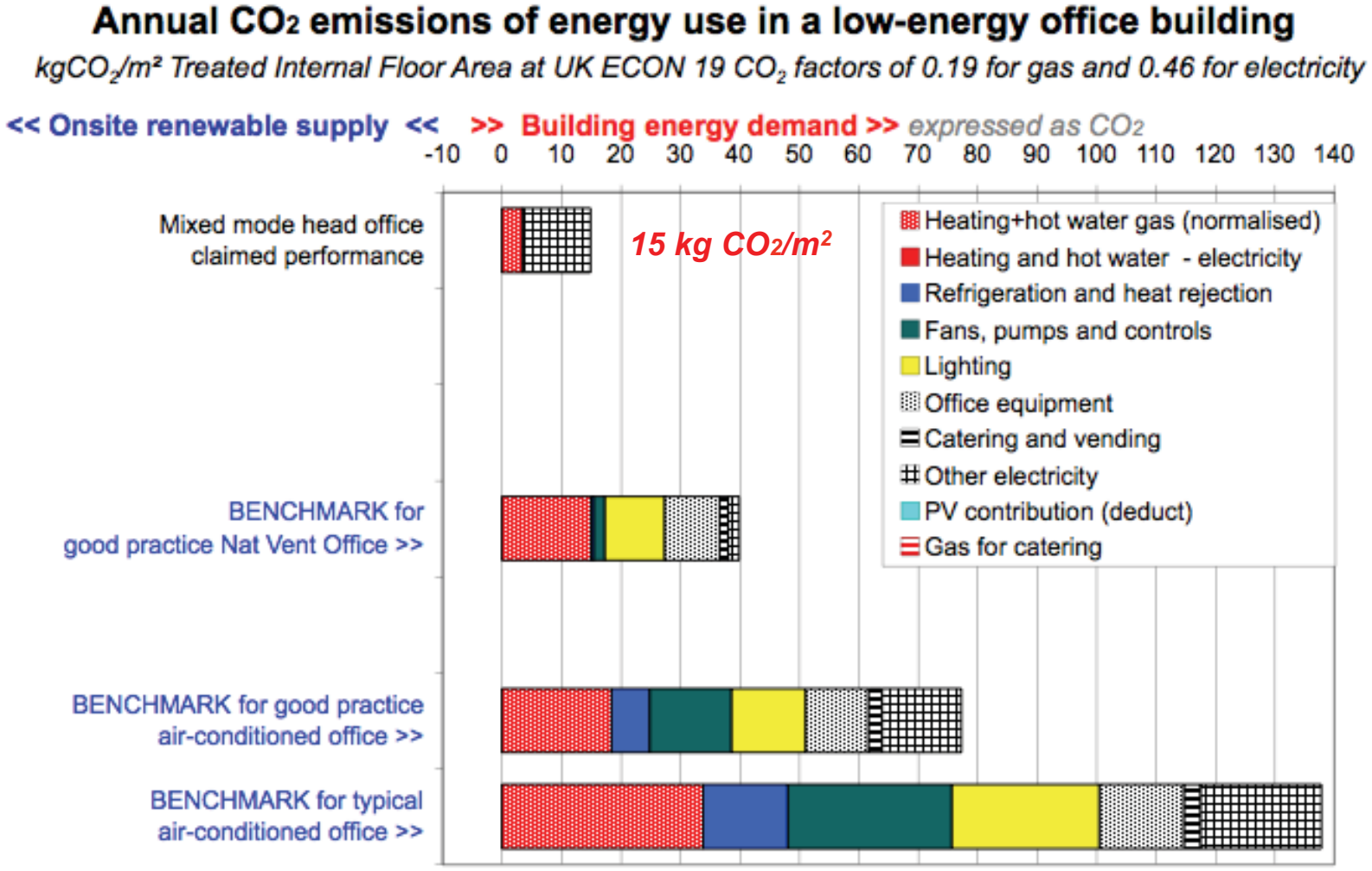
"I've seen many low-carbon designs, but hardly any low-carbon buildings"
ANDY SHEPPARD
Arup, 2009

We need to take much more account of the evidence under our noses.

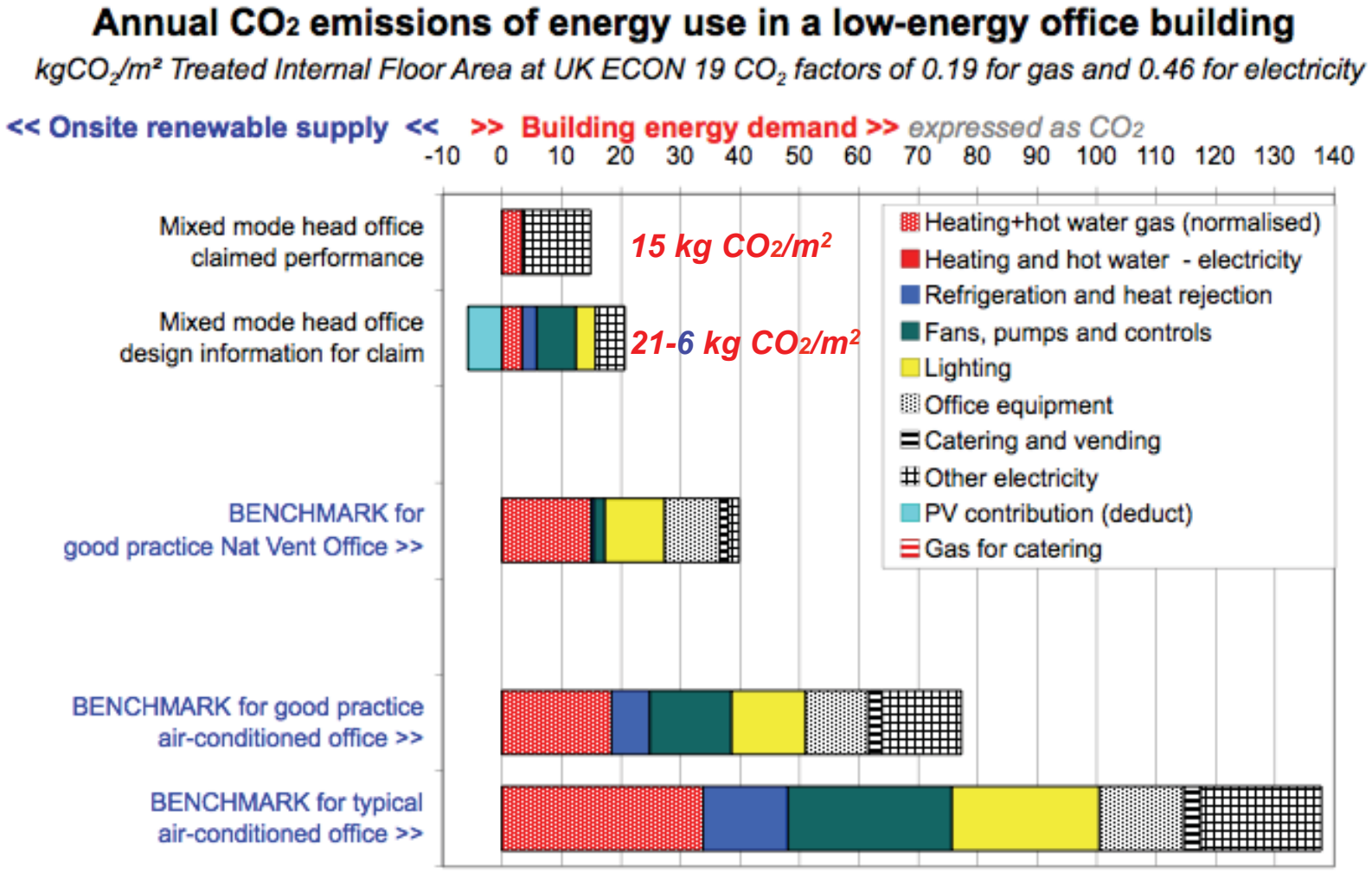


SOURCE: Hellman cartoon for W Bordass, *Flying Blind,* Association for the Conservation of Energy & OXEAS (2001)

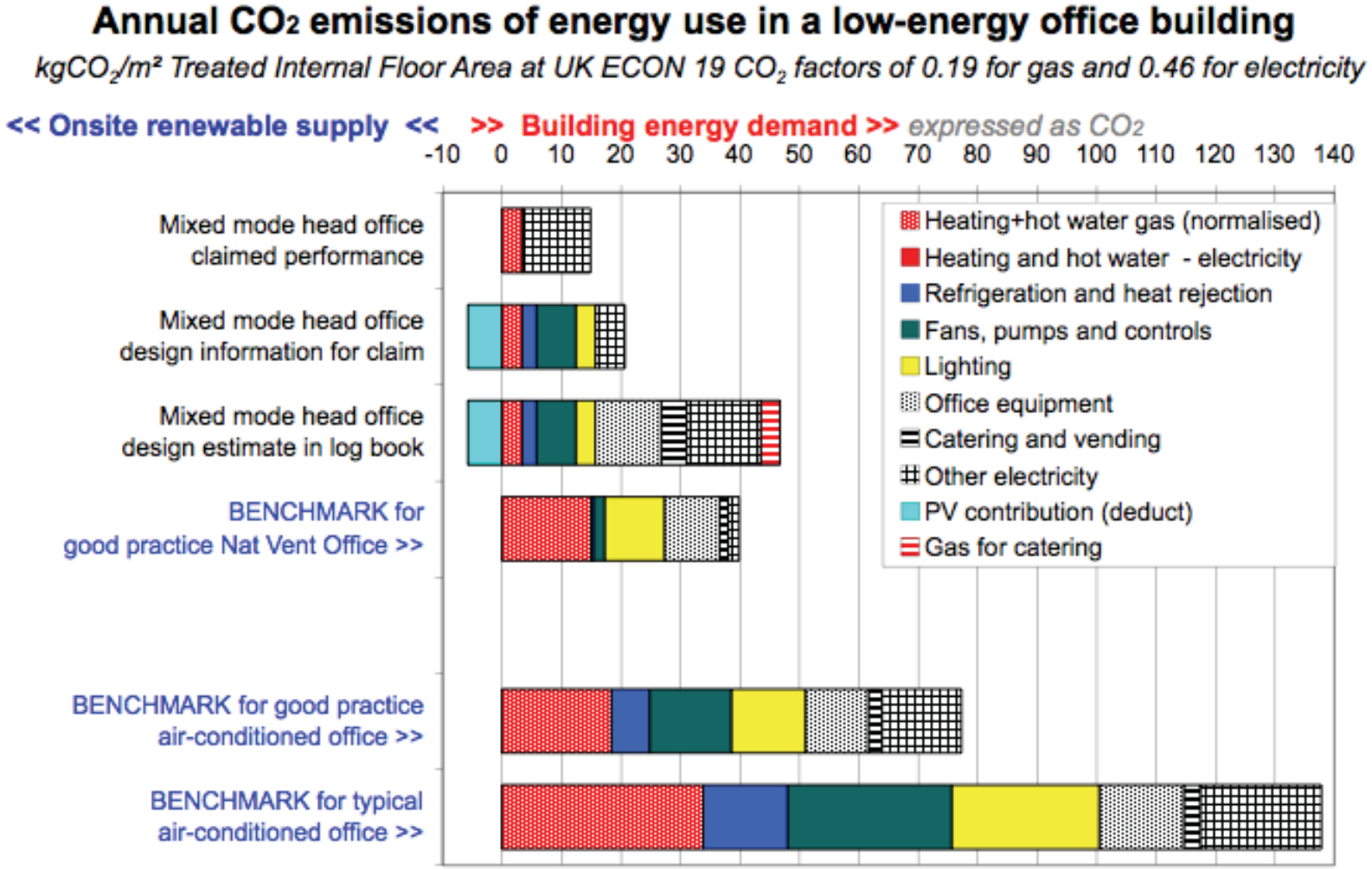
Are we counting things properly?
1. the design claim



Are we counting things properly?
2. supply and demand basis for the claim

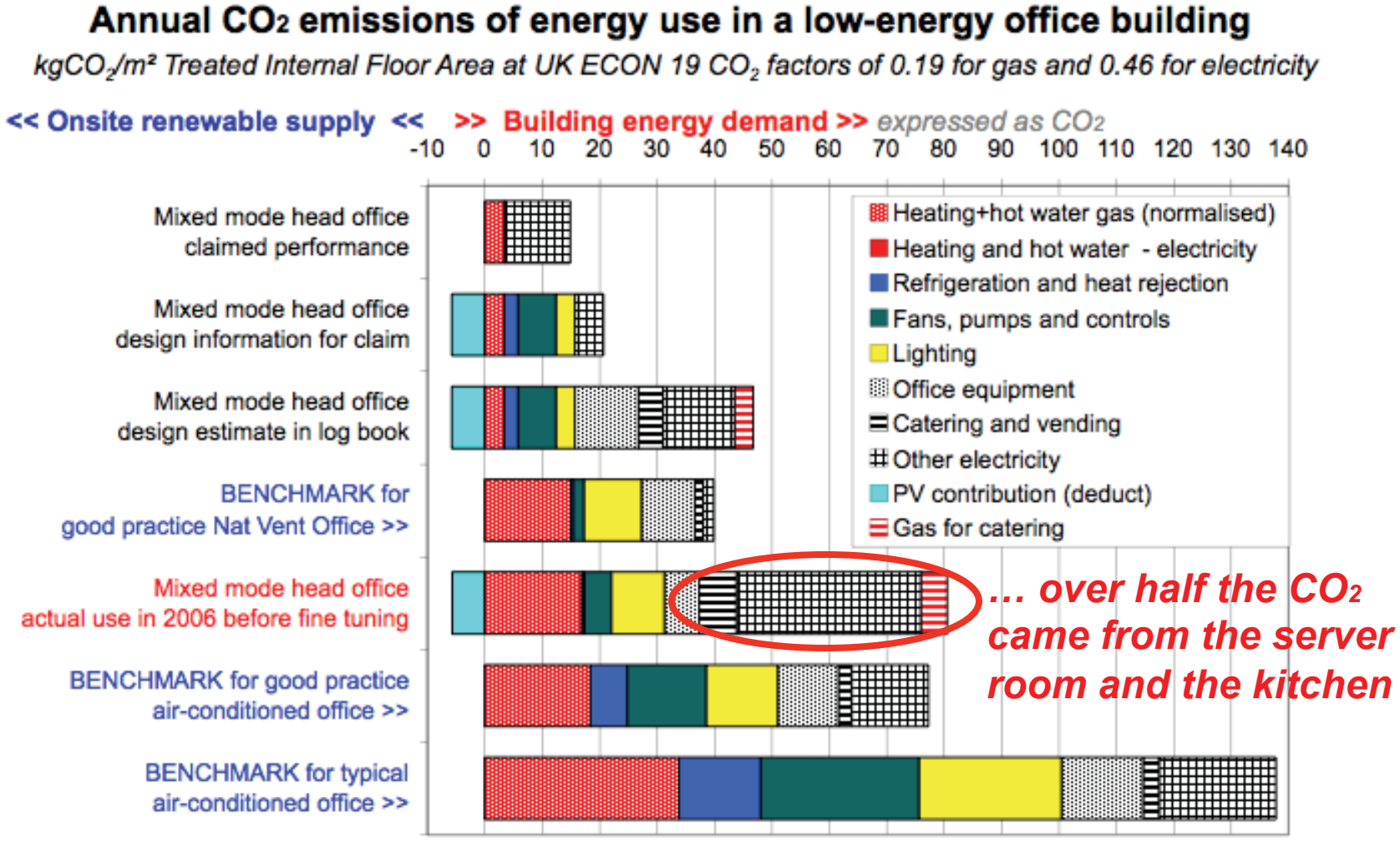


Are we counting things properly?
3. From the log book: 2.5 x the claim.



Is it working as anticipated?

In use, regulated CO_2 was twice the prediction, ***and*** *…*



Some underlying reasons for this particular gap

- PROCUREMENT: Transferred to developer at Stage E. *Some continuity of design intent lost.*
- HEATING: *Issues with fabric integrity, controls and less sophisticated plant than the designers had anticipated.*
- HOT WATER: *Better separate from the heating?*
- LIGHTING: *Predictions optimistic owing to control issues and insufficient daylight on some walls and ceilings.*
- SERVER ROOM: *Efficient air-conditioning provided, but independent specialist advice on the energy performance of the servers themselves would have been helpful.*
- CATERING KITCHEN: *Some items overspecified.*
- CONTROLS and METERING: *Need for better integration, commissioning and fine tuning.*

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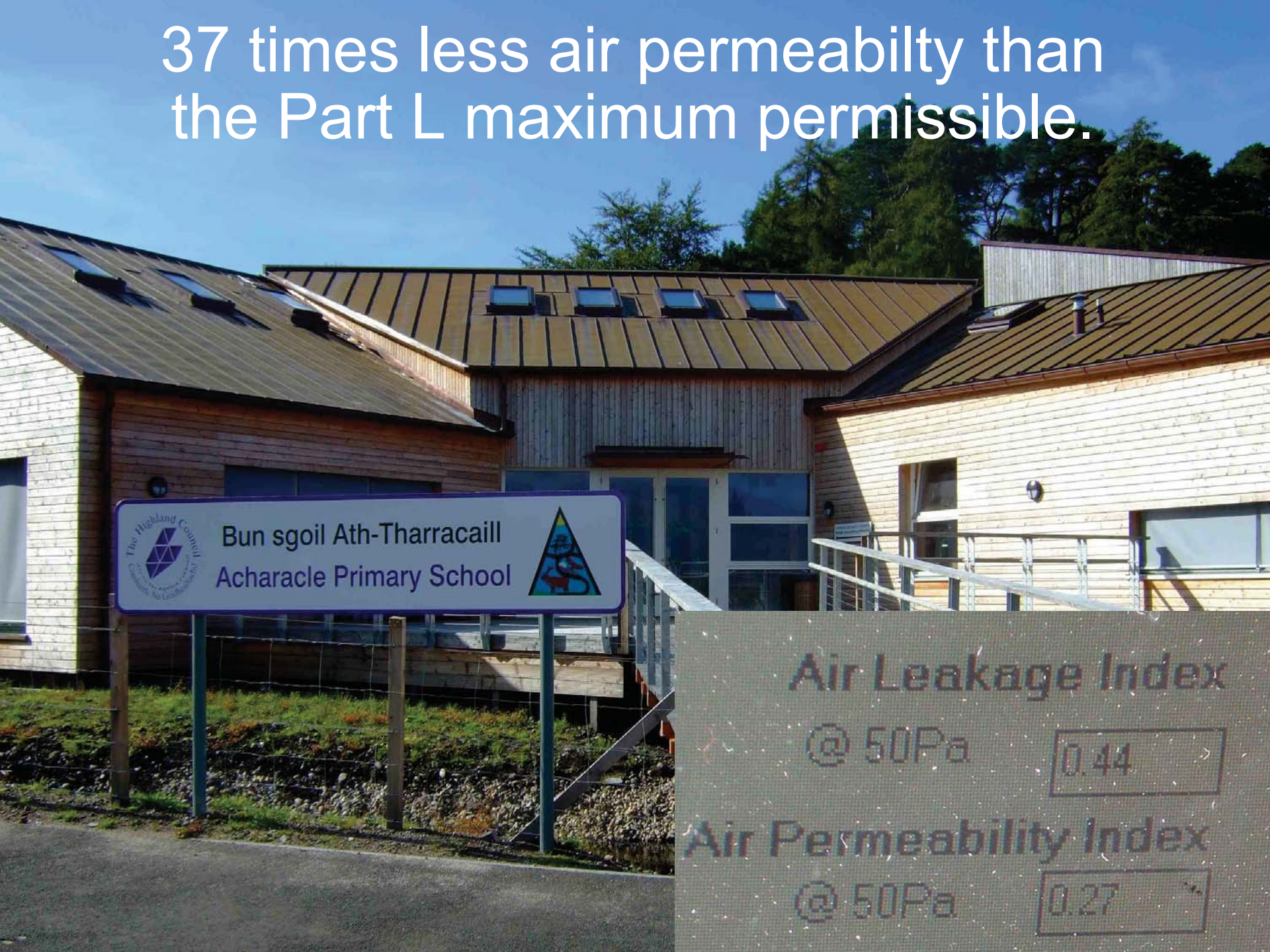
GETTING REAL: IMPROVING NEW CONSTRUCTION AND REFURBISHMENT

Make things simpler and smaller if you can, and do them better!

Fabric First:
Efficient services need to be able to rely on it

Air pressure test of the Maths Building Cambridge as part of a Probe POE

37 times less air permeabilty than the Part L maximum permissible.



Gentle engineering
Not over-engineering

"Evening out fluctuations has become an egalitarian enterprise which it is heresy to question."

MICHAEL YOUNG, *The Metronomic Society (1988).*

"There is something inelegant in the mass of energy-consuming machinery needed at present to maintain constant RH … something inappropriate in an expense which is beyond most of the world's museums."

GARRY THOMSON, *The Museum Environment (1978).*

"What we've got used to, we're not entitled to" … R BUNN (2008)

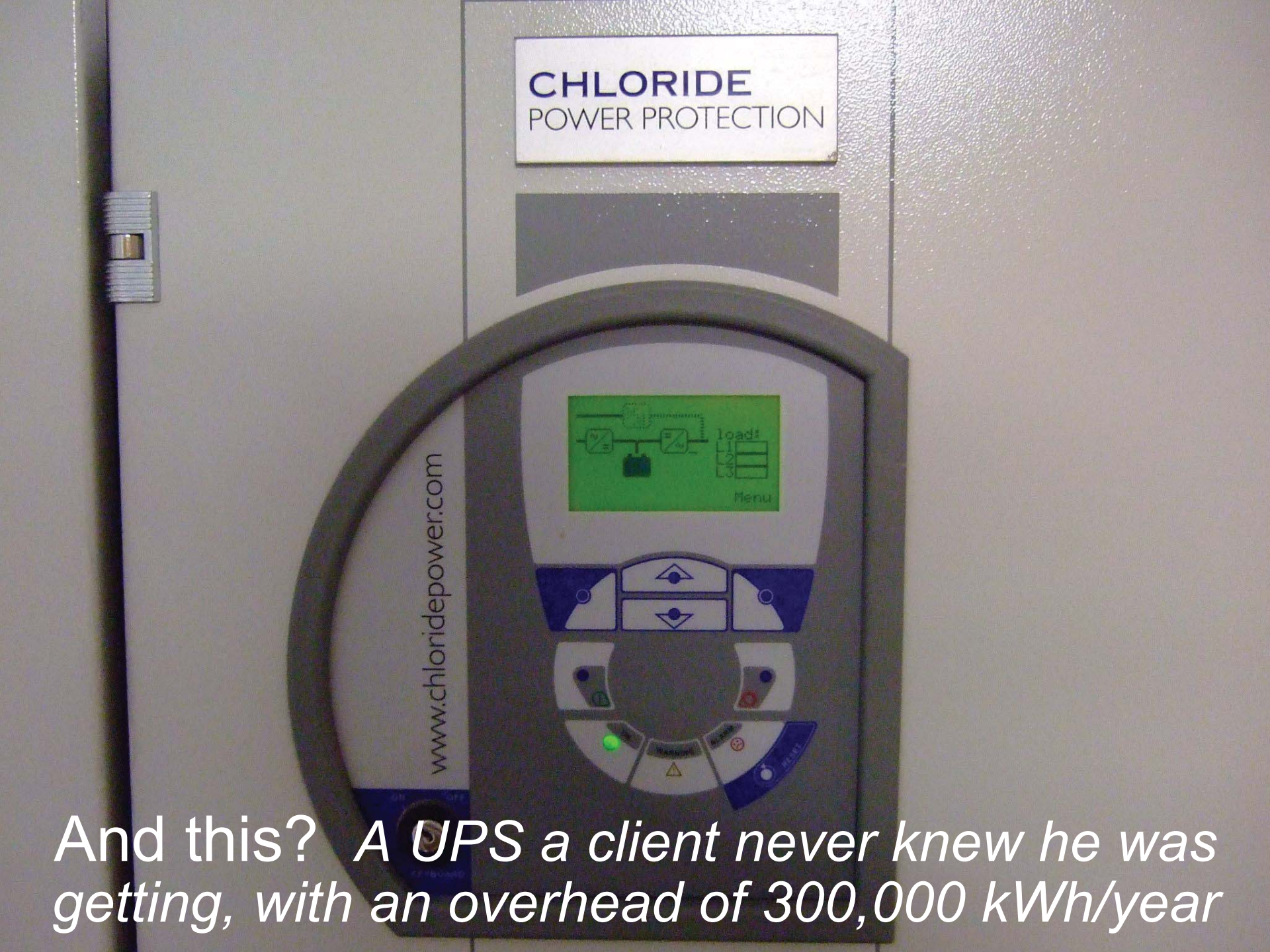
In 1994, two of these boilers heated a 3200 m^2 university building – *E Fry (@ 15 W/m^2).*

So why does a recently-completed UK "zero-carbon" school have 60 W/m^2 of biomass boiler power with gas backup?

And what about this?

In a new "low energy" building's kitchen

OVER-PROVISION IS WIDESPREAD

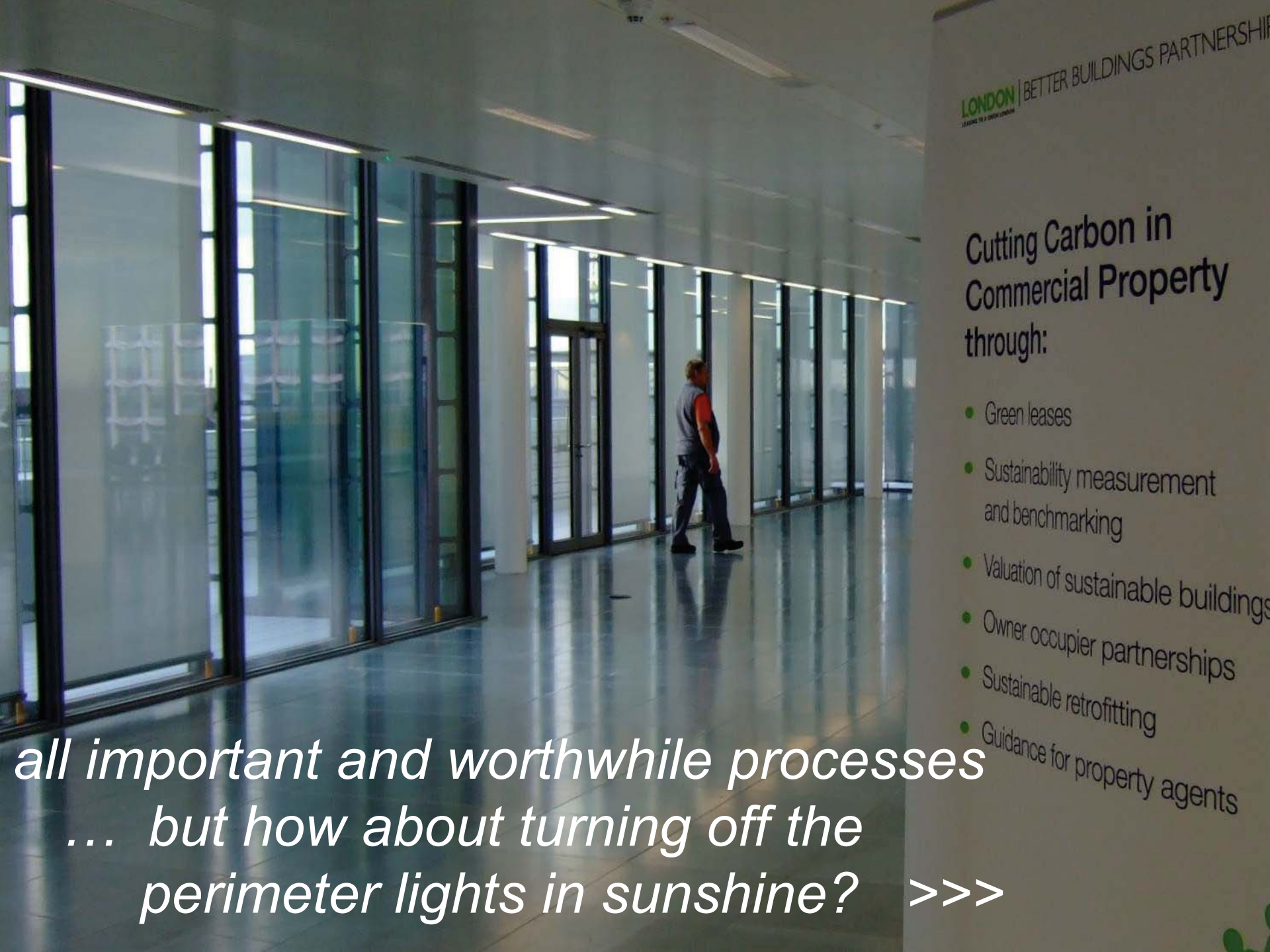


And this? *A UPS a client never knew he was getting, with an overhead of 300,000 kWh/year*

Controls, manageability and usability need to receive much more attention

"An intelligent building is one that doesn't make its occupants feel stupid"... ADRIAN LEAMAN

"We sell dreams and install nightmares"...BMS SUPPLIER



all important and worthwhile processes … but how about turning off the perimeter lights in sunshine? >>>

Don’t add “green bling”

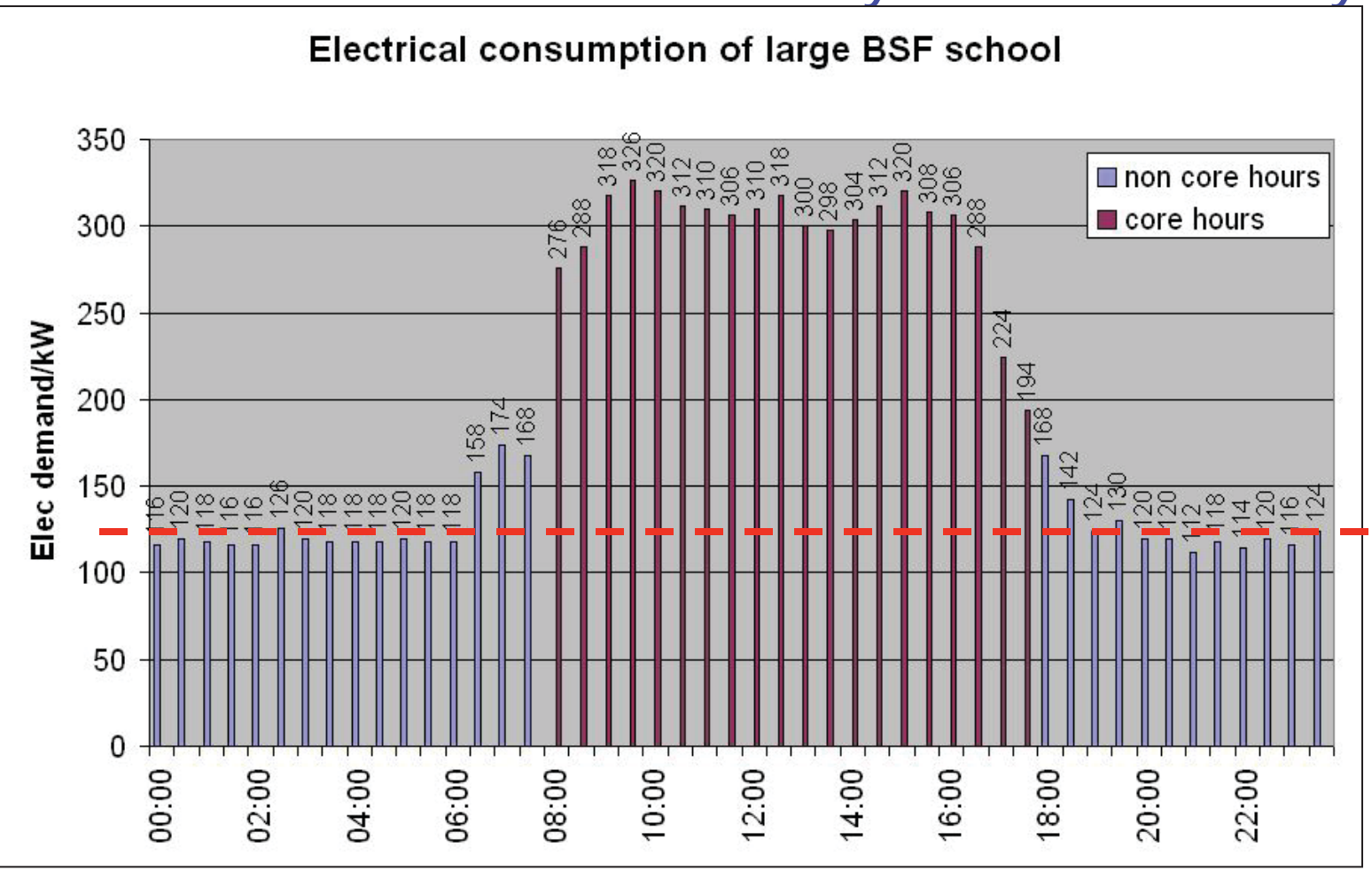
unless you’ve got the fundamentals right

Don't provide what occupiers can't afford to manage

Why are we being forced to make things complicated in the name of sustainability?

Make sure you tackle the night loads

kWh/half hour in a recently-built secondary school



120 kW baseload: ca. 7 W/m² or 45 kWh/m² p.a. Equivalent to 60% of all lighting or 1000 PCs including screens. printers etc.

Breakdown of annual electricity use: ***44% used between 0800-1800 on term time days***
56% (~£75,000) of electricity used at other times: ***14% term weekends, 26% term nights, 16% holidays***

SOURCE: Buro Happold (October 2009)

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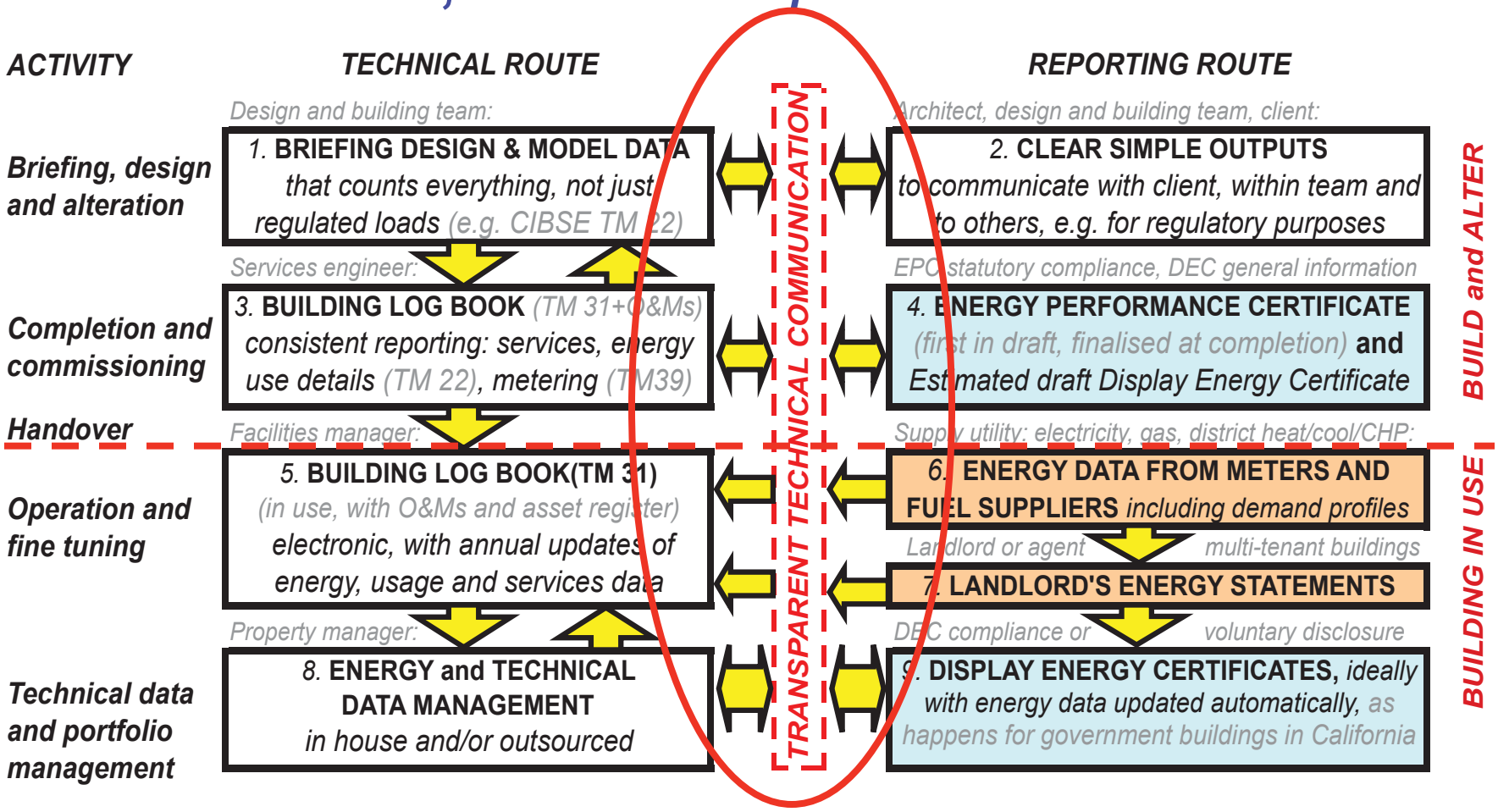
GETTING REAL: IMPROVING COMMUNICATION OF BUILDING ENERGY AND CARBON PERFORMANCE

We need a strong focus on in-use performance, *with transparent communication*



We need proper resources to pull together procedures and provide good quality information and publications.

Carbon Buzz is helping to do this

but we also need consistent underpinnings that can bring together statutory, professional and industry measures

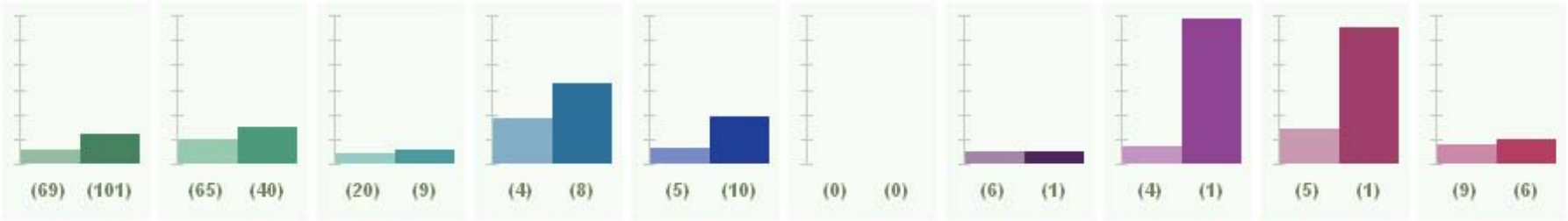
CarbonBuzz
an RIBA CIBSE platform

Home News

EVIDENCE

The graphs represent the median CO2 emissions for both design and actual records sector-by-sector on a scale of 0-300 kgCO2/m2/yr. The figures below each column represent the number of records per sector. Click on the graph to see a detailed breakdown of projects in related DEC benchmark categories and to view anonymous project sheets.

Current records often miss either design or the actual record as designers rarely have operational data and occupants rarely have design data. CarbonBuzz campaigns for the broader rollout of Display Energy Certificates to improve the feedback loop between design and operation.



A independent Technical Platform could *help to support many interests, e.g.*

Supply side	**Influencers**	**Demand side**
Property industry	Government	Building occupiers
Building industry	Government agencies	Building managers
Developer clients	Government clients	End-use clients
Building professions *(as businesses)*	Building professions *(ideally)*	Agents, advisers and consultants
Product and equipment suppliers *for buildings*	Voluntary bodies and independent advisers	Product and equipment suppliers *for occupiers*
Energy suppliers	Teaching and research	Energy support services
INDEPENDENT PUBLIC INTEREST PLATFORM		

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GETTING REAL: IMPROVING PROCUREMENT

Sorting things out: Procurement
Soft Landings can help

1. **Inception and Briefing**
   Appropriate processes, better relationships.
   Assigned responsibilities, including client.
   Well-informed targets related to outcomes.
2. **Design and construction**
   Including ***expectations management.***
3. **Preparation for handover**
   Better operational readiness.
4. **Initial aftercare**
   Information, troubleshooting, liaison, fine tuning, training.
5. **Longer-term aftercare**
   monitoring, review, independent POE, feedback and feedforward.

Runs alongside any construction process

Downloadable free
from www.usablebuildings.co.uk
and www.softlandings.org.uk

BSRIA *is hosting a UK industry group.*

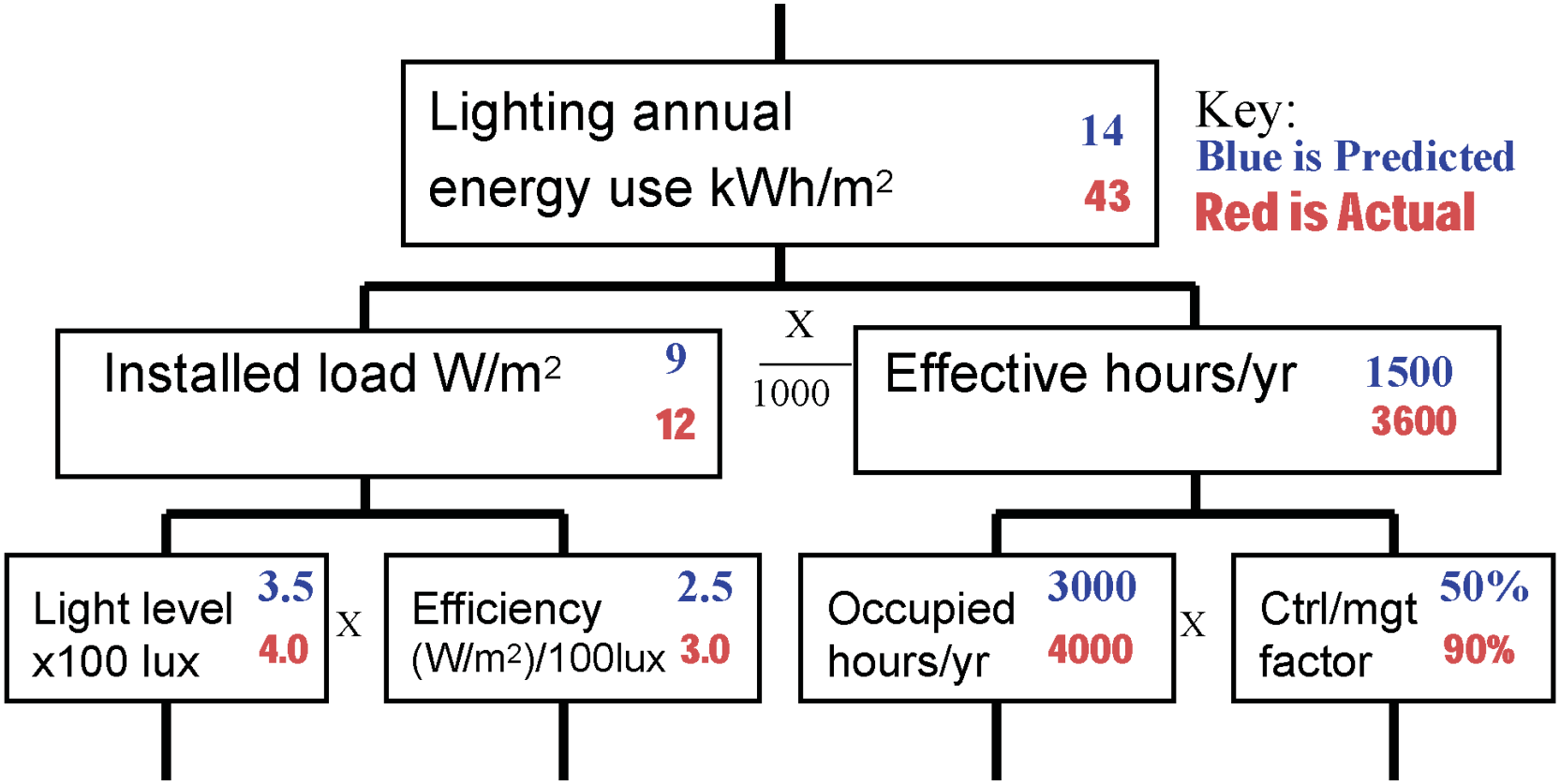
SOURCE: downloadable from www.usablebuildings.co.uk and www.bsria.org.uk

Soft Landings and the performance gap

- STAGE 1
  Better briefing and initial estimation.
- STAGE 2
  Expectations management and reality-checks during design and construction. *Needs a champion to progress.*
- STAGE 3
  More thorough preparation for handover, with better commissioning, more dialogue with users and operators.
- STAGE 4
  Follow-through and tuning-up after practical completion.
- STAGE 5
  Longer term monitoring, review and feedback.

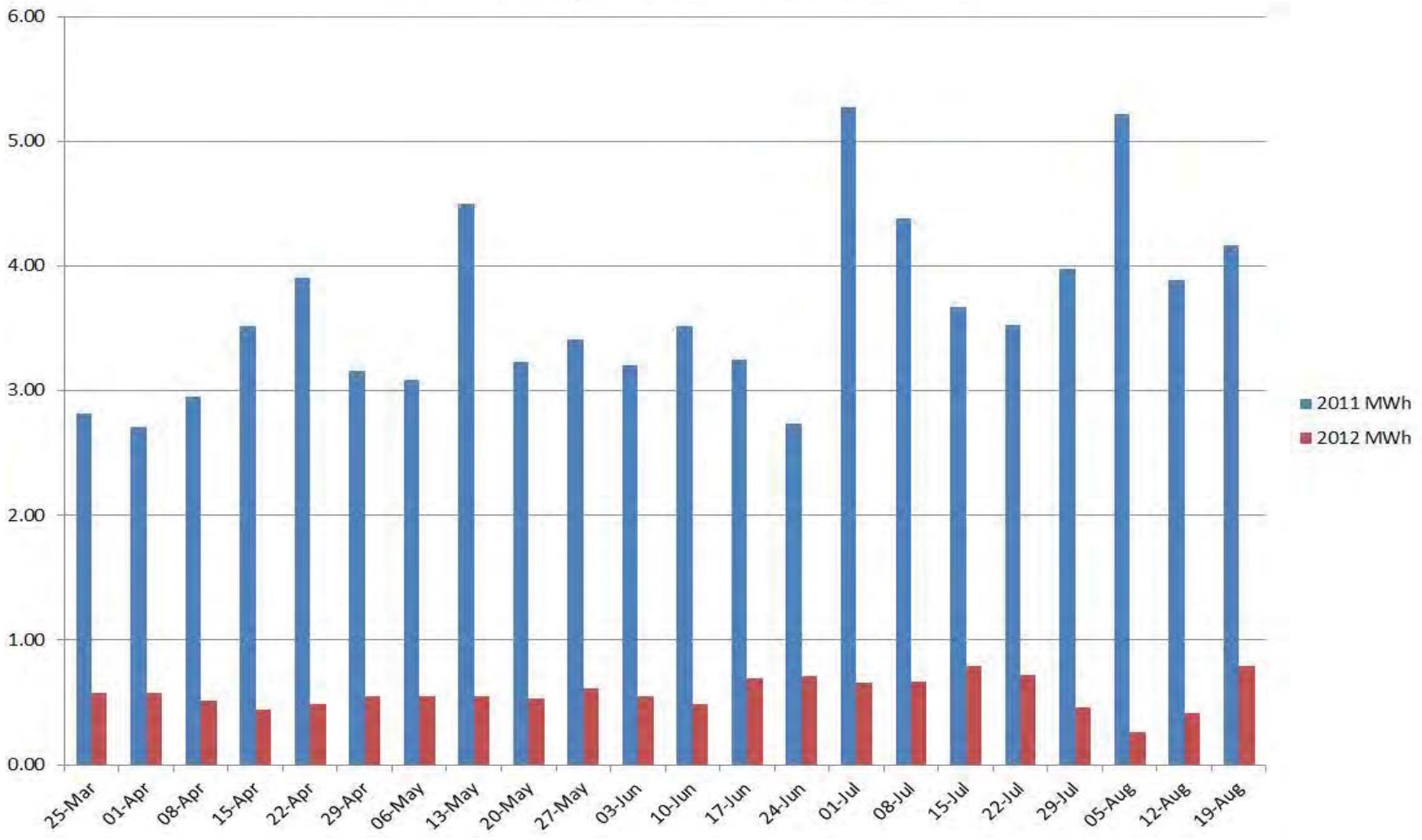
CIBSE TM22 provides a way to keep tabs

Actual versus predicted in a low-energy office design



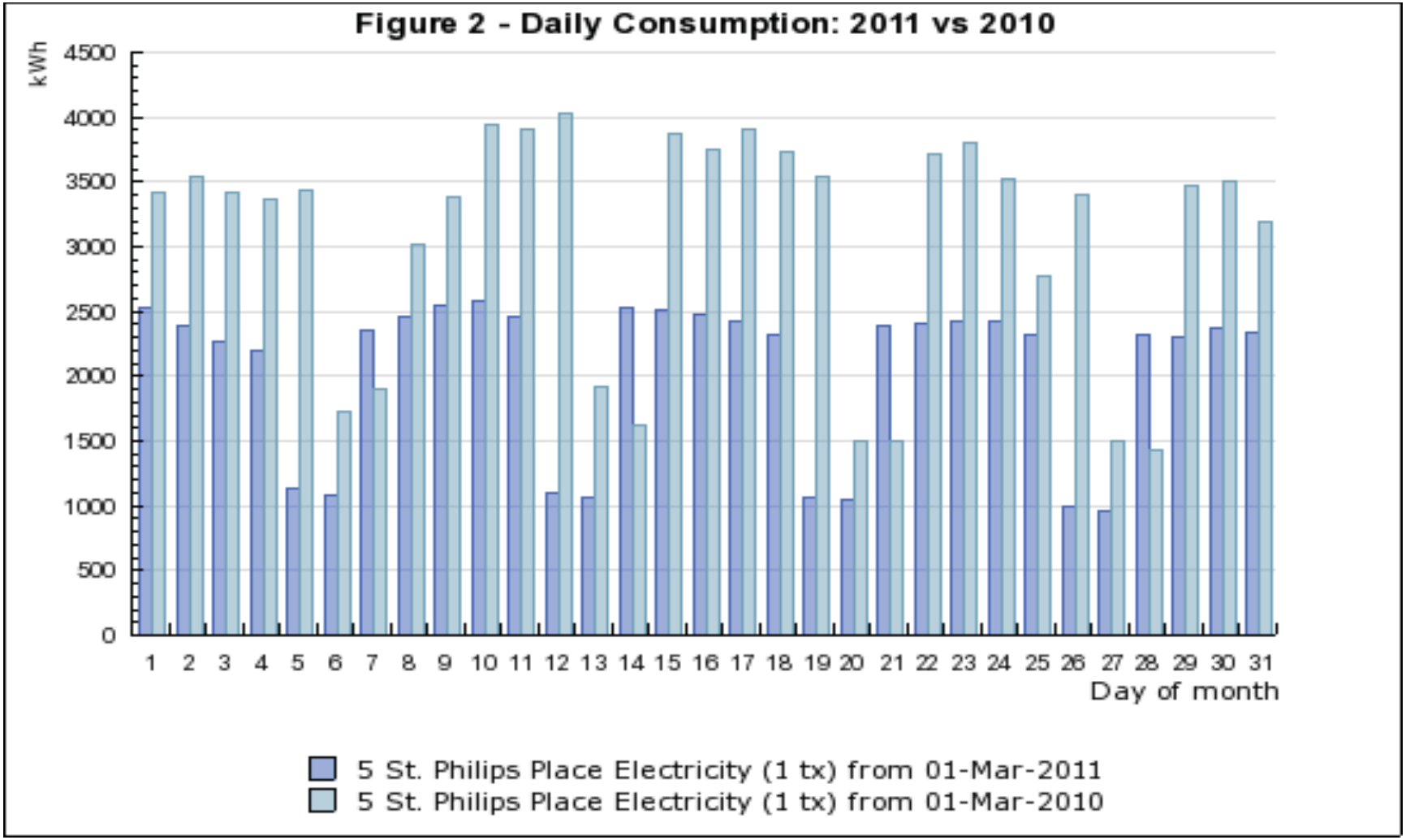
The process is described in CIBSE TM22: *Energy Assessment and Reporting Method, London:* CIBSE (1999 and 2006)

Why buildings need tuning up:
Chilled water 2012 vs 2011 in a new building



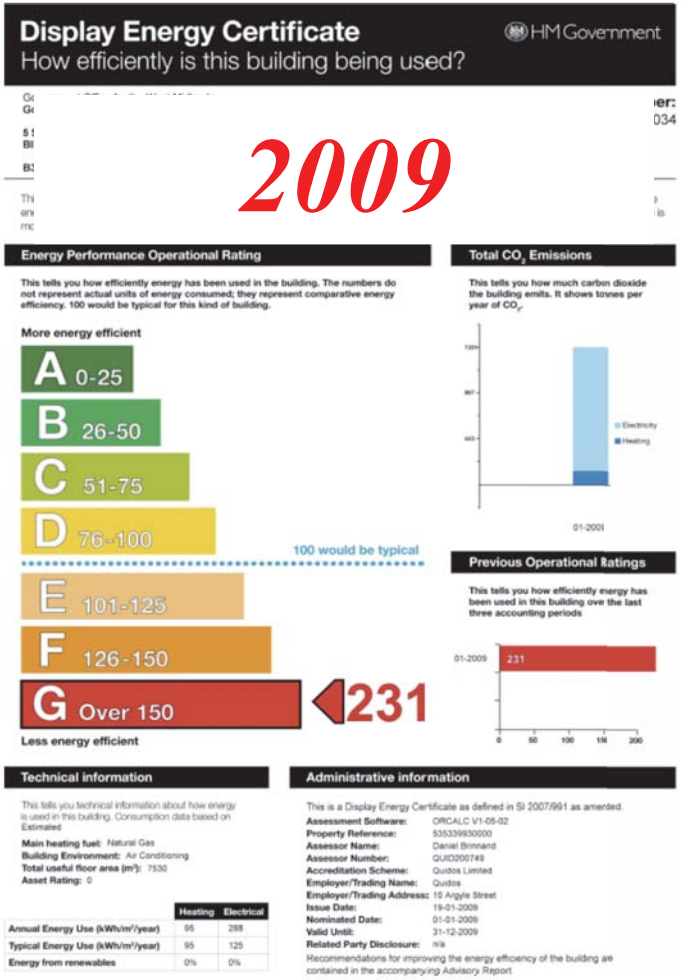
SOURCE: Current project on a university teaching/office building completed in 2010. Unpublished.

Why buildings need tuning up:
Continuous commissioning in a government office



Source: EMOTR project by ABS at St Philips Place, Birmingham.

Visible performance can mobilise management *without spending vast amounts of money*



Display Energy Certificate
How efficiently is this building being used?
HM Government

2009

Energy Performance Operational Rating

This tells you how efficiently energy has been used in the building. The numbers do not represent actual units of energy consumed; they represent comparative energy efficiency. 100 would be typical for this kind of building.

More energy efficient
A 0-25
B 26-50
C 51-75
D 76-100
100 would be typical
E 101-125
F 126-150
G Over 150 ◀231
Less energy efficient

Total CO_2 Emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO_2.

Electricity
Heating
01-2009

Previous Operational Ratings

This tells you how efficiently energy has been used in this building over the last three accounting periods

01-2009 231
0 50 100 150 200

Technical information

This tells you technical information about how energy is used in this building. Consumption data based on Estimated

Main heating fuel: Natural Gas
Building Environment: Air Conditioning
Total useful floor area (m²): 7530
Asset Rating: 0

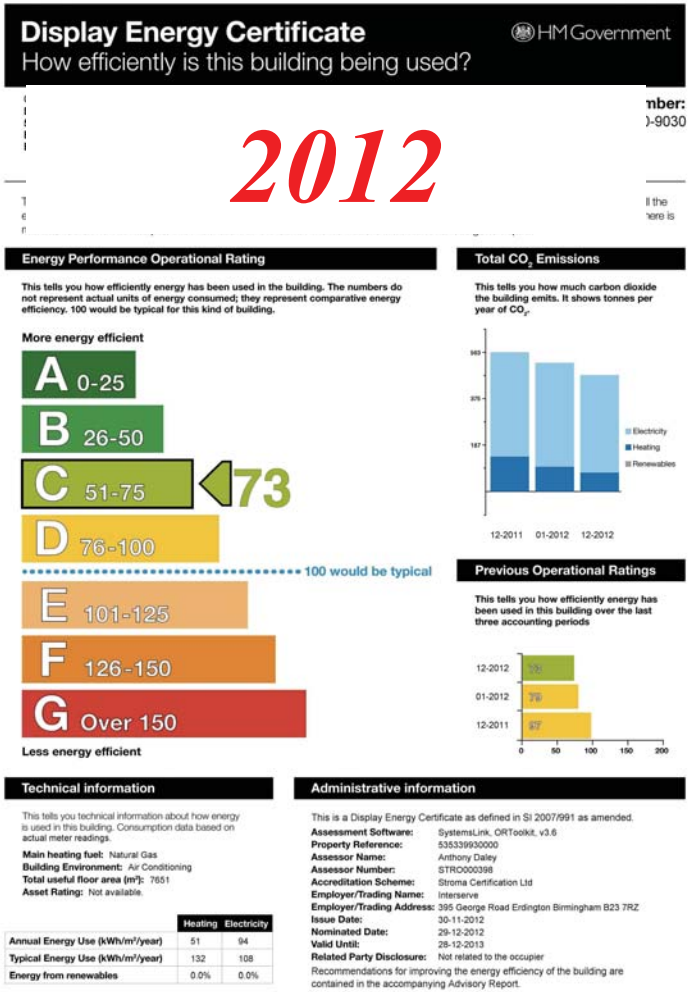
	Heating	Electrical
Annual Energy Use (kWh/m²/year)	95	288
Typical Energy Use (kWh/m²/year)	95	125
Energy from renewables	0%	0%

Administrative information

This is a Display Energy Certificate as defined in SI 2007/991 as amended.

Assessment Software: ORCALC V1-05-02
Property Reference: 535339930000
Assessor Name: Daniel Brinnand
Assessor Number: QUID200749
Accreditation Scheme: Quidos Limited
Employer/Trading Name: Quidos
Employer/Trading Address: 10 Argyle Street
Issue Date: 19-01-2009
Nominated Date: 01-01-2009
Valid Until: 31-12-2009
Related Party Disclosure: n/a

Recommendations for improving the energy efficiency of the building are contained in the accompanying Advisory Report



Display Energy Certificate
How efficiently is this building being used?
HM Government

2012

Energy Performance Operational Rating

This tells you how efficiently energy has been used in the building. The numbers do not represent actual units of energy consumed; they represent comparative energy efficiency. 100 would be typical for this kind of building.

More energy efficient
A 0-25
B 26-50
C 51-75 ◀73
D 76-100
100 would be typical
E 101-125
F 126-150
G Over 150
Less energy efficient

Total CO_2 Emissions

This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO_2.

Electricity
Heating
Renewables
12-2011 01-2012 12-2012

Previous Operational Ratings

This tells you how efficiently energy has been used in this building over the last three accounting periods

12-2012
01-2012
12-2011
0 50 100 150 200

Technical information

This tells you technical information about how energy is used in this building. Consumption data based on actual meter readings.

Main heating fuel: Natural Gas
Building Environment: Air Conditioning
Total useful floor area (m²): 7651
Asset Rating: Not available.

	Heating	Electricity
Annual Energy Use (kWh/m²/year)	51	94
Typical Energy Use (kWh/m²/year)	132	108
Energy from renewables	0.0%	0.0%

Administrative information

This is a Display Energy Certificate as defined in SI 2007/991 as amended.

Assessment Software: SystemsLink, ORToolkit, v3.6
Property Reference: 535339930000
Assessor Name: Anthony Daley
Assessor Number: STRO000398
Accreditation Scheme: Stroma Certification Ltd
Employer/Trading Name: Interserve
Employer/Trading Address: 395 George Road Erdington Birmingham B23 7RZ
Issue Date: 30-11-2012
Nominated Date: 29-12-2012
Valid Until: 28-12-2013
Related Party Disclosure: Not related to the occupier

Recommendations for improving the energy efficiency of the building are contained in the accompanying Advisory Report.

Source: work by Bordass Associates, Power Efficiency, and ABS Consultancy for Climate Change Capital (landlord) and DCLG

But some buildings just can't be tuned:
the fabric, systems and controls aren't up to it

Why good buildings go bad while some are just born that way

Dr Paul Bannister, Exergy Australia Pty Ltd

ABSTRACT

With the realisation that climate change is not going to be resolved by inaction or unrealised promises, the issue of actual building performance has become focal in today's commercial buildings sector. With this has come the genuinely problematic issue of delivering and operating buildings at levels of efficiency higher than have been achieved before.

While some argue that good design is all, those involved in operating buildings are generally aware that the issues of delivering and operating high-efficiency buildings are somewhat more complex. A building that has a good theoretical performance may not perform well in practice, while many lesser buildings may be easier to operate and improve.

In this paper, a range of issues that cause apparently well designed buildings to perform poorly are explored, with particular emphasis on the issues affecting base buildings under the Australian Building Greenhouse Rating scheme. These issues include items that can be seen as the responsibility of various participants in the supply chain, as well as many that are the product of numerous such participants. It is identified that delivering and operating high-efficiency buildings is a complex and multifaceted problem that requires a holistic rather than reductionist view of the building process. Some guidelines for more reliable delivery of efficient buildings are also provided.

SOURCE: Ecolibrium, the Journal of the Australian Institute of Refrigeration, AC and Heating, 24-32 (February 2009)

We need to save real energy and carbon
not virtual energy and carbon!

NATURE CAN'T BE FOOLED ... Richard Feynman

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