ECEEE Summer Study - *Is Efficient Sufficient?*
Presqu'îsle de Giens, France
7 June 2019

Saving Energy in a Hurry

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Something's happening … 17 Nov 2018

Something's happening … 17 Nov 2018

Dozens arrested after climate protest blocks five London bridges

Thousands of protesters occupied bridges across the Thames over extinction crisis in huge act of peaceful civil disobedience

Something's happening …

25 Jan 2019

Climate change

'Our house is on fire': Greta Thunberg, 16, urges leaders to act on climate

Greta Thunberg

Swedish school strike activist demands economists tackle runaway global warming. Read her Davos speech here

Fri 25 Jan 2019 14.57 GMT

8,651

▲ 'I want you to panic': 16-year-old issues climate warning at Davos – video

Something's happening … 25 Apr 2019

Something's happening … 1 May 2019

MPs endorse Corbyn's call to declare climate emergency

Environment secretary calls for cross-party approach as Labour leader says vote can 'set off wave of action'

Something's happening … 5 Jun 2019

Scotland just became the first country to declare a climate emergency.

by Anna Sheffer

June 5, 2019 at 18:25

"The house is on fire"
- GRETA THUNBERG

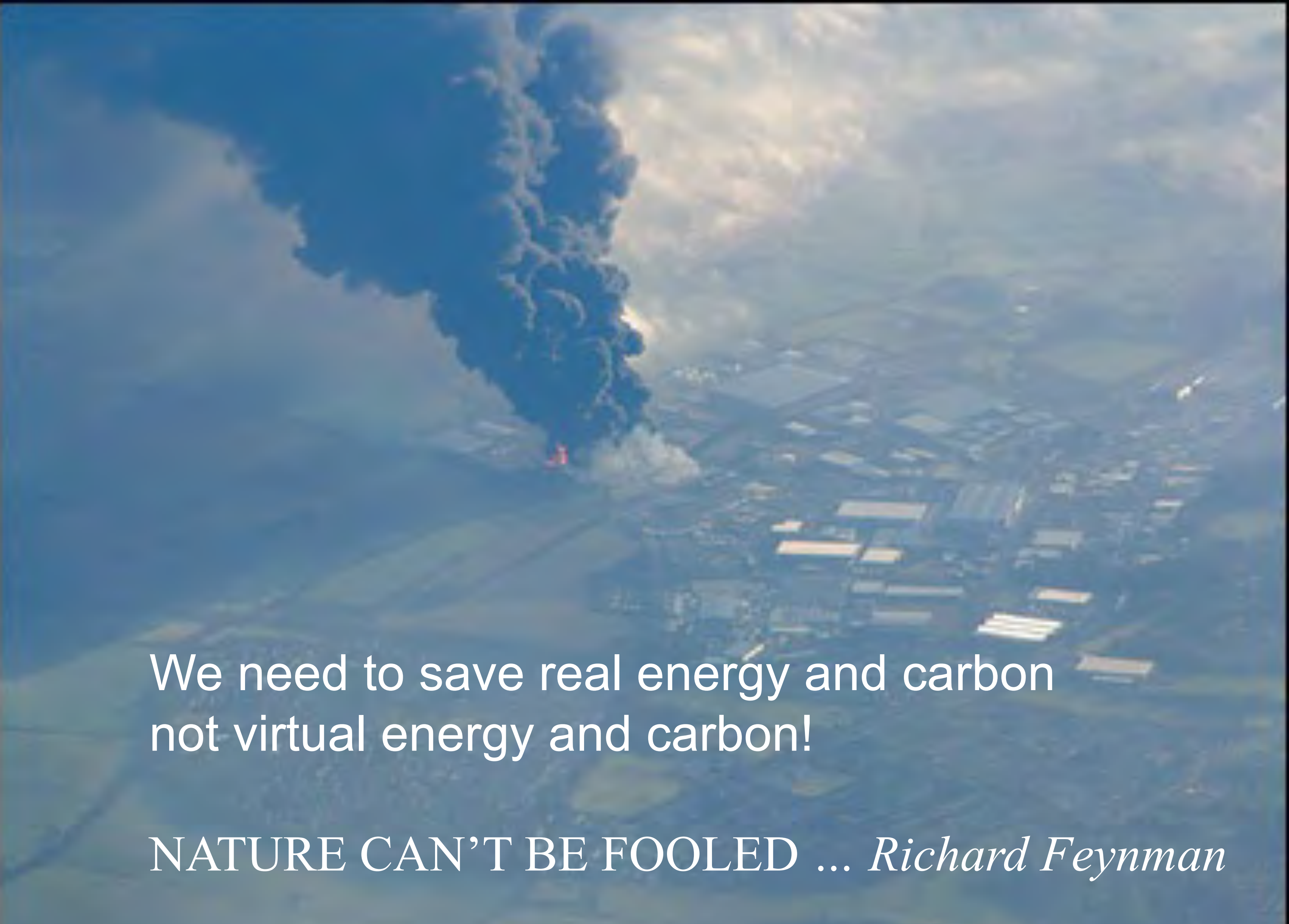
We must save energy and carbon in a hurry – embodied not just operational.

We need more thought and less stuff.

Are we experts UP FOR IT?
Are we experts UP TO IT?

Or have we just been messing about?

REMEMBER: *Much of what we have got used to in the West, we're not necessarily entitled to.*



Buncefield oil depot fire Hemel Hempstead,11 December 2005. Global CO2 emissions equal nearly 2000 of these, constantly burning, every day.

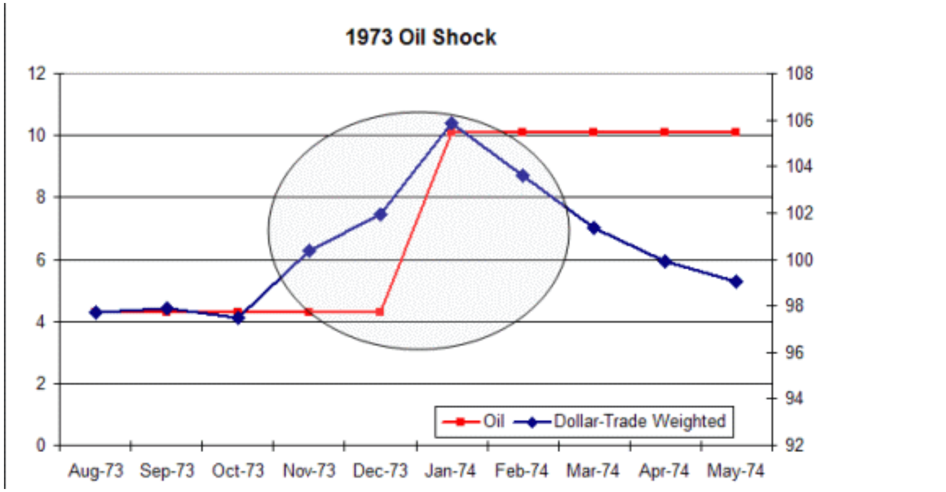
Sleepwalking into unsustainable buildings

Half a century of sleepwalking towards climate change

15 April, 2019 By Bill Bordass

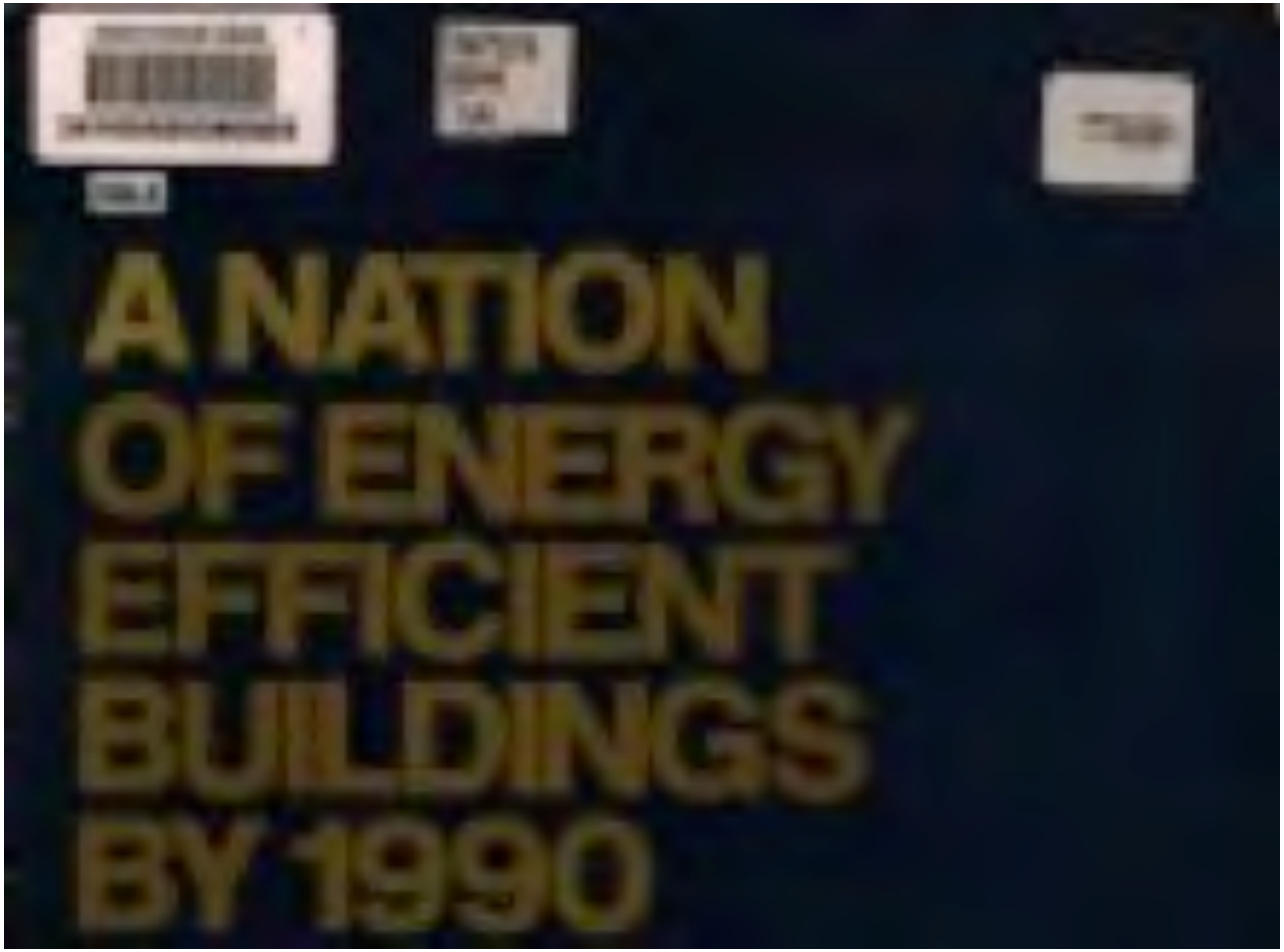
AJ THE ARCHITECTS' JOURNAL

At the end of 1973, we had the oil crisis

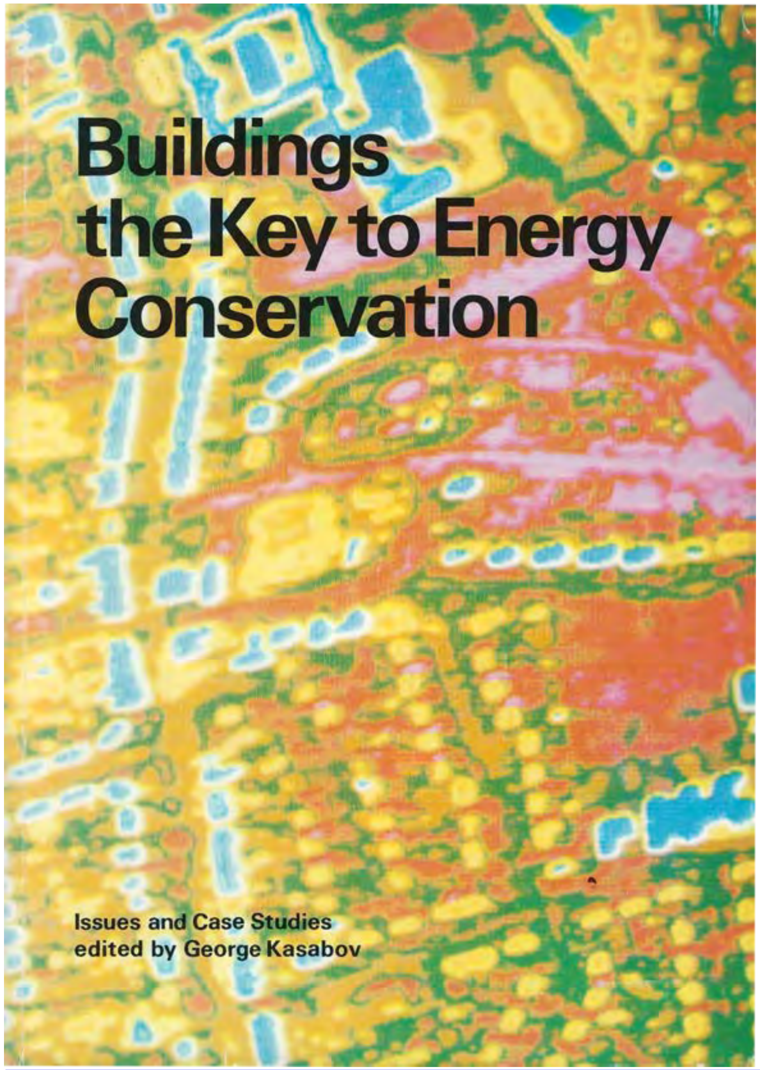


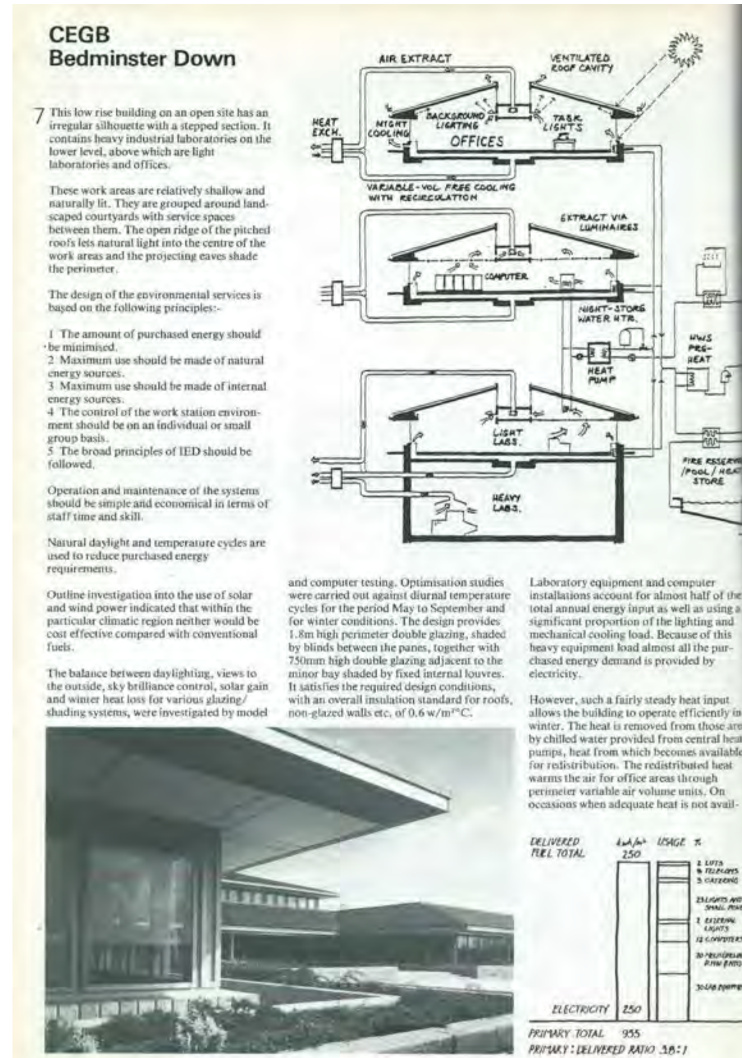
In 1974, coal supplies also ran short in the UK, through trade union action, bringing on the 3-day week and bringing down the Tory Government …

The American Institute of Architects
published a policy document



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





CEGB Bedminster Down

7 This low rise building on an open site has an irregular silhouette with a stepped section. It contains heavy industrial laboratories on the lower level, above which are light laboratories and offices.

These work areas are relatively shallow and naturally lit. They are grouped around landscaped courtyards with service spaces between them. The open ridge of the pitched roofs lets natural light into the centre of the work areas and the projecting eaves shade the perimeter.

The design of the environmental services is based on the following principles:-

1 The amount of purchased energy should be minimised.
2 Maximum use should be made of natural energy sources.
3 Maximum use should be made of internal energy sources.
4 The control of the work station environment should be on an individual or small group basis.
5 The broad principles of IED should be followed.

Operation and maintenance of the systems should be simple and economical in terms of staff time and skill.

Natural daylight and temperature cycles are used to reduce purchased energy requirements.

Outline investigation into the use of solar and wind power indicated that within the particular climatic region neither would be cost effective compared with conventional fuels.

The balance between daylighting, views to the outside, sky brilliance control, solar gain and winter heat loss for various glazing/shading systems, were investigated by model and computer testing. Optimisation studies were carried out against diurnal temperature cycles for the period May to September and for winter conditions. The design provides 1.8m high perimeter double glazing, shaded by blinds between the panes, together with 750mm high double glazing adjacent to the minor bay shaded by fixed internal louvres. It satisfies the required design conditions, with an overall insulation standard for roofs, non-glazed walls etc. of 0.6 w/m²°C.

Laboratory equipment and computer installations account for almost half of the total annual energy input as well as using a significant proportion of the lighting and mechanical cooling load. Because of this heavy equipment load almost all the purchased energy demand is provided by electricity.

However, such a fairly steady heat input allows the building to operate efficiently in winter. The heat is removed from those areas by chilled water provided from central heat pumps, heat from which becomes available for redistribution. The redistributed heat warms the air for office areas through perimeter variable air volume units. On occasions when adequate heat is not avail-

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

but 20 years later, in 1990 …

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).

… and in the USA

ELSEVIER

Energy and Buildings 21 (1994) 121–131

ENERGY AND BUILDINGS

Two-to-one discrepancy between measured and predicted performance of a 'low-energy' office building: insights from a reconciliation based on the DOE-2 model

L.K. Norford, R.H. Socolow, E.S. Hsieh, G.V. Spadaro[1]

Center for Energy and Environmental Studies, Princeton University, Princeton, NJ, USA

Received 1 February 1989; accepted in revised form 25 April 1994

Abstract

Computer models of building energy use, if calibrated with measured data, offer a means of assessing retrofit savings, optimizing HVAC operation (on- or off-line), and presenting energy-consumption feedback to building operators. The calibration process itself can pinpoint differences between how a building was designed to perform and how it is actually functioning. Our initial goal was to identify why the actual annual energy consumption of an office building was 325 kWh/m^2, over twice the predicted value of 125 kWh/m^2. Part of our effort to understand its performance involved calibrating a DOE-2 model prepared at the design stage. In the process, we formulated calibration guidelines and developed insights that may be of use to others. Of particular interest are the major sources of the wide discrepancy between predicted and actual energy use. Unanticipated tenant energy consumption, both during the day and the night, contributed 64% of the two-fold increase. Heating, ventilation and air-conditioning (HVAC) equipment operation beyond the expected 10 h per weekday contributed 24%. We attributed the remaining 12% to HVAC equipment not operating up to specification; building conductive heat loss in excess of the design-stage prediction; and minimum outdoor-air intake differing from the design value. The calibration process involved working on major input parameters independently of the others, then combining the results into one simulation. The calibrated model accounted for 94% of measured site energy for the building.

… and in Australia, *though its NABERS system has improved things in rented offices*

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

Dr Paul Bannister, Exergy Australia Pty Ltd

ABSTRACT

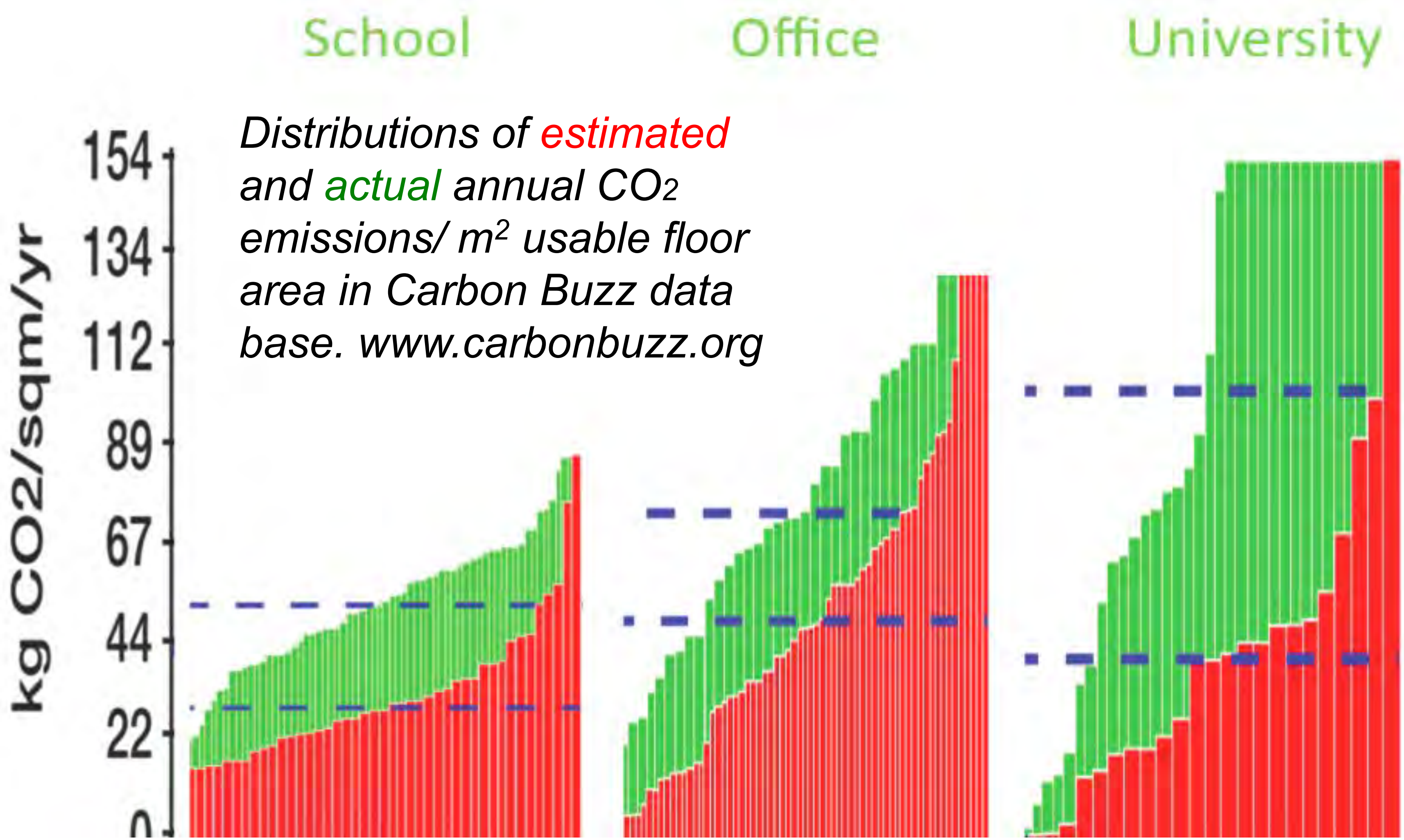
With the realisation that climate change is not going to be resolved by inaction or unrealised promises, the issue of actual building performance has become focal in today's commercial buildings sector. With this has come the genuinely problematic issue of delivering and operating buildings at levels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

Evidence of UK performance gaps is now overwhelming; *in some other countries too.*



SOURCE: Ian Taylor and Judit Kimpian, *Carbon Buzz Launch slides,* 6 June 2013. www.carbonbuzz.org

Even CIBSE admits it

UK Chartered Institution of Building Services

CIBSE Energy Performance Group

CARBON BITES

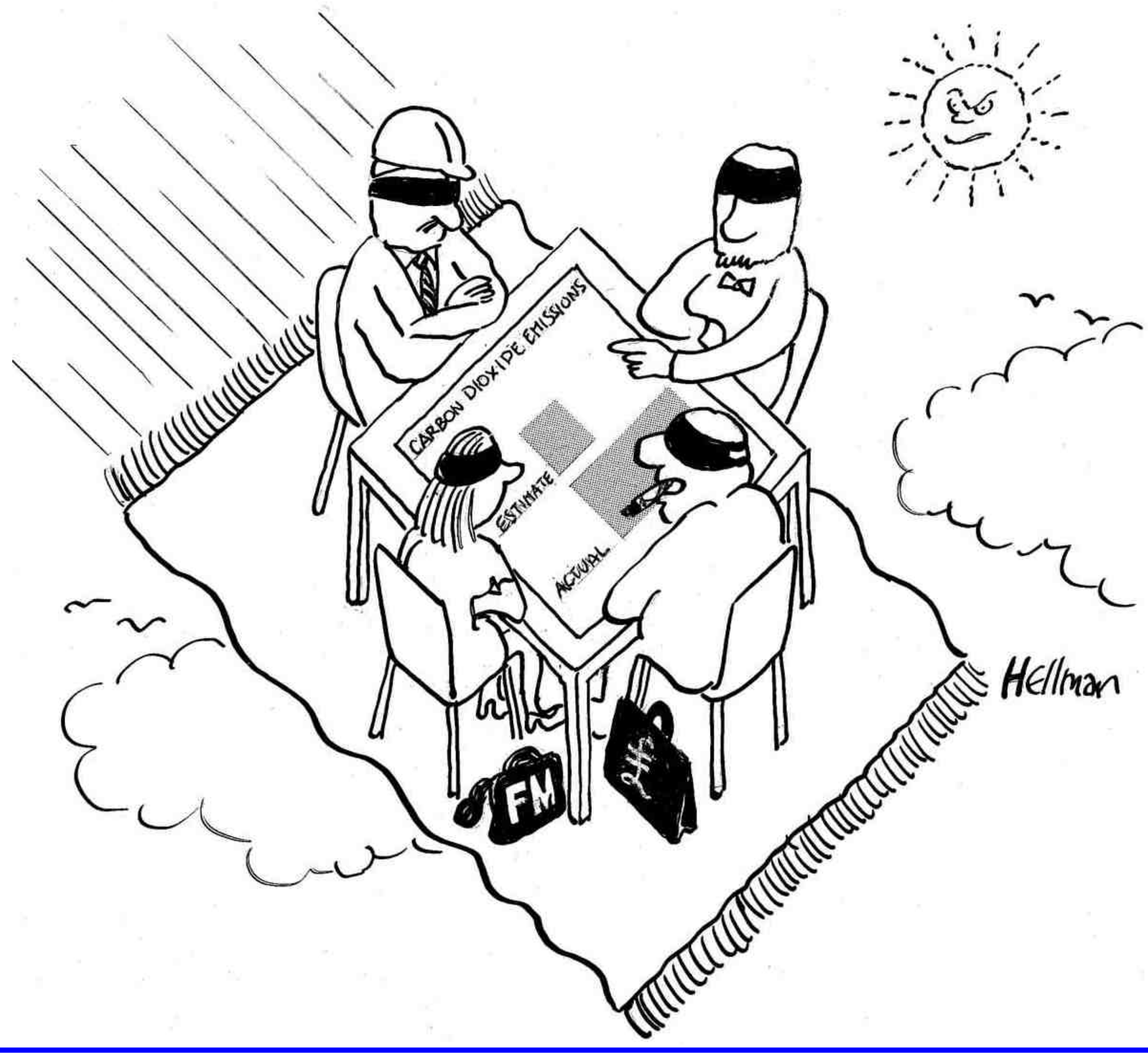
From the CIBSE ENERGY PERFORMANCE GROUP

The Performance Gap

What is The Performance Gap?

There is significant evidence to suggest that buildings do not perform as well as anticipated at design stage. Findings from the PROBE studies (Post Occupancy Review of Buildings and their Engineering) demonstrated that actual energy consumption in buildings will usually be twice as much as predicted. This was based on post-occupancy reviews of 23 buildings previously featured as 'exemplar designs' in the Building Services Journal (BSJ) between 1995 and 2002. More recent findings from the Carbon Trust's Low Carbon Buildings Accelerator and the Low Carbon Buildings Programme have demonstrated that in-use energy consumption can be 5 times higher that compliance calculations. Both studies suggest that lack of feedback following occupancy is one of the biggest contributors to this gap. Another key factor is that calculations for regulatory compliance do not account for all energy uses in buildings. These calculations are commonly misinterpreted as predictions of in-use energy consumption, when in fact they are simply mechanisms for compliance with Building Regulations. Unregulated sources of energy consumption such as small power loads, server rooms, external lighting, etc, are rarely considered at design stage. Yet these typically account for more than 30% of the energy consumption in office buildings, for example.

But 45 years after the oil crisis, *many remain in denial about the true outcomes*



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

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

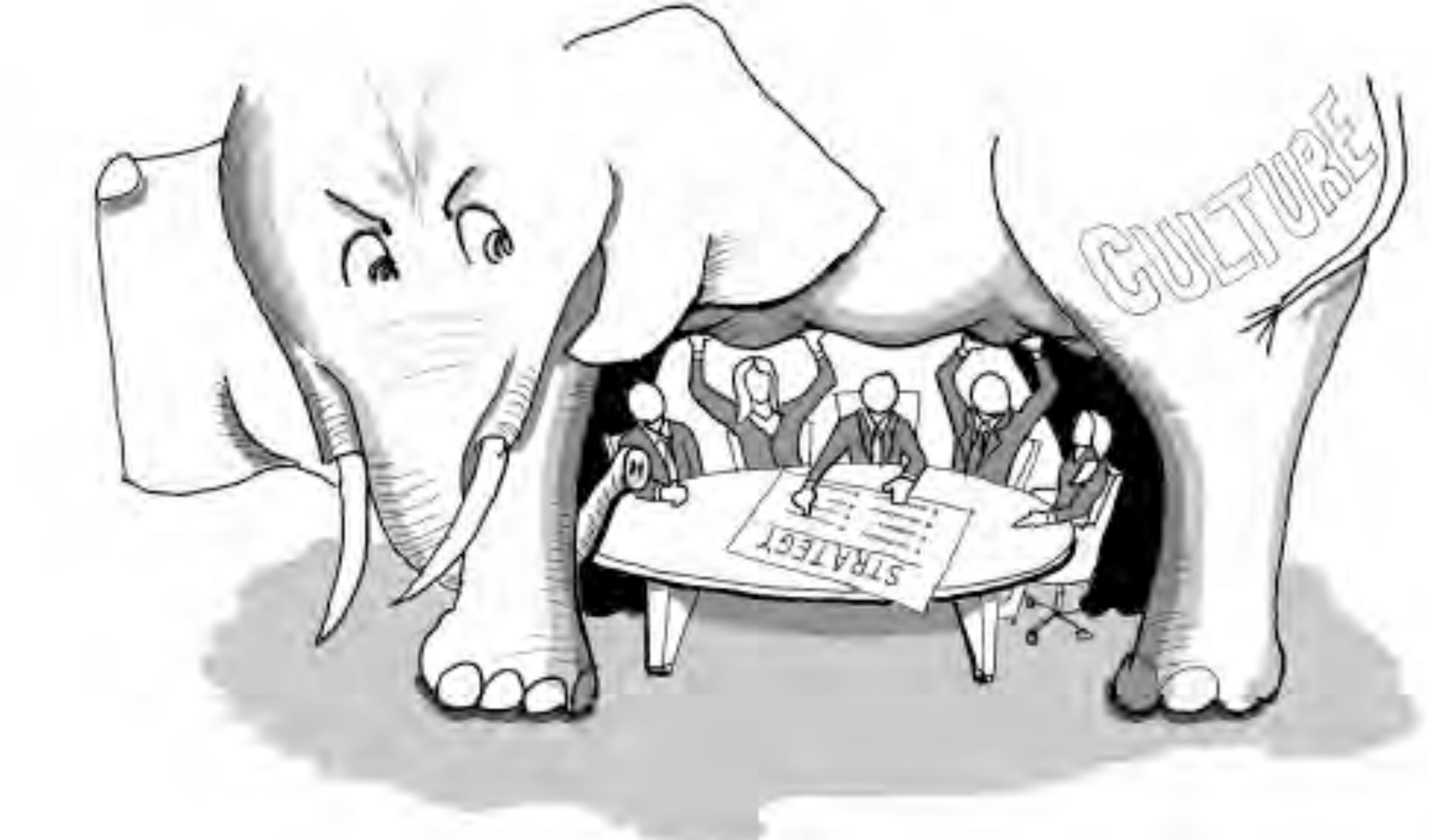
FIVE MISUNDERSTANDINGS *(after Flyvbjerg)*

1. *General knowledge is better than context-specific knowledge.*
   NO: *They complement each other.*
2. *You can't begin to generalise from a single case.*
   NO: *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.*
   NO: *They can also test hypotheses, using multiple methods.*
4. *They have a bias to confirming the investigator's bias.*
   NO: *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 help us develop coherent strategies for the future.*

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

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

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

Technology - management interactions:
conclusions from the Probe studies of public and commercial buildings and 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:

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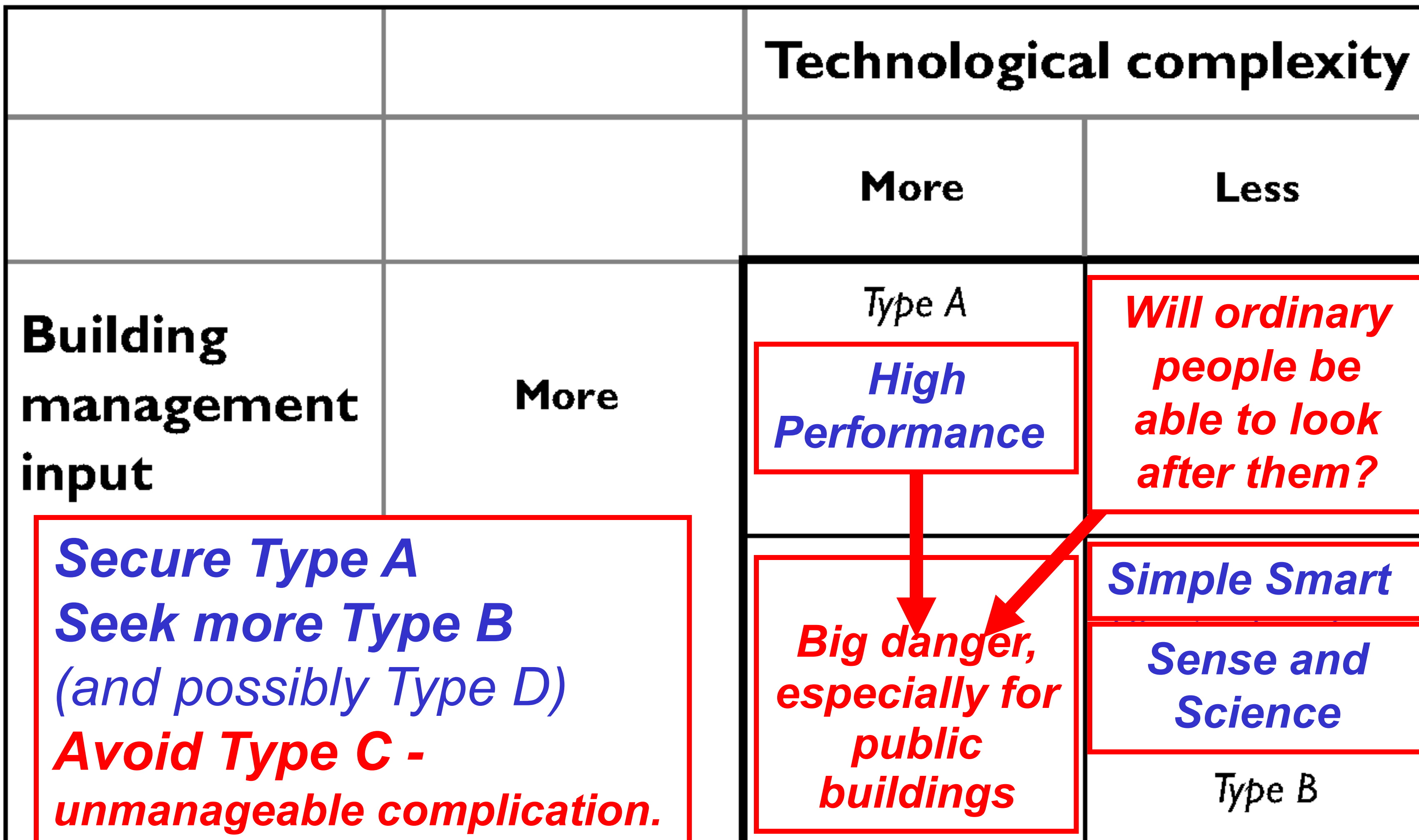


Diagram first appeared in: *Probe 19: Designer Feedback,* Building Services, the CIBSE Journal, page E21 (March 1999).

In spite of these insights from the 1990s, *complication has burgeoned in recent years*

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

So less money to spend on basics

The complication disease has now spread to housing too!

AND 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).

A path to energy sufficiency ?

- Engage people – *you can’t leave them out!*
- Reduce demand – *by not having things.*
- Increase efficiency – *of the stuff that’s left.*
- Improve controls – *make them user-friendly.*
- And only then decarbonise supplies – *low carbon energy is not to be squandered.*
- Avoid waste – *there is such a lot of it.*
- **Make things simpler and do them better.**
- Maintain a *golden thread* from design intent to use.
- Follow through, report outcomes, share learning.

How can we save energy in a hurry?

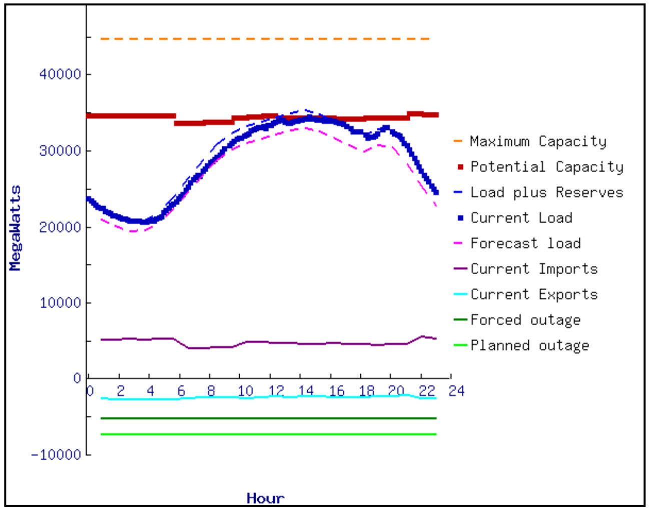
over to Alan Meier
who's done it.

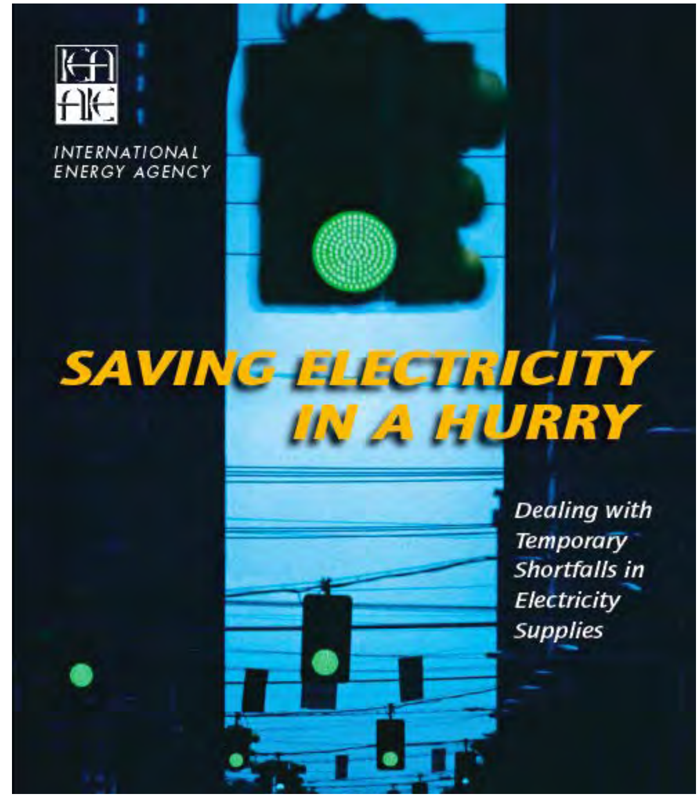
Saving Electricity in a Hurry

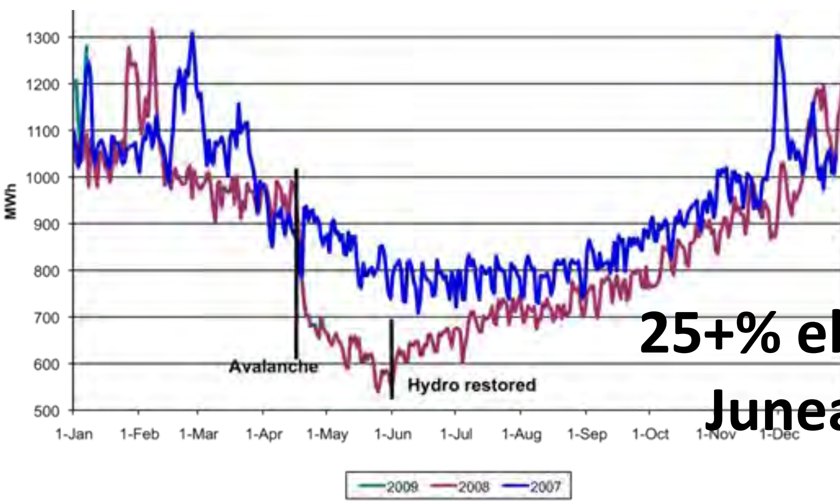
Alan Meier

Saving Electricity in a Hurry (International Energy Agency, 2005 & 2011)

currentenergy.lbl.gov (2001)







25+% electricity reduction in Juneau, Alasaka, (2008)

A Special Kind of Crisis

- A <u>temporary</u> shortfall in electricity supplies
  - Usually lasts days to months
  - Typically caused by a *combination* of technical and social problems
- Not enough time to bring replacement equipment or finish repairs
- The grid is intact, so delivery of power to customers is not a problem
- The goal is to avoid blackouts and allow near-normal economic activities (and keep your job!)

What Causes the Crisis?

Weather, Technical Malfunctions, Market Failures

- A drought in Brazil
- Flawed deregulation in California
- Tsunami in Japan
- Safety flaws in Japanese nuclear power plants
- Transformer explosion in Arizona (USA)
- Refinery explosion in Australia
- Avalanche in Alaska
- Heat waves and cold waves in USA, France, Sweden, Korea (?)
- Unexpected increase in demand from economic growth in South Africa, Korea (?)

Reminder: Technical Failures Require Time to Repair

An explosion at the Westwing transformer station in Arizona

Strategies to Balance the Grid

1. Rolling blackouts
2. Raise the price of electricity
3. Ration electricity
4. Reduce demand quickly through voluntary measures

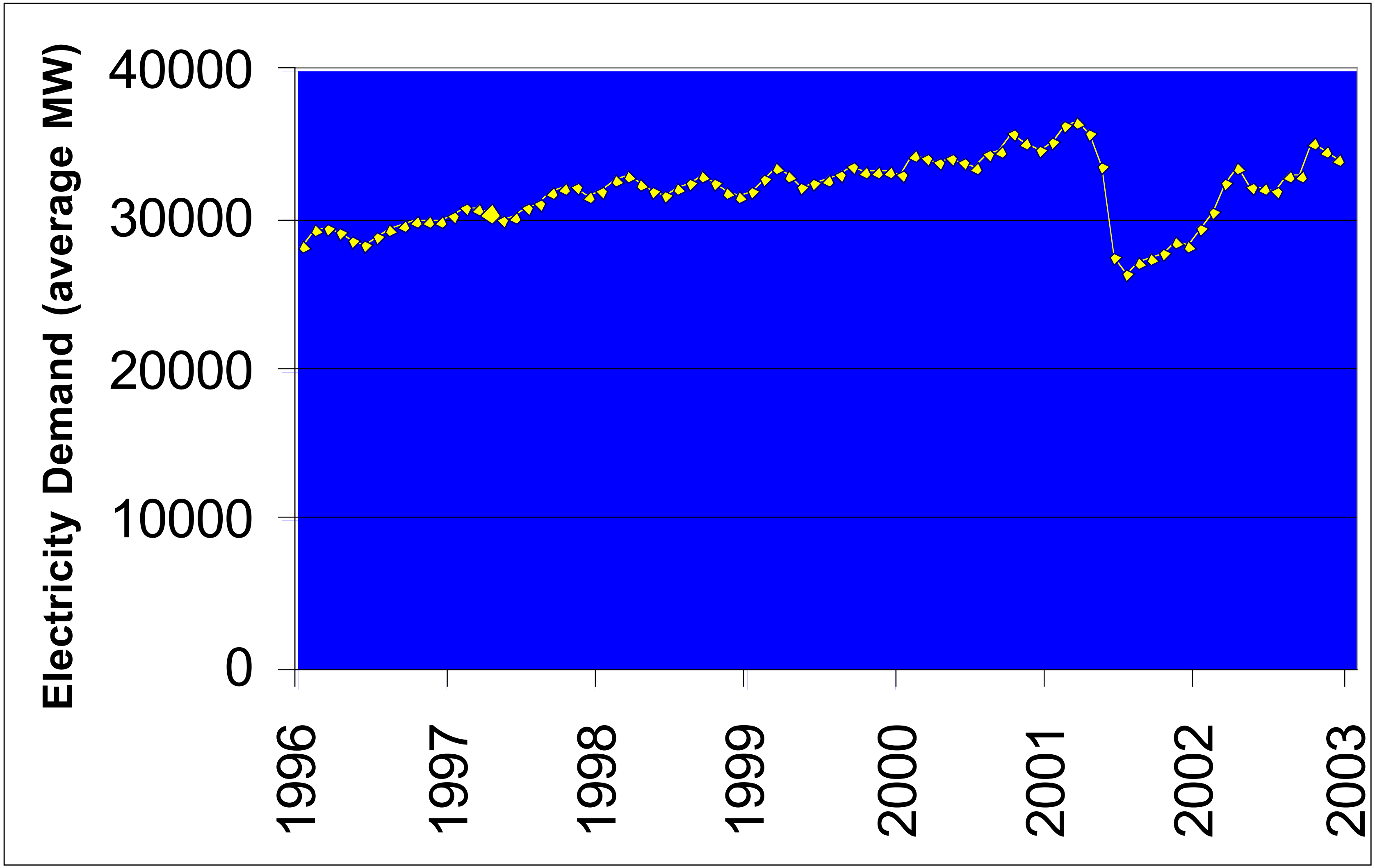
Example: Drought in Brazil (2001)

- Brazil is 100% hydro and highly integrated
- Drought caused 20% shortfall in supplies
  - Long-term problem: Brazil failed to build new capacity because of uncertain market liberalization
- Government treated the problem as a national crisis
  - Emergency committee run by president's chief of staff

Conservation Actions in Brazil

- 20% <u>mandatory </u>reduction in electricity use vs. last year for all customers
  - disconnections for those who fail
- HUGE media campaign
  - Contests, comparisons between towns
  - Symbolic actions, such as re-scheduling football games
- Technical changes
  - Millions of CFLs
  - Freezers unplugged
  - Industries re-sold firm power
- No price hikes for most residential customers

Brazil Results: 20% reduction



- No blackouts, economy survived, savings continued

Voluntary Measures to Conserve

Changes in behavior can happen very quickly (within hours) and lead to rapid reductions in demand. Steps to conserve:

1. Convince the public that a crisis exists
2. Explain to the public how their actions can help solve the problem and what actions to undertake
3. Provide incentives, feedback and encouragement
   - Effective programs are expensive

Advertisements from New Zealand using humor to communicate message

Voluntary Programs Need Mass Participation to Succeed

- Use **mass** media
  - Generation of electricity is a highly centralized activity but **the <u>consumption</u> of electricity is highly dispersed and diffuse. Mass media is the only way to influence consumption quickly**
  - TV, newspapers, radio, websites
- Use **social** media to target special user groups
  - Facebook, social media, websites
- Make saving electricity fashionable (popular)
  - Use television stars, actors to deliver message
  - Use humor to encourage behavior change
  - Start contests, competitions
- <u>Pay</u> for savings with incentives, rewards, prizes

Never Waste a Crisis!

Prepare to save electricity gradually

- Improve electricity pricing and feedback
  - Adjust tariffs to reflect cost of supply
  - Install smart meters
  - Organize “Demand Response” for large customers
- Introduce new energy-efficient technologies
  - Minimum efficiency standards (MEPS) & accelerated appliance replacement
  - Fuel switching
- Encourage consumers to maintain their energy-saving behaviors

Conclusions

- Rapid, temporary, reductions in demand are achievable without damaging economy
- Effective use of the media is critical
  – Humor works
- Many short-term reductions were achieved without raising prices
- Shortfalls are likely to happen more often in the future because
  – Market liberalization reduces reserve capacity
  – Climate change increases weather variation

DISCUSSION
Saving energy and carbon in a hurry

- HOW MUCH?
- HOW FAST?
- HOW?
- WHO?
- WHERE?

POINTS MADE IN DISCUSSION - 1

- *How can "hot" and "cold" politics work best together?*
  We need both the radical and the reflective.
- *We need to shift emphasis from What? to How?*
  For example, Extinction Rebellion's 2025 UK zero-carbon target is probably impossible, but Reading University suggests that 2030 might be achievable.
- *What can we do and do well now?*
  Probably quite a lot. We're not starting from a blank slate, as some policy makers think. Make them aware of this.
- *We often need more action, not more research.*
  Or, at the very least, action research.
- Build on what we've got: refine it by applying it.

POINTS MADE IN DISCUSSION - 2

- *Why shy away from the truth?*
  We should learn from failures, not hide them.
- *Get away from the neoliberal viewpoint:*
  Treat people as citizens, not just consumers.
- Develop local skills and networks for retrofitting etc. based on trust: *relationships, not just transactions.*

AND FOR OURSELVES PERSONALLY…

- *Who if not we?* We're part of the problem too, SO:
- *Lead by example and walk the talk.* Otherwise we are hypocrites. Setting an example can also lead to unexpected emulations and spin-offs by others.
- *Get out there!* Increase our presence where we live, via schools, community groups, politicians and so on.

SPECIFIC IDEAS RAISED

- *Never waste a good crisis:* Prepare for the inevitable, like a repeat of the 2003 European summer.
- *Why not ban internal flights,* where trains are available?
- Alan Meier's *Saving Electricity in a Hurry* was for short-term emergencies. How can one avoid fatigue in a long emergency? Sufficiency needs to be rewarding too.
- *Inject more humour into the whole subject.*
  The British were seen to excel at Situation Comedy TV: How about a low-carbon version of *The Good Life?*

PLEASE SEND MORE IDEAS TO
ADAM HINGE hingea@aol.com

HE WILL RELAY THEM TO ACEEE