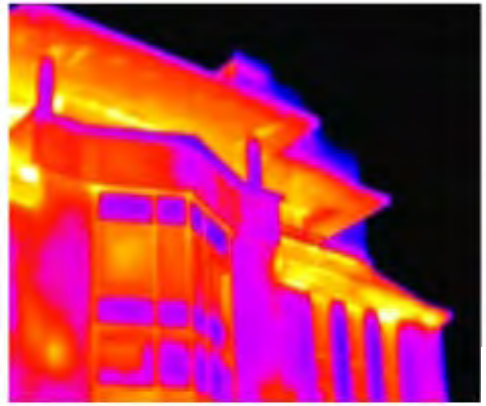


Health, wellbeing and productivity

Where next for building metrics?

Roderic Bunn BSRIA and UCL



SOFT LANDINGS

UCL

BSRIA

"No industry owning capital equipment of a similar cost to buildings could survive unless it had more data on performance"

Building Performance, Markus *et al*, **1972**

Soft Landings in a sentence

"Soft Landings is graduated handover of a new or refurbished building, where a period of professional aftercare by the project team is a client requirement – planned for and carried out from project inception onwards – and lasting for up to three years post-completion"

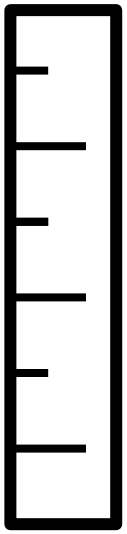
Purpose…?

To produce better buildings!

Technical criteria

Temperature, air quality, ventilation rate, light levels, operational energy, carbon emissions

BPE



Contextual criteria

Quality of work environment, space use, resource efficiency, health and well-being, productivity, zero FM complaints

…To many clients, the CONTEXTUAL CRITERIA are more important than the technical criteria in judging the success of a building

If we really want to deliver on the contextual factors, we need to do four key things

1. *Focus on outcomes*

2. *Make performance visible*

3. *Take ownership of performance*

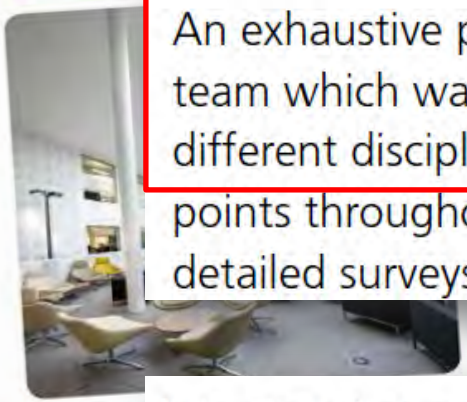
4. *Look at things more down the end-users end of the telescope*

Big data, and the health, wellbeing and productivity bandwagon

Process and scope

This is a complex issue, so to retain focus this report deals only with offices, and is concerned with both new and existing ones. On occasion, research is cited from non-office sectors where we think there is relevance. Similarly, the findings have resonance beyond just the office sector.

An exhaustive process of evidence gathering has been carried out, informed by a project team which was able to draw on over 50 industry and academic experts from across different disciplines, sectors and locations. Wider outreach was conducted at particular points throughout the process, including webinars that reached another 100 people, and detailed surveys of HR professionals that engaged another 25 stakeholders.



Healt
Produ
The next

It is aimed at a mainstream, non-technical real estate audience who are rightly eager to understand the business benefits of greener, healthier buildings. It is not primarily aimed at sustainability professionals, but we hope it will used by them in their discussions with clients, colleagues and customers.

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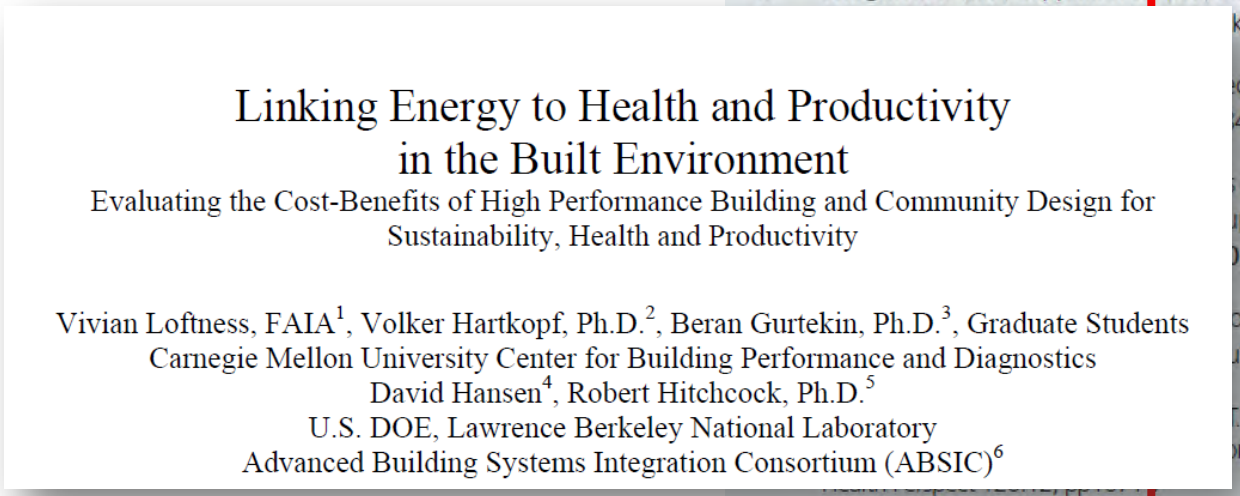


Linking Energy to Health and Productivity in the Built Environment

Evaluating the Cost-Benefits of High Performance Building and Community Design for Sustainability, Health and Productivity

Vivian Loftness, FAIA[1], Volker Hartkopf, Ph.D.[2], Beran Gurtekin, Ph.D.[3], Graduate Students
Carnegie Mellon University Center for Building Performance and Diagnostics
David Hansen[4], Robert Hitchcock, Ph.D.[5]
U.S. DOE, Lawrence Berkeley National Laboratory
Advanced Building Systems Integration Consortium (ABSIC)[6]

Footnotes

5. Loftness V. Hartkopf V. and Gurtekin B. (2003) "Linking Energy to Health and Productivity in the Built Environment: Evaluating the Cost-Benefits of High Performance Building and Community Design for Sustainability, Health and Productivity," USGBC Green Build Conference, 2003. Available: **http:cbpd.arc.cmu.edu/ebids** Last accessed 5 August 2014

6. Wargorcki P. (ed.) Seppänen O. (ed.) Andersson J. Boerstra A. Clements-Croome D. Fitzner K. k: Indoor Climate and Productivity In Offices

cts of outdoor air supply rate on work performance during 4–2905.

MD. (2000) Risk of Sick Leave Associated with Outdoor Air upant Complaints. Indoor Air 10, pp 212-221. Available: **http:// 0.pdf** Last accessed 5 August 2014

ochhar N. Awbi HB and Williams MJ. (2012) Ventilation rates uilding and Environment 48, pp 215-223

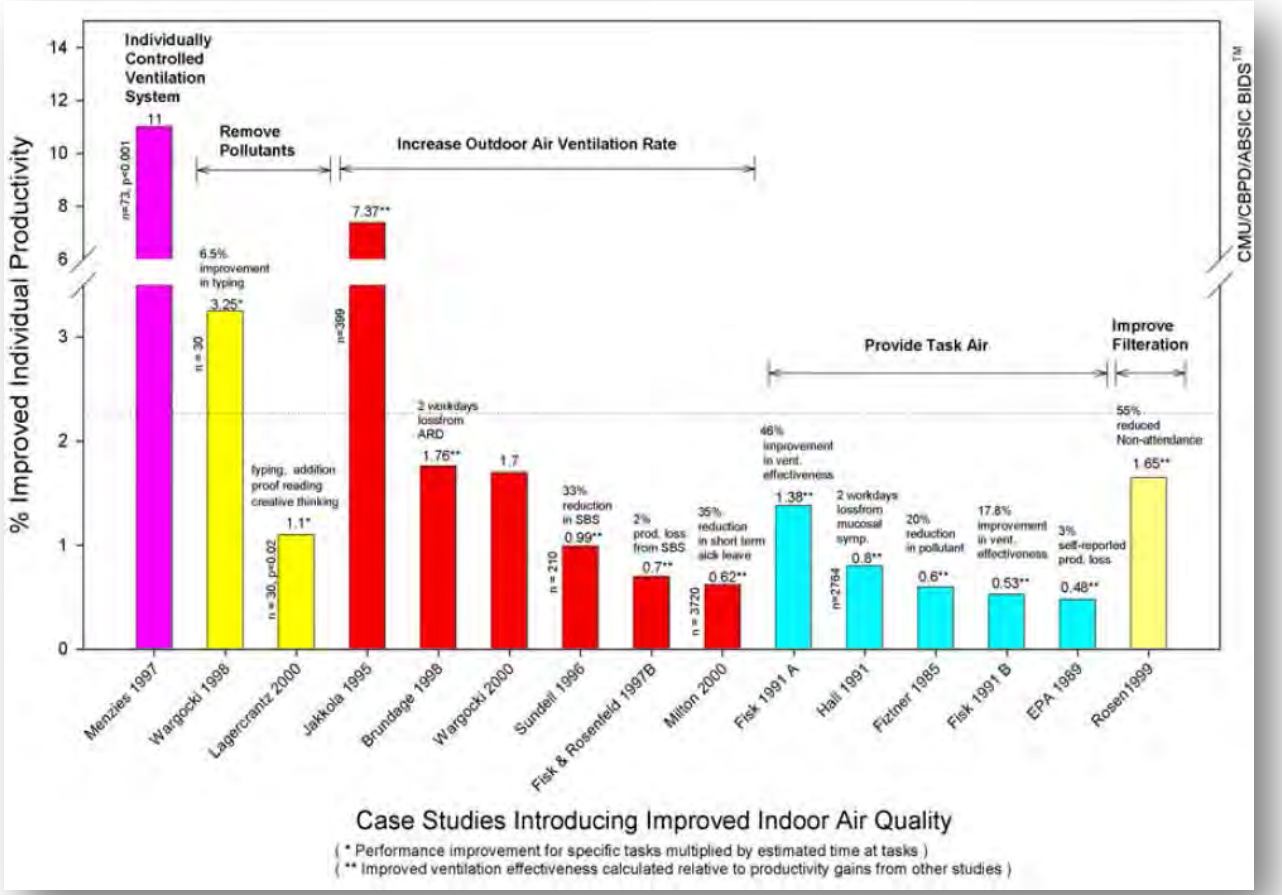
T. Sullivan D. Streufert S. Fisk WJ. (2012) Is CO_2 an Indoor Pollutant? ncentrations on Human Decision Making Performance. Environ

11. Carnegie Mellon (2004) Guidelines for High Performance Buildings – Ventilation and Productivity. Available: **http://cbpd.arc.cmu.edu/ebids/images/group/cases/mixed.pdf** Last accessed 5 August 2014

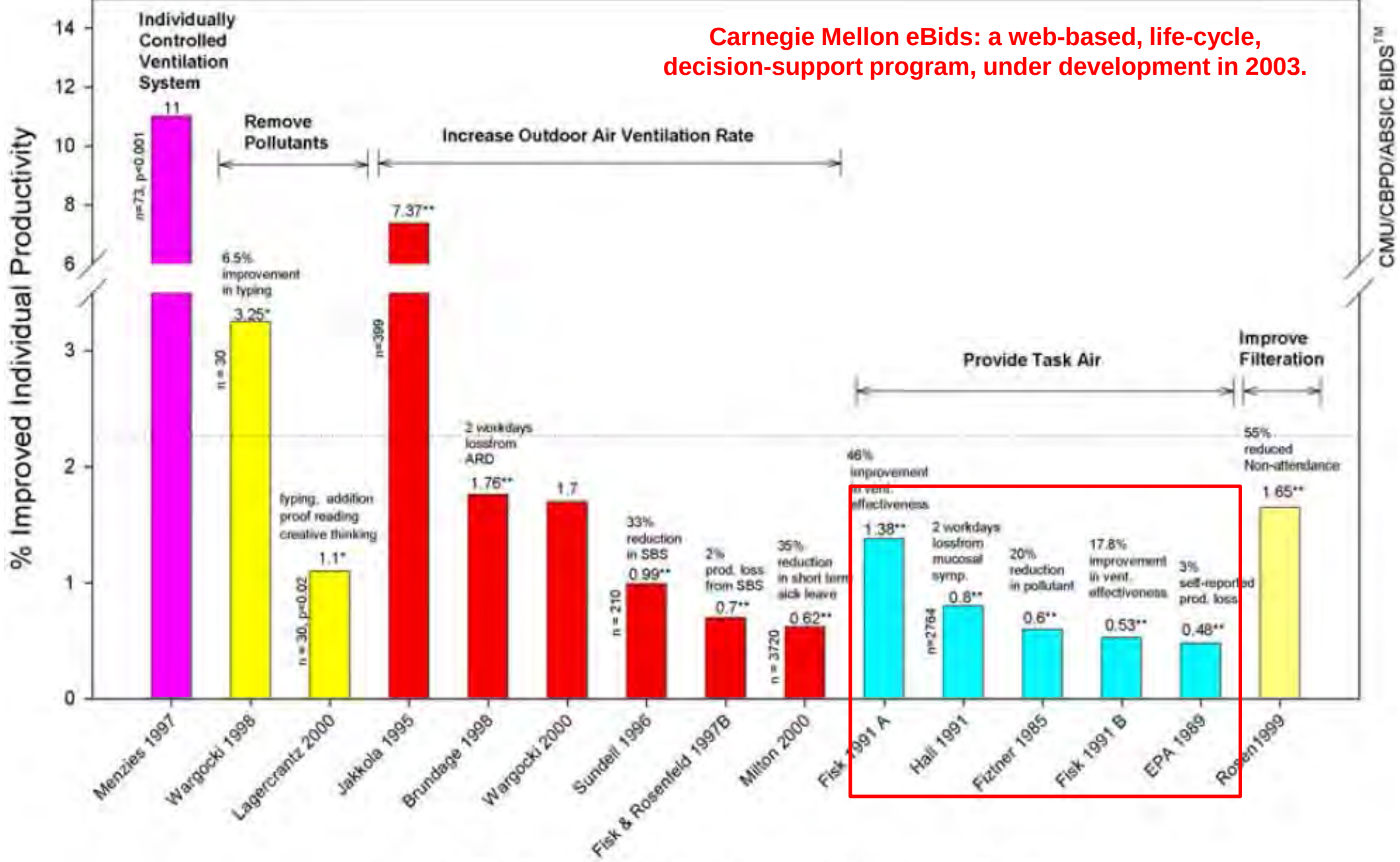
12. Wolverton BC. Douglas W. Bounds K. (1989) A study of interior landscape plants for indoor air pollution abatement. Available: **https://archive.org/stream/nasa_techdoc_19930072988/19930072988#page/n0/mode/2up** Last accessed 13 August 2014

13. Wolverton BC. (1997) How to Grow Fresh Air: 50 House Plants that Purify Your Home or Office. New York, Penguin Books cited in Environmental Health Perspectives 2011, 119:10

The research results cited originated in a research paper 'Linking Energy to Health and Productivity in the Built Environment', a non-peer reviewed paper delivered at the US-GBC Greenbuild Conference in 2003 (Loftness, V.; *et al*, 2003)

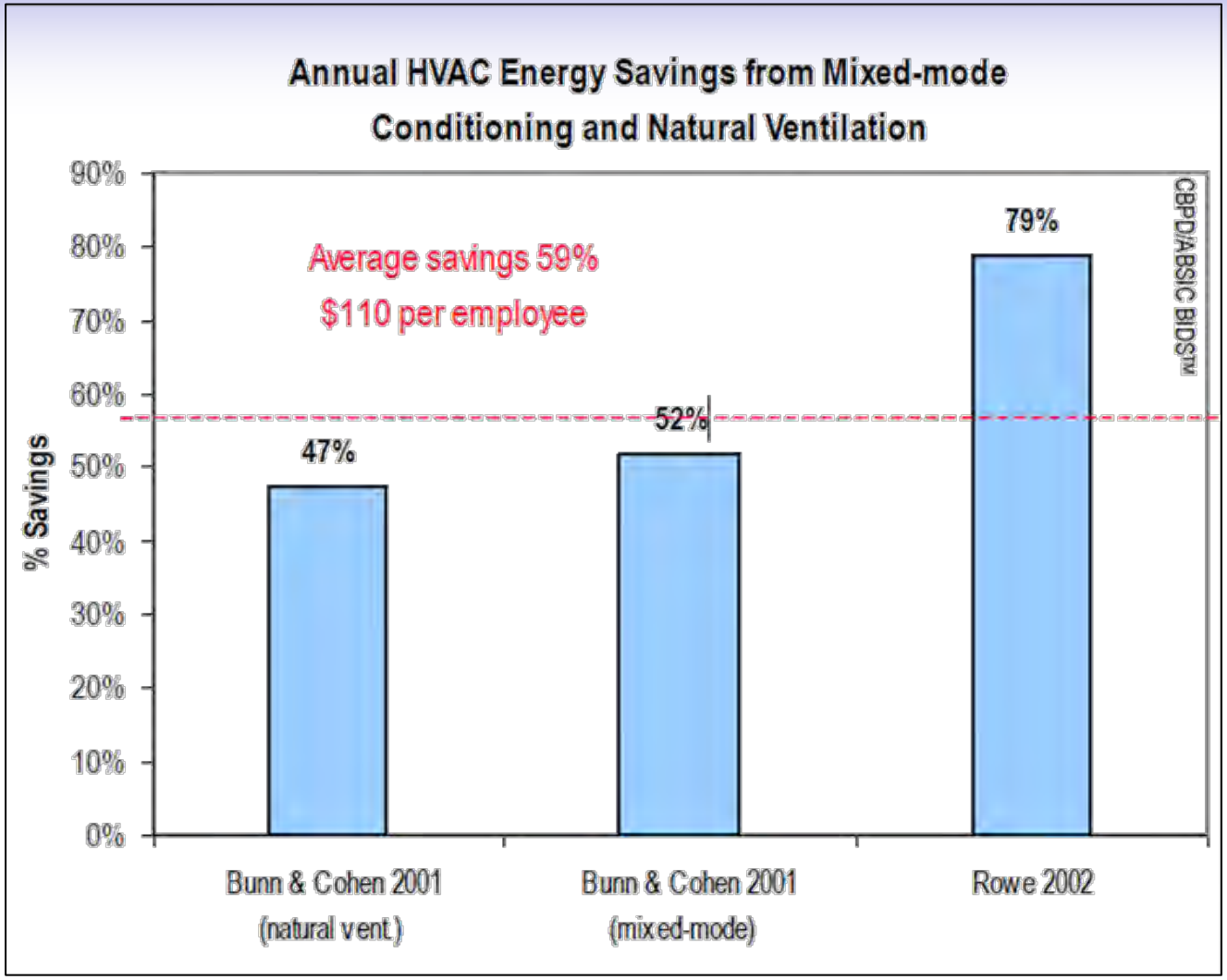


Carnegie Mellon eBids: a web-based, life-cycle, decision-support program, under development in 2003.

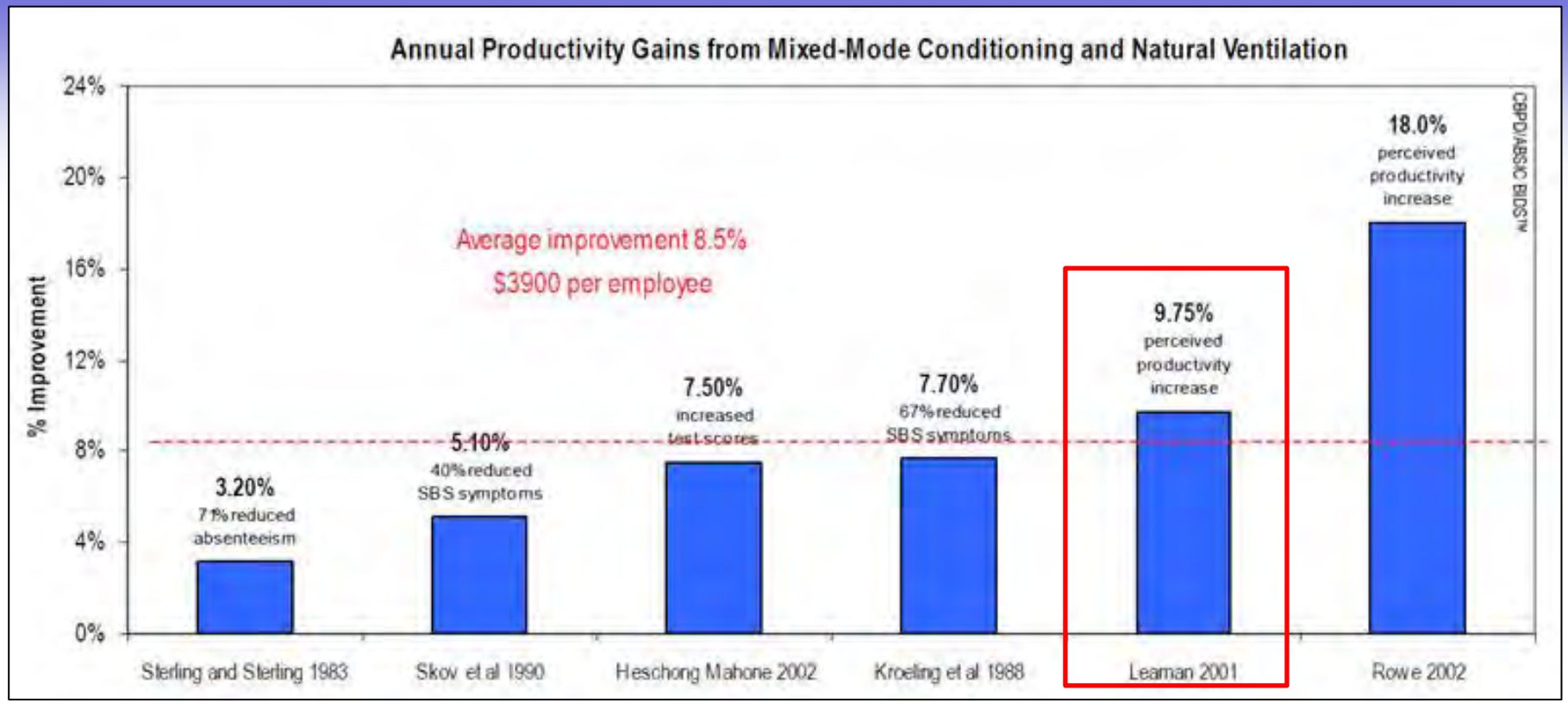


Case Studies Introducing Improved Indoor Air Quality

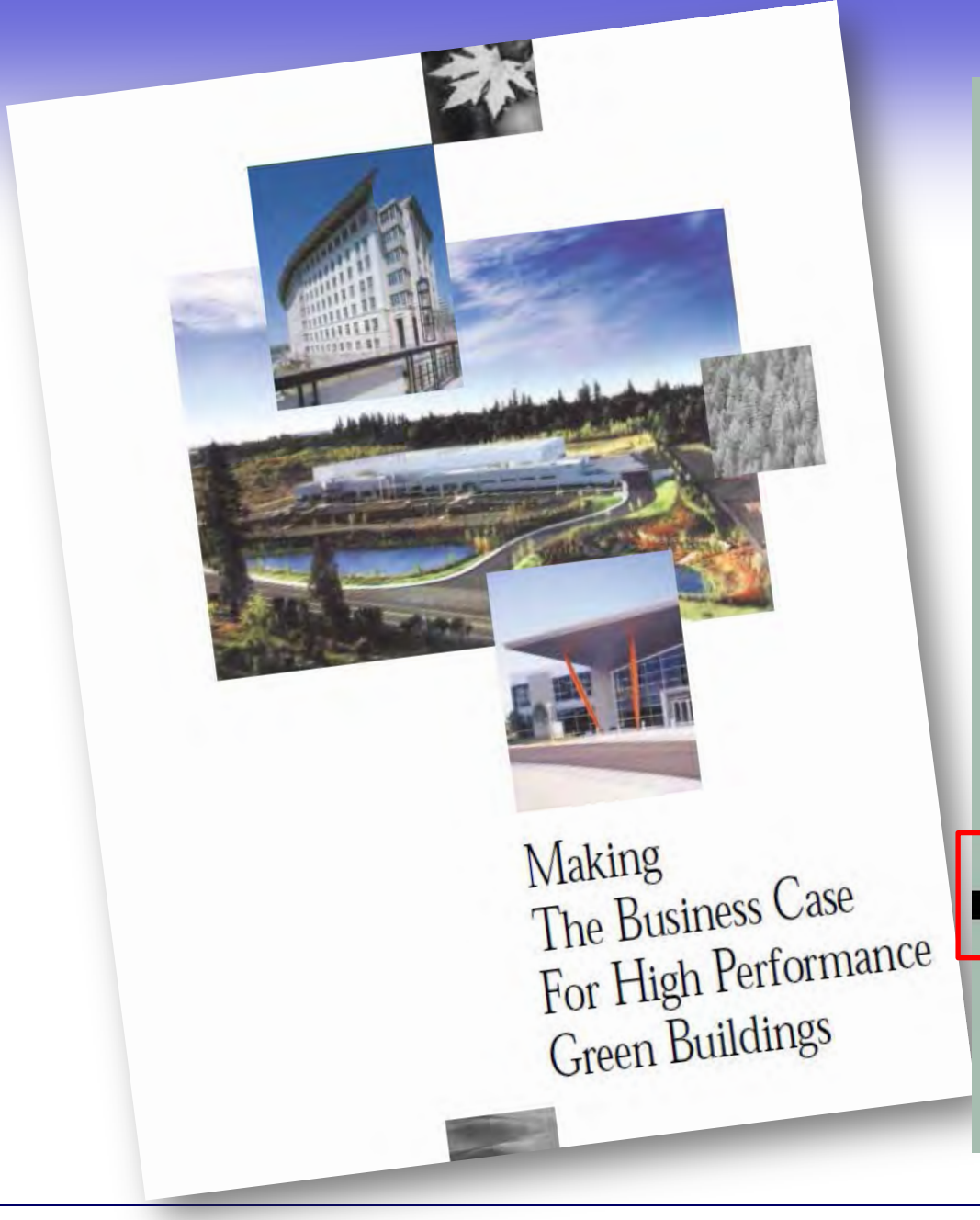
(* Performance improvement for specific tasks multiplied by estimated time at tasks)
(** Improved ventilation effectiveness calculated relative to productivity gains from other studies)



- Research findings from the PROBE studies had been re-interpreted to show that mixed-mode buildings can lead to 59% savings in running costs.
- Not only was this not a finding of the PROBE research, there was no baseline of performance against which such a savings calculation could be justified.



- The PROBE dataset were re-interpreted to show that the self-assessed scores for perceived productivity equated to a 9.75% productivity increase
- The productivity scores were then given a US employee cost-weighting. The averaged perceived productivity ratings became an 8.5% average improvement, equating to….
- **$3900 per employee, per annum.**



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Making buildings better

BSRIA

[3] *Indoor Quality Update*, October 1996, Vol. 9, No. 10.

[4] These and many other case studies can be found in Green Developments, a federally funded project of the Rocky Mountain Institute, 2001.

[5] W.J. Fisk, "Health and Productivity Gains from Better Indoor Environments and Their Relationship to Building Energy Efficiency," *Annual Review of Energy and the Environment*, 25: 537-566, 2000.

[6] Judith Heerwagen, "Sustainable Design Can Be an Asset to the Bottom Line," *Environmental Design and Construction*, July-August 2002.

A recent Lawrence Berkeley National Laboratory study reported that feasible and commonly recommended improvements to indoor environments could reduce health care cost and work losses from communicable respiratory diseases by 9 to 20%; from reduced allergies and asthma by 18 to 25%; and from other nonspecific health and discomfort effects by 20 to 50%.

William Fisk, “Health and Productivity Gains from Better Indoor Environments”

Figure VIII-2. Potential Productivity Gains from Improvements in Indoor Environments

Source of Productivity Gain	Potential Annual Health Benefits	Potential U.S. Annual Savings or Productivity Gain (2002 dollars)
1) Reduced respiratory illness	16 to 37 million avoided cases of common cold or influenza	$7 - $16 billion
2) Reduced allergies and asthma	8% to 25% decrease in symptoms within 53 million allergy sufferers and 16 million asthmatics	$1 - $5 billion
3) Reduced sick building syndrome symptoms	20% to 50% reduction in SBS health symptoms experienced frequently at work by ~15 million workers	$10 - $35 billion
4) Sub-total		*$18 - $56 billion*
5) Improved worker performance from changes in thermal environment and lighting	Not applicable	$25 - $180 billion
6) Total		*$43 - $235 billion*

Fisk's own stated limitations are never reported

- "The estimated health and productivity gains… are based on extrapolations of the findings obtained in a relatively small number of studies to the general population"
- "One of the weaknesses of the available literature on respiratory illnesses is that 5 out of 10 studies took place in….military housing and jails with a high occupant density, and Antarctic quarters"
- "The major weakness of the SBS-related estimates is a consequence of the limited information available to quantify the influence of these symptoms on worker productivity"
- "Publication bias, i.e. preferential publication of papers from studies that found significant associations, may have upwardly-biased estimates of potential health and productivity gains"
- "Allergy and asthma symptoms overlap with SBS symptoms; thus, there may be some double counting associated with these two categories of health effects"
- "The accuracy of the quantitative extrapolations is not well understood"

[3] *Indoor Quality Update*, October 1996, Vol. 9, No. 10.

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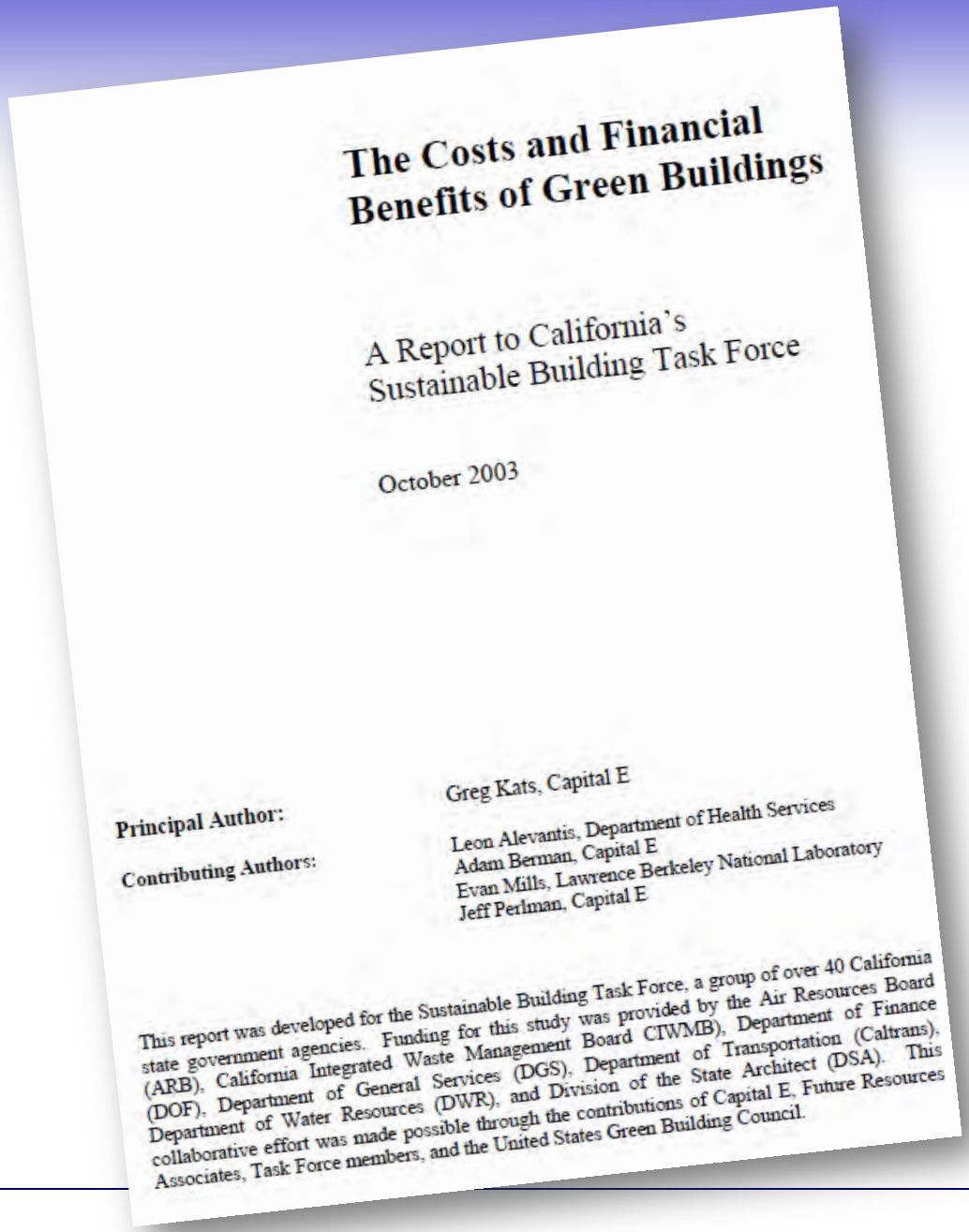
A recent Lawrence Berkeley National Laboratory study reported that feasible and commonly recommended improvements to indoor environments could reduce health care cost and work losses from communicable respiratory diseases by 9 to 20 from reduced aller asthma by 18 to 2 and from other no health and discom effects by 20 to 5

The researchers also found that this would generate estimated savings of from $17 to $48 billion annually in lost work and health care costs.[7]



The Costs and Financial Benefits of Green Buildings

A Report to California's Sustainable Building Task Force

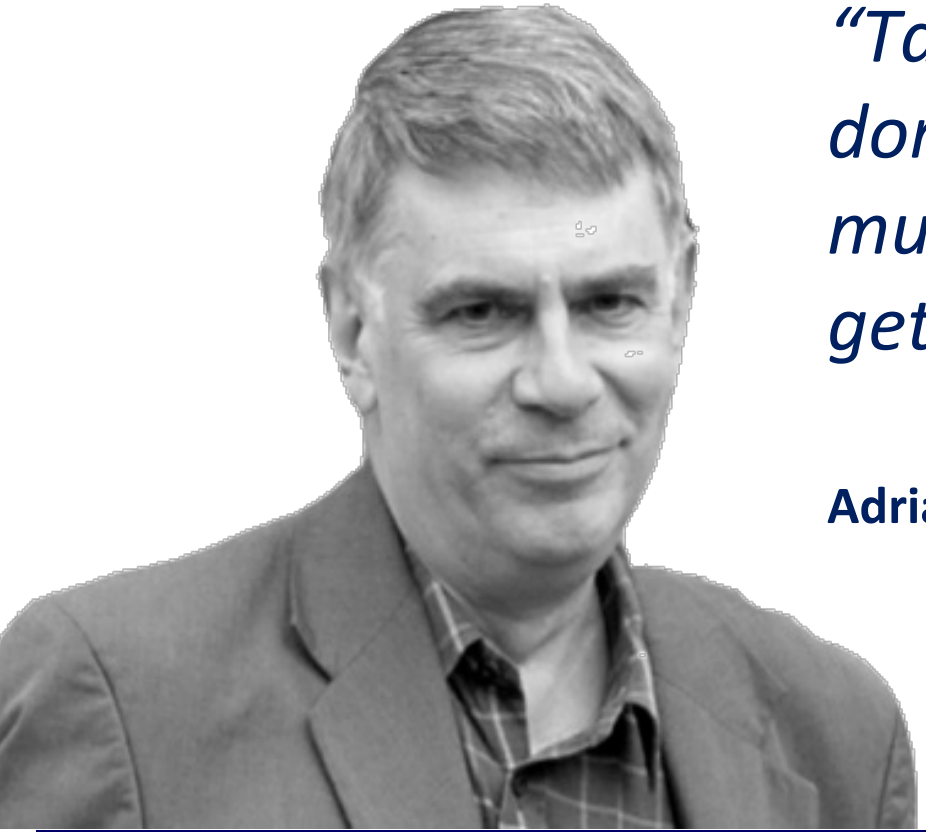
October 2003

Principal Author: Greg Kats, Capital E

Contributing Authors: Leon Alevantis, Department of Health Services
Adam Berman, Capital E
Evan Mills, Lawrence Berkeley National Laboratory
Jeff Perlman, Capital E

This report was developed for the Sustainable Building Task Force, a group of over 40 California state government agencies. Funding for this study was provided by the Air Resources Board (ARB), California Integrated Waste Management Board CIWMB), Department of Finance (DOF), Department of General Services (DGS), Department of Transportation (Caltrans), Department of Water Resources (DWR), and Division of the State Architect (DSA). This collaborative effort was made possible through the contributions of Capital E, Future Resources Associates, Task Force members, and the United States Green Building Council.

- Comfortable temperature (ranked highest in importance by tenants of leased office space) [6]
- Higher ventilation rates, which have been found to:
  - enhance productivity by between 4% and 17% [7]
  - reduce absenteeism by 35% [8]
  - reduce illness by between 9% and 50% [9]
- Greater control of ventilation:
  - is linked with 0.5% to 11% higher productivity[10]
    - Daylighting, reduced energy use, and personal controls in the workspace[11] [12]
    - Lower glare[13]
    - Access to natural views[14]
    - Green buildings' healthier environments have been linked with lower health care costs and enhanced productivity[15]



"Take off the decimal points, don't add them on. And don't multiply by the annual salary and get some ludicrous sum"

Adrian Leaman, Building Use Studies

Are corporate motives driving the agenda?

of properly attributing such gains as reduced absenteeism and staff turnover rates.

In the case of speculative or leased facilities, it is more difficult to assign a market value to occupant productivity gains and have them properly reflected in the business case at the decision-making point. Nevertheless, there is sufficient evidence quantifying the effects to justify taking them into account on some basis. Though the owner of a leased facility does not financially benefit directly from increased user productivity, some indirect benefits can be achieved if a convincing message of significant benefits can be conveyed to the user; this will allow rental fees to be increased and occupancy rates to increase (See Section 5.5). For most commercial buildings, even a conservative estimate of the potential reduction in salary costs and productivity gains will loom large in any calculation, as indicated in the following case studies.

Highlights: Key research

Seminal research in 2003 identified 15 studies linking improved ventilation with up to 11% gains in productivity, as a result of increased outside air rates, dedicated delivery of fresh air to the workstation, and reduced levels of pollutants[5].

A meta-analysis in 2006 of 24 studies[6] – including 6 office studies – found that poor air quality (and elevated temperatures) consistently lowered performance by up to 10%, on measures such as typing speed and units output. This analysis appeared to demonstrate that the optimum ventilation rate is between 20 and 30 litres/second (l/s), with benefits tailing off from 30 up to 50l/s. This is significantly higher than minimum standards required, which are typically between 8-10l/s (although these vary considerably by country).

Similarly, in a 2011 lab test which mimicked an office, a range of office-related tasks were carried out with the presence of airborne VOCs. Increasing ventilation from 5l/s to 20l/s improved performance by up to 8%[7].

“The propagation of fallacies”

Jeremy Bentham - The Book of Fallacies

So, where do we go from here?

- **The property world wants simple uncomplicated answers, and there are people and organisations prepared to quote figures proving a "causal relationship" between HVAC and productivity**
- **Can we really trust the current interpretation of research papers?**
- **If not, is it possible to create health, wellbeing and productivity metrics that will be trustworthy, robust, scalable, and repeatable?**
- ***I think it might be….***

What evidence do we need?

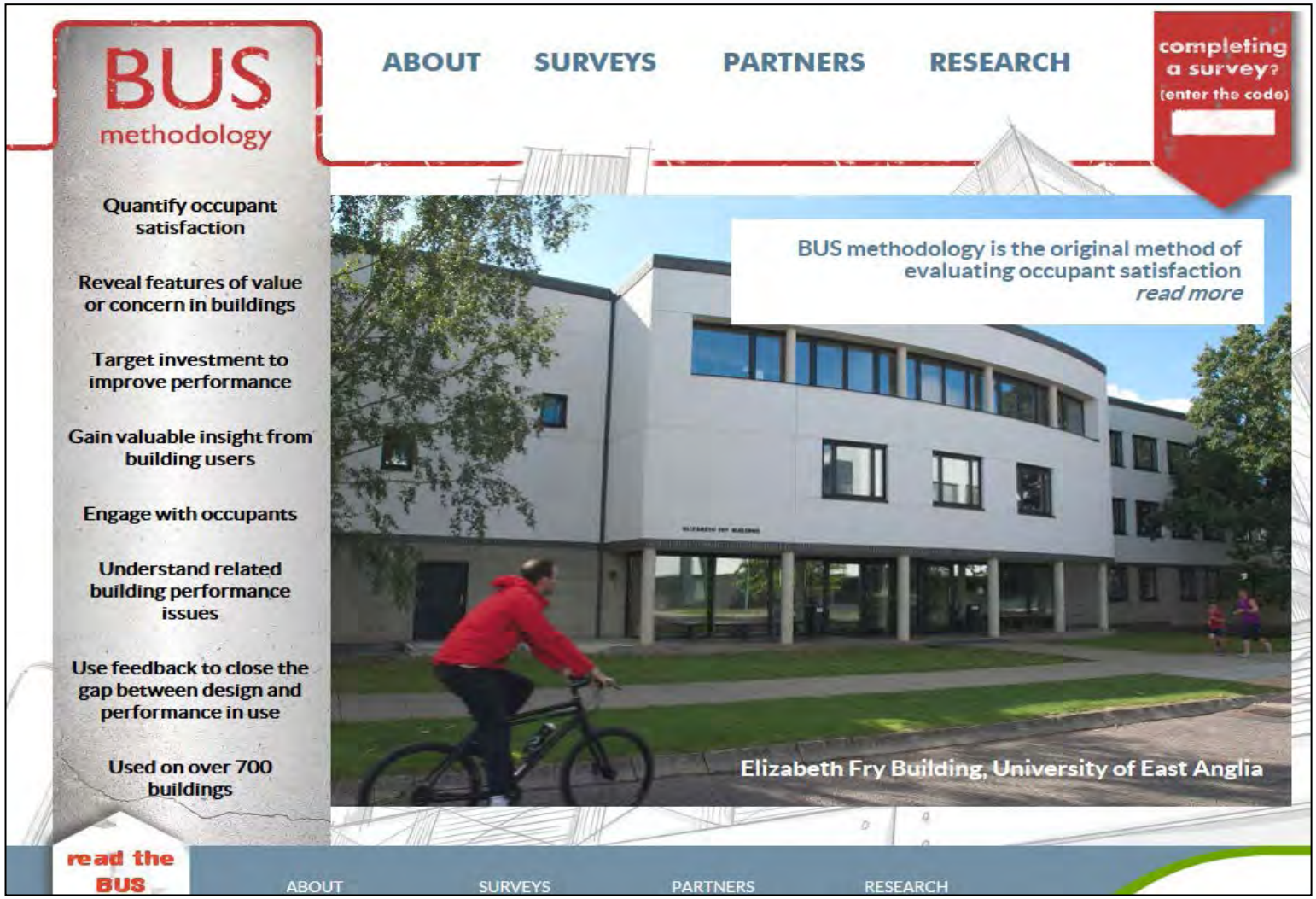
- **Physical aspects** *simple and robust measures – nothing complicated*
- **Ventilation type (with sub-variants)** *but also other physical factors*
- **Social and behavioural aspects** *the historical context of the building and its occupants*
- **Management issues** *primarily of the building*

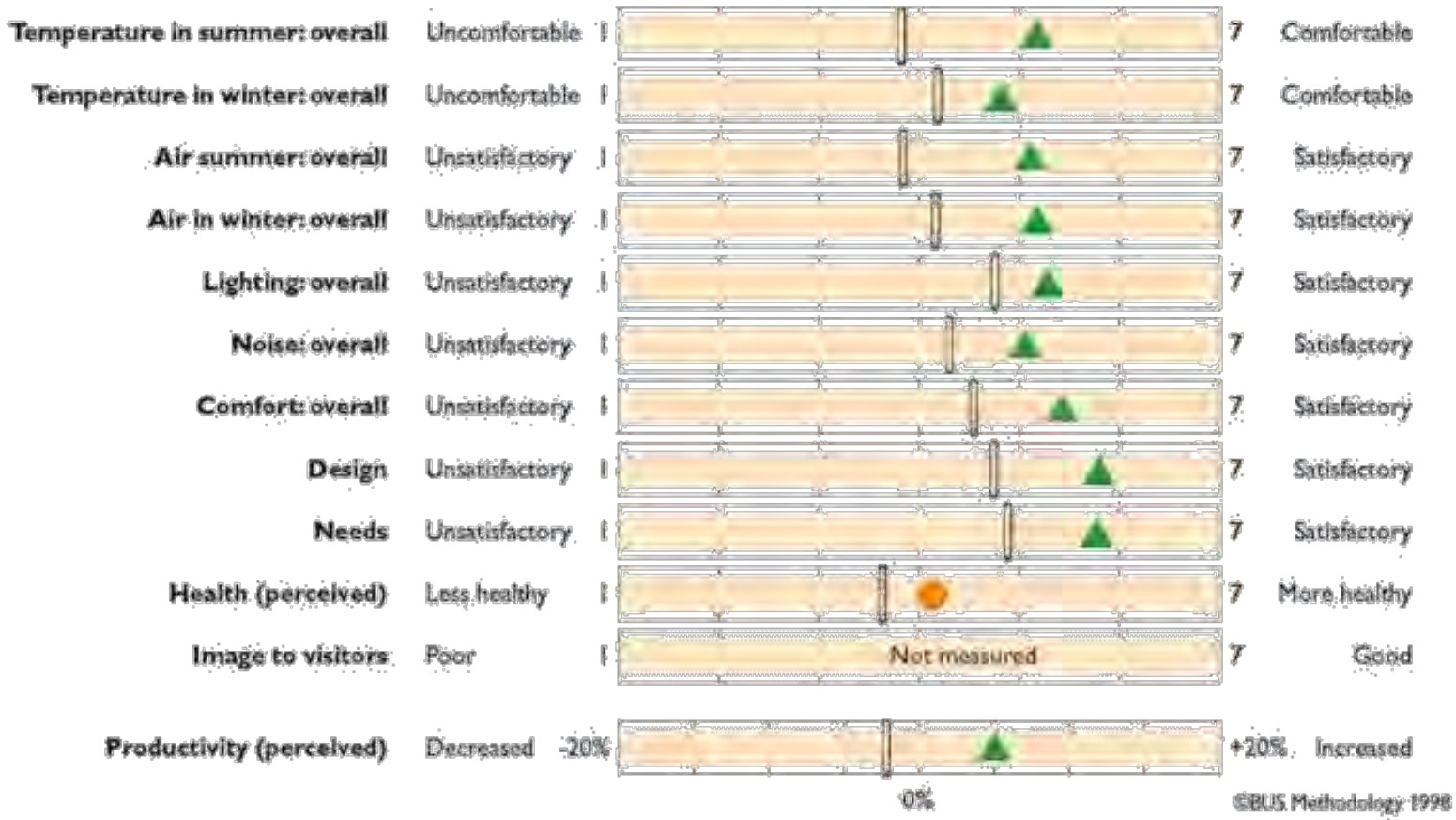
Simulation models, equations and physical field measurements will only get us so far

We need to talk to people

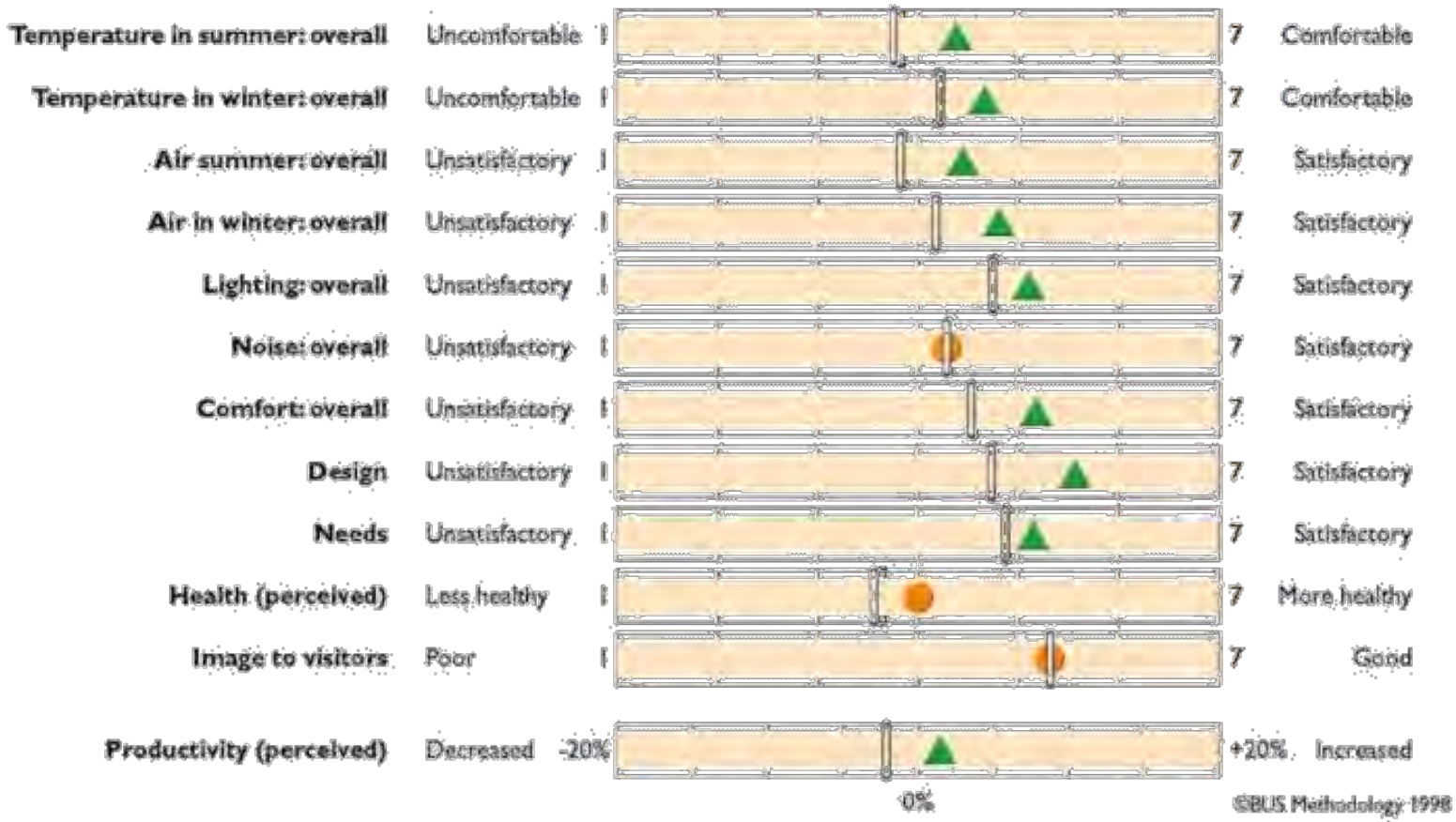
This requires a survey technique that is well-constructed, properly-curated, ethical in its approach, and preferably proven to deliver reliable results

www.busmethodology.org.uk



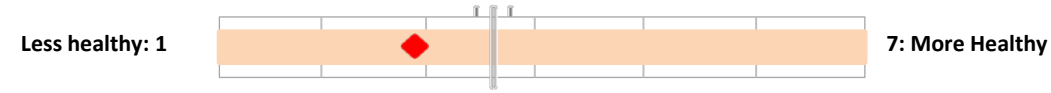


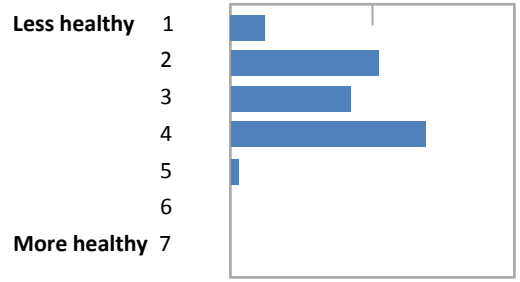
Green triangles represent mean values significantly better or higher than both the benchmark and scale midpoint. Amber circles are mean values no different from benchmark. Red diamonds are mean values worse or lower than benchmark and scale midpoint. The UK benchmarks are represented by the white line through each variable.



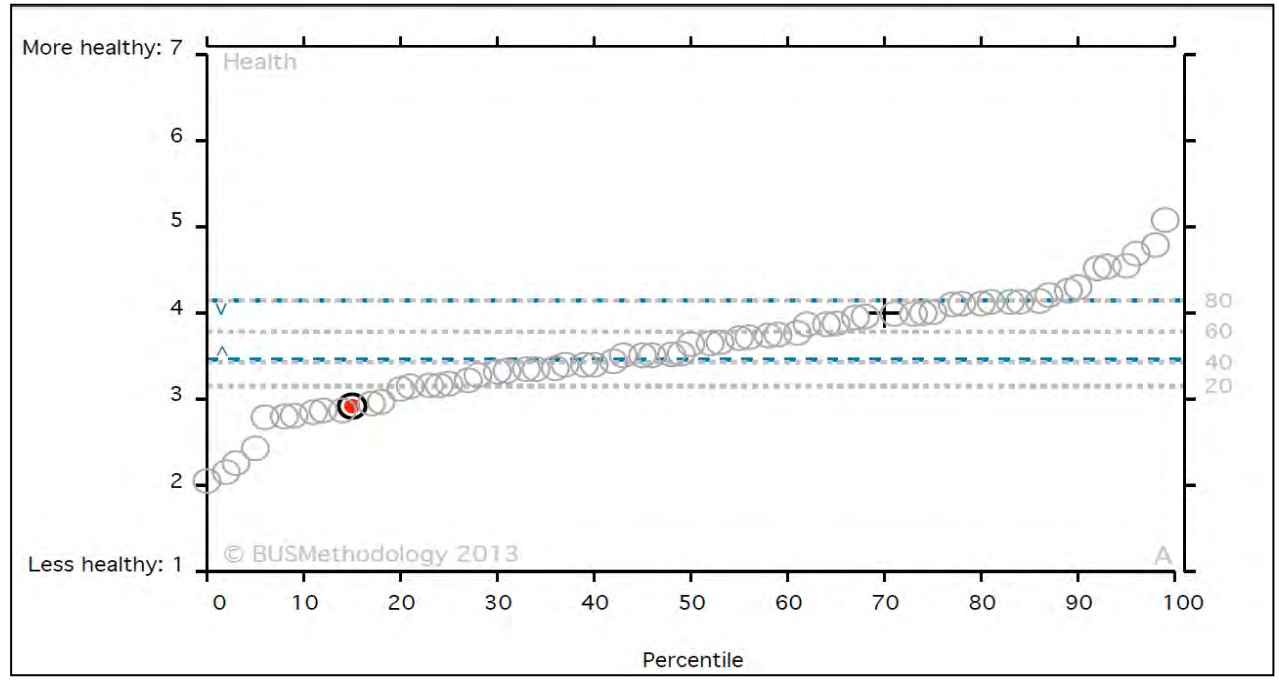
Green triangles represent mean values significantly better or higher than both the benchmark and scale midpoint. Amber circles are mean values no different from benchmark. Red diamonds are mean values worse or lower than benchmark and scale midpoint. The UK benchmarks are represented by the white line through each variable.

Health (perceived)





		Count	Per cent
Less healthy	1	6	10
	2	17	27
	3	14	23
	4	24	39
	5	1	2
	6	0	0
More healthy	7	0	0



So, if occupant satisfaction can be reliably measured, can it

A: be predicted using occupant survey input data?

B: Be subsequently measured as part of POE…?

If so, how might one go about this?

What do we need?

- **Research to develop the means by which projects can input factors and get a reliable pre-survey prediction of occupant satisfaction**

- **A process whereby input data can modified as the project progresses**

What could be the output?

- **Nominal values:** *Is the building good or bad, yes or no?*

- **Ordinal values, benchmarking against other buildings.** *Possibly, will depend on the quality of the benchmarks. BUS has a lot of data – needs much more*

- **Interval points like the WGBC report?** *No – way too risky. Will lead to unrealistic references like two decimal points on self-assessed productivity X salary factor*

- **Ratio level, percentages and weightings** *Well dodgy – avoid.*

Thank you for listening

It’s been 97.5% productive

Any questions?

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