Lessons Learned

Adrian Leaman

Usable Buildings Trust | Building Use Studies

Distinctive Learning
Wednesday 20 March , 2013

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Lessons learned

Above all, beware …

Unmanageable complexity

So ...

Keep it simple,

Do it well.

TEST of TIME

Too many new public and commercial buildings fail to live up to their expectations for energy savings and user comfort, but can the good ones maintain their performance? With support from CIBSE, a team of experts returns to a university building that was found to perform exceptionally well in the late 1990s. **Bill Bordass** and **Adrian Leaman** report on their findings. A separate article on the performance of school buildings generally starts on page 39

A 'PROBE' investigation into the Elizabeth Fry Building at the the University of East Anglia in the 1990s found that it had exceptionally good performance in many respects. A recent follow-up visit found that, despite some inevitable 'drift' in its operations, it is still performing better than many brand-new buildings. In the background is the Queen's Building, an earlier building by the same design team

In the early 1990s, the editorial advisory board of *Building Services Journal* (the forerunner of *CIBSE Journal*) had wondered how well the buildings it featured actually performed in practice. In 1994 the *Journal* made a successful bid under the government's Partners in Technology programme to undertake and publish the 'PROBE' (Post-occupancy Review Of Buildings and their Engineering) studies.

Between 1995 and 2002, a total of 20 non-domestic buildings were surveyed, typically two to four years after handover. The process, results and general findings are described in 29 articles in the *Journal*, and in reviews elsewhere.

PROBE number 14 investigated the Elizabeth Fry Building at the University of

30 CIBSE Journal March 2010 www.cibsejournal.com

Trust in construction

In the atrium, the stairs and wall cladding are made entirely of wood from National Trust estates. A very hard wearing carpet, produced from Herdwick sheep grazed on Trust farmlands, is used in the office areas.

FACTS AND FIGURES

Client
The National Trust/Kier Ventures
Project architect
Feilden Clegg Bradley
Environmental design consultants
Max Fordham LLP

Construction value £10.4 million (shell and core)

Start on site: January 2004

Occupation: 4 July 2005

Treated floor area: 7350 m²

Occupancy: 470 (330 average)

Airtightness: 5.51 m³/(h.m²)

Like many organisations with a strong environmental conscience, the National Trust was keen to ensure that its new central office building trod upon the earth as lightly as possible. In Trust language, sustainability translated into low energy consumption, low running costs, and an outstanding place to work. The Trust also wanted open-plan offices to encourage good communication between departments, formerly in different buildings.

The Trust also desired a brownfield site. A suitable location was found on a plot of land among former railway engineering sheds in Swindon. The trapezoidal site was a challenge for architect Feilden Clegg Bradley and environmental consultant Max Fordham who designed the shell and core.

The footprint of the Heelis building closely follows the boundaries of the site (Figure 1). The building's design - from its pitched roofs to the use of blue engineering brick - gives an affectionate nod to the nineteenth century sheds.

The building was needed as the Trust wanted to centralise staff from six sites. People came from 1970s smoked-glass office blocks and converted stately homes. They therefore arrived with varying expectations of the new building.

Design description

The Heelis building was developed by Kier Ventures as a pre-let for the National Trust.

In the analysis that follows, it is important to recognise that Keir Ventures used the RIBA Stage D report as the basis of costing and financing the project. Although the design team developed the engineering concepts to get the most effective packages, they were not aware that the developer had already set the budget. Ultimately, this affected the choice of some engineering systems, which are not as tightly specified as they could have been.

The design team settled on a two-storey deep-plan building on a north-south axis, with the longest facade angled due south. The construction is conventional, being of a steel frame on a concrete base, with a pitched roof, in-filled with exposed, 80 mm thick, pre-cast concrete planks to provide thermal mass.

The 30° pitched roofs on the south side provided a suitable orientation for 1554 photovoltaic panels, while the north-facing slopes provided a location for northlights. These are located between prominent motorised extract ventilators (called snouts).

The envelope is a mixture of aluminium curtain walling to the south, with smaller windows set into brick walls of the remaining elevations. Two courtyards break up the deep-plan nature of the building and to enable cross-ventilation. Lightwells through the first floor mezzanines bring daylight to the deep plan areas of the ground floor.

The Heelis building is mostly naturally-ventilated, with fresh air supplied through

10 BSRIA Delta t

MARCH 2007

Test of Time download

Outstanding results from an occupant survey, so follow up and discover why …

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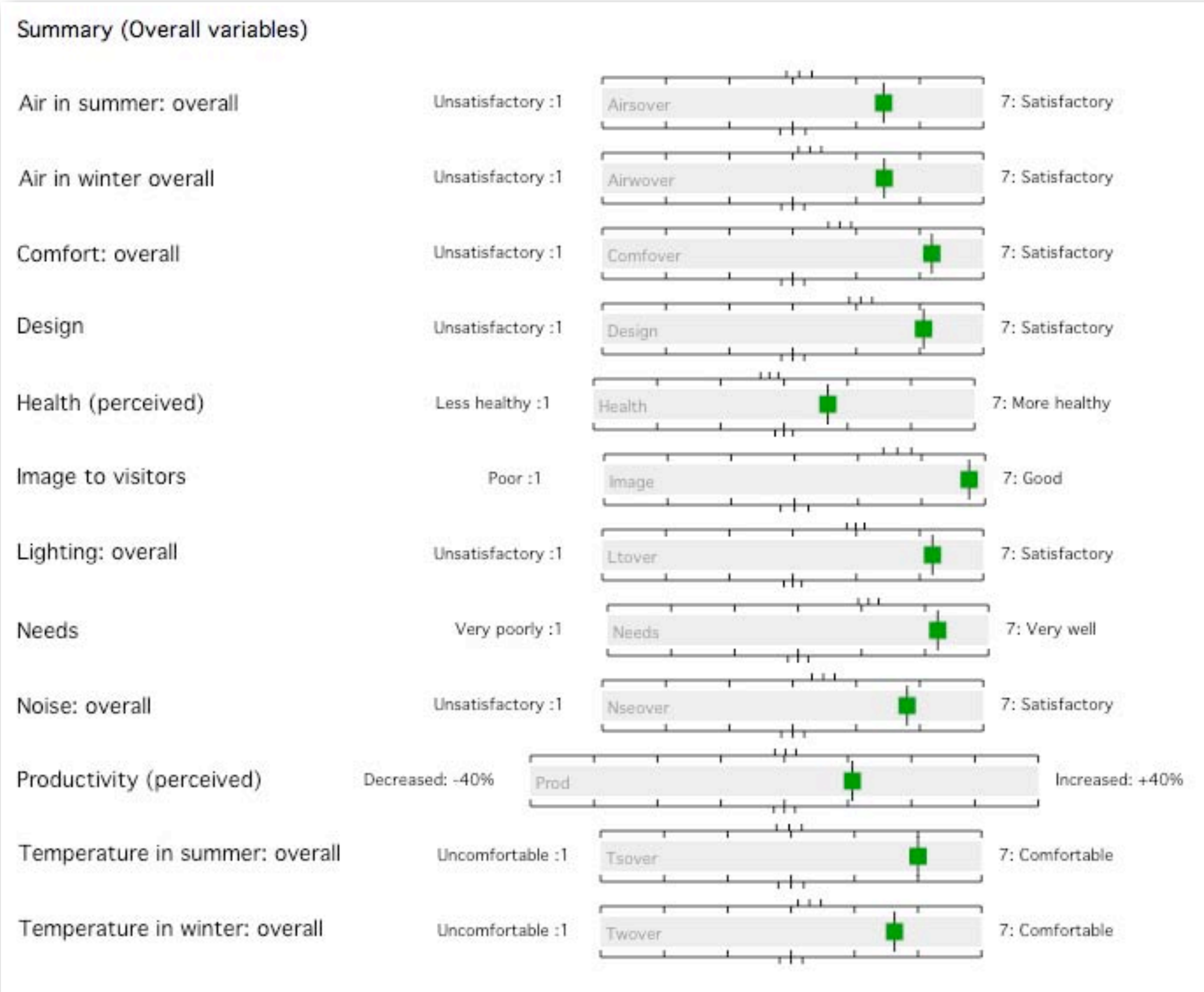
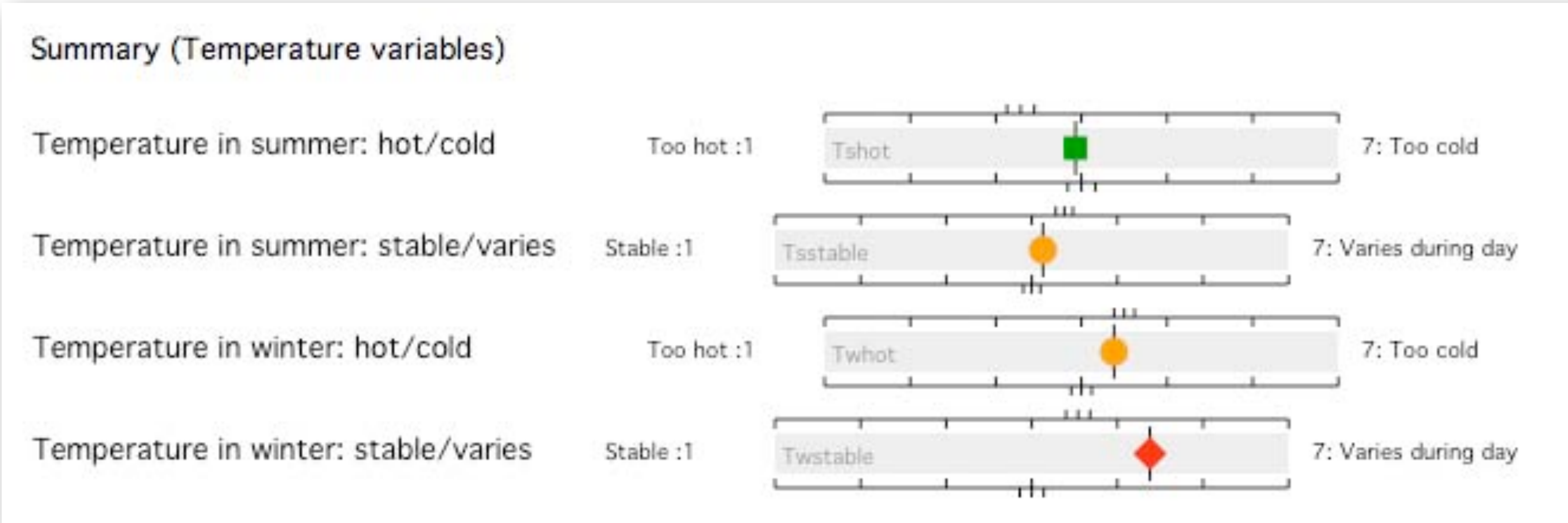
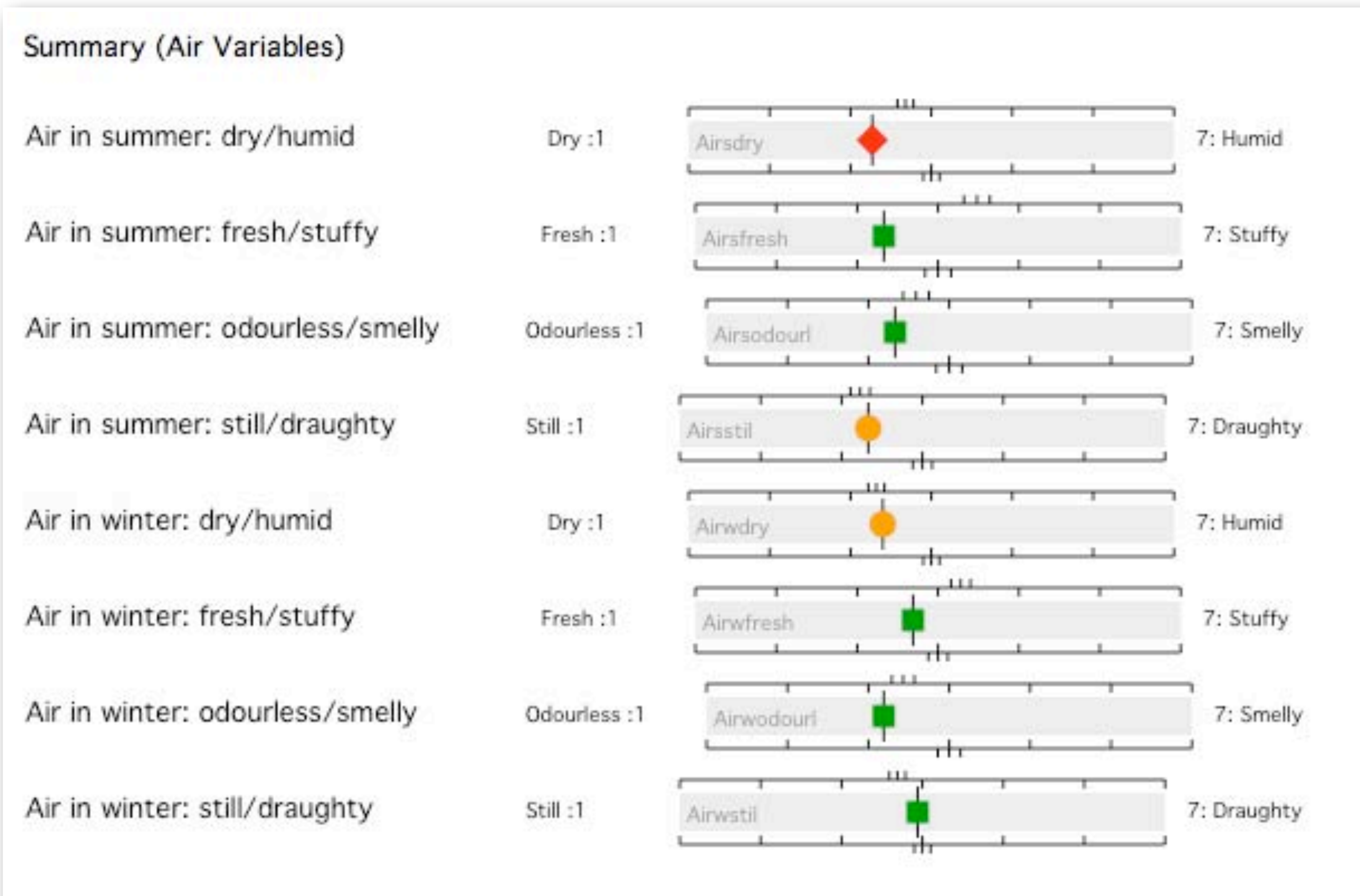
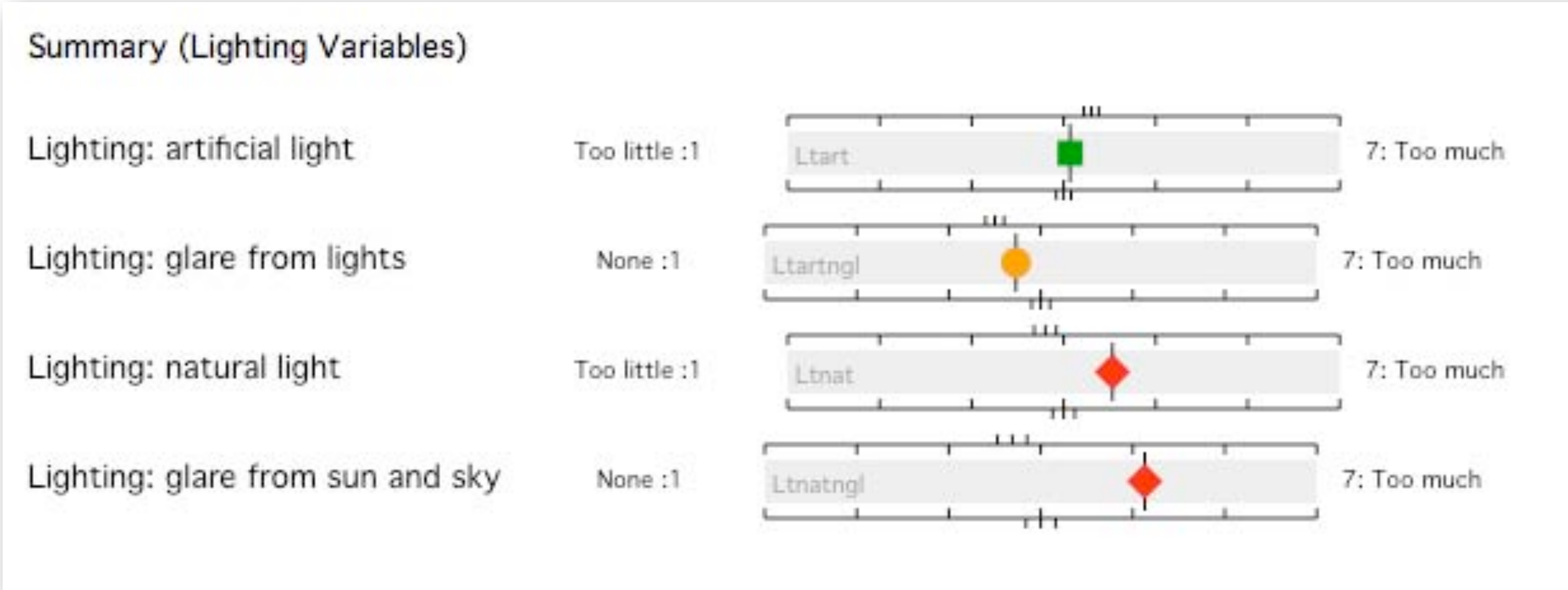
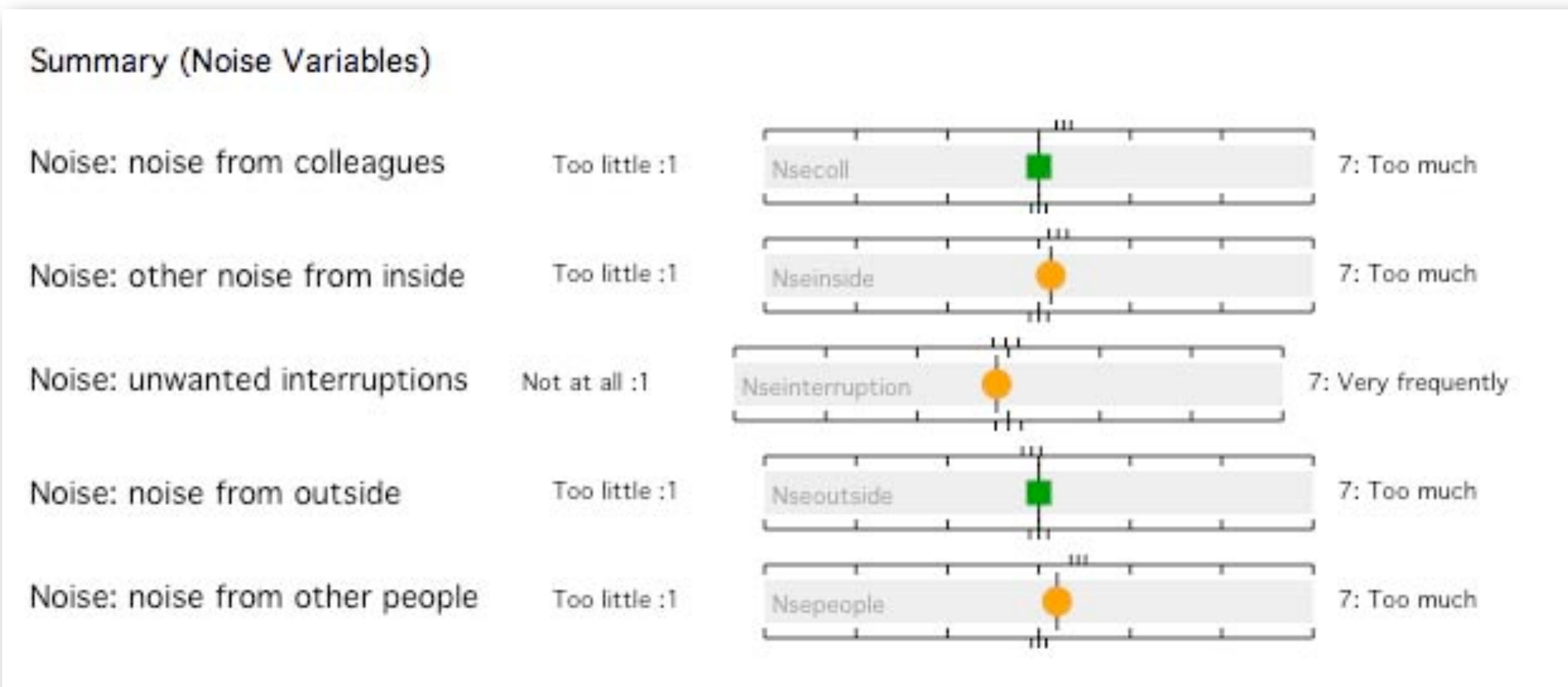



Summary (Temperature variables)
Temperature in summer: hot/cold
Too hot :1
Tshot
7: Too cold
Temperature in summer: stable/varies
Stable :1
Tsstable
7: Varies during day
Temperature in winter: hot/cold
Too hot :1
Twhot
7: Too cold
Temperature in winter: stable/varies
Stable :1
Twstable
7: Varies during day

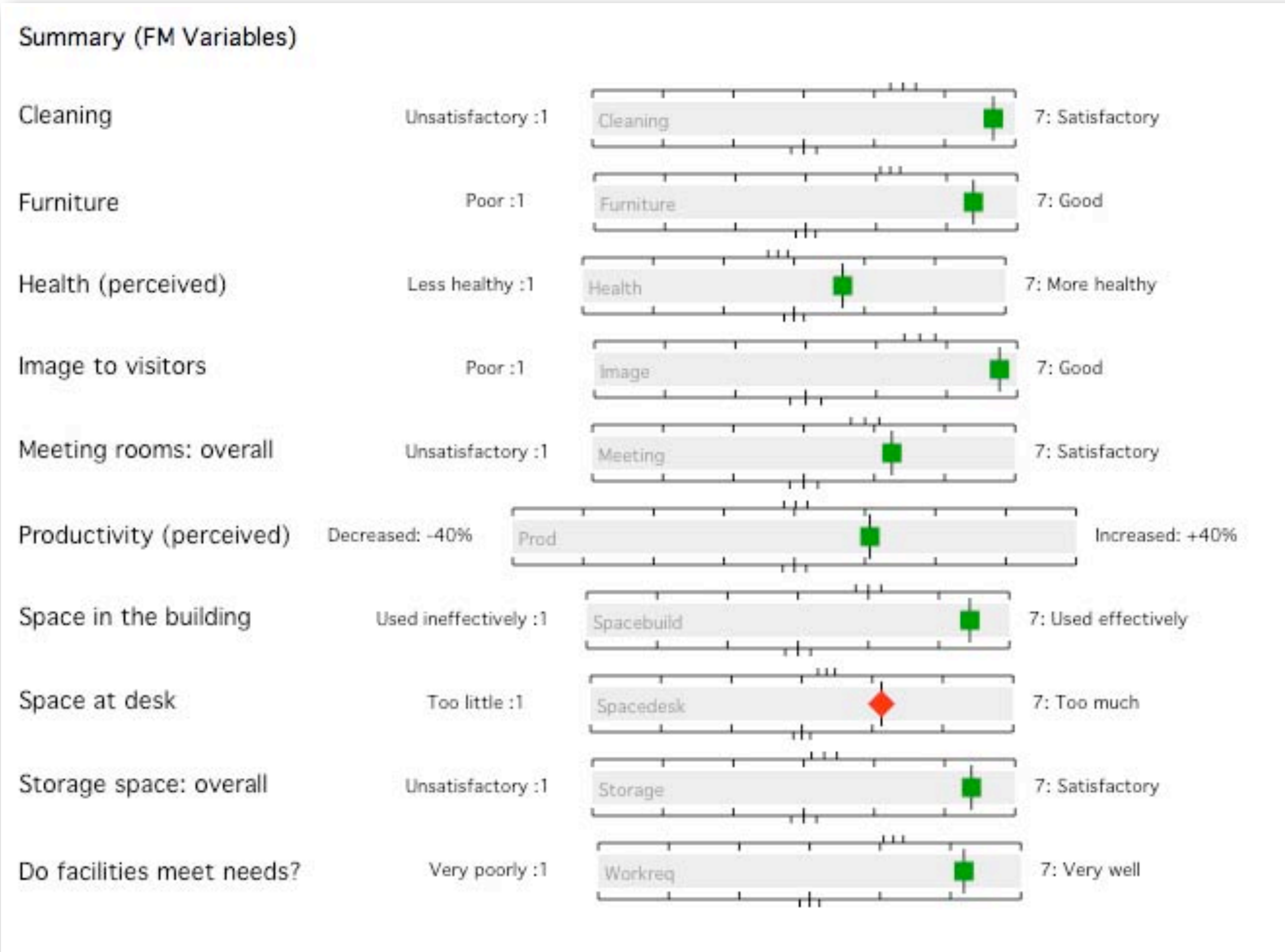

Summary (Air Variables)
Air in summer: dry/humid
Dry :1
Airsdry
7: Humid
Air in summer: fresh/stuffy
Fresh :1
Airsfresh
7: Stuffy
Air in summer: odourless/smelly
Odourless :1
Airsodourl
7: Smelly
Air in summer: still/draughty
Still :1
Airsstil
7: Draughty
Air in winter: dry/humid
Dry :1
Airwdry
7: Humid
Air in winter: fresh/stuffy
Fresh :1
Airwfresh
7: Stuffy
Air in winter: odourless/smelly
Odourless :1
Airwodourl
7: Smelly
Air in winter: still/draughty
Still :1
Airwstil
7: Draughty


Summary (Lighting Variables)
Lighting: artificial light
Too little :1
Ltart
7: Too much
Lighting: glare from lights
None :1
Ltartngl
7: Too much
Lighting: natural light
Too little :1
Ltnat
7: Too much
Lighting: glare from sun and sky
None :1
Ltnatngl
7: Too much


Summary (Noise Variables)
Noise: noise from colleagues
Too little :1
Nsecoll
7: Too much
Noise: other noise from inside
Too little :1
Nseinside
7: Too much
Noise: unwanted interruptions
Not at all :1
Nseinterruption
7: Very frequently
Noise: noise from outside
Too little :1
Nseoutside
7: Too much
Noise: noise from other people
Too little :1
Nsepeople
7: Too much


Summary (Control Variables)
Control over cooling
No control :1
Cntco
7: Full control
Control over heating
No control :1
Cntht
7: Full control
Control over lighting
No control :1
Cntlt
7: Full control
Control over noise
No control :1
Cntnse
7: Full control
Control over ventilation
No control :1
Cntvt
7: Full control


Summary (Design/needs Variables)
Comfort: overall
Unsatisfactory :1
Comfover
7: Satisfactory
Design
Unsatisfactory :1
Design
7: Satisfactory
Needs
Very poorly :1
Needs
7: Very well



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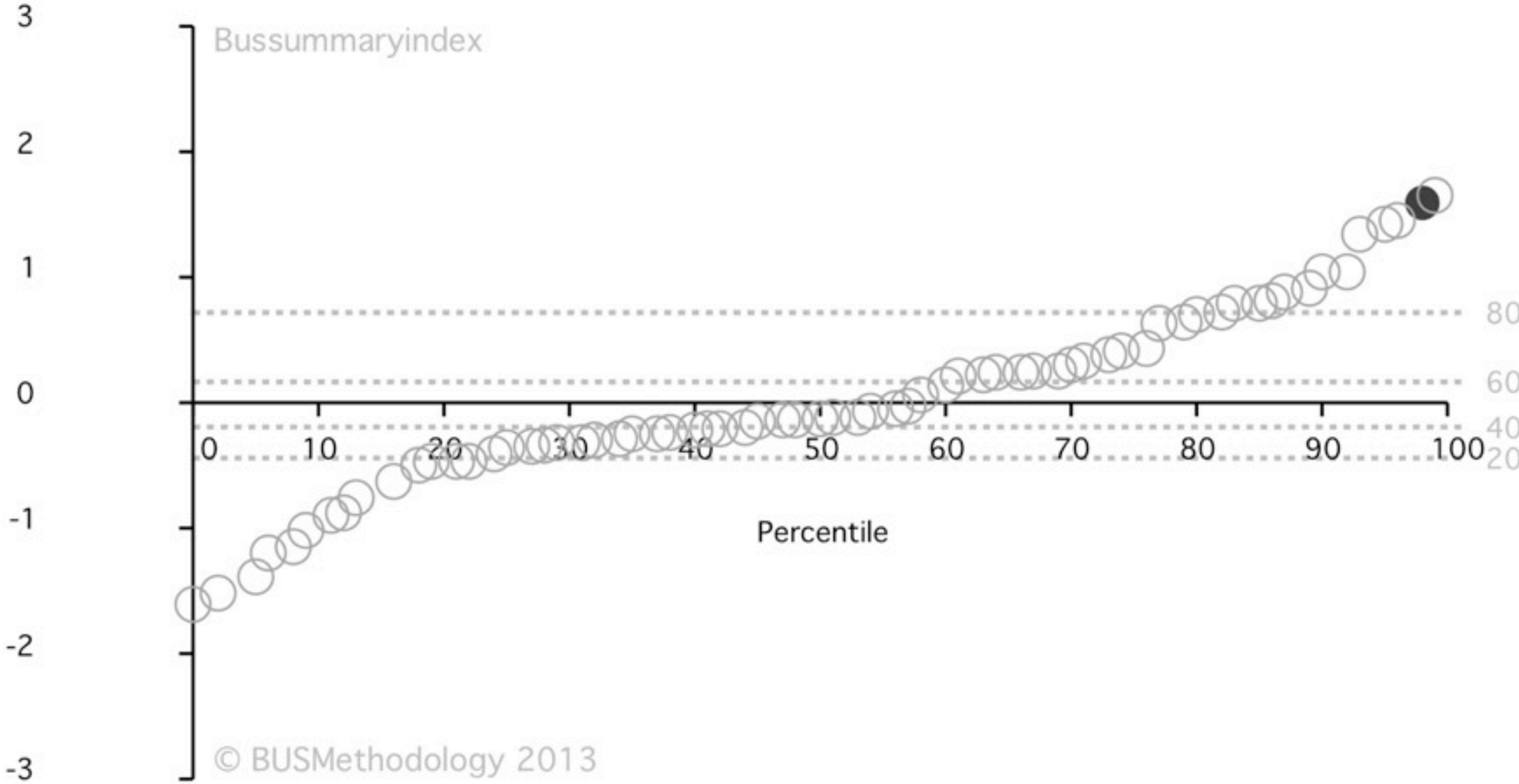

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St John the Apostle

Total 31 kWh/m2

2011-2012 19 kWh/m2 gas 12 kWh/m2 electricity

Occupied 8:50 to 2:30 Mondays to Fridays for 183 days in the year.

Some after hour classes

Community group on Sundays

Heating switched off from April to October,weather permitting

During heating season heating switched on for 2.5 hours a day on a school day and 2 hours on a Sunday.

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Ireland's generic repeat design schools programme
CELE Exchange 2011/5

Ireland's generic repeat design schools programme

By Tony Sheppard, Department of Education and Science, Ireland

The Irish Department of Education and Skills (DoE) is strongly committed to energy efficiency and to reducing CO_2 by developing and implementing energy level ceilings in relation to school design that aim to remain below half of the accepted good practice in the field. This approach works within normal departmental budgetary limits to create school buildings that are breaking ground for building designers.

INTRODUCTION

Practical simplicity

The DoE's Planning and Building Unit is now developing low-energy educational buildings with the help of generic repeat design (GRD). This is a programme delivering many primary schools, not just a single demonstration prototype building. To minimise risk on so many projects, it brings together proven-in-use technologies. It is significant because of the practical simplicity of its low energy design and repeatability on sites with varied orientations.

South-facing two-storey classroom block and entrance of first-completed GRD school
© David Barbour/BDP

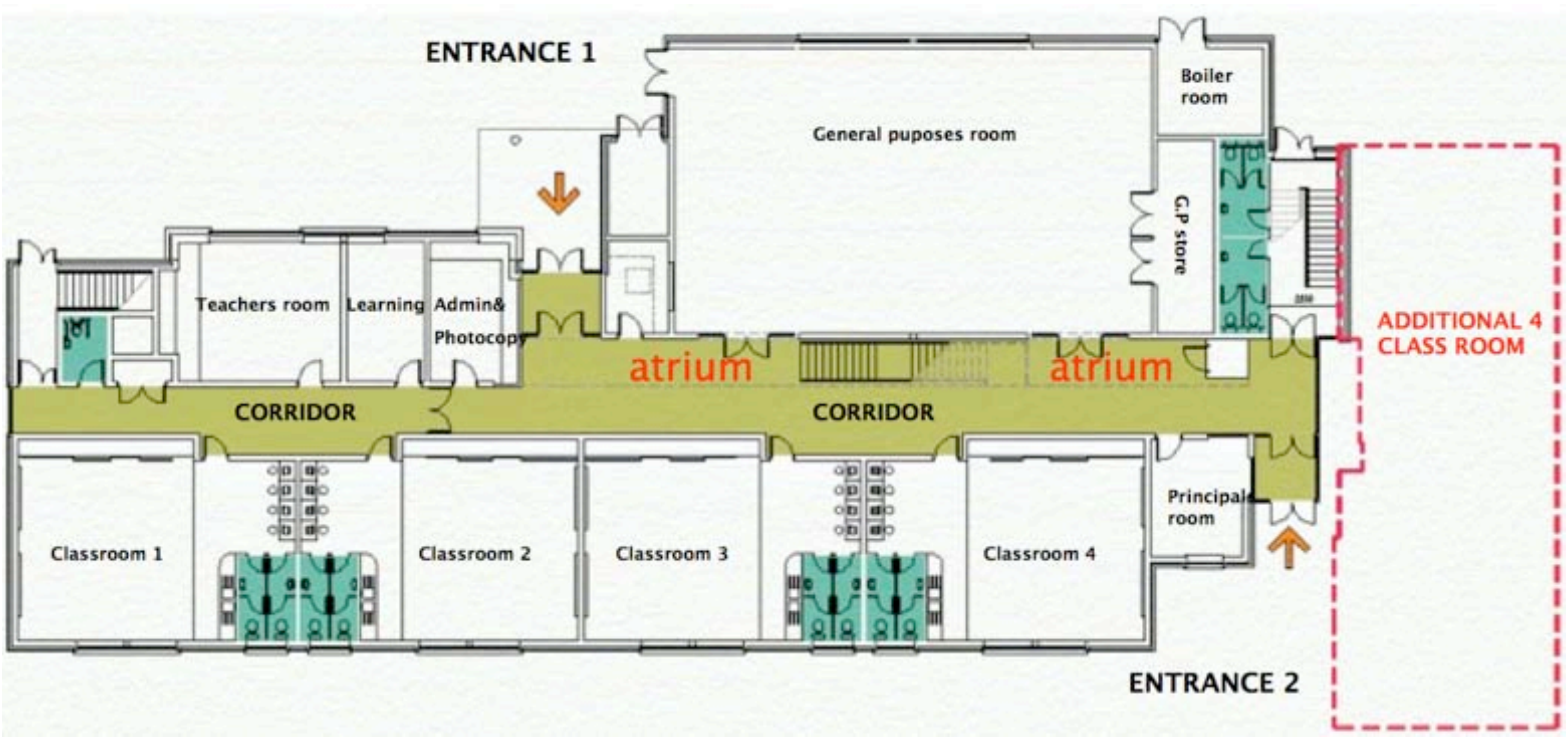
Precedent

There are clear precedents in Ireland for the use of highly refined standard school plans as part of the government's response to the demands of providing accommodation for large numbers of pupils. The GRD has evolved this procurement method with complete superstructure tender packages available.

Previous research

Given the requirement to minimise risk on multiple projects, the GRD brings together all currently available proven and tested-in-use technologies.

Typical questions from building evaluation studies' debrief



GRD Schools Ireland download

Q

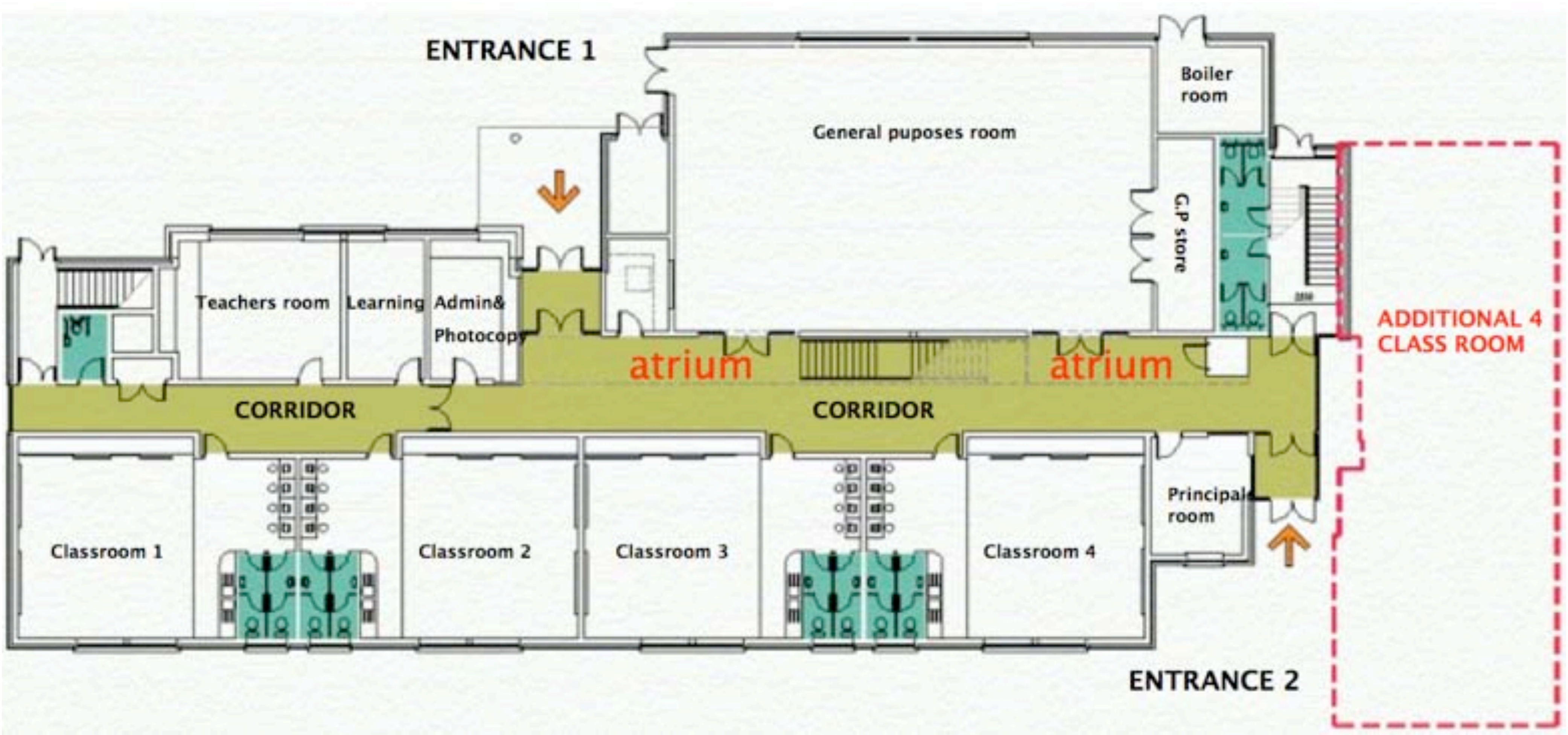
Blinds are down on nearly all the high level windows on the south side, designed to provide deep daylight, and quite a lot of the lower ones too. Why?

A

"... the Metadata on this indicated a time of 14.52 in May, so I suspect pupils have left all of the classes for the day. The caretaker or teachers close down blinds to enhance security (and reduce night time radiation loss). The first on left with blinds and windows open is used as a staff room so it may be still in use."

Q

Why two entrances?



GRD Schools Ireland download

A

“One of the drivers of the dual entrances was the need to locate these schools on multiple sites with various approach orientations.”

Q

Why are the classrooms south anyway? We have found that north-facing can be better in association with carefully placed rooflights and vestibules.

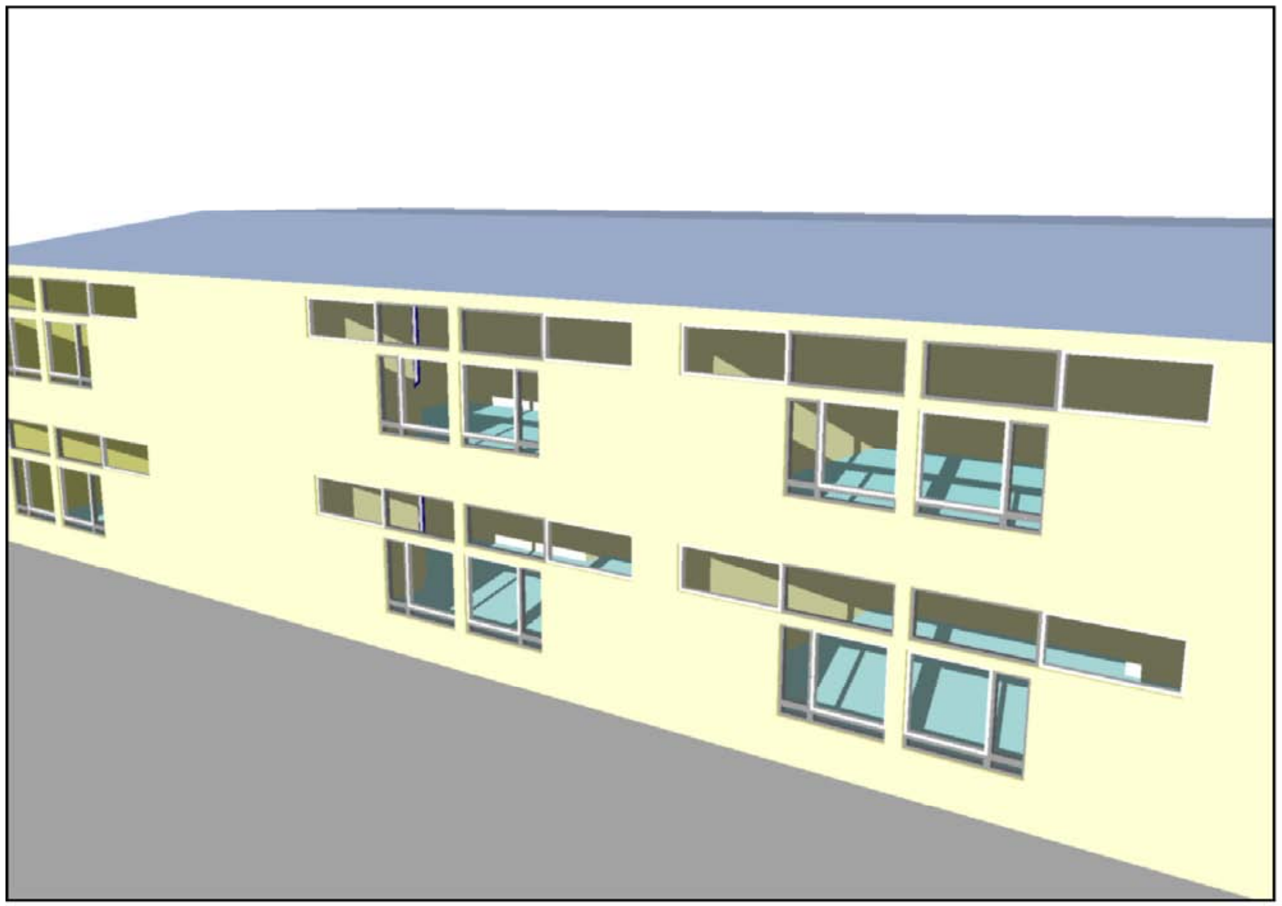
A

"At 53 degrees north, and typically a more temperate maritime climate than the UK, after full modelling excessive heat gain was not considered a risk. Primary schools in Ireland are occupied for 180 days per annum, typically 9.00 to 14.30 to 15.00 and are completely closed hottest months of July and August."

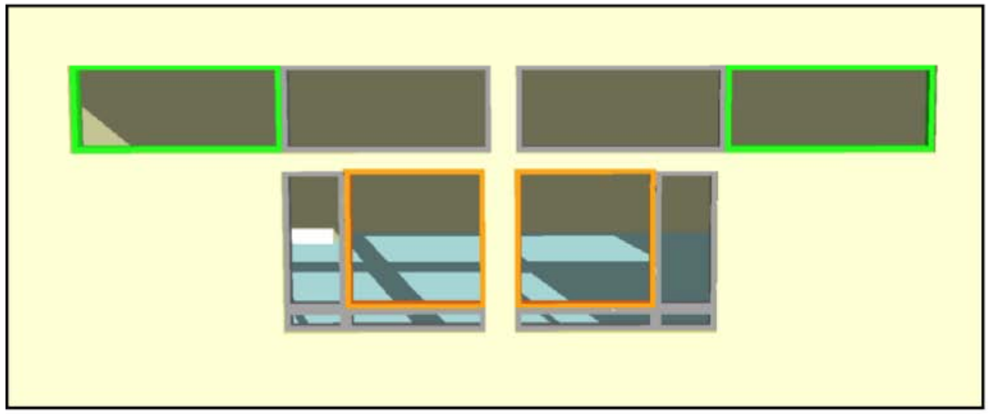
1 SIMULATION

A full dynamic simulation model has been constructed using the TAS simulation package.

The rooms of particular interest are a typical classroom on the ground and first floors of the building and are shown in the following image.



The opening window sections are shown in the following image:



RESULTS

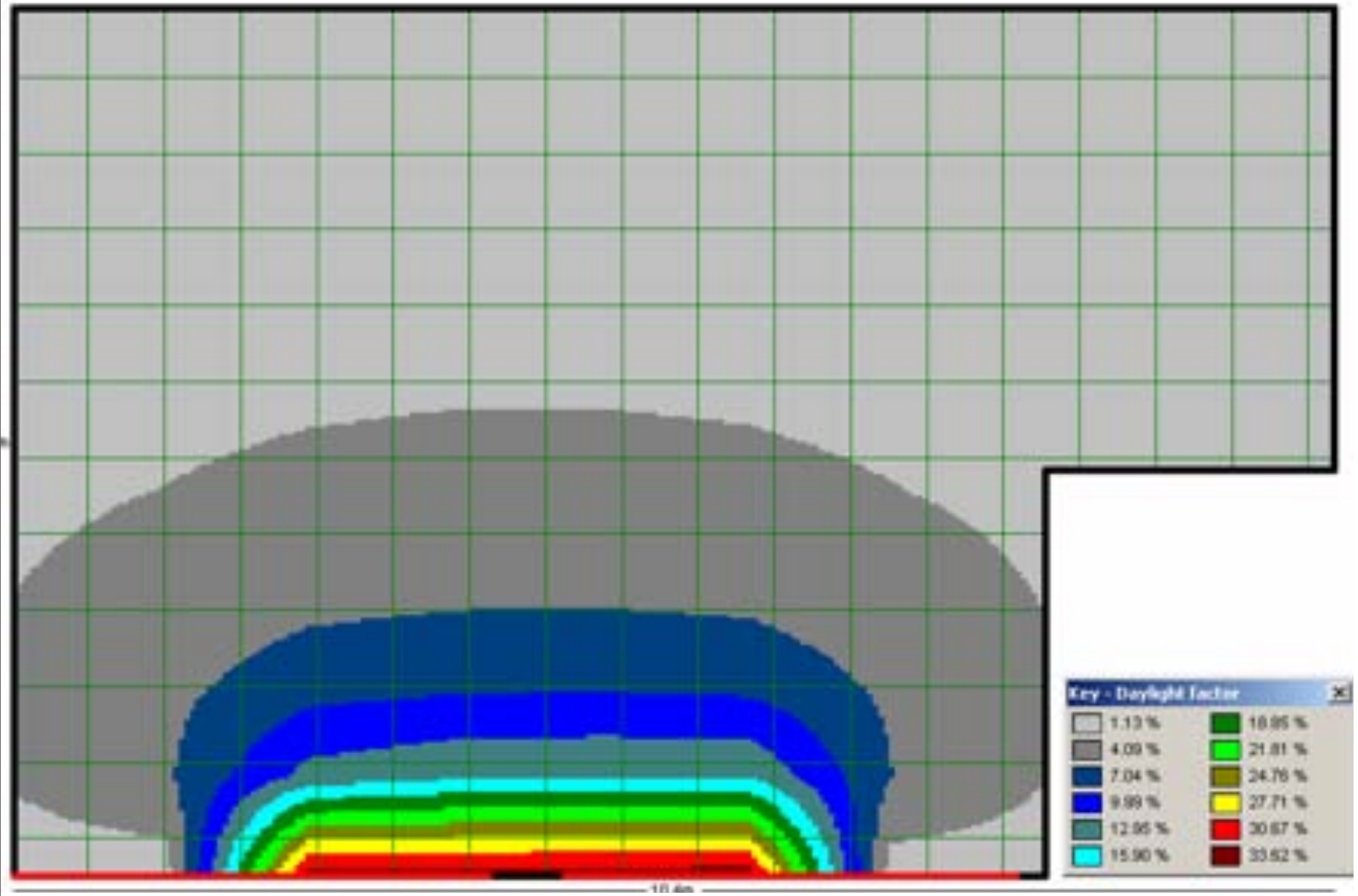
After the construction of Archbishop Ryan school, a ceiling was added to the upper floor of the GRD design. Simulation results with the ceiling in place

Space	% of occupied time above 25°C	% of full year above 25°C
GROUND FLOOR CLASSROOM	0.5%	1.5%
FIRST FLOOR CLASSROOM	1.2%	5.5%

PROPOSED MODIFICATIONS – SIMULATION

It has been proposed that the building specification will be modified to allow an additional two upper windows to open as highlighted in the following image from the simulation model.

The simulations show that the additional opening areas result in the number of hours when the internal resultant temperature rises above 25°C during occupied periods, dropping by 60%. This represents a significant improvement in internal temperatures.



Daylight Analysis

Typical Classroom

Q

“Note lights on in atrium. At least there aren't very many of them. This is something that [we have seen] on several school visits. Down to failure to calibrate daylight sensors that are covering this area. Like the roof light. But can the atrium be blacked out?

A

"This rooflight worked out well. It has opal glass to disperse any direct sunlight. We have refined this feature further on another school ... under construction. As these hall-type spaces are usually located north-facing .. we normally have not provided glare or blackout blinds."

‘Measuring’ buildings

‘There is nothing more dangerous than a heckler with statistics.’

Rich Hall

Three perspectives

Human needs: Are needs being met?
Environmental performance: How benign?
Affordable and manageable?

One objective

Better feedback aimed at the most effective people in the process.

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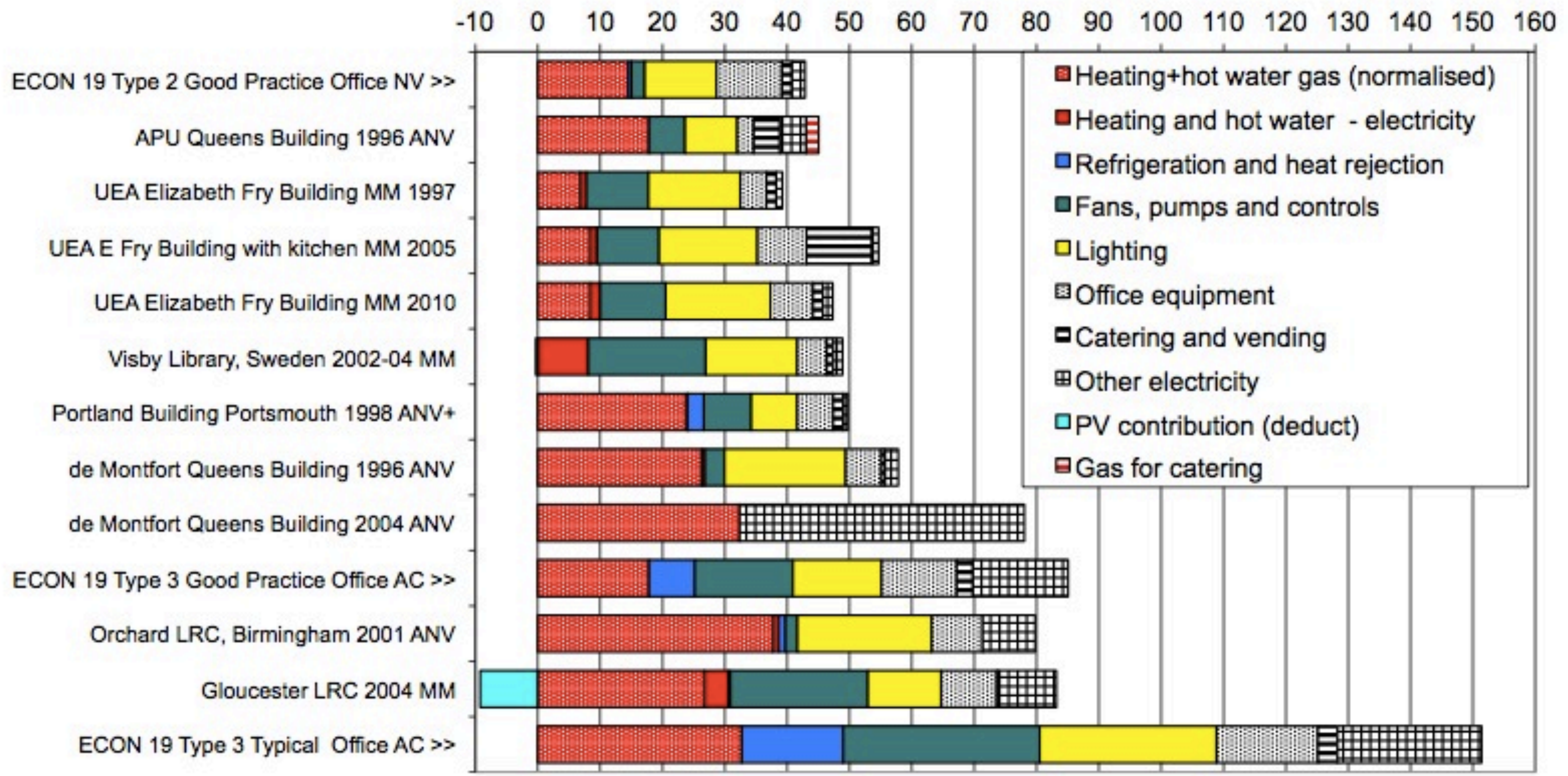
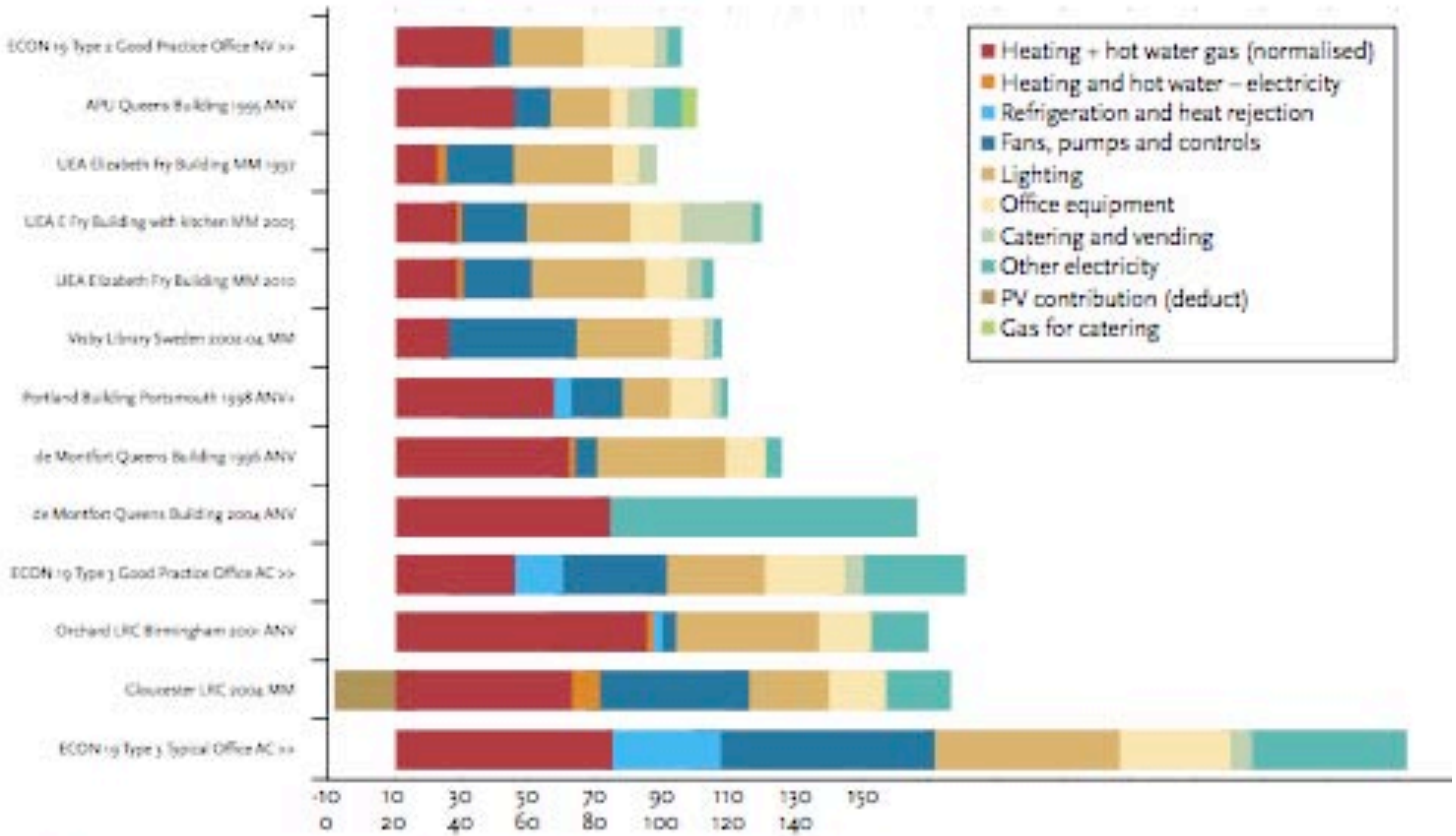
Annual CO_2 emissions from university buildings

kg/m² Treated Floor Area at UK CO_2 factors of 0.184 for gas and 0.525 for electricity



AC= Air Conditioned, ANV = Advanced Natural Ventilation, MM = Mixed Mode.

Aside:
This happens when graphic designers take over …



Annual CO2 emissions from university buildings (kg/m² Treated Floor Area at UK CO_2 factors of 0.184 for gas and 0.525 for elecricity)

AC = air conditioned, **ANV** = advanced natural ventilation, **MM** = mixed mode, **NV** = naturally ventilated

The diagram shows the estimated breakdown of energy use in 1997, 2005 (when the catering kitchen was in full operation) and 2010, in relation to office benchmarks from the Carbon Trust's Energy Consumption Guide 19 (marked with chevrons) and to other university buildings reviewed in PROBE and related studies. The graphs are expressed as annual CO2 emissions at Defra 2011 UK factors. The data are sorted by CO2 emissions for heating, hot water, cooling, ventilation and lighting.

At all three dates, Elizabeth Fry still maintains its place towards the low-carbon end of the range. The biggest changes between 1997 and 2010 are in heating and hot water, largely due to the change to 24/7 hot water and the appearance of some additional electric heaters. Lighting and office equipment energy use have also gone up owing to increased occupancy and equipment levels.

In relation to other buildings and benchmarks, energy use for heating and hot water is still good, while lighting has deteriorated owing to the low efficiency of the original pelmet system and greater hours of use now. CO2 emissions from fans, pumps and controls (mostly fans) are reasonable in relation to the other mixed-mode buildings and to air-conditioned benchmarks, but nevertheless of a similar magnitude to those from heating and hot water.

Strategies # 1

- Client, users and the design team embrace the concept, understand design intent and provide sufficient resources to run the building efficiently and effectively.

Strategies # 2

- A simpler, less intensive approach with robust and basic systems which are easy for the users to understand and operate, and provide clear management and cost information about performance.

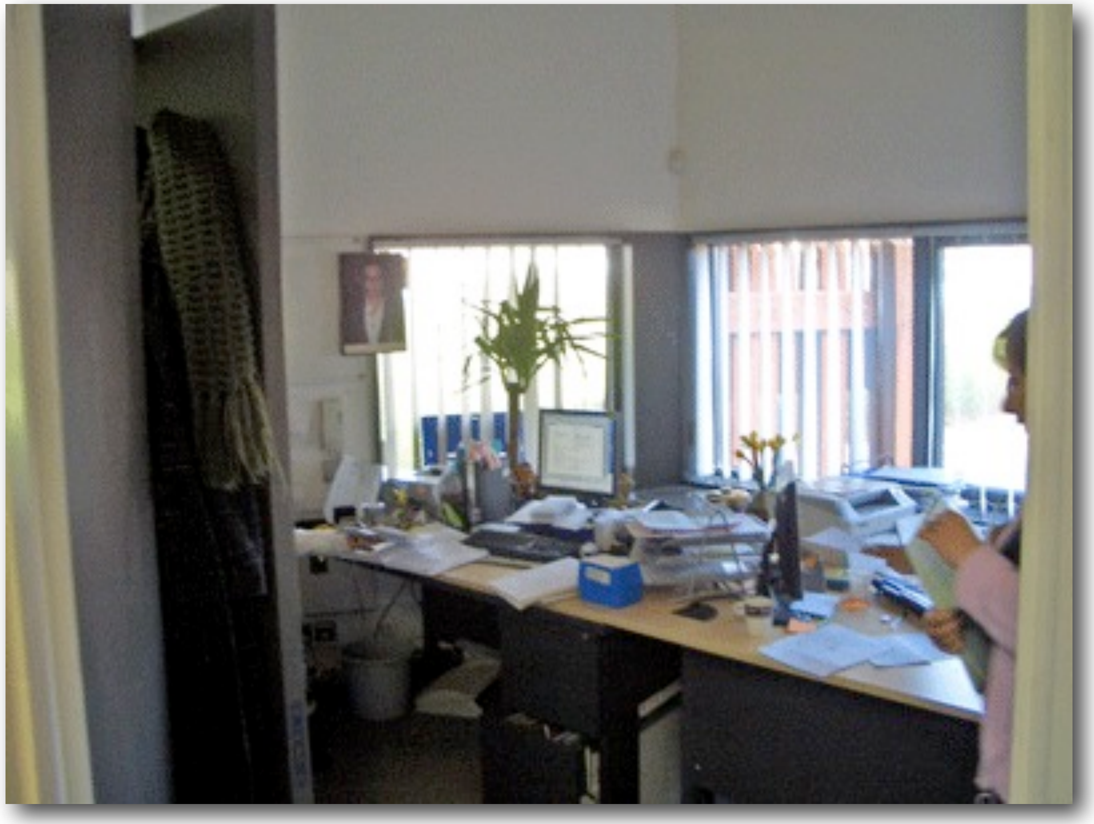
Location

- Is it really necessary to site the building on the brow of the hill when there is so much land available?

Q: What is this called on the plan ... ?

“The Lagoon”

Shape



- Avoid odd shapes.

Orientation

- **Classrooms do not have to be south facing.**

Space

- Enforced (l.) and deliberate (r.) multiple use

Circulation

- The best buildings tend to have unobstructed and wide-enough circulation.

Storage

- **Container in playground. Classic symptom of storage crisis!**

Lighting

- Careful thought required!

Ventilation

- Controls. Usable and close to the point of need!

Make Performance Visible

- Clear feedback with instant response to everyone.

Noise

- Doors on classrooms, please.

Windows #1

- **Classic revenge effect.**

  Cobbles are supposed to deter, but they attract play with disastrous consequences when the window is open.

Windows #2

- Constant conflicts with other needs.

Classrooms

- Hear the teacher, see the teacher. The most basic requirement.

Journey to School

- A lot of unrealised potential.

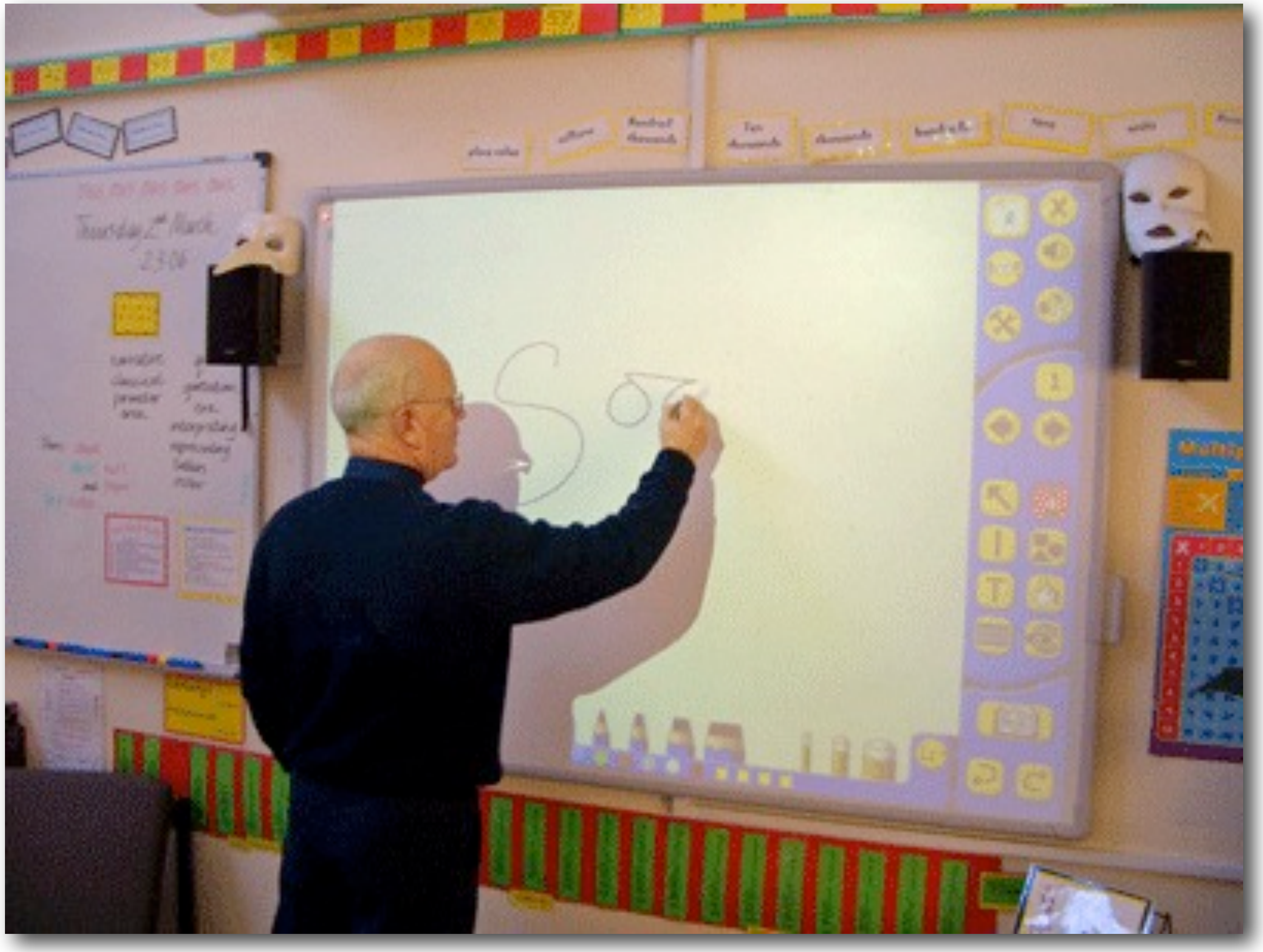
Laboratories

- Beware putting the constraints in the wrong places.

ICT rooms

- Often found in unwanted spaces with poor ambient conditions.

Interactive white boards



- 50 years of wortk ion Daylight Factors are undermined by one new technology. Careful attention to detail needed.

Cooling

- Complexity? Running costs? Controllability?

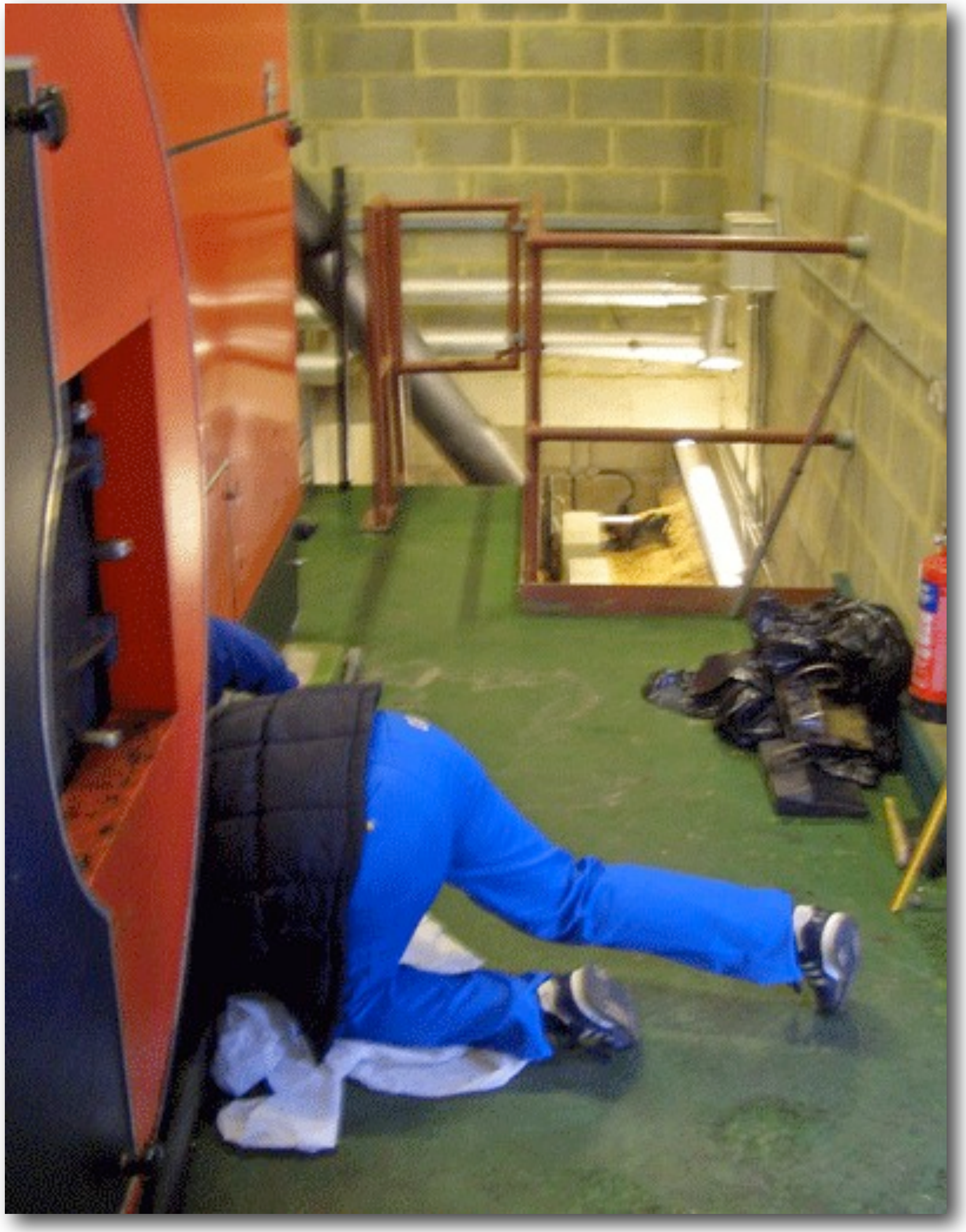
Space left over

- Teachers' hot-desking. Oh dear.

Reception

- Often very poor ambient conditions. Do not assume that receptionists will always be there as unsecured entrances may have to be shut .

Own goal



- Do not procure what you cannot manage yourself.

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