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**Tailored energy benchmarks
for offices and schools
*and their wider potential***

Bill Bordass, Esfandiar Burman,
Robert Cohen, John Field, Sung-Min Hong,
Paul Ruyssevelt and Rachel Spevack
UCL, Verco and WBA

A benchmark is ... *a point of reference for measurement*

USES FOR ENERGY BENCHMARKS INCLUDE:

- Comparing with typical examples *where do we fit?*
- Comparing with best practice *are we doing well?*
- Setting a challenge *can we do better?*
- Setting targets *we plan to achieve ...*
- Avoiding exaggeration *are our targets realistic?*
- Follow-through reality checks *is the design drifting off?*
- Providing feedback *did we meet our goals?*
- Providing insights *if not, why not: what can we learn?*

*IT IS NOT an end in itself, e.g. “meeting the benchmark”
BUT a means of developing understanding
and motivating improvement by all players concerned.*

Some items that cause problems when benchmarking operational energy

BUILDING TYPE CLASSIFICATION:

How similar are the buildings compared?

OPERATIONAL STRESS FACTORS:

Patterns of use, densities of occupation.

SPECIAL AREAS AND EQUIPMENT:

Particularly with high energy intensity.

UNITS and MEASURES OF EXTENT:

Dealing with complicating features

Office antecedent: ECON 19 (1991)

BUILDING TYPE CLASSIFICATION:

How similar are the buildings compared?

Four iconic Types created, to differentiate features found significant in case studies.

OPERATIONAL STRESS FACTORS:

Patterns of use, densities of occupation.

Packaged into the Type descriptions.

SPECIAL AREAS AND EQUIPMENT:

Particularly with high energy intensity.

Packaged into the Type descriptions.

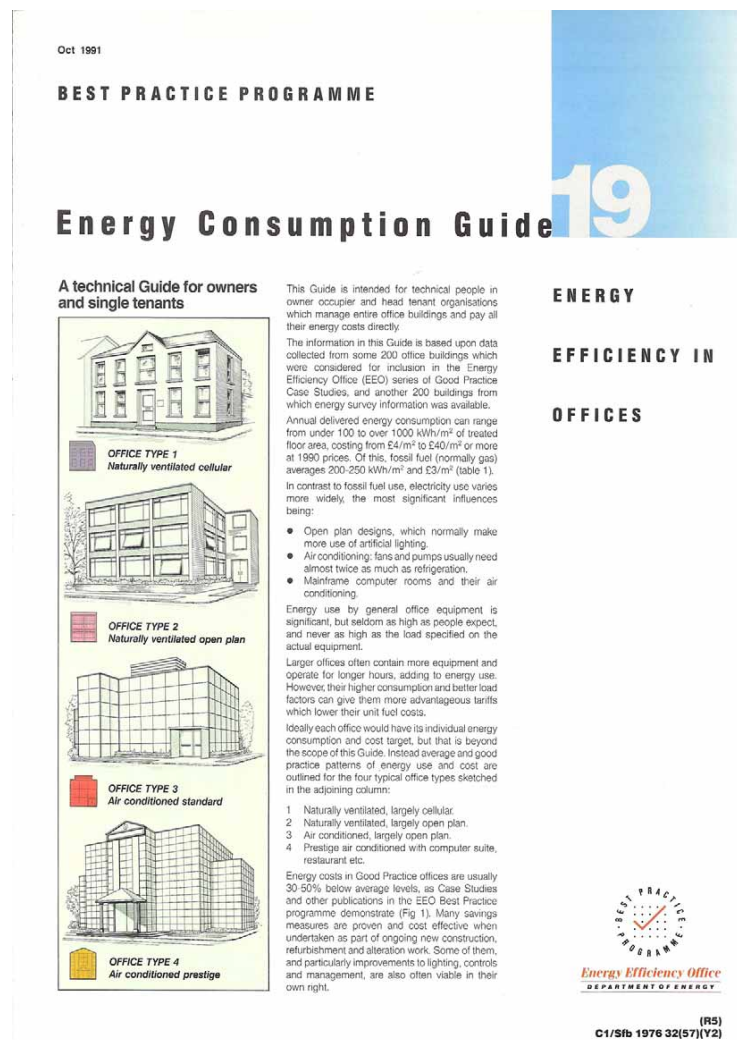
Special energy use separately identified.

UNITS and MEASURES OF EXTENT:

Fuel, Electricity, Cost.

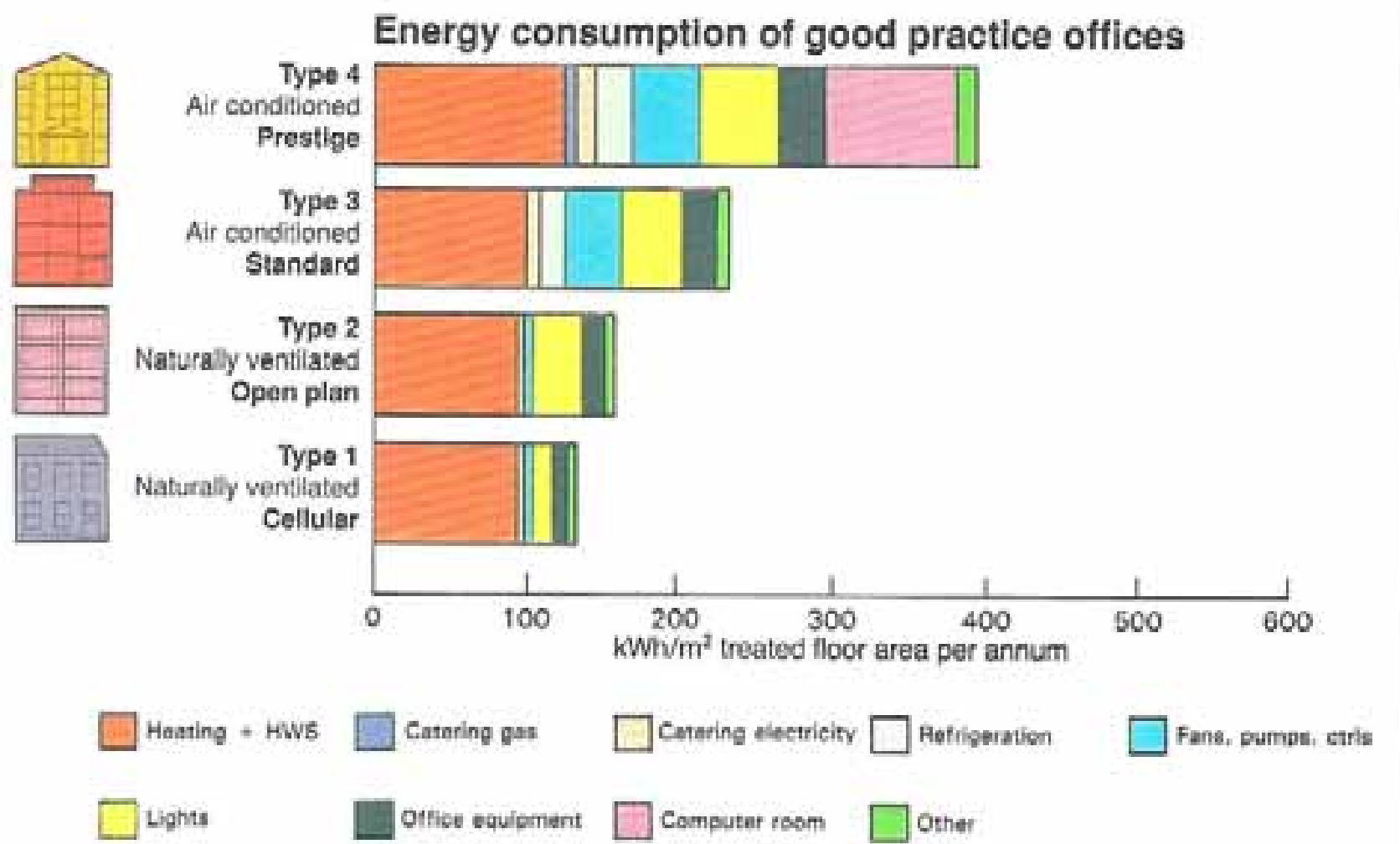
Careful definition of floor areas.

Treated floor area the principal unit.



Dealing with complicating features

Office antecedent: ECON 19 (1991)



Dealing with complicating features

Office antecedent: ECON 19 (1998)

BUILDING TYPE CLASSIFICATION:

How similar are the buildings compared?

Four iconic Types preserved from 1991.

OPERATIONAL STRESS FACTORS:

Patterns of use, densities of occupation.

Build-up by Type made more explicit in tables, and with underlying software.

SPECIAL AREAS AND EQUIPMENT:

Particularly with high energy intensity.

Packaged into the Types.

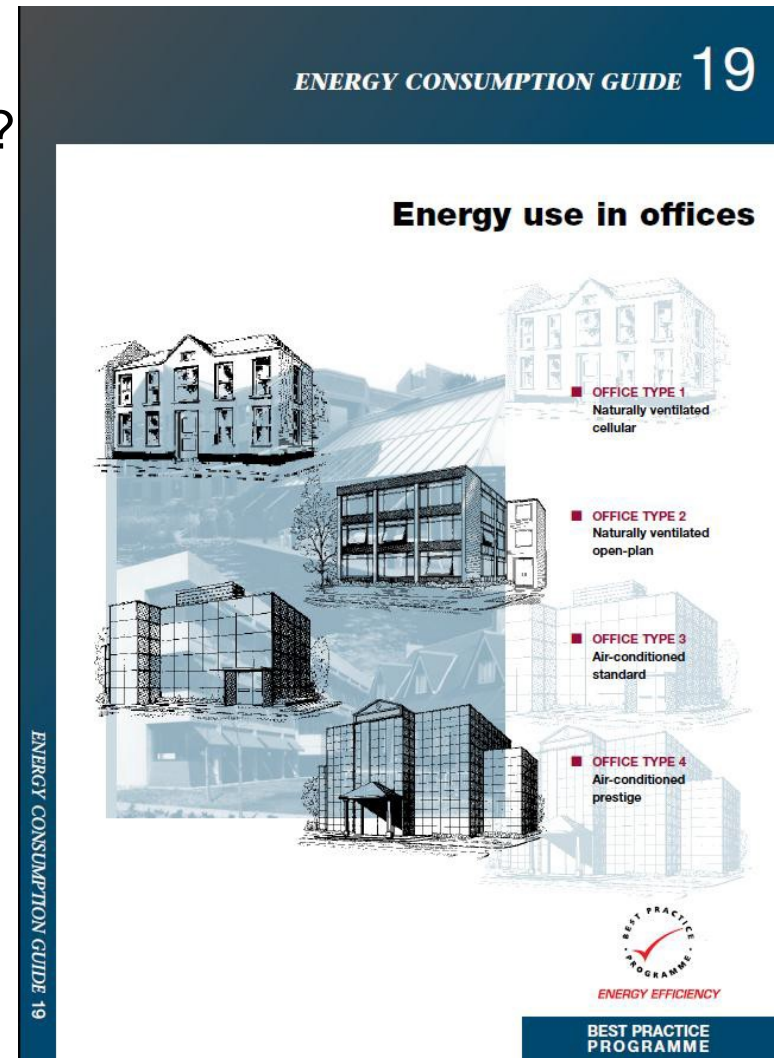
Energy use separately identified.

UNITS and MEASURES OF EXTENT:

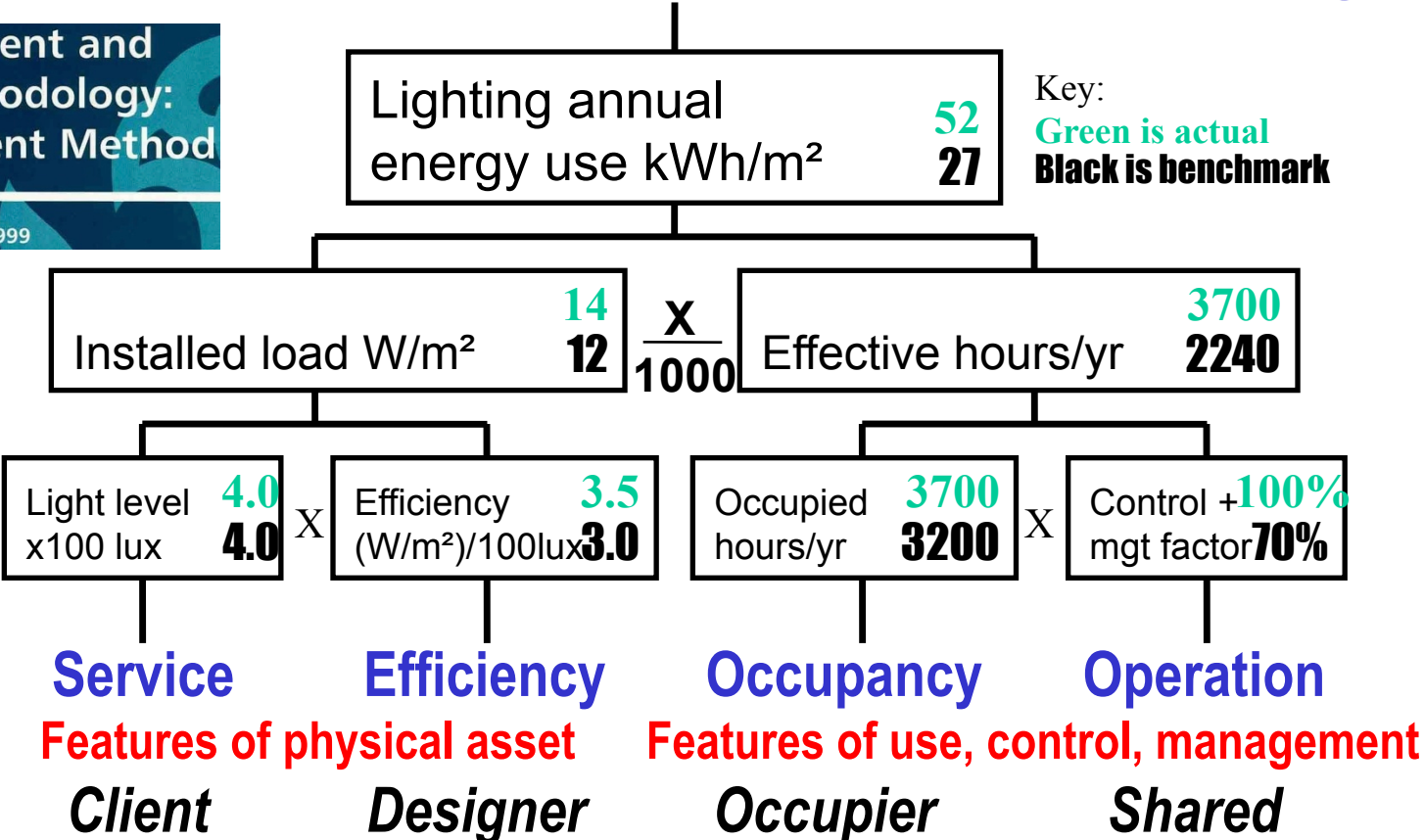
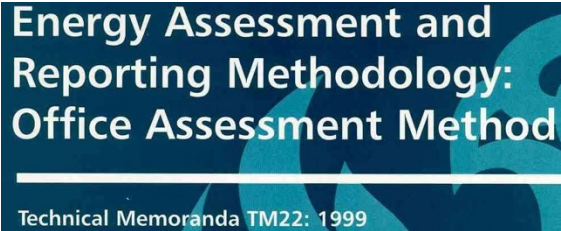
*Fuel, Electricity, **CO₂** instead of cost.*

Careful definition of floor areas.

Treated floor area the principal unit.



CIBSE TM22 (1999) provided a language to underpin more detailed benchmarking



Cells can be filled from bottom-up (*easiest for design*), or top down (*easiest in use*), to any level of detail (*for each area and end use*) to suit context and budget. The approach can also be used in successive approximation.

Tree diagram components: *a reporting and benchmarking language you can calculate with*

- You can use each box to report a benchmark, target, design estimate, survey result, or performance indicator.
- You can apply them at any scale, *from an individual component, room or system, to a building or group, to international statistics.*
- You can enter the summary data from any source - *from the most detailed model or monitoring to the roughest estimate.*
- You can do algebra with them, at least up to a point.
- You can reconcile top-down totals with bottom-up breakdowns.
- You can switch between applications, e.g. using benchmark component data to initialise energy end-use breakdowns.
- **Unlike most other benchmarking, it can support ACTION,** telling you not just where you are but why; & what you might do.

*Helps organise data from different sources and make it compatible.
Helps close the feedback loop from outcomes to intentions.*

Using TM22 to underpin benchmarking: ECON 19 tailored benchmark software (2001-2)

BUILDING TYPE CLASSIFICATION:

How similar are the buildings compared? *The 4 iconic office Types were superseded by a schedule of six activity areas: 1. Cellular, 2) Open plan, 3) Call centre, 4) Dealing room, 5) circulation & support, 6) common parts.*

OPERATIONAL STRESS FACTORS:

Patterns of use, densities of occupation.

Each activity area had its own servicing, occupation density, daylight availability and Weekday-Saturday-Sunday occupancy schedules.

SPECIAL AREAS AND EQUIPMENT:

Particularly with high energy intensity: *data centre, server room, catering. Energy use separately identified, with three choices for each: Standard benchmark, Sub-metered energy, or Rule-of-thumb calculation.*

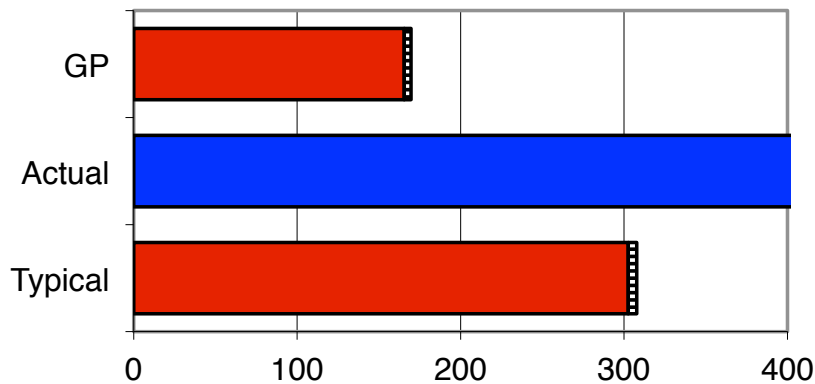
UNITS and MEASURES OF EXTENT:

Fuel, Electricity, CO₂.

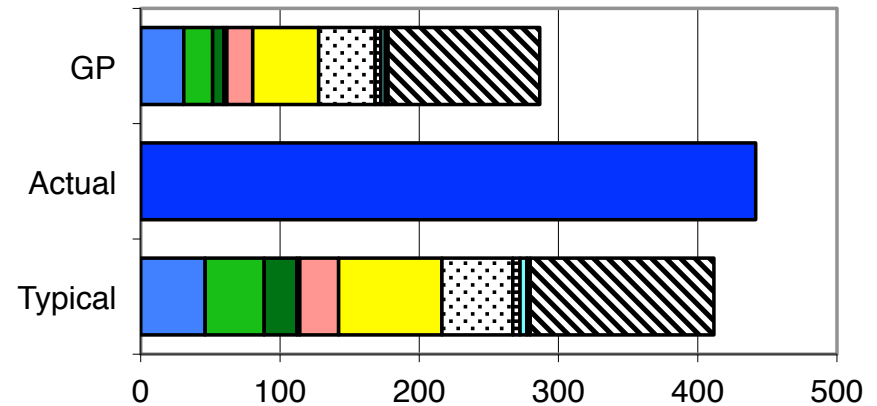
Careful definition of floor areas. Nett lettable floor area the principal unit: the “business area”. Other denominators possible, e.g. per person-hour.

Using TM22 to underpin benchmarking: ECON 19 tailored benchmark software (2001-2)

Fossil fuel usage (kWh/m² NLA per year)



Electricity usage (kWh/m² NLA per year)



- | | | |
|-------------------------|---------------------|--------------------|
| ■ Heating & hot water | ■ Refrigeration | ■ Fans |
| ■ Pumps etc | ■ Control systems | ■ Humidification |
| ■ Interior lighting | ■ Office equipment | ■ Catering kitchen |
| ■ Vending machines etc. | ■ Lifts | ■ Other end uses |
| ■ Communications rooms | ■ File server rooms | ■ Computer rooms |
| ■ Car park lighting | ■ Special B | ■ TOTAL ACTUAL |

The benchmarks and their components altered with the values entered and choices made in the Excel software.

TM22 benchmarking antecedent: ECON 78

Sports benchmarking & Design sizing (2001-2)

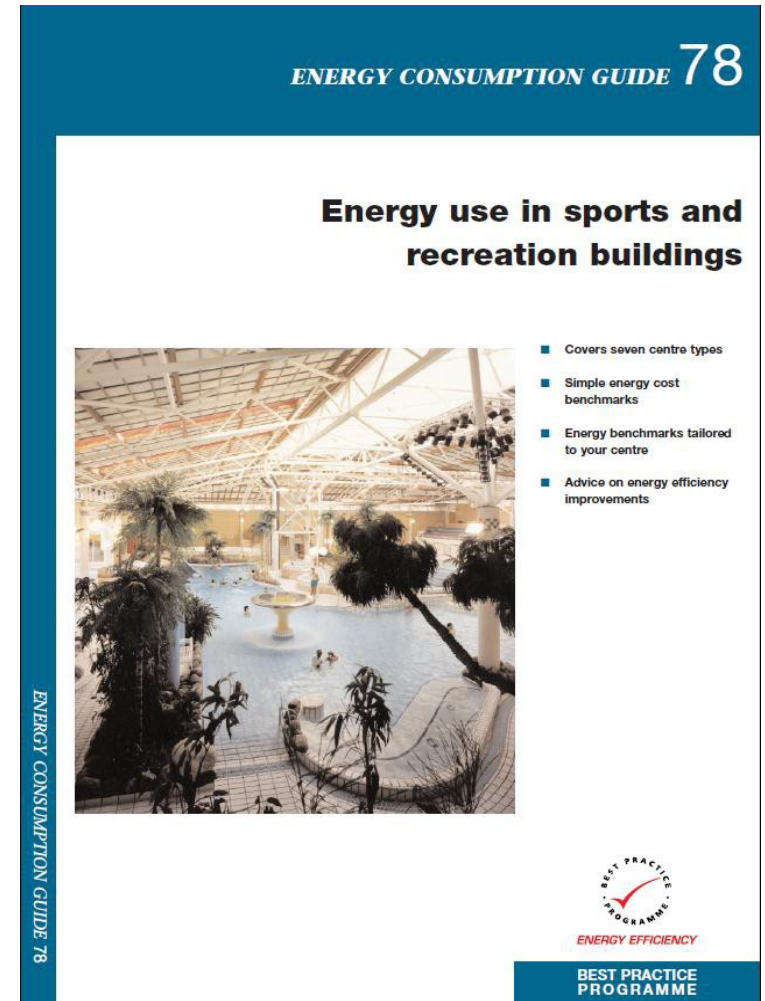
ECON 78 (2001)

An activity area and energy-using system approach similar to ECON 19 was used to create operational benchmarks for eight different kinds of sports building, and reconcile them with empirical data.

The underlying software allowed tailored benchmarks to be created, *e.g. altering area schedules and swimming pool temperatures.*

SPORTS DESIGN SIZING (2002)

The same software was applied to design and savings predictions, using benchmark component values (*e.g. W/m^2 for lighting*) discussed with leading firms of engineers. The approach looked promising.



Benchmarking and the EPBD (2002)

EPBD, Energy Performance of Buildings Directive was published, AND

- The European Commission supported the EuroProsper bid to research a Display Energy Certificate operational rating process for offices*, which drew on the ECON 19 tailored benchmarking system.

HOWEVER:

- The UK government's *Energy Efficiency Best Practice programme* (EEBPp) *which had funded the Energy Consumption Guides and the associated research*, came to an end.
- It was superseded by the Carbon Trust's *Action Energy* programme, which did not give the same priority to benchmarking; and so ...
- the EEBPp's recommendation that tailored benchmarking might supersede Consumption Guides in all sectors was not taken up.
- **So extension of tailored benchmarks to other sectors did not happen.**

* R Cohen et al, *Grading non-domestic buildings for their energy performance*, IEECB Conference, Frankfurt (April 2004).

Benchmarking and the EPBD (2006-07)

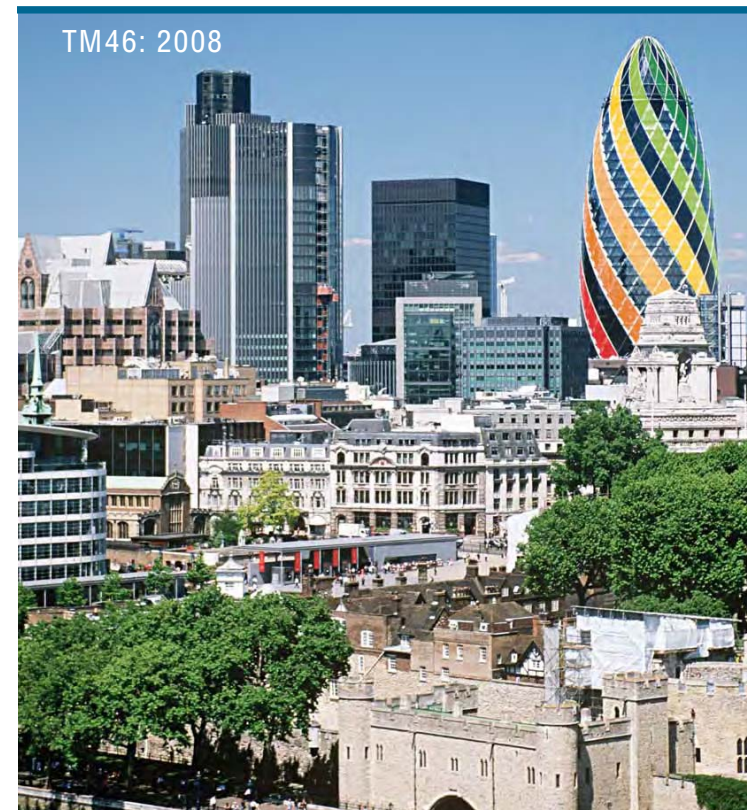
In June 2006, the government decided Display Energy Certificates required by the *EU* would be based on actual energy use.

In late 2006, it asked CIBSE to comment on the associated benchmarks.

THE REVIEW FOR CIBSE FOUND:

- The existing benchmarks were inconsistent, out of date, and could give perverse incentives (*e.g. bigger benchmarks for air conditioning*).
- Too little time left to develop a tailored benchmarking system for all sectors.
- Better to start with a new, simpler system, with placeholder benchmarks that could evolve over time.
- CIBSE TM 46 was the result.

Energy benchmarks



Complementary benchmarking routes

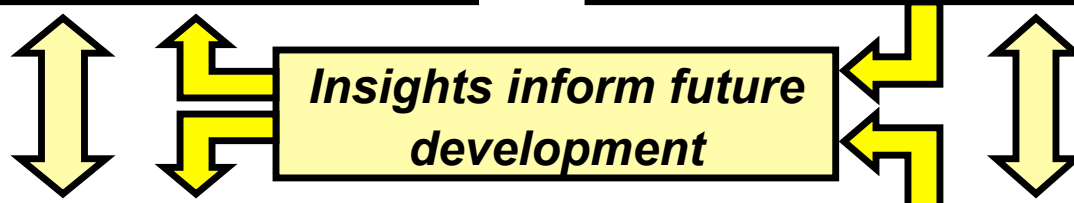
Strategy proposed to CIBSE & DCLG in 2007

1. BENCHMARKS FOR DEC*s*

- Simplified starter benchmarks.
- Thermal and electrical values, then converted to **CO₂**.
- Severe: assume low intensity of use and standard services.
- Optional corrections allowable for *specials* and high intensity use, *if rigorously verified*.
- Will evolve in the future.

2. VOLUNTARY BENCHMARKING

- *Encouraged within sectors etc.*
- *Can make use of relatively poor data, e.g. sorted into rank order.*
- *Can take account of differences between building types, uses and systems the industry is aware of.*
- *Can be displayed alongside the DEC, but must not look anything like a DEC.*

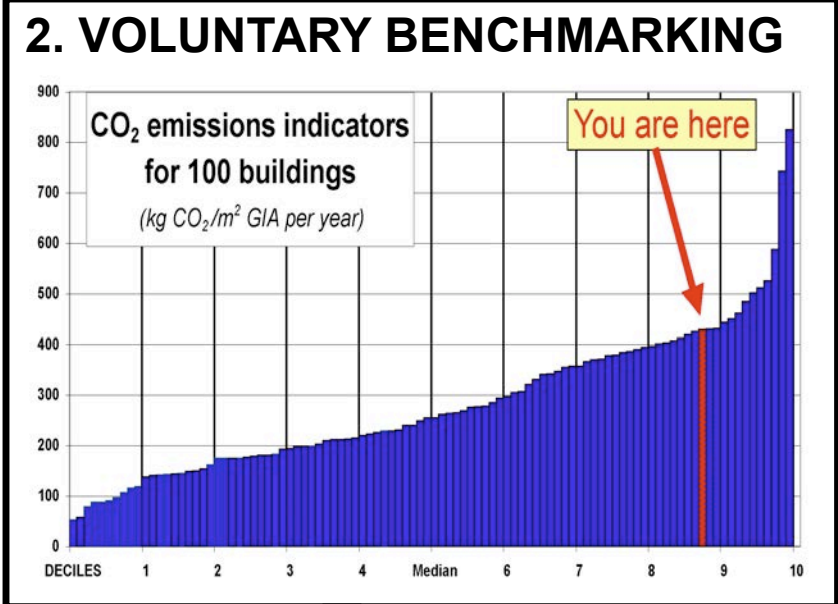
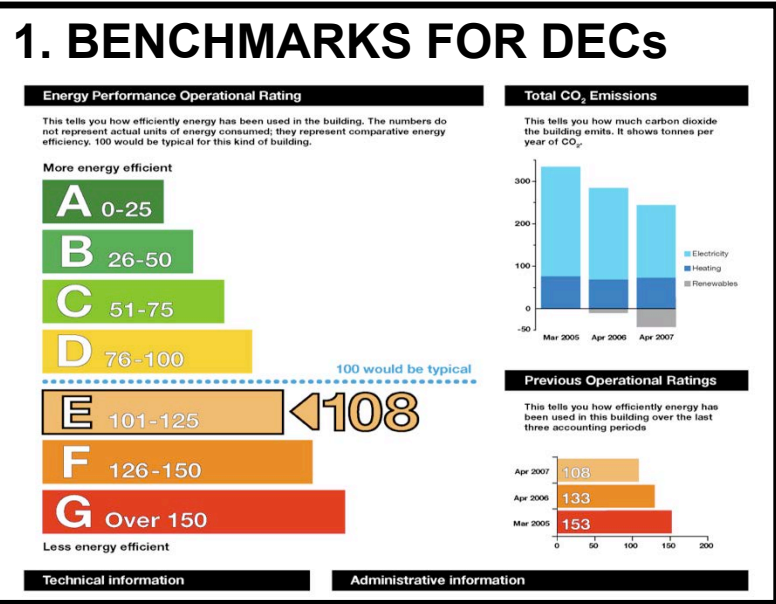


3. TECHNICAL UNDERPINNINGS

- *Technical standards, technical details, technical review.*
- *Detailed understanding of elements of energy use. Tailored Benchmarking.*

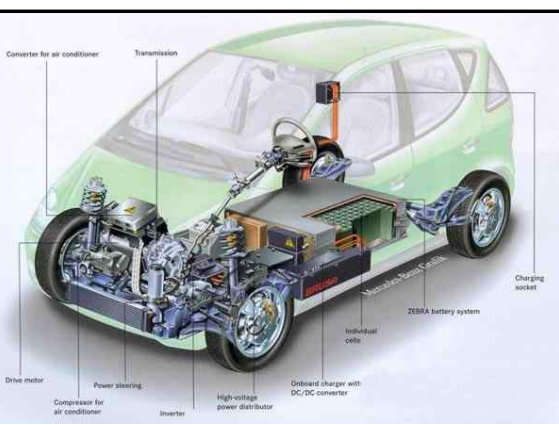
Complementary benchmarking routes

Strategy proposed to CIBSE & DCLG in 2007



3. TECHNICAL UNDERPI

- Technical standards, te
- Detailed understanding

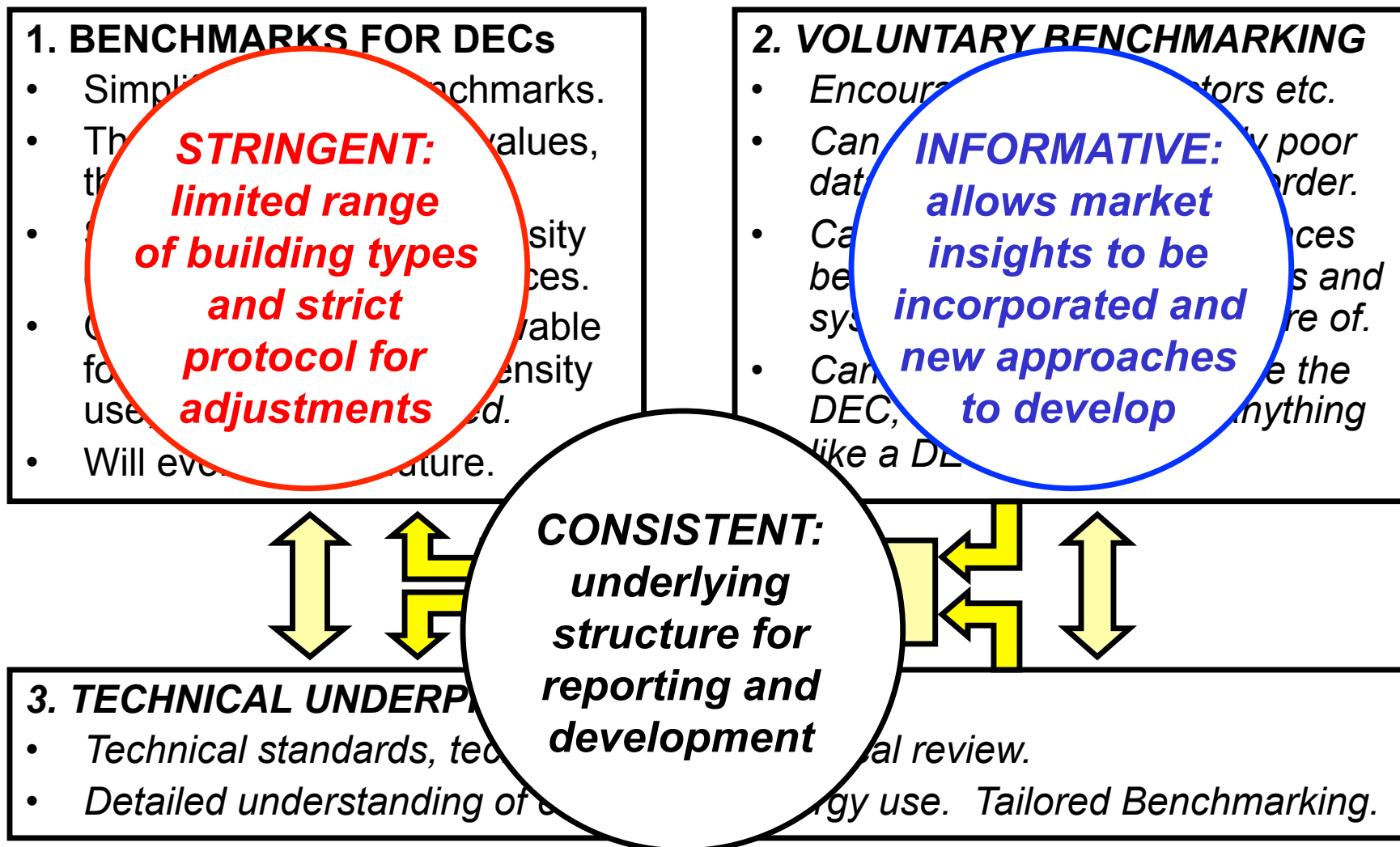


review.

. Tailored benchmarking.

Complementary benchmarking routes

Strategy proposed to CIBSE & DCLG in 2007



Since then, there has been little of the expected investment in the underpinnings

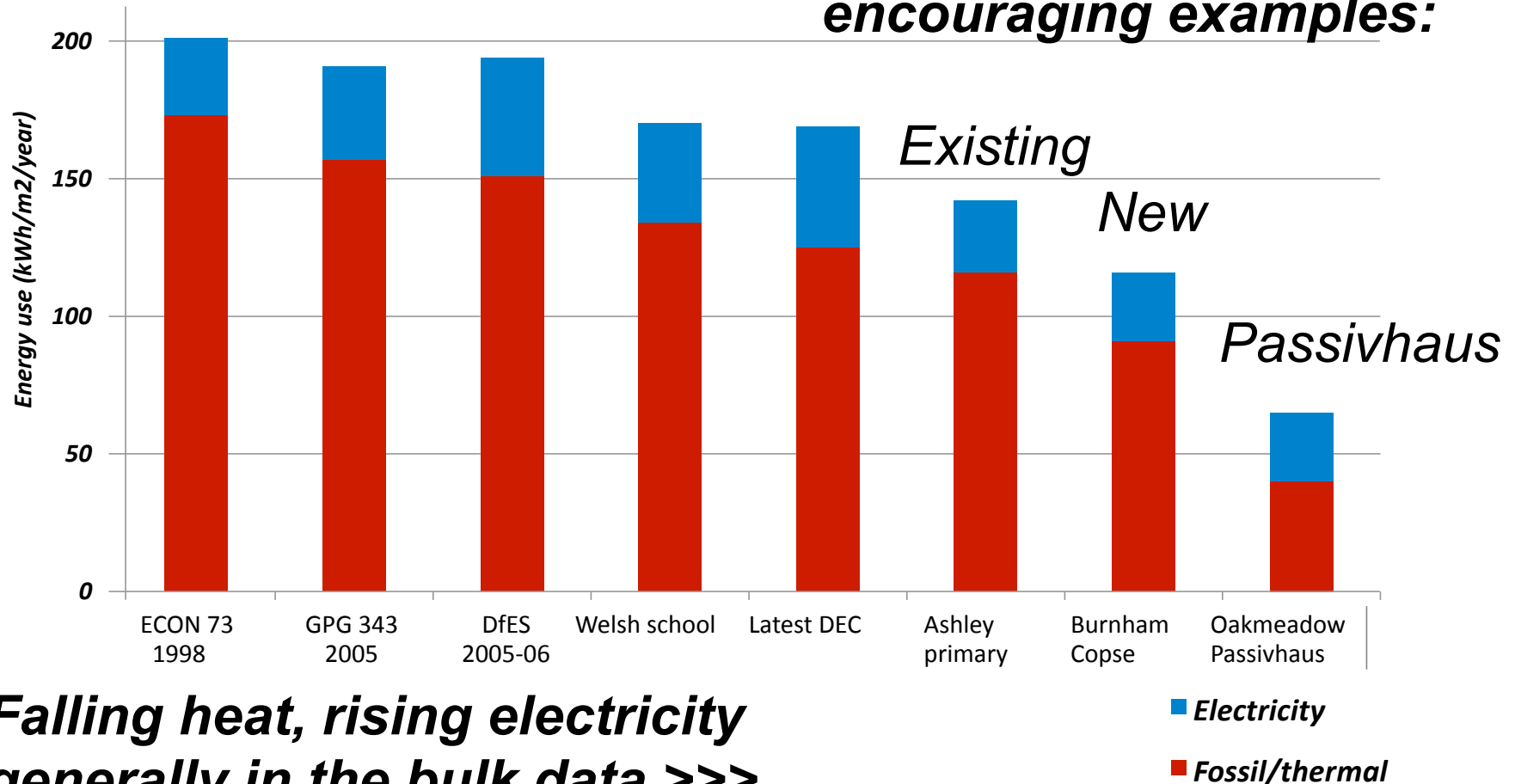
- Lack of a central policy focus on building energy use in operation: *CRC and GHG reporting are blind to building performance. ESOS is likely to focus on improvement measures, not benchmarking.*
 - Poor integration of policies within and between Ministries.
 - Little technical support to public sector DEC's: *locked up as a bureaucratic procedure, not an evolving window on performance.*
 - Difficulty of efforts by others (e.g. CIBSE, BPF, BBP) to gain traction (e.g. getting buy-in, attracting industry funding and academic support) in the absence of a docking station to connect to government.
 - **The consequences have included a lack of stakeholder confidence in benchmarks; and much duplicated, misplaced and wasted effort.**
 - An effective system needs to work across all sectors.
 - The market can't do this alone.
 - Stakeholders want a level playing field endorsed by government, but that also takes into account their interests and concerns.
-

Tailored benchmarking revisited: Scoping study for Schools (2013)

- Short (3 month) study of the potential for tailored benchmarking in a new sector, including development of prototype software.
 - Led by the University College London Energy Institute, with funding from the Engineering and Physical Sciences Research Council.
 - Technical support by Verco, who (as ESD) had led the EU energy certification research projects Europrosper and EPLabel. Verco also brought in other members of these project teams, who had also developed the tailored benchmarks for offices and sports.
 - The project took advantage of UCL's work including case studies of energy and internal environment in schools, and support to CIBSE's reviews of the Display Energy Certificate database in 2010 & 2013.
 - Detailed data was added from other sources, including the UK's *Building Schools for the Future (BSF)* programme.
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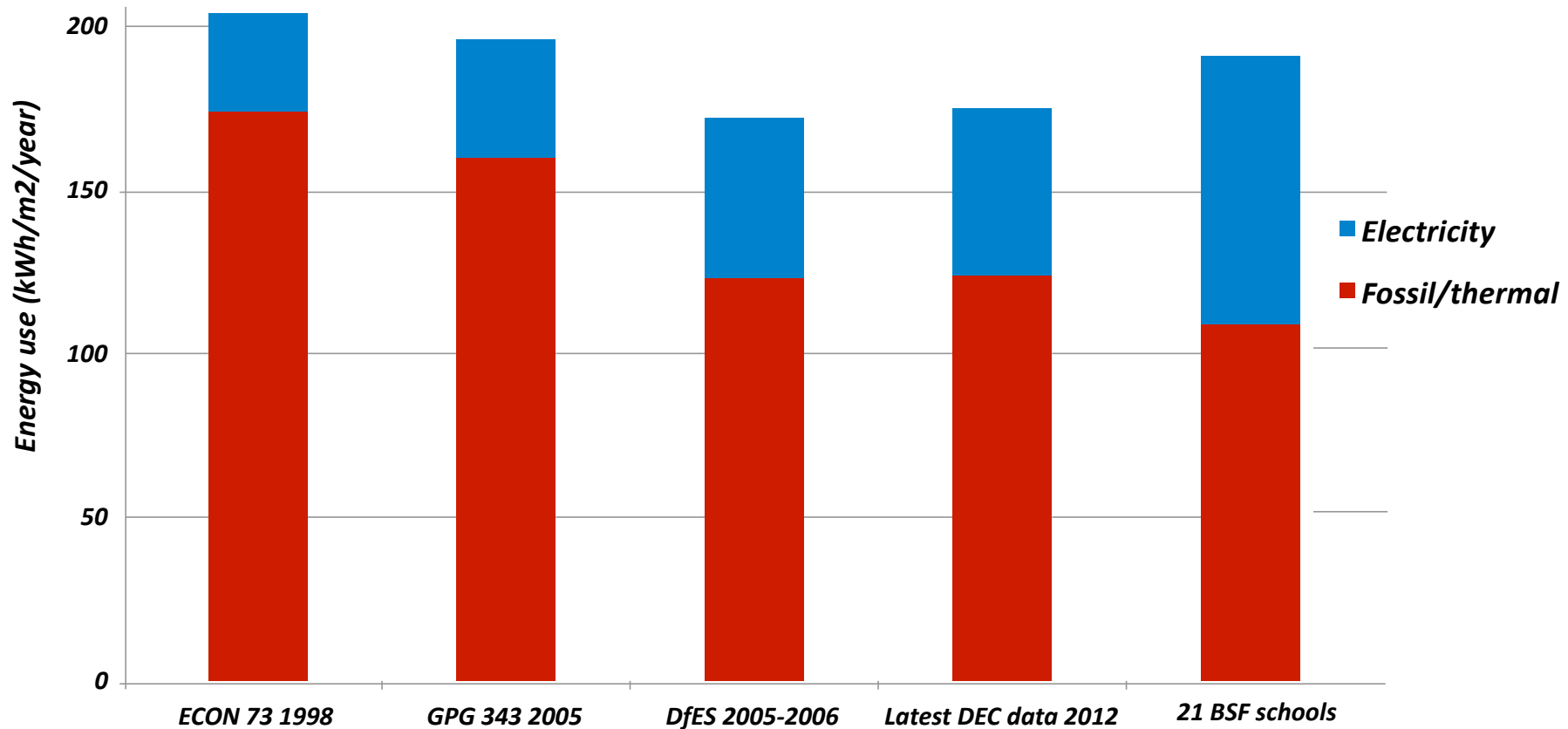
Background: Trends in energy use: Primary Schools

***Some recent
encouraging examples:***



***Falling heat, rising electricity
generally in the bulk data >>>***

Background: Trends in energy use: Secondary Schools



Trend to falling heat but greatly increasing electricity >>>

Tailored benchmarking for schools: principles of the approach

- Adjust Benchmarks not Actuals.
 - Allow for factors related to the activities in the building: Schedule of accommodation; Hours of use; Intensity of use; Special energy uses.
i.e. what the building DOES, not the fabric + technical systems it has.
 - Excel software builds up allowances based largely on Tree Diagrams for all the energy end uses required by each activity taking place.
 - Benchmarks calculated at three different levels of energy performance:
 - **Typical**: Median of the existing stock
 - **Standard** New Build – consistent with performance of new schools satisfying current standards.
 - **Advanced** Practice – technically proven and cost effective over the building's lifecycle with available technology, e.g. Passivhaus.
-

Tailored benchmarking for schools:

Three levels of evaluation

Level 1: Quick start

Basic inputs to produce an initial benchmark.

- *School type: secondary, primary, or special. Additional sixth form?*
- *School capacity: maximum number of pupils and current roll.*
- *Gross internal floor area. Annual electricity and heating fuel use.*
- *Number of terms per year, dates, number of days per half term.*

Default schedule of accommodation to BB98 and BB99 specification.

Level 2: What the building does

Tailored benchmarks recalculated using extra details and refinements.

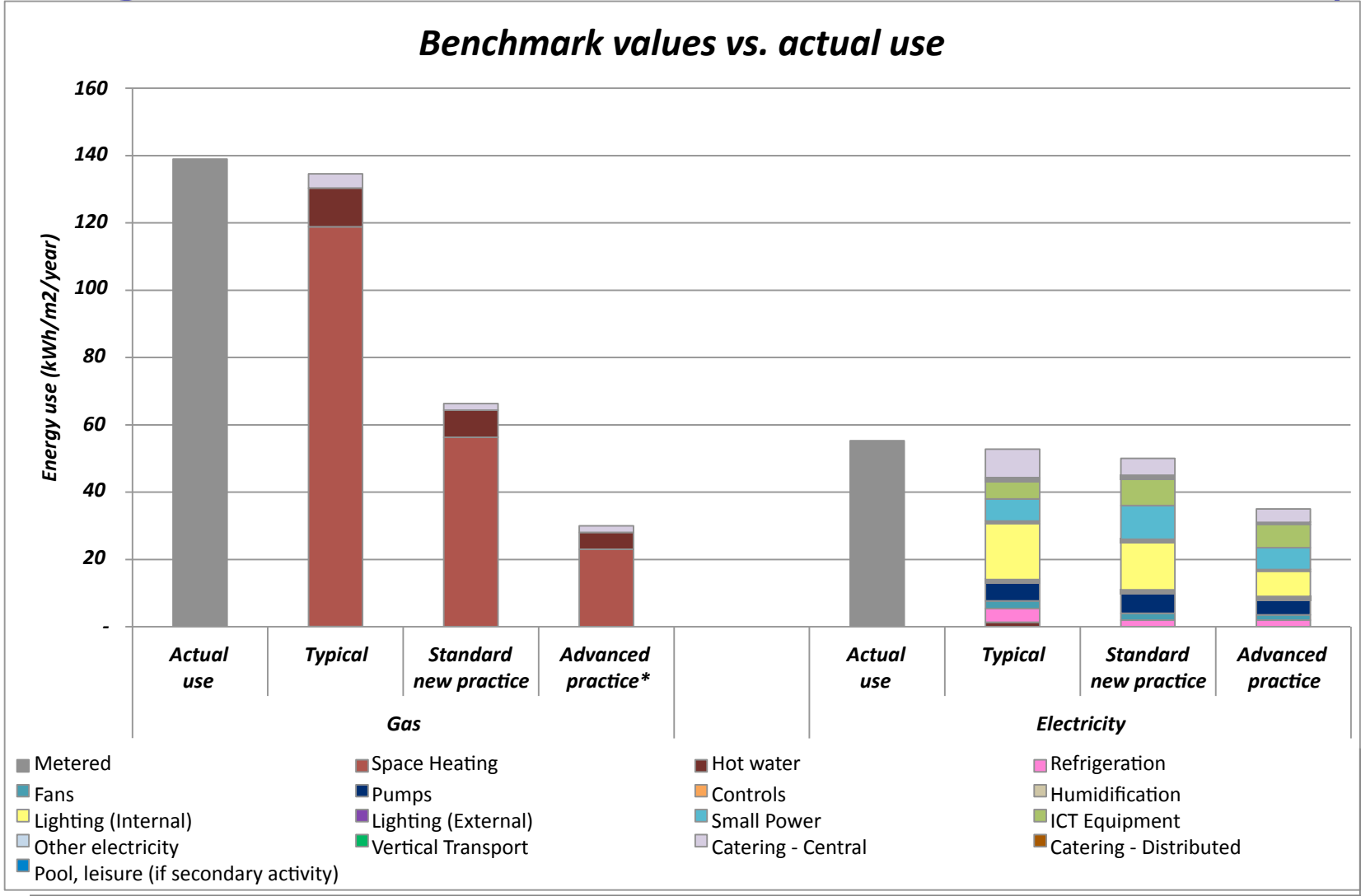
- *Replace defaults for schedule of accommodation and hours of use.*
- *Catering and ICT inventory. Presence and use of lifts.*
- *Outdoors: External lighting, sports facilities etc.*
- *Specials: Pools, Kilns, Workshops, Recording studios, CCTV.*

Level 3: What the building is *(module to be developed in the future)*

Allows building-specific improvement measures to be identified.

Stage 2 school output graphic

(Stage 1 similar, but no end use breakdown)



Conclusions on tailored benchmarking and its wider potential

- Addresses stakeholder concerns benchmarks do not suit their context.
- Improves transparency. Helps to motivate and support action.
- Can incorporate automatically recorded meter and sub-meter data.
- Potential to revolutionise communication and benchmarking.
- **Needs further work on developing and validating the approach.**

QUESTIONS:

- The best balance between the costs and benefits of providing detail.
A drill-down strategy allows the user to choose ... BUT
 - QA repeatability, where used for statutory purposes. *Limit the options?*
 - What energy end-uses are allowable? *This may well vary with purpose.*
 - Taking account of intensity of use factors that may be difficult to obtain or commercially confidential, *e.g. actual occupancy levels, or turnover.*
 - **Creating an effective institutional mechanism to progress all this.**
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THANK YOU

CONTACTS

p.ruyssevelt@ucl.ac.uk
robert.cohen@vercoglobal.com
bilbordass@aol.com
