APPENDIX B. BUILDING TYPES AND THEIR BENCHMARK VALUES

B1. Review of existing classifications of building types

85 **INTRODUCTION**

Buildings are classified differently for different purposes. This complicates the correlation of energy benchmark data with building type data. Here we review four classifications (the EPBD, SBEM, the Valuation Office’s and the current set of energy consumption guides summarised in Chapter 20 of CIBSE Guide F) and examine the scope for harmonising descriptions. We also inspected but rejected the SIC Standard Industrial Classification, as this focuses on the type of industry that is occupying the buildings, not the type of buildings they occupy. We have prepared a large Excel spreadsheet which compares the classifications and is available on request.

86 **CLASSIFICATION IN THE EPBD**

The EPBD includes seven non-domestic categories only: offices; education buildings; hospitals; hotels and restaurants; sports facilities; wholesale and retail trade services buildings; and other types of energy-consuming buildings. This does not provide sufficient detail for benchmarking.

87 **CLASSIFICATION IN SBEM**

SBEM (see www.ncm.bre.co.uk) has twenty-seven non-domestic categories. These are still quite coarse, for example with a single category for offices and a single one for retail (though retail warehouses and launderettes rate separate categories). But retail can range from a fairly low-energy dry goods store to an intensively-used and highly-serviced supermarket with long operating hours. SBEM itself requires the user to assemble activity areas for each building. While this would also be possible for an advisory level of benchmarking, it would be too elaborate a requirement for mandatory purposes, especially when the system is getting started.

88 **VALUATION OFFICE CLASSIFICATION**

Information from the Valuation Office (VO) and its relation to building energy use been reviewed over the years by a team at University College London, which has provided us with its Primary Table. This has 117 headings, including industrial and outdoor facilities. This classification looks more detailed for private buildings (particularly the retail, hospitality, industrial and office sectors) than public ones (e.g. with only one VO category for hospitals and another for universities). This is presumably because the main purpose of the VO is to collect rates from the private sector.

89 **CIBSE GUIDE F CLASSIFICATION**

Guide F summarises data from published sources. Table 20.1 has nearly 100 building types in 15 main categories: catering, entertainment, further & higher education, schools, hospitals, hotels, industrial, local authority, MoD, offices, primary healthcare, public, residential and nursing homes, retail, and sports & recreation. With Tables 20.4 to 20.6 added, there are over 140 building types, including fossil-fuelled and all-electric examples and some entries from Northern Ireland.

90 **COMPARING THE CLASSIFICATIONS**

We combined the classifications by grouping the Valuation Office list under the SBEM headings and then cross-referencing it to the CIBSE list. The general conclusions were that:

- For only 12 types were the VO and CIBSE classifications reasonably similar: primary schools, secondary schools, surgeries, restaurants, public houses, ice rinks, post offices, banks & building societies, community centres, fire stations, ambulance stations and police stations.
- In general the coverages of the VO and CIBSE were distinctly different. For example, while the largest number of buildings in both classifications is in the retail sector, CIBSE made major distinctions between food and non-food retailing while the VO did not.
- Putting the various classifications together led one to ask questions about the consistency of coverage of building types in the existing classifications and benchmarks, particularly in terms of the influence of building description on likely levels of energy consumption and CO2 emissions.

91 **CONCLUSIONS**

None of the classifications really work or map very well onto each other, and the complexity of the more detailed classifications does not appear to be justified. In this appendix we therefore review the Guide F benchmarks to see whether the data give us any clues about a simpler approach.

---

17 The building stock model team at UCL has recently given us a new list with about twice this number of headings, which they think might relate more closely to energy use, but we have not yet had time to analyse it.
B2. Whole building benchmark values in Guide F

92 THE SOURCE MATERIAL
Chapter 20 of CIBSE Guide F contains several tables with whole-building benchmarks:

a) Table 20.1, the largest, contains Typical and/or Good Practice values for fossil fuel and electrical consumption from the Energy Efficiency Best Practice programme and its successors, normally in the form of Energy Consumption Guides now published by the Carbon Trust.

b) Table 20.4 includes similar data from samples of buildings in Northern Ireland.

c) Table 20.5 includes similar data from samples of retail buildings.

d) Table 20.6 is for a variety of buildings, mostly retail.

Both fossil/electric and all-electric buildings are included, particularly in Tables 20.4 to 20.6. Most of the data comes from the mid-1990s and sometimes earlier. Since then, efficiency improvements have been undermined by increases in electronic equipment, hours of use, and air conditioning.

93 DATA COMPILATION
We compiled an Excel workbook with data from all four tables above and split it into sectors based on those used in Table 20.1: Catering, Entertainment, Further and Higher Education, Schools, Healthcare, Hotels, Industrial, Local Authority, MoD, Offices, Public, Retail and Sports. The benchmarks use a range of different area definitions: gross, treated, nett lettable, sales floor area and gross parking area, and these are recorded. Although conversion factors are often given, we did not apply these as we wanted our initial analysis to be as close as possible to the raw data.

94 DATA MANIPULATION
We sorted the data by sector, by electricity use, by fossil fuel use, and so on. The most informative single graphic was sorted first in approximately ascending order of the CO2 emissions from the average building in the sector concerned, and then, within each sector, by the Typical benchmark for annual CO2 emissions for the building types. The data is discussed by sector below. The weighting factors used for emissions here were 0.19 kg CO2/kWh of delivered fossil fuel (i.e. assuming it is all gas) and 0.55 for electricity [Pout, 2007]. The Typical benchmarks are shown in Figures A1 and A2, which include annotations to indicate groupings and possibly anomalous data.

95 SCHOOLS
The school sector has the lowest levels of CO2 emissions, with Typical benchmarks of about 45 kg/m² GIA, made up of about 150 kWh/m² of fossil fuel and 25 kWh/m² of electricity. This is a product of their historically short working year, short hours of use (mostly in daylight hours) and relatively limited use of electrical equipment. But times are changing: utilisation is increasing, use of ICT and other equipment is growing, and new schools – even those claiming to be low energy – are tending to use considerably more electricity than their predecessors, typically 40 kWh/m² and sometimes much more. The benchmarks therefore no longer represent current practice.

96 Not surprisingly, secondary schools with swimming pools use more energy: about 30% more gas and 10% more electricity. While this justifies a different benchmark, we think it would be better to treat energy-intensive facilities such as swimming pools separately: they can be very variable in size and intensity of use, and if merged into a whole building benchmark, opportunities for insightful comparison and purposeful improvement are likely to be overlooked. One could do this by either:

a) creating a composite benchmark for the overall performance of the school by combining an area-weighted benchmark for the school with another for the actual characteristics of the pool;

b) or examining the energy performance of the pool on its own merits and deducting it from the total.

97 LOCAL AUTHORITY BUILDINGS (not in 24 hour use)
CO2 emissions from local authority buildings fall into the following groups:

a) Relatively low emissions of course from outdoor and indoor car parks.

b) Just over 50 kg/m² for youth and community centres, which are not dissimilar in their energy use to schools and are probably similar in their levels of usage and equipment.

c) Considerably more in depots, town halls and day centres, which each have distinctly different fossil/electric breakdowns. We will return to these in later sections on related building types.

---

18 Where the differences are small, similar sectors have been put next to each other to make direct comparison easier.

19 Bailey and Pout [2005] show 0.53 as an average for 2000-04, but the 2005-06 average rose to 0.56. 0.55 kg CO2/kWh was chosen as a reasonable figure for 2007-10. These figures are for bare CO2 [Pout, 2007] and so may need augmenting.

20 Buildings in Northern Ireland use considerably less, in all sectors. It is not clear why: are they actually better (in which case what can we learn from them?), or less intensively used, or is floor area measured differently (e.g. gross external area).

21 A recent review of five City Academies showed electricity consumption between 65 and 125 kWh/m².
98 PUBLIC BUILDINGS (not 24 hour use)
a) The relatively low energy use of the Northern Irish public lavatory probably represents basic provision. We would expect wide variations depending on the quality and use of the facility.
b) In spite of their large volumes, churches tend to have relatively low energy use per square meter as a result of short hours of use and often relatively Spartan levels of servicing. Practical benchmarks might take more account of this.
c) The benchmarks for the rest of the buildings are remarkably similar at around 70 kg/m². Are the differences between building types significant? We suspect not.
d) The specifications of museums and art galleries vary greatly, and we are not sure how useful or relevant the benchmark shown would be in practice.

99 FURTHER AND HIGHER EDUCATION
The CO₂ benchmarks for the first group of buildings (up to the science lecture room) are very similar to the main block of public buildings above. In addition:
a) As usual, the Northern Ireland sample is at the low end. It is again not clear why.
b) The lecture room figures are curious, as they relate to specific rooms not whole buildings.
c) The library data is curious, with the massive differences between naturally-ventilated (66 kg/m²) and air-conditioned (273 kg/m²) difficult to believe. Libraries have tended to become more energy intensive in recent years as they have turned into learning resource centres (LRCs) with banks of computers. Nevertheless, the emissions of recently-completed LRCs known to us lie in the range 50 to 100 kg/m², with the highest (mostly air-conditioned) at 105 kg/m².
d) The lab data is curious, as consumption varies a lot with the type of lab - this looks closer to physical science: chemistry, biology and medicine can be much more energy intensive.
e) The catering facilities might better be benchmarked on their intensity of use.

100 RETAIL HIGH STREET AGENCIES
The CO₂ benchmarks are all remarkably similar, even between the fossil/electric and the all-electric versions. Since the Bank/Building Society data shows at both ends of the scale (depending on source), there seems to be a strong case for making them all the same at 75-80 kg/m².

101 OFFICES
a) The open plan offices are similar to the high street agencies above. Differences between fossil-electric and all-electric are small. The cellular office buildings are somewhat less, but for simplicity one could use the same benchmark.
b) The air conditioned offices are responsible for much higher emissions levels. The effect comes mostly from their extra electricity consumption. For statutory purposes, should air-conditioned offices be permitted a bigger benchmark just because they have air-conditioning? We think not. There would need to be functional reasons for having it (e.g. more intensive use).
c) The main difference between the Type 4 and the Type 3 office comes from the data centre and restaurant in Type 4. The authors have argued (for example in CIBSE TM22 and the Office Tailored Benchmarks reports to BRE in 2001-02) that since these items can account for relatively large proportions of a building's energy consumption and can be very variable in size, use and energy intensity, they are best considered in their own merits.
d) In comparison with these benchmarks, Town Halls at 100 kg/m² come above naturally-ventilated offices but well below air-conditioned ones, probably a function of their out-of-hours uses; and the computer rooms, restaurants and halls not in the naturally ventilated benchmarks.
e) 

102 PUBLIC AND LOCAL AUTHORITY 24-HOUR BUILDINGS
a) These consist mostly of emergency services buildings and are tightly clustered, with the Northern Ireland buildings at the bottom end as usual. A single benchmark would probably suit them all on first approximation.
b) The other two are residential buildings (the temporary homeless unit and the residential care home), which have characteristics very similar to the health and hotel sectors, discussed below.

c) 

103 HEALTHCARE
a) Unfortunately the published GP and Dentist's surgery benchmark is for fossil fuel heating only, with a Typical consumption of 270 kWh/m², rather higher than most and probably representing rather higher temperatures and ventilation requirements.
b) Nursing homes, residential homes, and long stay accommodation have very similar emissions to each other and indeed to local authority homeless and residential care units. We suspect that they could all be given the same benchmarks.
c) Teaching, specialist, acute and maternity hospitals have surprisingly similar benchmarks to the residential units above, but with somewhat more electricity consumption, probably associated with their energy-intensive operational areas and with more night use for emergencies etc..
104 HOTELS
The difference between the benchmarks for the three types of hotel is surprisingly small – so small that we wonder if it is worth bothering about. We suspect it would be better to start by giving them all the same benchmark. Eventually this could be adjusted for real variables, like occupancy levels, presence and utilisation of restaurants; and conference, sports and swimming facilities.

105 ENTERTAINMENT
Here there is a factor of two difference between the datasets in Table 20.1 and Table 20.6. Which should we believe? Start with a single benchmark in the middle?

106 SPORTS AND RECREATION
a) Swimming pools are the major users. Benchmarks are given for both competition and leisure pool centres, but they are so similar that there seems no point in differentiating between them. Essentially the leisure pool has a smaller pool area but more energy-intensive servicing for catering, lighting, saunas, waterslides and so on.
b) Surprisingly at first sight, the Combined centres (with both pools and dry sports) are very much less energy-intensive, because the pools are relatively much smaller than in half a Pool centre.
c) The sports ground changing benchmark is rather higher than one would expect, particularly for electricity. It seems likely that electricity use by floodlighting is included. More data is desirable.
d) The fitness centre benchmark is questionable, but may reflect long hours and high occupancy.

107 RETAIL
Retail has by far the biggest range, with a factor of ten between the highest and lowest22. It also includes a lot of all-electric buildings, but where fossil fuel is used the CO2 benchmarks appear to be little affected:
a) For dry goods, there is a gradual increase from 55-75 kg CO2/m² for distribution warehouses and catalogue stores through to 200 kg/m² for electrical goods and department stores. The increases relate mostly to display lighting, electrical equipment (especially for electrical "rental" stores) and the associated air-conditioning.
b) Dry cleaners come at the top of the dry list at 250-300 kg/m² mostly as a consequence of the process, as the high fossil benchmark for the fossil/electric example reveals. It is surprising that the fossil/electric example has much higher emissions and we wonder whether there is a technical reason for this in the design or throughput of the dry cleaning equipment.
c) Small food shops and butchers all have similar footprints at 250 kg/m². They might as well all start off he same. So, surprisingly, do off-licences. This may need questioning.
d) Supermarkets and frozen food centres all have remarkably similar Typical benchmarks in the region of 600 kg/m². It is not clear whether it is worth differentiating between them.

108 CATERING
Typical CO2 benchmarks for both fast food and conventional restaurants are similar. Numerically they are also virtually identical23 to supermarkets, though the proportion of fossil fuel use is larger. However, their energy use is very much higher than similar facilities in higher education, where presumably the intensity of use is less. It is not clear how much sensible can be said without making proper allowance for this intensity of operation.

109 CONCLUSIONS
Our examination of the benchmarks summarised in Chapter 20 in Guide F suggests that:
a) Some of the published information is questionable.
b) There is a need both for more and for less detail. This can be accommodated within the framework of entry-level mandatory benchmarks (which can be considerably simplified from the current set), voluntary corrections to the benchmark comparisons (which allow adjustments to the mandatory entry level comparison if robustly supported), and advisory benchmarks which can get into informative detail but are not robust enough to be adopted at the mandatory level.
c) We think that a reduced set of entry-level benchmarks for many sectors could be produced using existing data; and that having a limited choice would greatly ease their application.
d) The initial benchmarks might also be set up on a simple parametric basis so that they could be adjusted for differences, say, between 5-day, 7-day and 24/7 use and give consistent answers.
e) The following sections explore how this might be done.

---

22 Note however that most of the retail benchmarks are based on sales floor area. Benchmarks based on gross or treated floor area will be smaller, depending on the ratio of sales to total area.

23 The actual values may not be as similar because the floor area metrics in the sectors differ. Or do they? The fast food restaurant value is taken from Table 20.1 of Guide F which says GIA, while the retail one in Table 20.6 is numerically almost identical but says sales floor area.
### Figure A1

**CIBSE Typical Benchmarks in kg CO₂/m² per year**

At fossil = 0.13, electricity = 0.55 kg CO₂/kWh

#### Education - Schools
- Primary school (NI fossil/elec)
- Secondary school (NI fossil/elec)
- School dining (NI fossil/elec)
- School dining (NI all elec)
- Secondary school

#### More Highly Serviced Education
- Secondary, with swimming pool
- School kitchen (NI fossil/elec)
- Community centre (NI all elec)
- Community centre NLA
- LA Depots
- Town hall
- Day centre NLA

#### Public Buildings (Not 24 hours)
- Car park (open)
- Car park (closed)
- Youth centre (NI all elec)
- Community centre (NI all elec)
- Library (NI fossil/elec)
- Library (NI all elec)
- Megagymnasium
- Library NLA
- Museum and art gallery
- County court TFA
- Combined court (county/crown) TFA
- Crown court TFA

#### Public Buildings (24 hours)
- Public library (NI)
- Church TFA
- Library NLA
- Church energy consumption varies greatly depending on building type and use

#### Retail - High Street Agencies
- Bank/Building society (NI fossil/elec)
- Post office (all elec)
- Post office (NI fossil/elec)
- Post office, main (all elec)
- Bank/Building society (all elec)
- High street agency (all elec)
- High street agency (NI fossil/elec)
- Bank/Building society (all elec)

#### Offices (TFA unless stated)
- Office NV cellular (NI all elec)
- Office Type 1, NV cellular
- Multitenanted office (fossil/elec)
- Office Type 2, NV open plan
- Office Type 3, NV open plan
- Office Type 4, AC standard
- Office Type 4, AC prestige

### Notes

- Why not start using the same benchmarks for primary and secondary? There has been a lot of recent change in school energy use with extra ICT etc.
- Energy intensive items such as swimming pools and kitchens can vary greatly in type, size, and use. Best benchmark on their own merits.
- Benchmarks for youth and community centres seem similar enough to make them all the same.
- Day centres have a distinctly different profile, but might be seen as a special case of 24-hour public buildings, see Chart 2
- Church energy consumption varies greatly depending on building type and use
- Library energy consumption tends to have a big range and electricity has been increasing

### Discussion

- Indeed, why don’t we just start with a SINGLE CO₂ BENCHMARK for courts, libraries, museums and galleries? It might make sense to apply the same CO₂ benchmarks to low energy intensity buildings in higher and further education as to the courts, libraries, museums and galleries above.
- A lecture room is not a building. Not clear how this could be used. Arts buildings would be better.
- Why is the AC library so massively different from the NV one? Not really believable or justifiable. Think again.
- The high street agency CO₂ benchmarks are all so similar that THEY MIGHT AS WELL BE MADE IDENTICAL AT THE ENTRY LEVEL. Interestingly, there seems to be little difference in the CO₂ between the all-electric and fossil-electric versions.
- The naturally ventilated office CO₂ benchmarks are all so similar that THEY MIGHT AS WELL BE MADE IDENTICAL AT THE ENTRY LEVEL. However, electricity use in offices has been growing with more open plan, extended use, electrical equipment and server rooms.
- Air conditioned office CO₂ benchmarks are VERY different. This is a result as much of the higher intensity of use and equipment as to the air conditioning. These special uses (which also occur in some naturally ventilated offices) need to be identified to give a fair comparison, but this may take time.
FIGURE A2
CIBSE Typical Benchmarks in kg CO₂/m² per year

at fossil = 0.19, electricity = 0.55 kg CO₂/kWh

0 50 100 150 200 250 300 350 400 450 500 550 600 650 700

All the emergency services CO₂ benchmarks are very similar, after allowing for the normal Northern Ireland (low) anomaly. MAKE THE ENTRY LEVEL THE SAME?

Sheltered Housing, Temporary Homeless and Residential Care are very similar; and also similar to Residential/Nursing Home in the Healthcare sector. MAKE THEM THE SAME? University Halls of Residence and Hospitals are not all that much different either - may be scope for further rationalisation.

Unfortunately Guide F gives no electricity benchmarks for surgeries. An electricity benchmark similar to a naturally-ventilated office might well be appropriate. Higher fossil use than offices may be due to longer hours and higher ventilation and hot water requirements.

The hotel benchmarks are all very similar. The differences are probably in the intensity of use, the presence of private bathrooms; and the catering, conference and sports accommodation, much need more careful study. MAKE THE ENTRY LEVEL THE SAME?

Might it be appropriate to use the all-electric entry in Table 20.1 (145 kg/m² is anomalous) and could probably have a single benchmark in the region of 200 kg/m² SFA. However, Department stores are largely clustered in this area at the top end of the non-food section, and could probably have a single benchmark in the region of 200 kg/m² SFA. However, the all-electric entry in Table 20.1 (145 kg/m² is anomalous).

Hospitals are all very similar to each other. The differences are probably in the energy intensive special areas, which would merit individual attention. MAKE THE ENTRY LEVEL THE SAME?

Vacant compared with the presence of private bathrooms. Hospitals are all very similar to each other. The differences are probably in the energy intensive special areas, which would merit individual attention. MAKE THE ENTRY LEVEL THE SAME?

This seems to be a basic level for facilities with utility services only (rudimentary HVAC, no display lighting, or operating equipment on display)

This may represent differences between older and newer data quality; warning !!!!!

The main causes of the increases across the sub-sector of dry goods retail are likely to be more display lighting, more air conditioning, and a smaller ratio of sales floor area to GIA (CIBSE says 67% in small shops, 55% in department stores, 43% (???) in supermarkets.

Healthy use by dry cleaners is likely to be related largely to the requirements of the cleaning equipment and its associated servicing systems.

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Energy & CO₂ emissions benchmarks for non-domestic buildings
Draft V3.2 26/1/07

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B3. An energy-based classification of buildings for the EPBD?

INTRODUCTION
In the main report we recommend a simplified range of fixed, entry-level benchmarks for initial grading of buildings under the EPBD. These benchmarks would be based on characteristic, but relatively lightly-used, examples of their type. Energy-intensive buildings (e.g. those with high occupation or equipment or equipment densities, special activities or energy end-uses, or with long hours of use) may initially tend to benchmark badly, but once the reasons are examined and validated, the comparison will usually improve. Meanwhile, voluntary sector benchmarks could help them to take comfort from their performance in relation to their peers, but not remove the statutory driver to closer examination and further improvement.

BENCHMARK SCALES
Scales are discussed elsewhere, but here is a brief recap:

a) The benchmarks discussed below would be “Typical” median levels.
b) Good Practice levels would not be used for statutory purposes, but could be made available for advisory purposes, both for peer group comparisons and in detail for technical investigations.
c) CO₂ benchmarks values mentioned are calculated using conversion factors of: 0.19 kg CO₂/kWh for heating fuel and 0.55 for mains electricity. These factors are of course open to review.
d) A factor R would be calculated, the ratio of the performance indicator under consideration to the benchmark value.
e) Following draft CEN standards, a building which performed exactly at the benchmark would have an R-value of 1. On an A-to-G scale it would be placed at the D-E boundary.
f) For other letter grades (termed Classes by CEN), we currently advocate the use of a simple linear scale down to zero, so Class A would require R to be less than 25% of median, Class B between 25% and 50%, and so on.

TOWARDS A POSSIBLE CLASSIFICATION
Further examination of the data from Guide F’s Chapter 20 and Figures A1 and A2 indicate that, for Operational Rating purposes, a simple but robust and defensible classification of buildings might start with their broad type and use characteristics, as outlined in the following paragraphs. We look forward to discussing this, and to investigating it further. We have started to manipulate the data, but it has not been possible to complete the exercise within the limits of the scoping study.

However, the approach looks promising and is summarised in Table A1. All the benchmarks shown have been converted to gross internal area (GIA) for consistency. However, different sectors may well prefer to use different metrics to suit their normal practices.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>BENCHMARK</th>
<th>BUILDING TYPES</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUBLIC BUILDINGS</td>
<td>kg CO₂/m² GIA p.a.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Lightly serviced or lightly used</td>
<td>Variable</td>
<td>Car parks, churches, public lavatories</td>
<td>Energy requirements vary with hours of use and the environmental conditions provided. Best to consider on their merits.</td>
</tr>
<tr>
<td>2. Public buildings with relatively short occupancy hours</td>
<td>50 or 55</td>
<td>Primary + secondary schools, youth and community centres.</td>
<td>The 55 figure would allow for some recent growth on the electrical side. Special areas like swimming pools would be examined separately.</td>
</tr>
<tr>
<td>3. Public buildings with normal occupancy hours</td>
<td>75</td>
<td>Municipal museums, libraries and galleries. Higher education arts buildings.</td>
<td>University self-catering residential is similar. Higher intensity buildings (labs, kitchens etc. would be dealt with on their merits. HEEPI benchmark for admin offices is 80. For Town hall, see Offices, Category 8.</td>
</tr>
<tr>
<td>University campuses</td>
<td>90</td>
<td>Typical campus mix.</td>
<td>Needs checking.</td>
</tr>
<tr>
<td>4. Emergency services</td>
<td>115</td>
<td>Police, fire and ambulance stations.</td>
<td>Police stations have increasingly variable use, which would preferably be quantified.</td>
</tr>
<tr>
<td>5. Hospitals and 24-hour residential</td>
<td>115</td>
<td>Residential home, homeless unit, cottage +long stay hospital.</td>
<td>Very similar energy use to emergency services, but probably preferable to keep separate.</td>
</tr>
<tr>
<td>Clinical hospital</td>
<td>130</td>
<td>Acute, specialist, teaching and maternity</td>
<td>The main difference is in electricity use. You could instead use the same benchmark as above and look at the clinical areas separately.</td>
</tr>
</tbody>
</table>
6. Hotels

<table>
<thead>
<tr>
<th>Category</th>
<th>Benchmark</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>All types of hotel</td>
<td>120</td>
<td>High energy use normally arises from restaurants, laundries,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>conference centres, and swimming pools, which should be examined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>separately.</td>
</tr>
</tbody>
</table>

7. Sports + recreation

<table>
<thead>
<tr>
<th>Category</th>
<th>Benchmark</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry sports centre</td>
<td>115</td>
<td>Fitness centres use more in ECON 78, but prefer to start with this</td>
</tr>
<tr>
<td></td>
<td></td>
<td>lower benchmark as entry level.</td>
</tr>
<tr>
<td>Swimming pool centre</td>
<td>350</td>
<td>Sports and leisure are very similar. Or it may be better to start</td>
</tr>
<tr>
<td></td>
<td></td>
<td>with a low benchmark and examine pools in their own right.</td>
</tr>
<tr>
<td>Combined centre</td>
<td>170</td>
<td>From ECON 78 Or examine the pool in its own right as above.</td>
</tr>
</tbody>
</table>

8. Offices

<table>
<thead>
<tr>
<th>Category</th>
<th>Benchmark</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturally-ventilated</td>
<td>75</td>
<td>Incidentally the same value as Category 3. ECON 19 Type 2, with a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>little more electricity for office equipment (but server room not</td>
</tr>
<tr>
<td></td>
<td></td>
<td>included).</td>
</tr>
<tr>
<td>High street agency</td>
<td>75</td>
<td>All-electric, but similar CO₂ to an office.</td>
</tr>
<tr>
<td>Town hall</td>
<td></td>
<td>Town hall benchmark in Guide F is 100, probably due to computer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>centre, restaurant, public rooms etc. These may be better</td>
</tr>
<tr>
<td></td>
<td></td>
<td>considered on their own merits.</td>
</tr>
<tr>
<td>Air conditioned offices</td>
<td></td>
<td>Additional equipment and intensity of use will need to be dealt with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>on its own merits.</td>
</tr>
</tbody>
</table>

9. Retail

<table>
<thead>
<tr>
<th>Category</th>
<th>Benchmark</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail warehouse</td>
<td>70</td>
<td>Includes catalogue showroom</td>
</tr>
<tr>
<td>Refrigerated warehouse</td>
<td>95</td>
<td>More data desirable</td>
</tr>
<tr>
<td>Non-food store</td>
<td>90</td>
<td>Basic installation. The rest (e.g. display lighting, live electrical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>goods, dry cleaning equipment) needs to be justified.</td>
</tr>
<tr>
<td>Small food store</td>
<td>170</td>
<td>Includes grocer and butcher. Also off-licence for which it may be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>too generous.</td>
</tr>
<tr>
<td>Supermarket, freezer</td>
<td>240</td>
<td>May need better metrics. Turnover and sales floor: gross area ratios</td>
</tr>
<tr>
<td>centre</td>
<td></td>
<td>will be big influences.</td>
</tr>
</tbody>
</table>

113 CONCLUSIONS

There does seem to be scope for a limited initial set of whole-building benchmarks, particularly in
the public sector – the first in which building will need to be labelled. Here (at least in the absence
of special features and energy end-uses) there are remarkable similarities in performance
indicators for annual energy use and CO₂ emissions between a range of different types of building
in different uses. If this idea is regarded as promising, we would recommend:

a) Checking against more recent data to test and if necessary adjusting the starting levels of the
   benchmarks.

b) Considering whether the benchmarks – particularly for the public buildings – could be generated
   in a consistent manner using simple “benchmark generation” software.24

c) Considering and if possible codifying methods of making corrections to the benchmark
   comparisons to account for special features where necessary.

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24 A benchmark generator was developed by the authors in 1997 to provide a basis for underpinning the ECON 19 office
benchmarks with an algebraic relationship or the to levels of equipment, patterns of use and industry rules of thumb. The
approach, together with the use of “tree diagrams” proved of benefit not only to descriptions in the publication but to the
development of TM 22 and a variety of more recent procedures, including a demonstration of customised benchmarking
based on the accommodation, use and equipment of an office and not its ECON 19 Type reference.