Building Energy Efficiency Survey

Introduction

The Building Energy Efficiency Survey (BEES) was published by the Department for Business, Energy & Industrial Strategy on 16th November 2016. The survey was designed to meet the following research objectives:

- To update the Department's understanding of how energy is used, for a snap-shot in time, across the non-domestic building stock in more detail than is available at present;[1]
- To update how energy use can be abated across the non-domestic building stock.
- To understand the barriers and enablers of energy abatement.

The first two objectives are featured in this article. The third objective is only addressed in the BEES overarching report. www.gov.uk/government/publications/building-energy-efficiency-survey-bees

Overview of project method

The BEES study reports on the non-domestic building stock for England and Wales. Within this overall scope the stock is split into 10 sectors. These are in turn made up of 38 sub-sectors, each of which were analysed separately. Industrial buildings are included but the survey did not collect information on energy use in industrial processes.

The study collected data through a large sample of telephone surveys (3,690) across all sectors. Each survey record is a premises which may represent a whole building or a part of a building. This information was obtained from a single organisation in a premises. A smaller subset of site surveys (214) across all sectors were sampled from within the telephone survey sample. The telephone survey respondents were randomly selected from national level datasets for England and Wales.

The telephone surveys were used as the primary input to two models. One model calculated the energy use (the energy use model) and the other calculated the energy saving potential (the abatement model). The energy use model estimated the energy consumption for space heating, hot water, lighting and up to 22 energy uses for each premises record. The abatement model determined the abatement potential of energy efficiency measures which could be applied to that premises, their capital cost and the amount of energy these measures could save.

The detailed findings from site surveys and a database of matched energy and activity data were used to calibrate the two models. The site surveys were also used to validate the telephone survey responses, and collect information on barriers and facilitators from the site contacts.

Overall, the model calibration process has shown that at a sub-sector level the energy consumption is reliable but that at a single record level the accuracy has a higher level of uncertainty.

The overall project method had weaknesses in two areas:

- Data inputs were obtained through telephone surveys, which were highly simplified. The telephone survey was designed to ensure it was easy to understand for non-energy experts. This meant questions could not be particularly technical and this further limited the sophistication of the input data to the model;
- The majority of the inputs were self-reported, which meant it was prone to a range of biases, such as differences in interpretation or understanding of a question by the respondent.

Following analysis of the data on the individual premises, the record results were weighted in order to produce results representative of all non-domestic buildings in England and Wales in each sector.

[1] The current non-domestic stock model (Pout, C (2000) NDEEM: the national non-domestic buildings energy and emissions model) is underpinned by field research conducted by Sheffield Hallam University in the 1990s.

Building stock sector overview

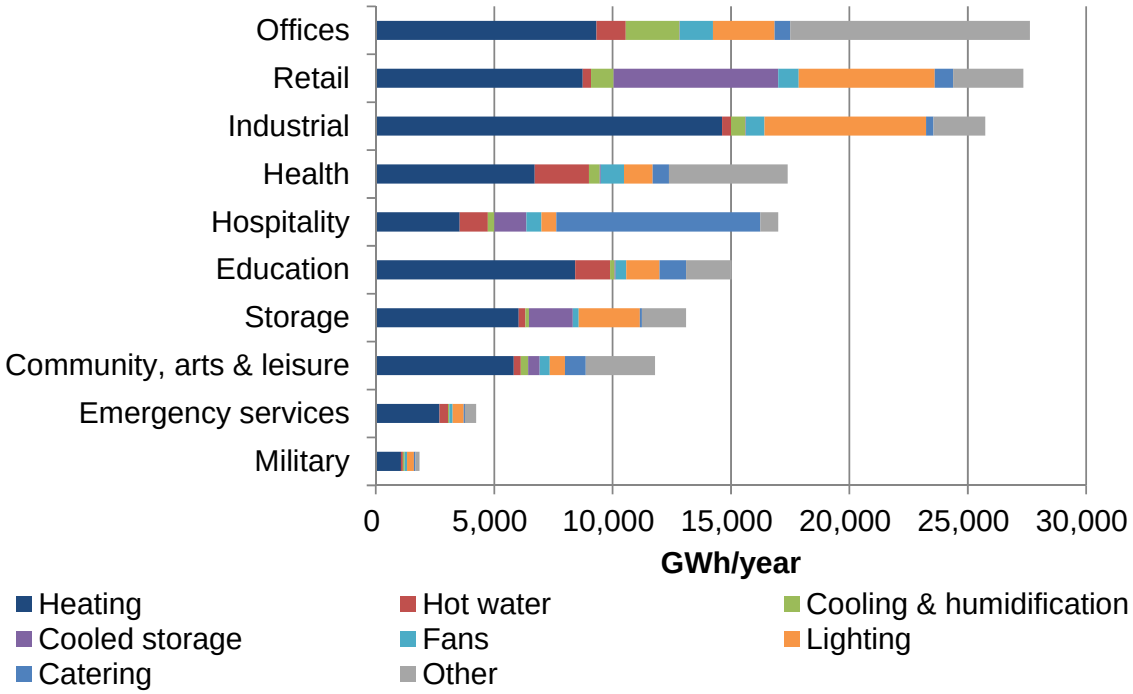
BEES building stock covers a total gross internal area (GIA) of 784million m2, across 1.57 million premises. The total non-domestic stock across England and Wales comprises 1.83 million premises.

Key findings

Energy consumption by sector and energy end use, 2014–15

- According to modelled data based on telephone survey responses, the total stock consumed 161,060 GWh/year of energy, of which electricity was 84,820 GWh/year (53 per cent of total) and non-electrical energy consumption was 76,240 GWh/year (47 per cent of total).
- The five largest sectors in terms of energy consumption were offices (27,620 GWh, 17 per cent), retail (27,340 GWh, 17 per cent), industrial (25,740 GWh, 16 per cent), health (17,380 GWh, 11 per cent) and hospitality (16,980 GWh, 11 per cent). Together these accounted for 71 per cent of total non-domestic energy consumption.
- The four largest energy end uses were space heating, internal lighting, catering and cooled storage (for storage of food and drink), which accounted for 70 per cent of total consumption. The three most common end uses of electrical energy were internal lighting (21,260 GWh), followed by cooled storage (10,790 GWh), and ICT equipment (7,910 GWh). The three most common non-electrical energy end uses were space heating (59,300 GWh), hot water (6,300 GWh) and catering (6,040 GWh).
- The five largest sectors in terms of floor area are the Industrial sector (180 million m2, 22 per cent), Storage (140 million m2, 17 per cent), Offices (120 million m2, 15 per cent), Retail (110 million m2, 14 per cent) and Education (80 million m2, 10 per cent). Together these account for 79 per cent of floor area within the scope of BEES.

Figure 1: Energy consumption by sector and energy end use, 2014–15



Source: Energy use model results for the sector covering England and Wales

Abatement potential in the non-domestic buildings, 2014–15

The energy abatement potential is the amount of energy savings that are technically available for a premises. The abatement model identified appropriate abatement measures based on the responses from the telephone survey, and then calculated the energy saved from the measure compared with the current energy end use consumption calculated in the energy use model. The technical annex sets out a detailed explanation of the abatement model[2].

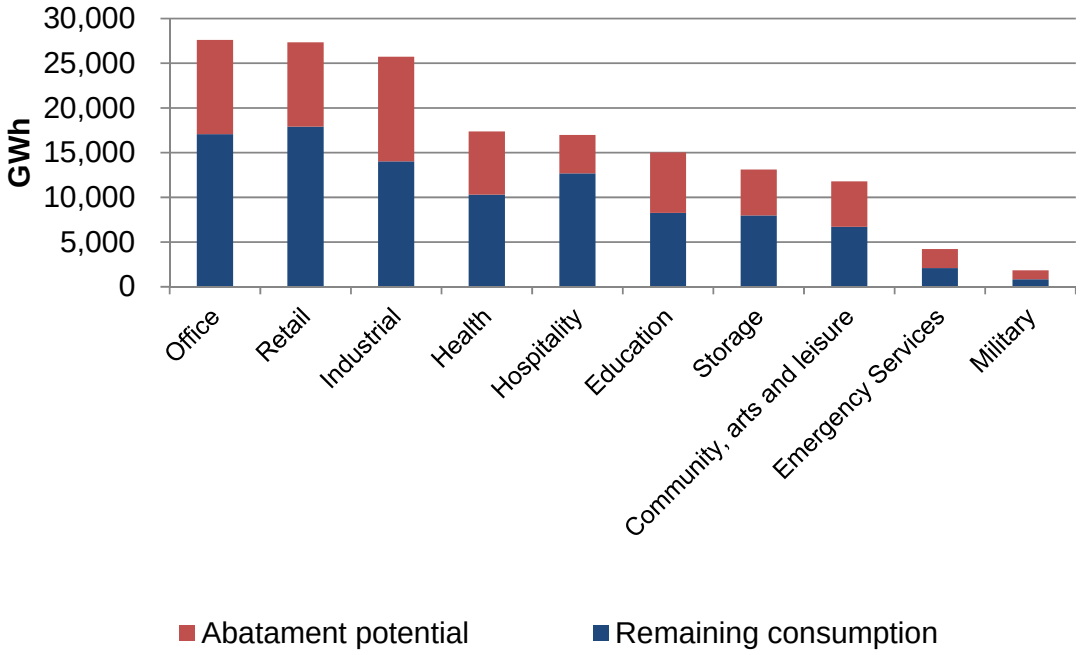
- Figure 2 shows the full technical abatement potential available by sector. This represents the possible reductions in energy consumption following implementation of all applicable measures. The results include measures that are not cost-effective and the model applies a simple assessment of measure suitability.
- The total technical abatement potential in all sectors was 63,160 GWh (39 per cent of total energy). Of this total the electrical abatement potential was 28,870 GWh (34 per cent abatement potential) and the non-electrical abatement potential was 34,290 GWh (45 per cent abatement potential). This could be achieved at a capital cost of £28.4 billion.
- The socially cost effective potential was 27,890 GWh of total energy consumption: 14,140 GWh of electrical energy consumption and 13,740 GWh of non-electrical energy consumption. A measure is socially cost-effective if the total benefits to society outweigh the total costs to society over the lifetime of the measure[3].
- Overall there were 22,080 GWh of total energy savings with a private payback period[4] of 3 years or less (9,850 GWh of electrical energy savings and 12,230 GWh of non-electrical energy savings).
- The sectors with the largest technical abatement potential were Industrial, with 11,710 GWh of energy (46 per cent reduction on consumption), Offices with 10,550 GWh of energy (38 per cent reduction on consumption) and Retail with 9,420 GWh of energy (34 per cent reduction on consumption).

[2] www.gov.uk/government/uploads/system/uploads/attachment_data/file/566038/BEES_Technical_Annex_FINAL.pdf

[3] The Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government shows how the societal benefits of carbon abatement are measured: www.gov.uk/government/uploads/system/uploads/attachment_data/file/483278/Valuation_of_energy_use_and_greenhouse_gas_emissions_for_appraisal.pdf

[4] Payback is calculated by dividing the capital installation cost associated with a measure by the annual financial savings achieved based on energy cost reductions accounting for any annual operational costs.

Figure 2: Abatement potential by sector, 2014–15



Source: Abatement model results by sub-sector, England and Wales

Table 1 shows the abatement potential by measure type. Definitions of measure type are included in the BEES Technical Annex (Table 4.4). The largest group of savings in terms of reductions in energy consumption related to the implementation of space heating measures, building instrumentation & control measures, and carbon & energy management. The largest group of savings in terms of the potential energy bill savings related to the implementation of lighting upgrades.

Table 1: Abatement potential by measure group, 2014–15 (All sectors)

Measure group	Total annual energy bill saving (£ thousands)	Total annual carbon saving ($ktCO_2$)	Total annual energy savings (GWh/year)	Total capital cost of measure (£ thousands)
Air conditioning and cooling	128,900	370	1,300	1,369,900
Building fabric	294,700	1,480	8,260	6,362,600
Building instrumentation and control	415,600	2,120	11,190	2,447,500
Building services distribution systems	75,200	240	760	1,310,500
Carbon and Energy Management	721,700	3,030	12,580	1,604,200
Hot water	49,600	290	1,520	496,800
Humidification	100	0	1	1,700
Lighting	1,085,400	3,260	10,930	4,401,300
Cooled storage	212,100	650	2,140	1,193,100
Small appliances	127,700	420	1,390	2,077,200
Space heating	294,700	1,690	9,260	3,735,200
Swimming pools	25,000	130	640	275,500
Ventilation	311,100	950	3,210	3,115,300
Total	**3,741,800**	**14,630**	**63,160**	**28,390,800**

Source: Abatement model results for the sector, England and Wales

Energy Consumption in the UK

BEES statistics are now used to produce the estimates of service sector energy by end use published in ECUK (www.gov.uk/government/collections/energy-consumption-in-the-uk). The ECUK tables containing BEES statistics are 5.05, 5.08, the services section of 1.04 and a new table 5.05a.

- Table 5.05a shows the final energy consumption of the services sector by BEES sector, subsector, end use and main fuel.
- Table 5.05 is a summary of these statistics at a BEES sector level, using the ECUK end use and heating fuel definitions. Assumptions were used to represent BEES statistics in the ECUK categories and these are explained in the section below.
- Table 5.08 uses the figures in table 5.05 and converts them to the primary energy consumption equivalents.
- Table 1.04 which shows the overall heat and other end uses by fuel uses BEES figures for the services sector.

The Building Energy Efficiency Survey (BEES) is based on modelled energy use. The model provided an estimated amount of electrical and non-electrical energy for each end use. The survey did collect the main fuel type for space heating. It is not possible to identify the main fuel for non-electrical energy uses for other end uses from BEES directly and assumptions have been made to enable this. All electrical energy is of course allocated to electricity.

Table 2: Allocation of non-electrical energy to fuel type by end use

	Main Heating fuel				
End Use	**Natural gas**	**Oil**	**LPG**	**District heating**	**Other**
Space heating, Water heating, Heating swimming pools.	Natural gas	Oil	Oil	Heat sold	Bioenergy and waste
Catering, Cooling & humidification, Other.	Natural gas	Oil	Oil	Oil	Oil

Some assumptions have been made for converting the BEES end uses to fit the ECUK definitions. It has been assumed that the ECUK ‘cooling and ventilation’ category is equal to the BEES end uses ‘fans, cooling and ventilation’. The BEES ‘cooled storage’ and ‘small power’ have been added to the ‘other’ category to match the ECUK ‘other’ category.

Figures 3 and 4 show the electricity and non-electricity consumption for previous ECUK publications and BEES by end use and show how the proportions of energy used for each end use have changed over time.

For electricity the most noticeable change was the reduction in the 40 per cent proportion of electricity being consumed by lighting in ECUK to only 23 per cent in the BEES figures. Over time there have been improvements in the efficiency of lighting that are not included in the ECUK trend, this increase in efficiency could explain why the BEES estimate for lighting consumption is lower than the historical modelling used in ECUK.

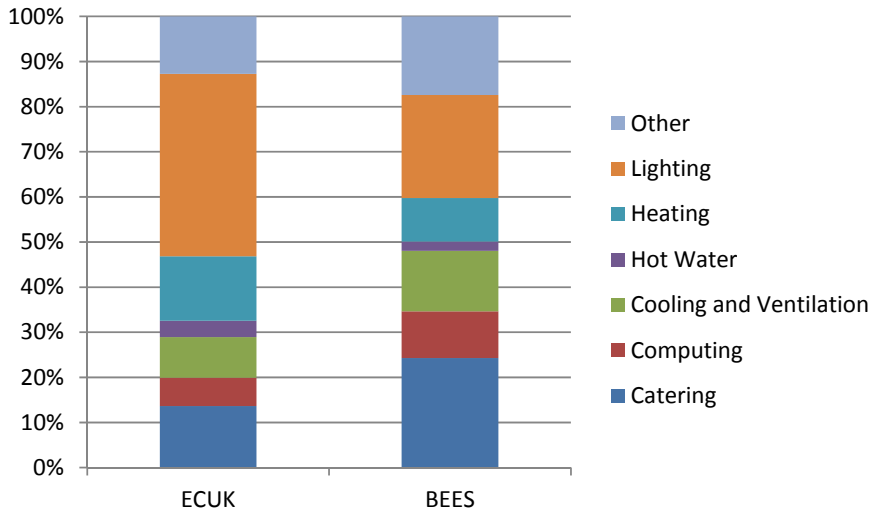
Cooling and ventilation is another end use where there is a difference in the proportion of electricity being consumed, increasing to 13 per cent in BEES compared to 9 per cent. An upward trend is also seen in the computing end use where the proportion of electricity consumed is now 10 per

cent in BEES compared to 6 per cent. The reason for these differences is the increase in these end uses since the previous survey.

The 17 per cent of electricity consumed in the “other” category for BEES is slightly higher than the 13 per cent in ECUK ; this reflects the increased use of electricity for modern small power end uses.

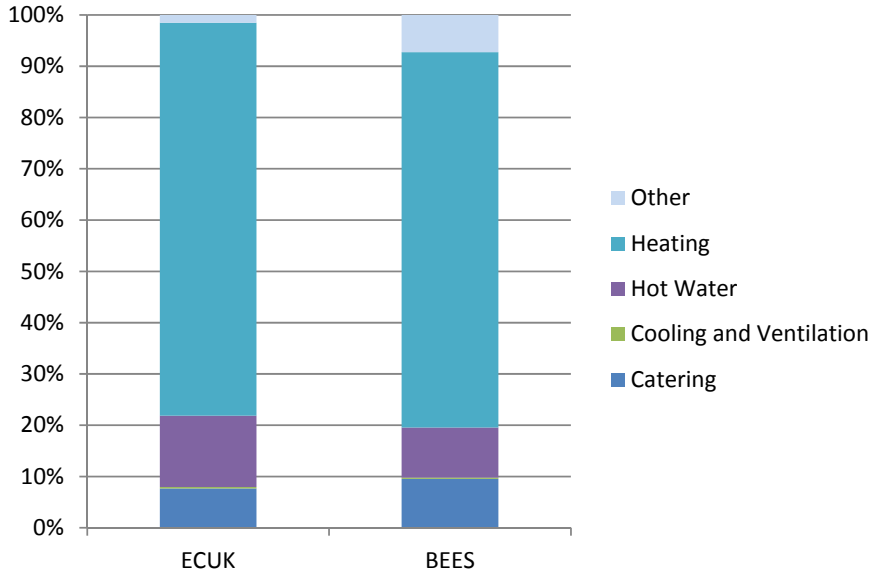
There was a large difference in the proportion of catering between the two data sources, with 14 per cent of electricity consumption in ECUK and 24 per cent of electrical consumption in BEES used for catering. This could reflect the rise in number of meals eaten at restaurants since 1995. It should be noted that the catering end use contains cooled storage for this comparison and any increase in the amount of warehouse style refrigeration and large food retailers may be contributing to this increase.

Figure 3: ECUK End-use electricity comparison



Compared to electricity there are fewer differences between ECUK and BEES for the proportions for each end use of the total energy used. The largest end use is heating in both cases: in ECUK it accounts for 77 per cent of non-electricity energy consumption and for BEES it accounts for 73 per cent. Hot water and catering proportions are similar, but the ‘other’ category is significantly higher in BEES, at 7 per cent compared to 2 per cent in ECUK.

Figure 4: ECUK End-use non-electricity comparison



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