# ICT Related Energy Use, Costs and Carbon Emissions in UK Universities and Colleges

## - Results from Use of the JISC/SusteIT Footprinting Tool, April 2012

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## Summary

This paper summarises the findings from use of the JISC-funded SusteIT ICT Footprinting Tool to estimate the ICT-related energy consumption and costs, and carbon emissions, of 27 UK colleges and universities. (The full results are in an accompanying Master Results spreadsheet). Scaling the results of 25 of these institutions to UK national level suggests that total ICT energy costs (which are mainly electricity) are around £90 million a year for higher education and around £57 million a year for further education. These figures are, respectively, around 30% and 20% higher than those produced in 2008 from a much smaller sample. As the sample size is larger, these new figures are more robust. The increase is also likely to be in part a result of increased IT intensity and more comprehensive assessmentsince the original institutions were audited. The new results also find personal computing (PC, laptop etc.) energy to be a somewhat smaller proportion of total ICT energy than in 2008, with an average of 37% in HPC-intensive universities, 33% in other universities and 45% in colleges. A major reason for this is likely to be the impact of powerdown measures.

## 1. Background

The SusteIT ICT Footprinting Tool[1] was developed as part of the JISC-funded SusteIT project, which reviewed the sustainability of ICT in UK Further and Higher Education.[2] The tool enables Universities and Colleges to estimate the energy consumption, energy-related costs and carbon emissions associated with ICT activity. It was first used in 2008 to analyse these issues at the University of Sheffield[3], and at Lowestoft and Norwich Colleges, as a basis for scaled up estimates of total sector consumption (see below). Since then results from using the Tool have been made available to SusteIT from 24 other institutions, mainly related to three projects:

1. A London Higher project funded by JISC;[4]
2. An EAUC project supported by the Scottish Funding Council[5]; and
3. An EAUC project in South-West England and Yorkshire funded by JISC.[6]

[1] A 2012 updated version is available following registration from www.goodcampus.org.
[2] More info at http://www.jisc.ac.uk/publications/programmerelated/2009/sustainableictoverview.aspx.
[3] The original Sheffield figures have been updated in the Master Results spreadsheet.
[4] More info at the Green ICT in London HEIs (GrILH) website www.londonhigher.ac.uk/grilh.html.
[5] More info at www.eauc.org.uk/sustainable_ict_in_scottish_further_and_higher_edu.
[6] More info at www.eauc.org.uk/sustetech/results_of_participants_green_ict_action_plans.

As the results are self reported, and in most cases have been collected by intermediaries, we have been unable to verify them directly (as we did with the original University of Sheffield figures) so there could be some inaccuracies. However, we believe that the sample size is sufficiently large to mean that the analysis provided below is a reasonably robust 'ballpark' estimate.

## 2. Results

The summary results of the 27 institutions have been collated in a Master Results spreadsheet available at www.goodcampus.org, and are analysed below. Note that the results for the various institutions were recorded in different years.

The Master Results spreadsheet has six separate charts on:

1. Total ICT Energy;
2. Total ICT Energy Normalised;
3. ICT Energy per Student FTE;
4. ICT Energy per Staff FTE;
5. PC Energy per PC;
6. ICT Energy as a Proportion of Total Electricity.

The charts provide data on the following 25 institutions, which have been grouped into three categories to aid comparison:

1. Research intensive (based on 15% or more of their ICT energy being used for HPC (High Performance Computing) – 5 comprising Brunel, Heriot-Watt, Imperial, Loughborough, and Sheffield.
2. Other universities/higher education – 13 comprising Bournemouth, Canterbury Christ Church, Central School of Speech & Drama, East London, Greenwich, Goldsmiths, Lincoln, London Metropolitan, London School of Hygiene and Tropical Medicine, London South Bank, Queen Margaret, Roehampton, and St George's.
3. Colleges (which are predominantly further education) – 7 comprising Angus, Bicton, Lowestoft, Norwich, Stevenson, Telford and West Lothian.

The Master Results spreadsheet also has data on two other institutions. The first is the University of London which has not been included in comparisons as it includes a stand alone data centre and other support facilities serving a number of universities.[7] The other is Edinburgh Napier University, where data is only available for PC energy before and after powerdown. Hence, it is included in the chart for PC Energy per PC, but there is no data from it in the other charts.

The results of the exercise are summarised in Tables 1 and 2.

[7] A RECSO/SusteIT case study on the University of London Computing Centre (ULCC) is available at http://www.goodcampus.org/susteit/susteit-cases/index.php

**Table 1: Green ICT Benchmarks by Category of Institution**

| | HPC-Intensive Universities | Other Universities | Colleges |
|---|---|---|---|
| Total ICT Energy Consumption (MWh/y) - Range | 3,568-22,838 | 339-6,432 | 453-1,242 |
| Total ICT Energy Consumption (MWh/y) - Average | 8,926 | 2,718 | 699 |
| ICT energy per student (kWh/y) - Range | 208-1,614 | 114-717 | 48-146 |
| ICT energy per student (kWh/y) - Average | 586 | 273 | 89 |
| ICT energy per staff member (All staff) (kWh/y) - Range | 683-2,358 | 292-2,904 | (a) |
| ICT energy per staff member (All staff) (kWh/y) - Average | 1,650 | 1,362 | (a) |
| ICT energy per academic staff member (kWh/y) - Range | 2,309-6,524 | 1,565-8,933 | (a) |
| ICT energy per academic staff member (kWh/y) - Average | 4,841 | 4,257 | (a) |
| PC energy use per PC (kWh/y) - Range | 209-364 | 144-520 | 200-587 |
| PC energy use per PC (kWh/y) - Average | 309 | 263 | 296 |
| ICT energy as % of institution's total electricity - Range | 14-22% | 14-57% | (b) |
| ICT energy as % of institution's total electricity - Average | 18% | 27% | (b) |

(a) Not estimated for Colleges as figures on no. staff not available

(b) Not estimated for Colleges as figures on total electricity use not available

**Table 2: Percentage Breakdown of Total ICT Energy by Equipment Category**

| | HPC-Intensive universities | Other Universities | Colleges |
|---|---|---|---|
| HPC (%) - Range | 14-32 | 0-7 | 0-1 |
| Servers (%) - Range | 13-33 | 14-63 | 18-38 |
| PCs (%) - Range | 26-48 | 19-55 | 35-61 |
| PCs (%) - Average | 37 | 33 | 45 |
| Networks (%) - Range | 8-11 | 6-30 | 3-15 |
| Telephony (%) - Range | 1-4 | 1-7 | 1-3 |
| Imaging (%) - Range | 3-14 | 4-18 | 5-19 |
| AV (%) - Range | 1-4 | 1-21 | 2-7 |

## 2.1 Total ICT Energy

Table 1 shows that this ranges from 3,568-22,838 MWh/y for HPC-Intensive universities, 339-6,432 MWh/y for other universities and 453-1,242 MWh/y for colleges. Research intensity is clearly a major influence on total consumption, as is size. Imperial College stands out from the others in terms of absolute consumption, but is less anomalous when its particularly high proportion (32%) of HPC, and its overall electricity intensity (which means that ICT as a proportion of this is fairly standard) which, together with its large size, explains the very high ICT energy consumption.

## 2.2 ICT Energy Normalised

This is the total ICT energy consumption normalised to 100, to allow comparison of the percentages by category. The original 2008 report concluded, on the basis of three institutions, that PC energy (which includes desktops, laptops and monitors) accounted for almost half of overall consumption in both further and higher education. The broader set of results now available suggests that this remains the largest component of consumption in most institutions but is a lower proportion than estimated in 2008, with an average of 37% in HPC-intensive universities, 33% in other universities and 45% in Colleges (see Table 2). A major reason for this is likely to be the impact of powerdown measures, as can be seen from the Edinburgh Napier data. Hence, a more appropriate broad bush estimate of PC related energy consumption today might be 35-40% of the ICT total in higher education, and 45% in further education.

## 2.3 ICT Energy per Student

The total ICT energy was divided by the number of FTE students in 2008/09 in each institution to give ICT energy per student (see Table 1). Unsurprisingly, the chart shows generally lower figures for the colleges (average 89 kWh/y) and generally higher figures for the HPC-intensive universities (586 kWh/y). The former is equivalent to a laptop actively used for 12 hours a day, 250 days a year, and the latter to 6.5 laptops actively used for 12 hours a day, 250 days a year.

## 2.4 ICT Energy per Member of Staff

The total ICT energy was divided by the number of FTE staff members (of all kinds) for the academic year 2008/09 to give ICT energy per staff member (see Table 1). Again the HPC-intensive universities tend to have higher ICT energy per staff (1650 kWh/y) than the other universities (1362 kwh/y). The latter is equivalent to 18 laptops actively used for 12 hours a day, 250 days a year. The differences are more pronounced for academic staff only rather than for all staff.

## 2.5 PC Energy per PC

The total energy for all PCs including desktops, laptops, thin clients and monitors, was divided by the total number of PCs (not including monitors) to get a figure of energy per PC. The figures were more consistent between different types of institution and ranged from 144 kWh/y to 587 kWh/y (see Table 1). The two figures for Napier University illustrate the reduction in energy before and after power management was implemented, with the energy per PC reduced by 40% from 476 to 297 kWh/y. These figures exclude any data centre or network energy related to use of the personal computing devices.

## 2.6 ICT Energy as % of Total Electricity

The total ICT electricity was presented as a percentage of total institution electricity consumption for the universities only. This ranged from a low of 14% to a high of 57% of total electricity (see Table 1). (NB This may slightly overstate the actual percentage in a few cases as a small proportion of the default value for data centre overhead energy may be gas that is used in cooling).

## 3. Overall Sector Estimates

The 2008 results for the University of Sheffield and Lowestoft and Norwich Colleges were scaled up to create national figures based on their percentage of national student numbers. The result was estimates of:

> Total ICT energy of 480,000-540,000 MWh/year at a total cost of around £60-65 million (at an electricity cost of 12p/kWh) for UK higher education: and
>
> Total ICT energy of around 390,000 MWh/year at a total cost of £47 million for English further education (with a likelihood that UK further education figures i.e. including Scotland, Wales and Northern Ireland, were 10-15% higher).[8]

A similar scaling up approach applied to the updated results from 25 institutions (see Table 3 below) gives estimates of:

> Total ICT energy for UK higher education of around 770,000 MWh/year, equivalent to around £90 million annually (at an electricity cost of 12p/kWh).
>
> Total ICT energy for UK further education of around 475,000 MWh/year, equivalent to around £57 million annually (at 12p/kWh).

The latter figure is the sum of two separate exercises, as students are counted differently in English and Scottish further education. This found that the total ICT energy for English and Scottish FE is around 433,000 MWh/year and 24,000 MWh/year respectively.

These figures are around 30% higher for higher education, and 20% higher for further education, than those produced in 2008. The larger sample size they are based on mean that they can be considered as more robust than earlier estimates. Some other factors which may be relevant to the higher estimates compared to 2008 are:

> An upward effect due to several universities adopting a higher figure than the default one of a 40% cooling and power supply overhead for HPC and servers;
>
> An upward effect due to deployment of more ICT equipment;
>
> An upward distortion to the university figures due to over representation of HPC-intensive universities in the sample;
>
> A downward effect from adoption of power management and other energy efficiency techniques; and

[8] See Footnote 2.

A downward distortion due to a relatively large number of smaller institutions in the other universities category.

The level of cooling and power supply losses related to HPC and server energy consumption is especially important as the latter are a significant element in sector consumption. The original SusteIT tool had a default of 40% for server cooling and power supply losses but the average overhead of organisations applying for accreditation under the EU Code of Conduct for Data Centre Energy Efficiency is 80% and SusteIT workshops have suggested that this or even higher figures are not uncommon in higher education. Hence, the 2008 figures probably underestimated the consumption and cost of this element.

Overall, it does seem likely that the 2008 estimates of IT related energy consumption were underestimates and that higher education is using around £90 million, and further education around £57 million, of ICT-related electricity a year. As it is almost certain that electricity prices will rise by a further 20-30% in the next 5 years, these figures are unlikely to reduce despite efficiency initiatives and may well increase further.

**Table 3: Scaled up total ICT energy for the UK HE sector and English and Scottish FE sectors**

| | **Universities Total** | **Scottish Colleges only** | **English Colleges only** |
|---|---|---|---|
| Number of institutions used for scaling up | 18 | 4 | 3 |
| Total ICT energy of institutions in SusteIT master (MWh/year) | 81,232 | 2,729 | 2,163 |
| Total no. of students at institutions in SusteIT master | 261,270 | 57,760 | 17,510 |
| Total no. of students in UK HE/FE in 2008/09 | 2,465,185 | 386,726 | 3,400,000[9] |
| % of students at institutions in SusteIT tool as % in HE | 10.6% | n/a | n/a |
| % of students at Scottish and English FE colleges in SusteIT tool as % in Scottish and English FE | n/a | 11.2% | 0.5% |
| Scaled up ICT energy based on no. of students (MWh/year) (Rounded to nearest 100 MWh) | 766,340 | 24,366 | 432,600 |

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[9] Approximate figures only are available.