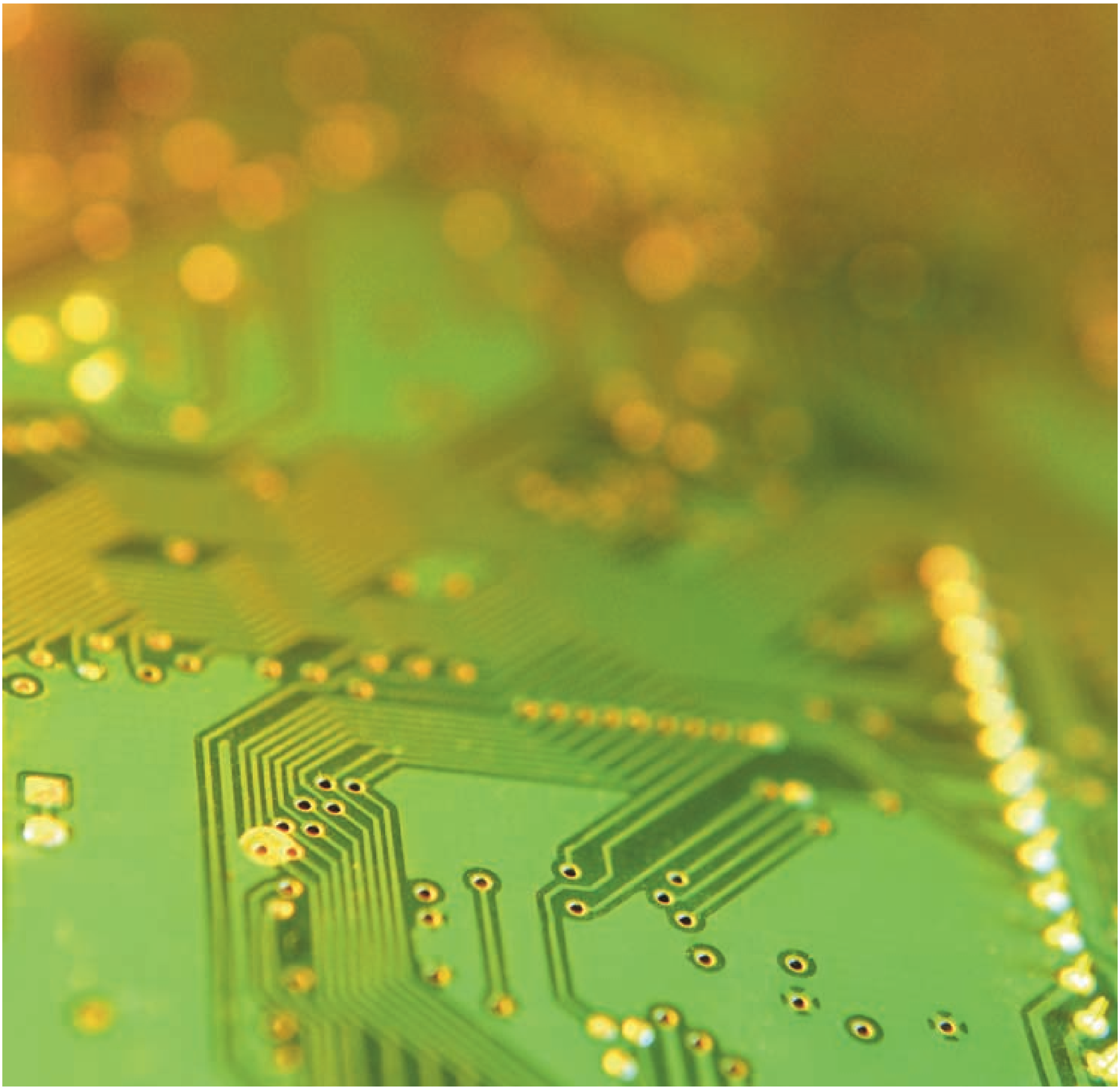
JISC

STRATEGIC OVERVIEW:
Managing Sustainable ICT
in Further and Higher Education

January 2009



INTRODUCTION

This document provides a strategic overview of the current issues concerning the management of environmentally sustainable Information and Communications Technology (ICT) in further and higher education. The information contained in this strategic overview draws on the final report of the JISC-funded SusteIT project (Sustainable ICT in Further and Higher Education: www.jisc.ac.uk/publications/publications/sustainableictfinalreport), with references to three other JISC-funded projects on low carbon ICT, location-independent working and thin client technologies. Further information can be found on the JISC Green ICT blog at: http://greenict.jiscinvolve.org/about.

The issue of man-made climate change is now a pressing one, and most institutions of further and higher education are keen to minimise the impact of their activities on the environment. At the same time, the economic downturn is forcing institutions to look at ways of cutting costs.

The public, too, is increasingly aware of environmental issues and this change in attitudes is leading to increased demand for flexible, sustainable alternatives to throwaway consumer items. The ethics of ICT use extend beyond the environment to the question of the social and health effects of production and disposal, which is often conducted in developing countries with little regard for health and safety. The result is that hazardous chemicals are often found in the soils, air and waters surrounding the areas where ICT and its component materials are produced or disposed of.

When it comes to tackling the problem of what institutions can do about climate change, ICT is hugely important, both because of the part it plays in creating harmful pollutants (directly during equipment production, and indirectly from emissions created by the generation of the electricity which it uses), and because of the role it can play in reducing them.

ICT has a heavy environmental impact in three main areas:

- The production of computer equipment (producing one PC and LCD monitor generates 193 kilos of greenhouse gases and releases heavy metals and other pollutants)
- The use of computer equipment (mainly through electricity consumed both to run the machines and to cool data centres)
- The disposal of computer equipment (electronic waste can release harmful substances that can damage people's health) (IVF, 2007)

There is mounting pressure on universities and colleges to adopt more sustainable approaches to ICT use. This pressure comes from the government, from regulatory sources and from the public, who are increasingly aware of the environmental cost.

This paper outlines the results of a strategic review by the SusteIT project of the environmental and social impacts of ICT in further and higher education and means of addressing them. This is one of a number of projects on the topic which have been commissioned by JISC. The review was informed by: interviews with many practitioners and experts inside and outside the sector; an online survey, which attracted 183 responses from 49 institutions; discussions at five workshops, attended by nearly 300 people; and a detailed audit of ICT use at the University of Sheffield. The project also produced a number of case studies and two tools to support energy and carbon footprinting to enable comparisons between thick and thin client solutions.

This document was written by Kim Thomas (**www.kimthomas.co.uk**) on behalf of JISC. Alternative formats of this document can be found at **www.jisc.ac.uk/publications**

The issue of man-made climate change is now a pressing one.

FACTS AND FIGURES

Figures relating to ICT use at the University of Sheffield, Lowestoft College and City College, Norwich, when scaled up, suggest that UK further and higher education:

- Uses 1,468,000 computers, 246,000 printers and 238,000 servers
- Will have ICT-related electricity bills of about £116 million in 2009
- Emits more than 500,000 tonnes of carbon dioxide a year through its ICT use

About half of the ICT-related energy consumption in UK further and higher education institutions is accounted for by PCs. Digital printing accounts for a further 10–16% of ICT-related energy use.

Through its Climate Change Act (2008), the UK government has a target to reduce carbon emissions by 80% by 2050. ICT use is estimated to account for 2% of carbon emissions worldwide (Climate Group, 2008).

The problem is not simply one of ICT use. The extraction and processing of materials for PCs also has a considerable environmental impact. One study (IVF, 2007) found that a European PC and 17-inch LCD monitor contain 20 kilos of materials. The production of these devices involved:

- Disposing of 37 kilos of non-hazardous waste, and 0.7 kilos of hazardous waste
- Consuming 3,244 megajoules of energy
- Using 920 litres of process water
- Generating 193 kilos of greenhouse gases
- Releasing considerable quantities of heavy metals, acid rain precursors and other air and water pollutants

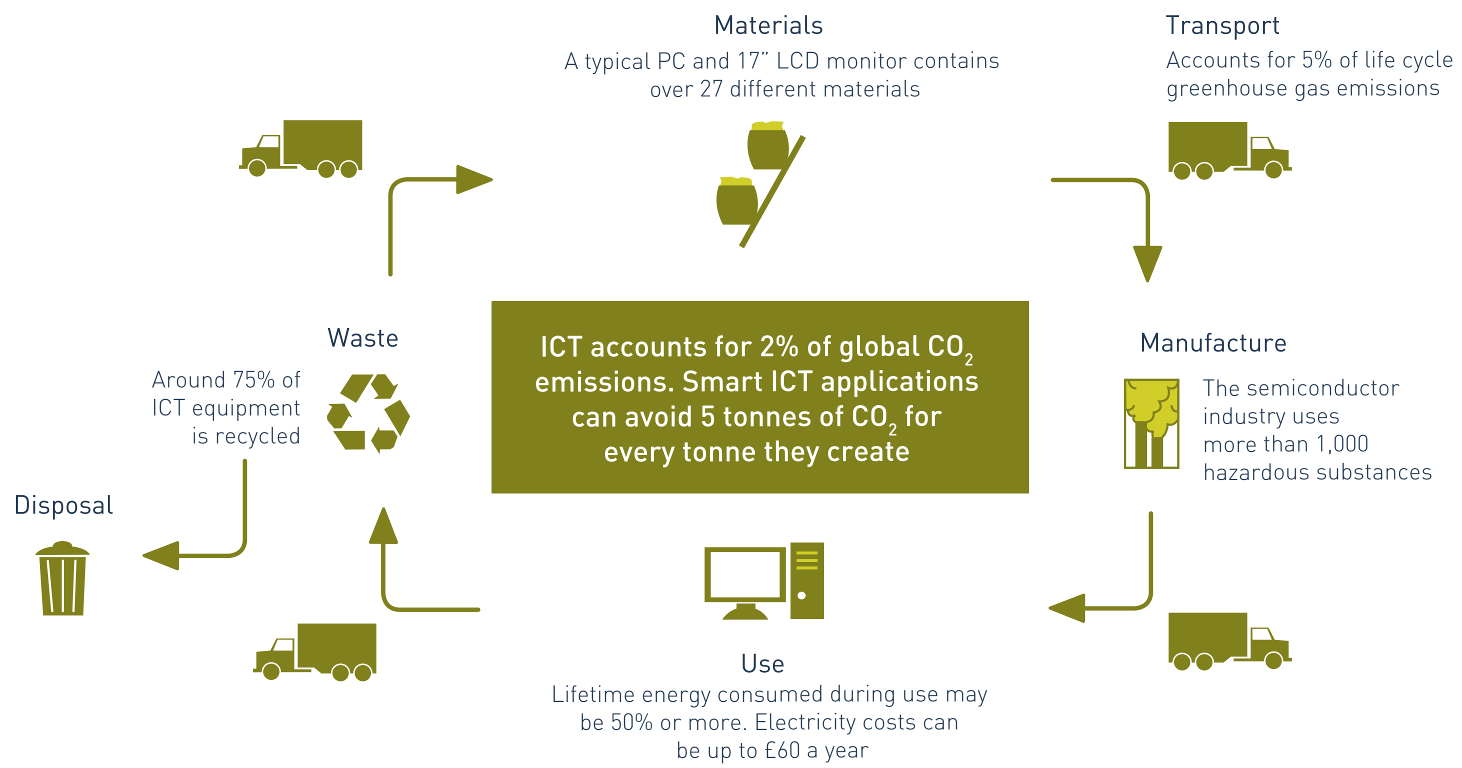
There is disagreement between experts about the balance of energy consumption and environmental impacts between the different stages. The SusteIT report examines the reasons for this, and concludes that, for UK non-domestic computers, it is likely that energy consumption is at least as great during ICT use as it is in the materials and manufacturing stages combined.

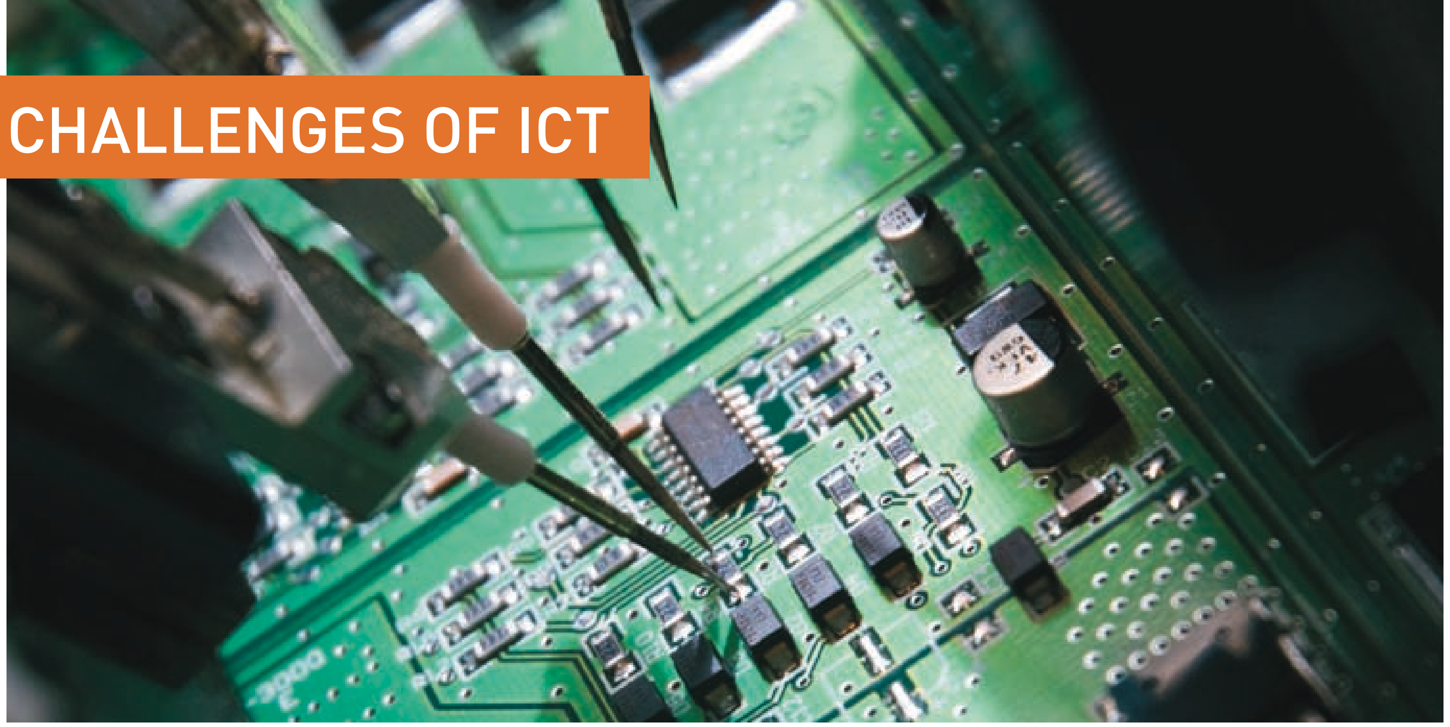
When it comes to disposing of equipment, one study (IVF, 2007) found that 76% of the 20 kilos of materials in an average European PC and 17-inch LCD monitor were recycled, and 24% were disposed of. The SusteIT survey, using data from five institutions, showed they were generating an average of 33 tonnes a year of electronic waste, and spending an average £9,400 on management of this waste.

But intelligent use of ICT, such as the use of video conferencing to replace face-to-face meetings, or the development of 'smart' buildings to control heating and lighting, can also reduce carbon emissions. One study (Climate Group Report, 2008) has found that ICT applications could reduce global carbon emissions by 15% in 2020, and avoid approximately five tonnes of carbon emissions for each tonne that they generate through production, use and disposal of equipment.

Leaving a computer on overnight for a year creates enough CO_2 to fill a double-decker bus.

Lifecycle of ICT





CHALLENGES OF ICT

ICT is used to administer payroll, admissions and student records, as well as in e-learning. Although it brings clear benefits of administrative efficiency and increased effectiveness in teaching and research, it is accompanied by an environmental and monetary cost. This cost is increasing considerably as new activities and applications are added to existing ones. For example:

- e-Learning, and especially versions with rich media content, are increasing the storage and processing of information within data centres, which are very energy-intensive
- Ever larger volumes of data, from research records to email archives, are being stored
- Many areas of research are becoming more computing-intensive

In the US, data centres account for 1.5% of national electricity consumption, and this is probably also true in the UK. And the figure is rising: the SusteIT survey found that 63% of institutions are expecting to invest in more servers over the next two years.

As with PCs, the production of servers has a hidden environmental impact. They are also heavy consumers of electricity, and this is exacerbated by the use of expensive air conditioning to cool data centres.

In some places, such as central London, the electricity grid is near capacity, which sets limits on further data centre expansion.

Printers are another major expense, and one that is getting out of control in some institutions, as a result of the trend away from centralised printing to localised printing, and the increased use of colour printers and multifunctional devices. (Multifunctional devices can cut costs and energy consumption if they genuinely replace other devices such as photocopiers, but in a straight comparison with ordinary printers, they are more inefficient.) Higher education has an estimated 148,000 printers, while further education has 98,000. The SusteIT survey found that respondents were printing an average of 224 sheets a week, or 10,000 a year. In larger institutions, this represents an annual cost of £1 million.

While ICT use increases steadily, there is growing pressure from government to reduce the environmental and social impact of ICT.

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BENEFITS OF SUSTAINABLE ICT

While there is external pressure to adopt sustainable policies towards ICT, there are also several benefits for the institution in doing so:

Cost efficiency gains

High ICT usage means hefty electricity bills: the University of Sheffield, for example, expects to pay £1 million for electricity used by its ICT equipment in 2009. More intelligent, sustainable use of ICT can reduce energy costs substantially. For example, printing costs can be reduced by simple measures such as duplex (double-sided) printing as a default; using recycled paper; switching printers off when not in use; and replacing single printers with multifunctional devices.

Improved reputation

Information about institutions' environmental and social performance now appears increasingly in the public domain. The implementation of the EU Energy Performance of Buildings directive requires institutions to publish information about the energy consumption of their buildings, which makes it possible to compare standalone data centres.

There is evidence (Forum for the Future, 2007) that staff and students take information about environmental and social performance into account when making decisions about where to work or study, and this information is also of interest to other institutional stakeholders, such as local authorities.

New opportunities for teaching and research

Sustainable ICT is an area of growing concern to both suppliers and major users, and so they need employees and advisers who understand the issues. This provides an opportunity for institutions to make sure they have the relevant expertise among staff and students.

Universities and colleges need to respond to such requirements by making sure that students are equipped to meet them, and that they have relevant expertise among staff. As the IT industry accounts for 6% of Gross Domestic Product in Europe and North America, there is an opportunity for institutions to thrive by exploiting this potential. The University of California, San Diego, for example, has a $2.6 million GreenLight facility that provides a computing resource for scientific research, and a testbed to research more energy-efficient methods of cooling data centres.

Possibilities for location-independent working

New organisational arrangements, and increased use of technologies such as call forwarding and video and web conferencing, can enable more staff to work remotely, whether from home, while travelling, or in other settings. This is usually known as 'flexible working' or 'location-independent working'.

These arrangements reduce the environmental impact of travelling to work, and can also reduce the amount of office space required, which in turn reduces the environmental impact of building use. One report (Cisco, 2007) comparing two adjacent buildings, one with conventional ICT infrastructure and working practices and another with hotdesking and a wireless network, found that the latter building could reduce energy load by 47% and space per employee by 40%.

Although people working remotely still use computers and, if at home, still have to heat and light their own working areas, the energy used and carbon emitted is often less than that used when they work in the office, and even when not is usually offset by carbon savings from avoided transport (James, 2008).

Evidence suggests that the opportunity to work flexibly is valued highly by staff. The SusteIT survey showed that 60% of respondents would like to do more work remotely, for three main reasons: reduced travel time; improved work/life balance; and a desire to work more effectively. Research shows that the introduction of flexible working, as well as allowing a reduction in building maintenance costs, can result in improved staff morale and retention (SUSTEL, 2004).

Employers also have legal obligations to provide flexible working opportunities. The Flexible Working (Procedural Requirements) Regulations of 2002 allow parents of children under six to request flexible working. A proposed amendment to the regulations will extend this right to parents of children aged 17 or under.

The University of Coventry is conducting a JISC-funded project, due to be completed in March 2009, to demonstrate the benefits of allowing staff to work remotely. Results from the pilot show that many of the anticipated benefits (improved productivity, reduced stress and increased flexibility) have been realised.

DRIVERS FOR SUSTAINABLE ICT

Environmental costs

The environmental drivers are compelling:

- The extraction of materials used to make ICT equipment consumes energy and creates both hazardous and non-hazardous waste
- Running ICT equipment consumes large amounts of energy – both directly and through the cooling and power supply requirements of data centres
- Disposing of ICT equipment releases heavy metals, acid rain precursors and other air and water pollutants that are harmful to the environment and can damage people's health

Energy costs

ICT is expensive to purchase and run: cost UK further and higher education institutions an estimated £121 million in 2009, a figure that will continue to rise. For example, in the University of Sheffield, the bill for running ICT equipment represents 18% of the institution's total electricity use, with PCs responsible for around half of this.

Many sustainable ICT measures can have a payback of less than two years. For example, PCs are typically used for fewer than 40 hours a week, but are often left on all day. A simple system of powering down or turning off PCs when they are not in use can save up to 75% of the running costs.

Funding council policy

Stakeholders such as the Learning and Skills Council (LSC) and the Higher Education Funding Council for England (HEFCE) are increasingly demanding action on sustainable ICT. HEFCE has stated:

We want to make sustainable development a central part of our strategy for the future development of the higher education sector. We will consider our vision set out in 2005 to be valid, namely that: within the next 10 years, the higher education sector in this country will be recognised as a major contributor to society's efforts to achieve sustainability – through the skills and knowledge that its graduates learn and put into practice, and through its own strategies and operations. (HEFCE, 2008)

Legislation

The Climate Change Act (2008) sets a legally binding target for reducing UK carbon dioxide emissions by 26% by 2020 and 80% by 2050, compared to 1990 levels. It also sets up the Carbon Reduction Commitment (CRC), requiring medium to large electricity users, including many universities, to monitor their electricity consumption and purchase carbon credits. There will be penalties for poor performance, and rewards for good performance.

There are also a number of directives that impose legal obligations on institutions in regard to their use of ICT equipment. These include:

- Waste Electrical and Electronic Equipment (WEEE) directive. This states that electrical waste should be separated from other waste and sent to authorised facilities or exporters
- Reduction of Hazardous Substances (RoHS) directive. This sets limits on the hazardous substances, such as lead and mercury, that can be used in new electrical equipment
- Energy Using Products (EUP) directive. This sets minimum performance requirements for energy consumption in the manufacture and use of ICT. It comes into force in 2009
- Energy Performance of Buildings directive. This requires minimum energy performance requirements in new and existing buildings and energy certification of buildings. Cooling installations such as those in data centres will be inspected every five years. Implementation is phased between 2007 and 2011

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BARRIERS TO SUSTAINABILITY

There are, however, several obstacles to developing a sustainable ICT strategy:

Lack of staff time and resources

Staff lack the time to deal with the challenges of sustainable ICT, which may be complex and time-consuming. IT departments already face increasing demands from their institutions, without a commensurate increase in staff. Many of the programming changes required to implement sustainable ICT require considerable technical skill to implement.

These constraints will become less pressing as staff become more familiar with the issues.

Lack of coordination

Implementation of a green ICT policy is often hindered by the lack of communication between different departments. In many cases, for example, there is little or no coordination between the IT department or academic departments and the Facilities Management department. Generally, neither the IT director, nor academic departments, pay the electricity bill, and so have no incentive to reduce electricity use. Only a third of energy and environmental managers in the SusteIT survey said they had an involvement with the IT function on sustainable ICT issues, and only 8% of those said they worked closely together.

Similarly, in many institutions, ICT equipment is purchased by individual departments rather than by the central IT function, making institution-wide initiatives difficult to implement. While IT managers may understand the importance of total cost of ownership (which takes long-term energy and disposal costs into account), senior finance managers may still insist that purchases are made on the basis of the initial cost of the equipment.

Budgetary constraints

Many universities and colleges feel they are under-funded, and a lack of capital budget means there is not enough money to spend on sustainable ICT activities: most capital budget for ICT has to be spent on activities that contribute to immediate goals. Universities and colleges are further disadvantaged because they do not qualify for Enhanced Capital Allowance. Savings from energy efficiency measures will result in lower operational costs, but normal budgeting systems make it difficult to transfer money saved from operational costs to a capital budget.

It is possible, however, to address this by creating ring-fenced energy efficiency budgets to finance additional capital expenditure. This is enabled by the Salix Finance and HEFCE Revolving Green Fund, which provides institutions with interest-free recoverable grants to finance projects that result in financial and carbon savings.

Use of such schemes depends on awareness of the energy costs associated with ICT, but according to the SusteIT survey, only 47% of respondents from IT departments were aware of these costs.

Lack of information and guidance

Because the issue of sustainable ICT is relatively new, many people, particularly teaching and research staff, do not know where they can find relevant information and guidance about it. Especially confusing is the fact that a number of vendors claim that their products are 'green'.

A common problem is that much of the ICT equipment used in the institution is not owned by the IT department, so it is hard to carry out an audit of what is owned by whom, and how energy-efficient it is. The situation is exacerbated by the lack of standardised metrics to assess the energy efficiency of ICT equipment.

A good understanding of the energy consumption associated with specific computer tasks is a prerequisite for better management, but without this kind of information it is difficult to set targets for, and therefore to measure the success of, sustainable ICT projects.

Lack of awareness

Many higher education staff, particularly those in teaching and research, lack detailed knowledge about the issue of ICT and sustainability.

Lack of good procurement practice

Good procurement practice – buying ICT equipment that is energy-efficient and has a small environmental footprint over its lifetime – can make a marked difference to institutional performance. This is particularly true of devices that are regularly replenished, such as PCs and servers.

It can be hard to implement better procurement, however, because:

- There is no well developed labelling scheme that makes it possible to assess the environmental performance of a piece of equipment through its lifecycle (although this may be available in future)
- In many recent invitation to tender (ITT) processes, there is little or no consideration of environmental and social issues
- Universities are often unfamiliar with techniques to estimate the total cost of ownership (TCO) of ICT equipment over its lifetime, or fail to use them in decision making. Hence, they often underestimate the long-term energy costs associated with ICT. The SusteIT survey found that only 17% of respondents conducted detailed TCO assessments

The situation is further complicated by the fact that, within an institution, procurement is rarely the responsibility of a single department: purchases can be made by IT departments, by academic departments and by individuals. IT departments may make their purchases independently or through national or regional agreements negotiated by the sector's purchasing consortia. This means that institutions working within an agreement cannot easily change its basic terms and specifications.

Many sustainable ICT measures create lower power bills which greatly exceed any increased capital cost. However, IT departments seldom have budgetary responsibility for energy, and so usually base decisions on capital spend alone.

CALL TO ACTION

Institutions can take the following actions to promote sustainable ICT within their organisations.

Create and implement an institution-wide environmental sustainability policy and strategy

As well as creating a written policy, institutions need to make it work. To do this, it is necessary to take a number of steps:

- Setting targets, generally quantitative, for achieving sustainable goals
- Regularly monitoring progress
- Creating an environmental 'champion' – a member of the management team given responsibility for sustainability
- Dedicating staff resources to investigating sustainable ICT solutions
- Creating a place for an ICT representative in a cross-functional strategic environmental group, tasked with auditing the environmental impact of ICT in the institution, examining low-impact alternatives and building awareness and support among users

Purchase environmentally friendly hardware and software

Institutions are not yet realising the full potential of sustainable procurement policies, but they have the potential both to reduce carbon emissions and to save money in the long term. This is particularly true of equipment that is regularly replaced, such as servers and PCs.

Implementing best practice procurement necessitates adopting an institution-wide procurement strategy, rather than leaving procurement to individual departments. This strategy should include:

- Calculating the total cost of ownership (the cost of a piece of equipment over its lifetime) before purchasing. This includes calculating how much electricity a piece of equipment will use, as well as how long it will last
- Purchasing from a central list of suppliers with environmentally friendly practices
- Purchasing energy efficient hardware which is compliant with the Energy Star standard as a minimum

Consolidate equipment

Institutions should minimise the proliferation of unnecessary equipment, for example, avoiding the purchase of desktops and laptops, or consolidating multiple printers and copiers into a smaller number of multifunctional devices.

Use alternative computing models such as thin client

In the widely used 'thick client' model, personal computers, which have a good deal of processing power and storage capacity, are connected to a server. They store information and run applications locally, as well as using the capacity of the server.

'Thin clients', by contrast, are devices with very little processing power and storage capacity, and are reliant on the central server for storage and processing. Although this transfers some energy use from the desktop to the data centre, net energy requirements can be less. Data is also more secure, because it is held centrally. Thin client terminals also have a smaller environmental footprint than desktops, because they are smaller and lighter. They generally have a longer life, because they are unlikely to be a target for thieves, and they are not so susceptible to virus attacks.

Thin client is not suitable for all applications, but can make environmental and business sense in many circumstances. The University of Bradford is running a JISC exemplar project to replace all its formal summative e-assessment technology with thin client technology, which offers the potential to reduce environmental impacts whilst running a much broader range of software for assessment purposes, and with increased integration with other university systems. The project will report in March 2009.

Create more energy efficient data centres

The new EU Code of Conduct on Energy Efficient Data Centres highlights many opportunities for achieving this. One of the biggest energy costs is in the use of air conditioning for cooling. There are several ways to address this problem: for example, by re-organising the positioning of servers to optimise the flow of cold air; by adopting water-based cooling; by reducing lighting; and by using 'free cooling' when temperatures are sufficiently low outside.

One of the best ways of making data centres more efficient can be to adopt virtualisation techniques (although, as with thin client, these are not suitable for all circumstances). Normally, every server is

dedicated to an individual application, and most of the time uses only up to 10% of its processing capacity (Fujitsu Siemens Computers and Knürr, 2007). This can be reduced by replacing physical servers with 'virtual machines' which enable a single server to behave like multiple servers running independently of each other. This means fewer servers are needed, which in turn makes it cheaper to cool the data centre.

Improve power management

Automatic powering down and switching off equipment when not in use is another, relatively simple, way of reducing energy consumption. Applications are now available that will power down PCs automatically when they are not being used, and this is probably more effective than relying on users. The University of Liverpool has developed free power-down software that can be downloaded and used by other institutions. Awareness campaigns to educate staff and students to switch off computers and equipment at night and weekends and during vacations can also be effective.

Power management software can also be used to make servers more efficient, by making sure that the amount of power they use decreases as their workload decreases.

The University of Oxford is carrying out a JISC exemplar project, due to report in March 2009, to look at how policies such as switching off PCs when not in use and virtualising servers can be carried out with minimum disruption to users. The university is testing software that simulates how people use computers. It can model the effects of standby, and give data on how much power is being used. As well as monitoring use, it can measure capacity and reveal opportunities for grid computing, to make the most of idle machines. The software will eventually be free for all educational institutions.

Make buildings more intelligent

'Intelligent' buildings minimise energy consumption through more efficient monitoring and management of activities such as heating, ventilation, lighting and air conditioning. The first generation of such buildings are already widespread in the sector, but further savings – and other benefits – are possible from second generation approaches, including use of Internet Protocol (IP) infrastructures for all building services.

Minimise paper use

Paper has a large environmental footprint, and so minimising its use is very important. A strategic approach to print/imaging management is required to ensure that the equipment purchased, and the operational activities being undertaken, meets student and staff needs in the most cost effective and sustainable way possible. Institutions should set targets for paper reduction based on print substitution, and better print management. This can be achieved through consolidation of print devices; print management software; easier online access to documents; greater use of recycled paper; and other means.

Minimise face-to-face meetings

Institutions can set targets to replace a certain proportion of face-to-face meetings with video conferencing, audio conferencing and web conferencing. One study has shown that the greater use of video conferencing has the potential to reduce global carbon emissions by up to 80 million tonnes by 2020 (Climate Group, 2008).

Most UK institutions of higher education have access to a very sophisticated video conferencing infrastructure, which provides the JANET Videoconferencing Service, and associated activities such as Access Grid. Currently, a new service, JANET Collaborate, is being piloted. It is open to teachers and lecturers looking for opportunities to work collaboratively, and then enables them to arrange video conferencing sessions. Usage is growing quickly, but there is still considerable spare capacity to support even faster expansion.

Allow staff and students to work remotely

Allowing staff to work remotely reduces the environmental footprint in terms of both the energy spent on travel and the cost of providing energy for heating, lighting and ICT use.

Replacing traditional face-to-face teaching with distance learning also has the potential for considerable carbon and energy savings. One study (Roy, Potter, Yarrow and Smith, 2005) found that distance learning courses in higher education consume on average 90% less energy and produce 90% fewer carbon dioxide emissions than campus-based courses. These energy savings come from the reduction in the amount of student travel; economies of scale in the use of the campus site; and the elimination of the need to provide energy in student housing.

REFERENCES

Cisco (2007) How Cisco Achieved Environmental Sustainability in the Workplace

Climate Group (2008) Smart 2020 – Enabling the Low Carbon Economy in the Information Age, Global eSustainability Initiative

Forum for the Future (2007) Future Leaders Survey 2006/07

Fujitsu Siemens Computers and Knürr (2007) Energy Efficient Infrastructures for Data Centers. White Paper, July 2007. Available online from: www.fujitsu.com/nz/whitepapers

HEFCE (2008) Sustainable Development in Higher Education. Available online from: www.hefce.ac.uk/pubs/hefce/2008/08_18

IVF Industrial Research and Development Corporation (2007) Lot 3: Personal Computers (Desktops and Laptops) and Computer Monitors, Final Report (Task 1–8)

James, P. (2008) 'Homeworking and carbon reduction – the evidence', in Dwelly, T. and Lake, A. (eds), Can Homeworking Save the Planet? Smith Institute

James, P. and Hopkinson, L. (2009) Sustainable ICT in Further and Higher Education. Available online from: www.susteit.org.uk

Roy, R., Potter, S., Yarrow, K. and Smith, M. (2005) Towards Sustainable Higher Education: Environmental Impacts of Campus-based and Distance Higher Education Systems, Final Report, Milton Keynes: Open University Design Innovation Group, March (Report DIG-08)

SUSTEL (2004) Is Teleworking Sustainable? – An Analysis of its Economic, Environmental and Social Impacts, UK Centre for Economic and Environmental Development, Peterborough

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Document Nº: 505
Version 1.1 January 2009