



An Inefficient Truth

Report

December 2007



AN INEFFICIENT TRUTH

Global Action Plan has over 12 years of experience helping organisations to reduce their environmental impact. Through practical involvement, we have realised that Information and Communication Technology (ICT) has a significant and growing impact on carbon emissions and climate change. In response to this Global Action Plan has established the Environmental IT Leadership Team (EILT) – a unique advisory group consisting of major ICT users seeking to make the use of ICT more efficient. At the first EILT meeting, the research scope of *An Inefficient Truth* was defined.

An Inefficient Truth illustrates the environmental impact of ICT and the energy security and supply issues associated with the huge growth within the sector. It explores the level of understanding that ICT managers have around environmental issues and the challenges that they face internally, from vendors and from Government in introducing more carbon efficient policies. The report provides some practical examples demonstrating how a wide range of organisations are starting to make a real difference in addressing this issue.

Finally, Global Action Plan has set out a 'Call for Action' that uses the findings of the report to encourage ICT users, vendors and Government to adopt more carbon efficient policies for the future.

PART ONE: THE ENVIRONMENTAL IMPACT OF THE ICT SECTOR

Climate change and energy use

There is broad scientific consensus that man-made climate change is happening. The world has not been as warm as it is now for a millennium or more. The three warmest years on record have all occurred since 1998 and 19 of the warmest 20 since 1980⁽¹⁾. There are growing fears that this warming will accelerate.

People are causing this change by burning nature's vast stores of coal, oil and natural gas to produce energy and destroying forests. This releases 49 billion tonnes of

carbon dioxide (CO₂) and other greenhouse gases every year⁽²⁾. The concentration of CO₂ in the atmosphere is the highest it has been in the last 650,000 years⁽³⁾, increasing by at least 35% since the industrial revolution and by 18% since 1960⁽⁴⁾.

The physics of the Greenhouse Effect has been scientific fact for a century. CO₂ is a greenhouse gas that traps the Sun's radiation within the lower atmosphere, crucially maintaining a stable climate suitable for life. As the concentration of greenhouse gases grows, heat is trapped in the atmosphere and less escapes into space.

This trapped heat alters the climate and weather patterns, causes sea level rises, melts polar icecaps and leads to more frequent and severe storms. The usage of the Thames Barrier has increased from once every two years in the 1980s to an average of six times a year over the past five years⁽⁵⁾. These impacts in turn may lead to mass extinction of species⁽⁶⁾ and dangers for humans such as population displacement through food and water scarcity⁽⁷⁾.

Greenhouse gases persist in the atmosphere for years, decades or, with some gases, centuries and millennia before they are broken down. Therefore the full impact of the man-made gas emissions already released has not yet been experienced⁽⁸⁾.

Scientists believe that we need to reduce CO₂ emissions by 70% to 80% to stabilise concentrations of CO₂ in the atmosphere - and thus future world temperatures⁽⁹⁾. However, the International Energy Agency's "business as usual" analysis reports that global energy demand will rise by 53%, leading to a 55% increase in global CO₂ emissions from energy by 2030⁽¹⁰⁾.

(1) The New Scientist

(2) IPCC Fourth Assessment Report November 2007

(3) BBC News, CO₂ 'highest for 650,000 years'

(4) The New Scientist

(5) Energy Saving Trust press release, Ken Livingstone's Energy Strategy Welcomed

(6) "Extinction risk from climate change", Nature, 8 Jan 2004

(7) "Climate Change, Vulnerability and Social Justice", SEI 2001

(8) The New Scientist

(9) The New Scientist

(10) www.berr.gov.uk, IEA

UK energy challenges

Using energy more efficiently is not important just because of climate change, but also because of energy security. The UK depends on a range of sources to generate electricity, such as coal, gas, nuclear and renewables. Fossil fuels will continue to be the dominant source of energy worldwide, meeting 83% of the increase in energy demand⁽¹¹⁾. To achieve energy security, the UK needs reliable sources of fuel materials and the capacity to provide electricity to users when it is required.

The UK is increasingly reliant on fuel sources from other countries, such as natural gas from Russia, to fulfil energy demand which is the equivalent of almost 235 million tonnes of oil per year⁽¹²⁾. The UK ceased to be an exporter and became a net importer of energy in 2004, which clearly undermines energy security⁽¹³⁾.

The UK also faces a real danger that the lights will go out. Existing power stations are reaching the end of their lifespan and, if no new power stations are built, within 10 years UK energy demand will surpass energy supply⁽¹⁴⁾. We will need to build almost half of the existing electricity generation capacity from scratch over the next two decades to fill the predicted energy gap⁽¹⁵⁾, while at the same time trying to reduce CO₂ emissions from the sector.

This growing threat of power cuts has serious ramifications for ICT in terms of potential loss of service. The common way to safeguard against such danger is to increase storage capacity, operate standalone generators and utilise an uninterrupted power supply. Some organisations also maintain duplicate ICT systems in backup offices to use in case of power failure at the primary office site. All of these solutions have the potential to increase the demand for energy and increase CO₂ emissions, thus we find ourselves in a spiralling cycle of energy consumption. Reducing ICT energy consumption up front will improve reliability of energy supply.

What does this have to do with ICT?

Computers have transformed the world in which we live. They have become commonplace at work and at home. There are currently more than 1 billion computers on the planet⁽¹⁶⁾. Gartner, the ICT research and advisory company, estimates that the manufacture of ICT equipment, its use and disposal accounts for 2% of global CO₂ emissions which is equivalent to the aviation industry⁽¹⁷⁾. Global man-made CO₂ emissions add up to around 49 billion tonnes per year⁽¹⁸⁾, therefore around 1 billion tonnes come from ICT.

In the UK there are now an estimated 10 million office PCs⁽¹⁹⁾ and 43% of the UK adult population regularly uses a PC at work⁽²⁰⁾. As the number of people using computers rises, so does energy consumed by UK organisations.

ICT equipment accounts for about 10% of the UK's total electricity consumption⁽²¹⁾, or four nuclear power stations worth⁽²²⁾. Between 2000 and 2006, energy consumption from non-domestic ICT equipment increased by more than 70%⁽²³⁾ and it is expected to grow by a further 40% by 2020⁽²⁴⁾. The appetite for storing data has also vastly increased. In 2006, storage capacity from factories was over one exabyte (1,000,000,000,000,000 bytes), a growth of 48.5% in just one year⁽²⁵⁾. Compare this with the heavily lobbied aviation industry. UK airports handled 235 million passengers in 2006, an increase of nearly 3% on 2005⁽²⁶⁾. The use of ICT is growing at a faster rate than the increase in flying. However, unlike the aviation industry, there are many simple alterations that can be made with relatively little cost. For example, it is estimated that 35% of all application data is duplicated⁽²⁷⁾.

The link between increased energy consumption of ICT and man-made climate change is clear, as is the link between increased energy consumption and increased cost. Putting aside the important issues of global warming and energy security, tackling the carbon footprint of ICT is simply good business practice. Being green will help organisations stay out of the red.

- (11) www.berr.gov.uk, IEA
- (12) www.worldcoal.org
- (13) World Coal Institute, UK Carbon Capture & Storage Technology Inquiry
- (14) EDF
- (15) 'Meeting the Energy Challenge', A White Paper on Energy, May 2007, Department of Trade and Industry
- (16) Richard Barrington, head of Public Policy for Sun UK and Ireland and UK government advisor
- (17) Gartner, 2007 Press Release
- (18) IPCC Fourth Assessment Report, 16 November 2007
- (19) The PC Energy Report – A Report by the National Energy Foundation and 1E
- (20) The PC Energy Report – A Report by the National Energy Foundation and 1E
- (21) Richard Barrington, head of Public Policy for Sun UK and Ireland and UK government advisor
- (22) Global Action Plan, from British Energy and EDF data.
- (23) The Market Transformation Programme
- (24) The PC Energy Report – A Report by the National Energy Foundation and 1E
- (25) IDC Worldwide Quarterly Disk Storage Tracker, March 2007
- (26) Civil Aviation Authority, News, March 2007
- (27) Forrester "Information Fabric: Enterprise Fabric Virtualization" 2006

IMPACTS OF DIFFERENT PARTS OF THE ICT SECTOR

Servers and data centres

Servers and data centres have become integral to business but as the size and capacity of these servers increase, so too does the energy consumed by them. The intensive power requirements needed to run and cool data centres now account for around a quarter of the ICT sector's CO₂ emissions⁽²⁸⁾.

It is estimated that a medium-sized server has roughly the same annual carbon footprint as an SUV vehicle doing 15 miles per gallon⁽²⁹⁾. The power required for a rack of high-density server blades can be 10-15 times greater than a traditional server⁽³⁰⁾.

A recent report⁽³¹⁾ in the USA found that, in 2006, 1.5% of national electricity demand came from energy consumption of data centres. It also revealed that the energy consumption of servers and data centres in the USA has doubled in the past five years and is expected to almost double again in the next five years to an annual cost of around \$7.4 billion. It is reasonable to expect the UK to mirror these trends.

Data centre requirements are already causing serious problems to UK organisations. Use of co-location companies is on the rise, particularly in urban areas such as London. Co-location companies lease servers in remote locations on behalf of organisations due to limitations in power availability and physical space. BT offers this service and has predicted a 20% growth in its co-location business over the next 3 years⁽³²⁾. Due to the growing reliance on co-location companies, they are in increasingly strong bargaining positions. For example, they are able to pass on rising costs of energy to customers.

It is not only the energy consumed by the servers and data centres themselves that contributes to their carbon footprint; a similar amount of additional power is required to remove the heat generated by them, using energy-intensive air conditioning units⁽³³⁾. The measure of direct electricity consumption to power servers compared to the indirect electricity used to cool the equipment is known as the Power Usage Effectiveness (PUE). As PUE increases, the ratio of indirect cooling electricity consumption

compared to the direct electricity used by the server increases. A PUE value of less than two is considered to be good practice.

A case study of an organisation that has adopted server virtualisation technology to maximise utilisation of servers is included in Part Three of this report.



(28) www.computerworlduk.com/TXPO 'Gartner use intelligent IT to green the business, IT chiefs told!'

(29) Carbon Neutral Company

(30) Rakesh Kumar, Gartner Analyst, Sep 2006

(31) Report to Congress on Server and Data Center Efficiency, US Environmental Protection Agency

(32) Information Age, Co-location's hunger for power, Nov 2007

(33) Rakesh Kumar, Gartner Analyst, Sep 2006

Desktop computers

In today's high-paced business environment, it is easy to disregard the amount of energy needed to power a desktop computer, but 1,000 PCs running 24/7 without energy saving modes activated can consume as much as £70,000 worth of electricity in a year⁽³⁴⁾. For every unit of electricity consumed by computers, another half unit of electricity is required to dissipate the heat given off⁽³⁵⁾.

An estimated 30% of the overall energy consumed by PCs is wasted because they are left on when they are not in use⁽³⁶⁾. A recent study⁽³⁷⁾ revealed that more than a third of employees in the UK never turn off their computers before leaving the office for the day, which costs the UK £123m a year; and only about 6% of users enable power management functions on their PCs⁽³⁸⁾. Reasons often cited for staff not turning off computers are the time taken to log on to computers, organisational policy and the misunderstanding of instructions from ICT departments.

Printing and paper waste

Half of ICT's energy consumption comes from office equipment⁽³⁹⁾ such as desktop PCs, monitors and printing equipment. Printers, photocopiers and fax machines left idle will continue to consume energy unnecessarily – and there are often an unnecessary number of these items in an office. Two printers, a photocopier and a fax machine use twice the amount of energy in a year as one multifunctional device which does the same job⁽⁴⁰⁾.

Despite the notion that the digital age would bring about the paperless office, paper use is soaring. In 1980, before the introduction of the PC, world office paper consumption was 70 million tonnes a year; by 1997 it had more than doubled to almost 150 million tonnes⁽⁴¹⁾.

In the UK, 120 billion pieces of paper are printed every year, which is the equivalent of a paper mountain more than 8,000 miles high⁽⁴²⁾. The manufacture of this paper emits 1.5 million tonnes of CO₂, without taking into account the impact of the manufacture of printing equipment and ink and the energy consumed by printers⁽⁴³⁾.

The average British office worker prints 22 pages every working day⁽⁴⁴⁾, and behavioural research⁽⁴⁵⁾ suggests that 44% of this is easily avoidable, such as printing drafts or emails, or submitting documents which could otherwise be submitted electronically. Over 21% of prints are disposed of before the end of the day.

“ Sadly the paperless office remains a myth for many. Office printing continues to be out of control ... there is a general lack of guidelines for employees around printing practices, and most people readily admit to not really thinking twice about hitting the "print" option. ”

Paul Parrish, Managing Director of Fujitsu Siemens Computers IT services

What is the problem with paper use?

- 10 litres of water are required to produce one sheet of A4 paper⁽⁴⁶⁾;
- The paper manufacturing industry is the world's third largest consumer of fossil fuels⁽⁴⁷⁾;
- The paper manufacturing process generates large amounts of solid waste which must be disposed of;
- Increased demand for paper means more timber is required;
- If it is not recycled, waste paper will release carbon emissions, either by being burned in an incinerator or buried in a landfill site.

(34) Global Action Plan 2007

(35) Roth et al. 2002

(36) Kevin Klustner, Chief Executive of Verdiem.

(37) Research for Fujitsu Siemens Computers

(38) Department of Trade and Industry and Department of the Environment, Food and Rural Affairs

(39) Silicon.com "The greening of IT: Do it yourself" Nov 2007

(40) Silicon.com "The greening of IT: Do it yourself" Nov 2007

(41) UK Wastewatch

(42) Research for Fujitsu Siemens Computers

(43) Global Action Plan calculation from DEFRA's waste strategy 2007

(44) Research for Fujitsu Siemens Computers

(45) www.zdnet.co.uk, Why disappearing ink isn't just for spies, Brinda Dalal, Xerox, Nov 2007

(46) UK Waterwise

(47) American Forest and Paper Association

Reuse, recycling and disposal of ICT equipment

Electronic waste from an ICT system consists of old PCs, servers, telephone systems, networking equipment, printers, copiers, fax machines and more.

Each year 125 million computers are removed from circulation⁽⁴⁸⁾ and in the recent past most of these have ended up in landfill sites. This number is so high because of the unnecessarily short lifespan of PCs – often just four or five years. The recent introduction of the WEEE directive by the EU⁽⁴⁹⁾ will ensure that useful parts of obsolete equipment are recovered and waste parts are disposed of correctly. Europe produces 10.3 million tonnes of electronic waste a year which is around a quarter of the world's total, and this amount is expected to rise to 12.3 million tonnes per year by 2020⁽⁵⁰⁾.

The manufacturing process for computers is very energy intensive. A recent study at the United Nations University in Tokyo⁽⁵¹⁾ found that most electrical products consume around 95% of lifecycle fossil fuels when in use; however, 75% of PC fossil fuel consumption has already happened before the computer is even switched on for the first time.

Furthermore, the study found that the manufacture of one PC requires about 1.7 tonnes of raw materials and water, and consumes over ten times the computer's weight in fossil fuels.

Production redesign to extend the useable lifespan of PCs could have a huge impact on reducing their environmental impact. Extending the working life of computer equipment would mean reduced resource use, less disposal issues and lower CO₂ emissions.

Electronic waste is also a human welfare issue. 70% of global electronic waste is dumped in China, with most of the rest going to India and African nations⁽⁵²⁾. Individuals that 'recycle' this equipment by attempting to recover the valuable metals within computer components risk ill-health from exposure to heavy metals. People that rely on water supplies potentially contaminated with heavy metals from open e-waste recovery sites and those living near metal works are also put at risk.

Transport

Transport is responsible for nearly a third of the EU's total energy consumption⁽⁵³⁾, and a significant proportion of this travel is business related. As well as energy consumption and the consequent CO₂ emissions, this business travel contributes to growing congestion problems and reduces the productive working hours of employees.

One recent study concluded that, if 20% of business travel in the EU was replaced by new telecommunications technologies, by 2010 around 25 million tonnes of CO₂ would be saved each year⁽⁵⁴⁾.

Summary

There is much that organisations can do, by implementing new technologies and introducing clear guidelines for employees around ICT use. Doing nothing to address this problem is no longer a commercially viable option. Organisations across the UK have already demonstrated the considerable savings that can be made from improving the energy efficiency of their ICT, as explored in part three of this report.

In part two of this report we explore the awareness of, engagement with and support for ICT professionals in the sustainability debate.

(48) Michael Dell, CEO Dell, 2007

(49) BERR, Environmental Protection 2006 No. 3289

(50) www.eubusiness.com, Europe must do more to cut e-waste: report, 16 November 2007

(51) Professors Rudiger Kuerh and Eric Williams, United Nations University in Tokyo

(52) www.iht.com, In 'e-waste' heartland, a toxic China, November 2007

(53) AeA Europe Energy Efficiency Report

(54) European Telecommunications Network Operators Association (ETNO) and the World Wildlife Fund

PART TWO: IS ICT ENGAGED IN THE MOVE TOWARDS SUSTAINABILITY?

ICT has become a crucial part of every organisation's operations, but is this role reflected in the sustainability strategies of organisations? A national survey of ICT professionals has been undertaken to gauge ICT departments':

- awareness of the environmental impact of their systems and equipment;
- level of involvement in organisational sustainability initiatives;
- data storage and capacity trends;
- access to support to aid implementation of 'Green IT' solutions.

The survey was conducted by Global Action Plan during September and October 2007 and was aimed at key ICT decision makers of predominantly larger organisations. Reflecting this audience, the survey was publicised in IDG's CIO, Techworld and ComputerworldUK publications. The nature of the questions ensured that senior ICT staff would need to either respond directly or provide guidance for more junior staff to respond. The analysis of the 160 responses focused solely on the 120 from UK ICT professionals. The responding ICT professionals manage the ICT requirements for over 500,000 UK workers and have a combined ICT budget in excess of £475 million.

Awareness of the link between ICT and the environment

Almost all responding ICT professionals are aware that their ICT use has an impact on the environment and just over half believe that the impact is significant. The majority also believe that environmental considerations will be important in their ICT purchasing decisions over the next two years. 54% of respondents considered their department to be concerned about their environmental impact, either due to an organisation wide environmental push, physical space or energy pressures on data storage, or as a lever to help them drive ICT change across the organisation.

Despite these attitudes, 86% of IT professionals do not know the carbon footprint of their activities and only 15% are planning to calculate this, although a further 38% would like to know but do not know how to determine this figure.

Although ICT is a significant consumer of energy, the majority of ICT departments are not directly responsible for this cost. More than half of the ICT departments surveyed do not see their organisation's energy bills and two-thirds do not directly pay their share of the energy bills.

Do ICT departments pay for the energy consumed by ICT equipment?



No and they don't see the bills	56%
No but they do see the bills	12%
Yes but only for specific functions such as the data centre	7%
Yes but the energy bill is shared out equally among departments	5%
Yes	20%

The apparent awareness and concern for the environmental impact of ICT is also not reflected in existing purchasing strategies. The survey reveals that environmental performance of equipment is not currently a major consideration for ICT professionals, even though over half of the respondents are aware of specific 'Green' technologies. Only 8% have purchased products purely on the basis of their environmental benefits. More than a third do not consider the environmental benefits when purchasing new products at all. Over a half do consider such benefits but only as a secondary, less important factor.

ICT professionals show a willingness to tackle their carbon footprint, but they require support and encouragement to do so. To encourage ICT departments to be more energy efficient, they must at least be made more aware of how much energy they are using.

ICT's involvement in sustainability strategies

ICT professionals display concern about their department's impact, but is this attitude translated to an inclusion in the wider strategy to reduce carbon emissions in all organisations?

The survey reveals that three-quarters of ICT departments are not integral to their organisation's social responsibility and sustainability strategy, but half of respondents are partially involved in the strategy. A quarter of departments are not involved at all.

To what extent are ICT departments engaged in organisations' sustainability strategies?



Not at all	25%
Partially	49%
Extensively	26%



Furthermore, nearly half of those surveyed have not been invited by other departments to join an organisation-wide energy efficiency project. Only 6% of the organisations surveyed have financial or personal incentives schemes for their ICT department to adopt environmentally friendly initiatives, although more than a fifth would like to see such a scheme.

Half of ICT professionals have actively sought to become involved in their organisation's environmental initiatives in some way, by approaching the relevant department or colleague, which again suggests that the willingness exists within ICT departments to tackle environmental issues.

The results of the survey suggest that organisations are under using a valuable asset by not fully involving their ICT departments in sustainability initiatives. The high energy consumption of ICT equipment means that there is significant room for improvement in their direct energy use. Perhaps more importantly, ICT departments have the skills and knowledge to greatly improve wider organisational efficiency in areas such as purchasing, travel and waste.

Data storage and capacity trends

The survey reveals that data storage strategies are confused and that organisations are struggling to cope with the scale of growth of data centres. 60% of ICT departments expect to run out of physical space for data storage within two years, with a third estimating that they will run out within 12 months. Two-thirds of ICT departments have already utilised 75% of their data centre floor space.

At the same time, only 42% of ICT departments that know their storage capacity are using more than half of the available server storage space. 36% of responding ICT professionals do not know or cannot measure how much of their server estate is being used. Worryingly, 80% of respondents do not have a power budget for their data centre. Of those that do have a power budget, over 70% are utilising more than three-quarters of that budget.

These pressures are in part due to excessive data storage. The majority of ICT professionals do not believe that their company's policies on data retention and storage are environmentally sensitive. Nearly 37% store all data indefinitely, and only a fifth feel their organisation has data storage policies that adequately allow for efficient control of information.

As explored in Part One of this report, ICT, the environment and energy use are inextricably linked, but the pressures on data storage highlighted through the survey also suggest that organisational and economic growth are impacted by ICT. There are stark inefficiencies demonstrated by the low utilisation level of existing data storage facilities occurring at the same time as organisations being concerned that storage capacity is running out.

Average utilisation of server capacity



Under 20%	9%
20 - 29%	20%
30 - 49%	29%
50 - 74%	33%
Over 75%	9%

Implementation of Green IT solutions

ICT professionals appear willing to engage in the sustainability debate and organisations are not taking full advantage of this position, but what obstacles are stopping ICT departments from taking on energy efficiency initiatives themselves?

ICT professionals cited time pressures, cost and lack of corporate commitment as the biggest obstacles to the implementation of new 'Green IT' technologies. Other significant barriers are the scarcity of information and a lack of knowledge within the organisation.

When asked what would be the most important support required to implement environmental improvements, there was overwhelming demand from ICT professionals for recognised industry standards and incentives such as tax allowances for organisations to take up 'Green IT' practices.

Reviewing the offering from the ICT market, most ICT professionals would like to see an improvement in the impartiality and robustness of environmental information provided by ICT vendors. 60% considered such information to be poor or confusing and only 1% rated such information as excellent. One in 20 professionals think that vendors are not genuinely concerned about the environment and feel that 'Green IT' is just another sales tactic.

Summary

ICT professionals display concern for the impact of ICT on the environment, but this impact is not well understood. Other departments are not fully utilising the skills of ICT staff to improve the efficiency of whole organisations and ICT departments find themselves having to store excessive amounts of data, which is not managed optimally.

ICT departments must increase existing server utilisation and plan for future storage requirements. Heads of organisations, the Government and vendors must create a situation in which ICT departments are incentivised and assisted to implement 'Green IT'.



PART THREE: SOLUTIONS TO REDUCE THE CARBON FOOTPRINT OF ICT

The carbon footprint of ICT must be addressed by all concerned parties - Government, ICT professionals, ICT vendors and leaders of UK organisations. Much of the technology exists and the sector is beginning to acknowledge its responsibility, but a paradigm shift is required to provide the necessary framework to make 'Green IT' solutions common practice.

The need for legislation

The UK Government has an important role to play in encouraging ICT vendors and users to be more energy efficient. Legislation is needed to encourage better energy efficiency in the sector, whilst ensuring that other policies do not unnecessarily increase the data storage burden.

We live in an era of unprecedented information growth. In 2006, 161 exabytes (161,000,000,000,000,000 bytes) of digital information was created and copied. That is equivalent to three million times the information in all the books ever written, or 12 stacks of books, each extending more than 93 million miles from the Earth to the sun⁽⁵⁵⁾. It is estimated that the amount of information created and copied in 2010 will increase six-fold from 2006⁽⁵⁶⁾.

Several regulations have been introduced in recent years relating to privacy and data security, which significantly increase storage requirements.

A 2006 EU Directive on data retention requires member states to ensure that communications providers retain data for between six months and two years⁽⁵⁷⁾. The MiFID (Markets in Financial Instruments Directive), together with proposed Government-led projects surrounding identity cards, the NHS and road pricing, will also have an enormous impact on data storage.

At the same time, the Government's Climate Change Bill aims for a 60% reduction in CO₂ emissions by 2050⁽⁵⁸⁾, which will require less emission-heavy electricity generation, together with improved efficiency of equipment that consumes this electricity.

Some regulations have already been introduced that will begin to reduce the environmental impact of ICT, but there remains much that could be done. Last year the EU implemented The Eco-design for Energy Using Products Framework Directive⁽⁵⁹⁾ to create efficiency standards for all electrical equipment. It is targeted at inefficient technology such as computers and household appliances that waste huge amounts of power when in standby mode.

Also, the Waste Electrical & Electronic Equipment Directive (WEEE) was introduced in 2007⁽⁶⁰⁾, which sets strict guidelines on the disposal of computers and other electronic equipment. It explicitly prioritises the re-use of PCs over recycling, which is important given the environmental impact of manufacturing PCs, as detailed in Part One of this report.



(55) The Expanding Digital Universe, EMC2

(56) www.idc.com

(57) Directive 2006/24/EC 15 March 2006

(58) Climate Change Bill [HL], HL Bill 07/08, Nov 2007

(59) Directive 2005/32/EC 6 July 2005

(60) BERR, Environmental Protection 2006 No. 3289

Technological solutions

Technological solutions will have a major role to play in reducing CO₂ emissions from ICT, and many of these technologies already exist.

Data centre optimisation

In the USA, a report by the Environmental Protection Agency⁽⁶¹⁾ estimated that existing technologies could reduce server energy use by 25%, and further still with advanced technologies.

It is possible to improve the energy performance of a data centre by up to 70%, while still maintaining accepted temperatures⁽⁶²⁾. Ways to make data centres more energy efficient include:

- Consolidation of resources (such as storage, networks, databases) so they all sit on a single server;
- Replacing old resources with smaller, faster, more efficient technology;
- Identifying and retiring any unused or unnecessary storage capacity;
- Intelligent design of the data centre room, such as 'dynamic cooling', which targets the hot spots within the room;
- Introducing server virtualisation technologies – see below.

The end goal of data centre optimisation should be to improve functionality, keep rack space to a minimum and reduce power requirements. This should in turn help to cut CO₂ emissions, save on energy bills and minimise physical space requirements. Typical phases of data centre optimisation might include:

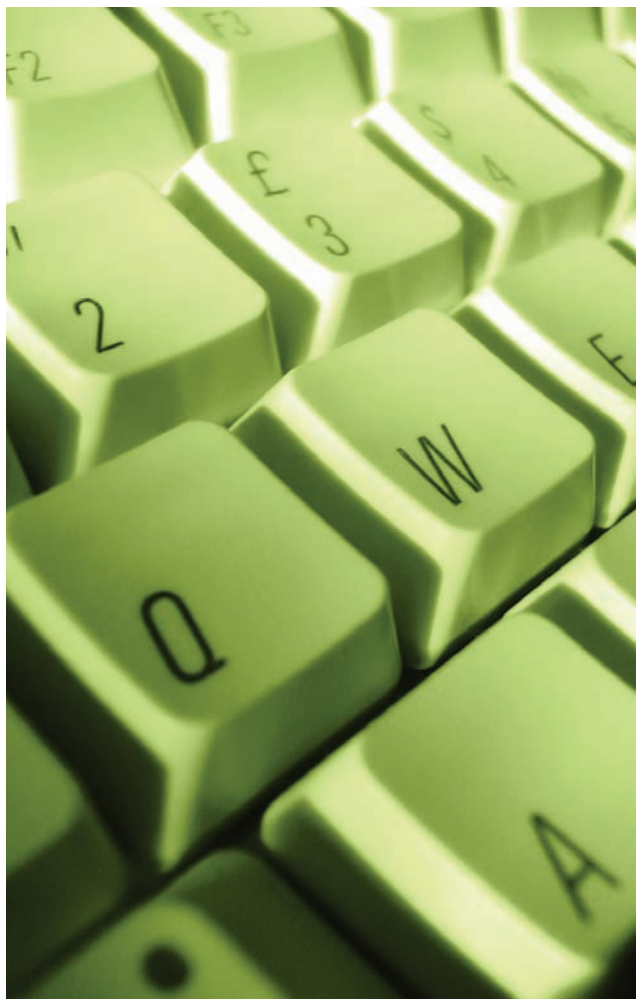
- A complete inventory of servers, storage and applications;
- An analysis of how the organisation uses technology and how technology underpins its activities;
- Identification of opportunities for optimisation, agreement on the desired outcome, and planning the process to achieve optimisation;
- Implementation, monitoring of progress and making adjustments where necessary.

Server virtualisation

Recent developments in virtualisation technology allow fewer servers to store the same amount of data. Server virtualisation involves a software application dividing one physical server into multiple isolated virtual environments. There are three different approaches to server virtualisation – hardware virtualisation, para-virtualisation and operating system virtualisation⁽⁶³⁾.

Online betting exchange Betfair has introduced server virtualisation, which has achieved an 84% energy saving⁽⁶⁴⁾.

See Case Study One



(61) Environmental Protection Agency - Report to Congress on Server and Data Centre Efficiency

(62) T. D. Boucher et al, 2006, 'Viability of Dynamic Cooling Control in a Data Center Environment', Center for Environmental Design Research, University of California, Berkeley

(63) Top Ten considerations for choosing a server virtualisation technology. SWsoft. Virtuozzo. July 2006

(64) www.computerweekly.com, How green IT delivers big energy savings, Posted May, 2007

Desktop Virtualisation, Thin Clients and Power over Ethernet

Desktop virtualisation allows a workstation to be equipped with low energy, secure 'thin clients' instead of traditional desktop PCs. The thin clients are linked to their own virtual desktops sitting on servers. It provides users with the same interface, applications and performance as a desktop based computer.

A thin client (also known as a lean client) depends primarily on the central server for processing activities, in contrast to a thick or fat client, which does as much processing as possible and only passes communications and storage data to the server. Because it is driven by a server instead of local processor, significant power savings can be achieved in a large environment.

As well as reducing energy consumption at the desktop, thin clients have other benefits:

- Improved data security;
- Reduced maintenance costs;
- Less environmentally damaging manufacture due to not requiring a hard drive and having limited microprocessor and memory requirements;
- Potential cost savings as thin clients are less expensive than PCs, although a more powerful server is required.

between 22,000 and 53,000 kWh, depending on the efficiency of the PCs. This equates to £1,800 to £4,300 and 11.5 to 28 tonnes of CO₂⁽⁶⁵⁾. This assumes that existing server capacity can cope with the increased demand and that there is no energy wastage outside of working hours.

Power over Ethernet (PoE) combines data and operating power (15W, 48V) into a single Ethernet cable. PoE can deliver power to IP telephones, wireless routers, security devices and various other low power equipment using standard cabling without any modification to existing infrastructure⁽⁶⁶⁾. This reduces the need for AC cabling and provides power to remote Ethernet devices. It allows cheap, fast and more resilient installation⁽⁶⁷⁾.

High deployment of PoE gives control and flexibility to facility managers. The power supply to lights, computers and peripherals could all be controlled through PoE allowing these to be turned on or off centrally. Coupled with a swipe card system, control could be done at the individual level, turning on equipment and lights in specific parts of the office when specific workers swipe in at the start of the working day.

See Case Study Two

(65) Global Action Plan 2007

(66) PowerDsine, Power over Ethernet - Inside or Outside the Switch?, IEEE802.3af

(67) Panduit, Facilities Management extend control using PoE, April 2007



Telecommunications

Although some of the early videoconferencing technologies were considered slow and unreliable, the technology has improved considerably in recent years. We now have access to computers with digital cameras and videoconferencing equipment, together with widespread fast and reliable internet connections.

See Case Study Four

Integrated telephony

Integrated telephony, or voice over internet protocol, is the concept of using the internet to carry voice conversations, which would otherwise be telephone call traffic. The traditional telephone handset can be replaced by software and a headset connected to a computer workstation, which saves energy. By optimising the efficiency of the server that carries the voice conversations, the power consumption of the entire phone system can be effectively reduced to zero.

Sleep mode

On average, no more than 7% of desktop computers have sleep / hibernation mode enabled, although most laptops do because it helps conserve battery power⁽⁶⁸⁾. Research also suggests that there is often confusion among employees as to whether or not their computers have sleep mode activated⁽⁶⁹⁾.

Power management software

A recent report commissioned by the National Energy Foundation estimated that the implementation of power management software has the capacity to reduce CO₂ emissions in the UK public sector by 140,000 tonnes per year⁽⁷⁰⁾. Power management software remotely ensures that equipment is put into sleep mode and then woken up when required.

Power management software can be an important tool for controlling power use. However, there are some important considerations to bear in mind regarding its implementation:

- Number of desktop PCs and laptops;
- Employee behaviour when using ICT – is power management software required?;
- Time required to run a pilot and roll-out of the software;
- Operating systems on each client (MS Windows™, Mac, Linux);

- Control that users will have over software settings and the ease of use of this interface;
- Level of control for the software to manage power used by individual desktop computer components, for example to power down the network interface card, graphic card or central processing unit, when possible;
- Ability to manage energy consumed by server components;
- Saving any programmes or unsaved data prior to shutting down a user's desktop (MS Office, emails, notes etc.) and how the user retrieves it when they next log on;
- Integration with bespoke software, such as databases - how will the bespoke software be recognised and handled by the power management software?;
- Compatibility with client machines (whether thin clients or PCs) and the server estate;
- Future developments planned for the software;
- Ability to quantify savings such as energy, cost and CO₂.

There are also some important cost considerations:

- The cost of running a pilot study;
- Upfront installation costs and script writing costs to adapt software for client systems and databases;
- Licence per user costs, licence period and ability to transfer the licence to another client if the PC is replaced;
- Inclusion of upgrades, patches or new-releases within the license period;
- Additional maintenance costs;
- Return on investment period.

See Case Study Three

(68) Market Transformation Programme - <http://www.mtprog.com>

(69) The PC Energy Report – A Report by the National Energy Foundation and 1E

(70) http://www.nef.org.uk/news-events/documents/1E_report.pdf

KVM Switches

KVM (Keyboard, Video, Mouse) switches can be installed in server rooms to cut down on the number of monitors needed. A KVM switch is a hardware device that allows multiple computers to be controlled from a single keyboard, video monitor and mouse.

Optimisation of resource use

Programmes are available that allow non essential ICT functions to be performed outside of peak power consumption periods. As well as reducing the power demand on grid during peak periods, considerable power savings can be achieved by performing tasks off peak.

Behaviour-led solutions

Technology is not always the most appropriate answer to energy efficiency conundrums. When technology is the best solution, humans still play a key role in interacting with and using it. There is also a danger that people can place too much faith in technology. When computers are being used to control a system or building, inefficiencies can sometimes be overlooked, because people assume that automated systems are working optimally.

Behaviour of people within an organisation is always a consideration, either as the primary route to improving energy efficiency or to interact with technology.

Switching off

One of the simplest ways to improve the energy efficiency of ICT is to encourage employees to switch off their computers whenever it is convenient to do so.

Leaving a computer on all the time typically costs four times more than if you switch it off at night and at weekends⁽⁷¹⁾. Leaving computers on standby does not solve this problem, because even on standby they can use as much as 70% of maximum power⁽⁷²⁾.

There are some circumstances in which it is essential to keep a computer running at all times, for example if this downtime is used for updates to avoid affecting performance during normal business hours. Therefore employees must be given clear guidelines on when to switch off their PCs; surveys of employees' ICT habits are useful when determining such guidelines.

Monitors generally don't need a big energy surge to power up, so if the user is going to be away from a workstation for more than a few minutes, it is worth switching it off.

Also see Case Study 5

Energy efficient use of computers

There are some straightforward ways to ensure more effective use of PCs that will improve working efficiency:

- Store less data on the hard drive and utilise data storage capacity on connected servers;
- Delete unnecessary data from computers, for example unwanted emails or duplicate files;
- Reduce the number of icons on the desktop;
- Avoid running lots of different programmes at once.

These practices will ensure that PCs run more quickly and take less time to shutdown and boot up, increasing the likelihood of people turning equipment off overnight.

Purchasing

When purchasing new ICT equipment, choose energy efficient models that have an energy star label indicating that they have a lower power mode. VeryPC (Treeton Series), Dell, Fujitsu and RM Ecoquiet have all developed computers with an energy efficient design.

Flatscreen/TFT/LCD monitors are preferable to CRT monitors as they generally consume less energy when in operation and on standby.

As well as the operational energy efficiency of the product, the environmental impact of the manufacturing process and end-of-life disposal should also be considered to complete a full life cycle analysis. The US Environmental Protection Agency has calculated that CRT monitors have a greater lifecycle cost than flatscreen monitors in 18 out of 20 impact categories studied⁽⁷³⁾.

(71) Carbon Trust 2006

(72) Fujitsu Siemens

(73) EPA. Desktop computer display, a life cycle assessment 744-R-01-004a

Printing

Organisations can reduce waste and CO₂ emissions through a few straightforward actions and guidelines around printing and photocopying:

- Switch off photocopiers at the end of the day and when not in use - a photocopier left on overnight wastes enough energy to produce over 1,500 copies⁽⁷⁴⁾;
- Introduce duplex printers, which print double-sided to reduce paper consumption;
- Ensure that printers are networked and accessible for lots of users to consolidate the actual number of printers;
- Activate the power saving function on printers and photocopiers, which will power down equipment by a varying percentage if not used for a certain period of time;
- If they do not have an in-built power saving function, timers can be installed on printers and photocopiers so that they are automatically switched off during down time.

CASE STUDIES

1. Data centres and server virtualisation

– A case study of improved energy efficiency through greater server utilisation.

Organisation: John Lewis Partnership (JLP).

Service / product provider: Intel Server Virtualisation

In late 2006 John Lewis Partnership (JLP) decided to make significant changes to their server estate for a number of reasons. Firstly, JLP were concerned about power, cooling and floor space. JLP also found itself leasing new data centre space at short notice and considerable cost and the in-situ commodity Intel servers were running at progressively lower utilisation levels - 8% on average.

JLP measured server utilisation for four weeks to predict results if widespread server virtualisation was adopted, finding that a ten to one ratio of virtual to physical servers was possible. A full pilot in the two main data centres was instigated in early 2007. Five commodity IBM xSeries servers were installed running VMware® ESX Server software to support a pilot of 20 virtual servers.

The pilot was an immediate success, so 60 virtualised servers were set up within a few weeks. They were a combination of test and production servers, new requirements and cutovers, and servers belonging to different teams.

Through the virtualisation of these 60 servers, JLP saved over £100,000 in new server purchases, 120 units of rack space, 1.5 metric tonnes in weight, numerous network and SAN connections, £8,000 in consumed power over five months, and associated air conditioning savings.

Global Action Plan estimates that this £8,000 power saving equates to 250 tonnes of CO₂ per annum. Awareness of green issues has also been raised across the ICT department as a result of the project.

Currently, JLP has nearly 150 virtual servers in operation and in 2008 more of its computing power will be virtualised than not. JLP has been shortlisted by Computing magazine for the 'Green IT project of the year' award, and desktop virtualisation is now under consideration.

“ The right environmental course of action proved to be an excellent one commercially - as we are seeing with JLP's other green IT initiatives, such as our use of software to automatically turn off unused PCs at night. ”

Gary Hird, Technical Strategy Manager, JLP and EILT board member

(74) Carbon Trust 2006

- 2. Thin client implementation and the virtual desktop** – The replacement of traditional desktop PCs with a thin client powered over ethernet and the hosting of a virtual desktop on a remote server.
Organisation: Reed Managed Services
Service / product provider: Wyse Technology

Reed Managed Services (Reed) is a high street recruitment agency that operates over 300 retail branches in the UK. Reed found that many servers were not being used to their full capacity. In addition, servers and desktop computers were generating significant heat which needed to be removed through air-conditioning, both in the workplace areas and the data centre.

As well as aiming to reduce its carbon footprint, Reed's target was to improve the cost-efficiency of its ICT and to ensure the ongoing security and effective management of its data.

Reed initially trialled thin client terminals provided by Wyse Technology for three months. Users were able to securely log into a session and access files from any workstation, whether they were working from home or from another office, without going through complicated log-on and networking procedures. The fast start-up time of the terminals also meant that Reed could encourage staff to switch off at lunchtime and at the end of the working day.

As a result of this successful trial period, Reed replaced all of its 4,500 PCs in just ten weeks. Thin clients can be used anywhere in the world, so the same servers are now used by users abroad at times when the servers would otherwise be idle. As well as improving energy efficiency, this flexibility enables Reed to quickly set up new offices.

Reed also reviewed its entire infrastructure to maximise its investment in the new thin client terminals. Blade servers were introduced in its data centre, servers in remote offices were decommissioned and server virtualisation technology was introduced in the data centre. Energy use from cooling its data centres was reduced by turning down the air conditioning, which had been set at an unnecessarily low temperature.

Within a year of the switch to thin clients, Reed has reduced energy consumption by approximately 5.4 million kWh of power, which estimate equates to 2,800 tonnes of CO₂ per annum. Reed has halved the number of storage drives, reduced the number of servers by a factor of 20, and the annual ICT budget has been reduced by a fifth.

“ Not only have we met our objective to significantly reduce our carbon emissions, but we have also discovered a more cost-efficient way of operating, which will continue to reduce our operating costs for years to come. ”

Sean Whetstone, Head of IT, Reed Managed Services

- 3. Power management Software** – The experiences of two organisations that have implemented power management software to reduce energy consumed by idle equipment
Organisations: Peterborough City Council and Irwin Mitchell
Service / product provider: NightWatchman® by 1E and Surveyor® by Verdiem

Peterborough City Council

Peterborough City Council (PCC) has 4,500 staff and it estimated that nearly a third of PCs were being left on out of hours, costing £40 to £60 per annum per computer. Behaviour change initiatives and a shut down policy made some progress, but a significant number of PCs were still being left on, so PCC introduced power management software called NightWatchman®.

The software allows the scheduling of daily, immediate or one-off shutdowns of PCs and it protects unsaved user data prior to shut-down. PCC has also been able to gain reports on energy, money and CO₂ emissions saved by the software, and reports on potential future savings.

The benefits to PCC include a saving of £50,000 per annum on electricity – a 250 tonne reduction in CO₂ emissions and return on investment in under three months.

“ When combined with carbon emission savings and better delivery to our in-house customers, this has proven to be one of our best ever investment decisions. ”

Nigel Green, Head of ICT at Peterborough City Council

Irwin Mitchell

Irwin Mitchell (IM) is a law firm employing more than 2,300 staff. They began looking at ways to improve the energy-efficiency of the firm's PCs and decided to introduce the power management software Surveyor®, which remotely ensures that equipment is put into sleep function and then woken up when required. By doing so, IM were able to reduce energy use by an average of 34% on all computers, which equates to around 107 tonnes of CO₂ a year.

“ Surveyor® is helping us provide a significant eco-contribution through PC energy efficiency. Garnering energy and financial savings from the desktop provides an opportunity for an immediate impact. ”

Gary Thomas, Head of IT Operations at Irwin Mitchell

4. Communications without travel – An organisation making good use of communications technology to reduce travel to meetings.

Organisation: Pearson plc

Service / product provider: Teliris Virtualive®

Pearson is an international media company with more than 29,000 employees based in 60 countries. They invested in the Teliris Virtualive® system to connect their main offices in London and New York.

The main benefits to Pearson of using the telecommunications system have been:

- Quicker and more flexible decision making because senior executives can meet, across the world if necessary, within minutes;
- Senior executives waste less time travelling;
- Substantial reductions in cost and carbon footprint have been made because fewer flights are necessary. Pearson has estimated that virtual meetings have helped them save more than 800 tonnes of CO₂;
- Some people prefer not to travel frequently with work, so staff are able to choose the option that best suits their work-life balance.

The introduction of telepresence software has had a major impact on how Pearson communicates. It is regularly used by senior executives for day-to-day meetings. Eight out of ten Management Committee meetings, which bring together senior executives, are now held virtually, whereas previously they were all face-to-face.

“ Green IT is a key part of our IT strategy within Pearson. Teliris telepresence is a great example of a solution that has made a big difference to the working practices of our senior executives as well making a significant contribution to our environmental goals. ”

Steve Scott, Technology Services Director, Pearson plc

5. Energy efficiency through behaviour change

– How the human aspect plays a part in improving energy efficiency.

Organisations: Construction Skills and Britannia Building Society

Service / product provider: Global Action Plan

Although technical solutions can help individuals to work more efficiently, employee behaviour is a vital consideration when aiming to reduce an organisation's environmental impact.

Individual employees have control over many ICT decisions during their daily work, such as whether to turn off equipment, print documents or save files and e-mails. Engaging staff in good environmental practices will benefit the organisation, employees, their families and the community.

Through running the staff engagement programme *Environment Champions* over the last ten years, Global Action Plan has enabled organisations to reduce the amount of energy wasted by ICT equipment. In this programme, groups of volunteer employees known as Champions identify areas of energy wastage within the organisation before running a communication campaign to encourage more energy efficient behaviour among their colleagues.

Construction Skills

One such group of Champions was established by Construction Skills in 2006 (then known as the Construction Industry Training Board). The Champions calculated that 10% of computers and 24% of monitors were left on over lunch and out of hours, wasting around 26,000 kWh and £2,000 of energy and emitting 14 tonnes of CO₂ each year.

The Champions illustrated the emissions from leaving one monitor on for an hour (about 40 litres of CO₂) by tying bunches of 8 party balloons to monitors around the site.

This was coupled with the introduction of an energy league for different departments. In random spot checks, Champions left green stickers on equipment turned off and put red stickers on equipment needlessly left on. This element of friendly competition particularly inspired managers, who rigorously promoted energy efficiency to their teams to avoid coming bottom of the league.

The Champions reduced PC and monitor energy waste by 58%, saving 15,000 kWh, £1,200 and eight tonnes of CO₂ – substantial savings considering that there were only around 90 individuals who were not turning off their PCs in the first place.

Britannia Building Society

There are more than 250 branches of Britannia Building Society in the UK, each with typically 5 to 15 staff members who have a substantial level of independence and control over the use of their ICT equipment. The branches have a range of equipment, from computers to kitchen dishwashers to TVs, which were not being used efficiently. There was one proviso – that PC base units should never be turned off.

Working with Global Action Plan, one Champion from each branch was trained and supported to address energy efficiency issues. After energy efficiency was encouraged, 62% of printers were turned off by staff. In a year across the network this saves 425,000 kWh, 222 tonnes of CO₂ and £34,000.

This case study highlights the importance of clear and well communicated guidelines on ICT equipment, to not only explain what should be left on, but also what should be turned off, and when and how this should be done.

THE FUTURE TRUTH

The illustrated case studies are a welcome step in the right direction. However, more profound and rapid change is required to achieve the reductions in CO₂ emissions that scientists tell us are necessary to avoid runaway climate change.

Practical action is required from all stakeholders to achieve the level of change required. Based upon the findings of An Inefficient Truth, Global Action Plan has issued the following call for action.

Central Government

Central Government must create a scenario in which ICT departments are incentivised and guided to implement

'Green IT'. New legislation will be required to encourage ICT vendors and users to be more energy efficient. Equally, the Government must be careful not to introduce legislation that will unnecessarily increase the data storage burden.

“ We need a strong policy framework that creates a long-term value for carbon-emission reductions and consistently supports the development of new technologies⁽⁷⁵⁾. ”

As stated by the Corporate Leaders Group on Climate Change: Central Government must create a more robust response to the energy supply and security challenges facing the UK. The growth of organisations is being restricted by lack of energy supply and some organisations are starting to move their data centres overseas to address supply problems in the UK. These energy demands must be met by lower carbon energy supplies.

Vendors

Vendors must improve the transparency, accuracy and quality of the environmental information that they are providing to users. The wave of green froth coming from vendors must be replaced by recognised industry standards. This was rated by users as one of the two most important incentives required to encourage the take up of 'Green IT'.

User organisations

Organisations must ensure that ICT departments are integral to their sustainability strategies. Used creatively and efficiently, ICT could significantly help organisations to reduce their environmental impact, for example through the increased use of technology to reduce the need to travel.

Structures should be set up to make ICT departments more accountable for their energy costs. This will encourage ICT managers to place greater emphasis on energy efficiency, better cooling systems, increased server utilisation and environmentally conscious purchasing decisions.

ICT departments need to up their game regarding the quality of their environmental communication to employees. Significant savings can be achieved through simple changes of behaviour within the workplace and ICT departments are well placed to encourage these changes.

(75) <http://management.silicon.com>, Climate change is costing us money, says BT

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