Assessment of Potential for Energy Savings from PC Software Management

NATIONAL ENERGY FOUNDATION

CONTENTS

1. Executive Summary

Global climate change is now known to be a serious threat, with firm evidence of shifting climate patterns, melting ice-caps and rising sea levels. The UK Government has committed itself to a series of policies to reduce emissions of Carbon Dioxide (CO_2) the main "greenhouse gas" contributing to climate change. The main cause of the increase of CO_2 in the atmosphere is the burning of fossil fuels - often to generate electricity. Demand appears to be ever-increasing, and the growth in numbers of personal computers (PCs) has been a significant driver of this demand. But much of energy used by PCs is wasted, powering machines that are not in use, left on overnight and illuminating only an empty office. This energy could be saved, producing an immediate benefit for both the environment and the computers' owners, in terms of lower CO_2 emissions and lower electricity bills.

The National Energy Foundation (NEF) was commissioned by 1E to review the current UK environmental agenda in relation to IT, business and government, including background context such as UK energy efficiency targets. Taking advantage of commissioned research into the percentage of UK workers who fail to properly shut down their computers at night, and the motivations behind this behaviour, this report also seeks to quantify the cumulative energy that is wasted by predominantly large companies and the UK as a whole over the course of a year and estimates the financial cost to a typical large company and the UK as a whole.

The market research suggests that over 40% of the UK adult population regularly use a PC at work, and that as many as one-sixth of computers are never switched off at night or weekends, with a further seventh not switched off on some days each week. Our estimates, based on the market research findings and available data on PC energy consumption, is that use of a product such as 1E's NightWatchman® to switch off networked PCs centrally could save up to 1.5TWh (1.5 billion kWh) per annum, with a value around £115 million. In carbon dioxide terms this would equate to potential savings of 700,000 tonnes of CO_2 (equivalent to almost 0.2MtC). This single action could make a significant contribution to UK national targets.

2. Introduction

Global climate change is now agreed to be a serious threat. Accumulating evidence of rapid changes to weather patterns and changes to sea levels shows that the time to discuss whether or why global climate change is taking place must come to an end. Instead, urgent action is needed by the UK, and other Governments, to set in place tools and policies that will lead to a rapid reduction in the levels of emissions of the main greenhouse gases. The main greenhouse gas is, of course, carbon dioxide, and it is this gas on which most effort can, and must, be focused.

The main cause of the increase in Carbon Dioxide concentrations in the atmosphere is the burning of fossil fuels, releasing carbon into the atmosphere that has been stored for tens of millions of years. Much of the fuel is required to generate electricity, the demand for which seems to be ever-increasing, as there is an increasing penetration of appliances in both homes and businesses. In particular, small PCs have grown from a curiosity just 25 years ago to a ubiquitous and essential tool in workplaces across the world. In the UK alone, we estimate that there are over 10 million PCs in active service in workplaces. All these PCs use electricity and are responsible for CO_2 emissions from Britain's power stations. Much of this energy is wasted, powering machines that are not being used, left on overnight and illuminating only an empty office. This energy could be saved, producing an immediate benefit for both the environment and the computers' owners, in terms of lower CO_2 emissions and lower electricity bills.

The National Energy Foundation has been commissioned by 1E to review the current UK environmental agenda in relation to IT, business and government, including background context such as UK energy efficiency targets. We attempt to tie these in to the morass of Government reports, programmes and reviews, to identify how grand ideas about reducing the risks of climate change are being implemented into real policies. We also look at how the humble PC can have a significant impact on energy saving through sheer numbers.

Taking advantage of commissioned research into the percentage of UK workers who fail to properly shut down their computers at night, and the motivations behind this behaviour, this report also seeks to quantify the cumulative energy that is wasted by predominantly large companies and the UK as a whole over the course of a year and estimates the financial cost to a typical large company and the UK as a whole.

3. Context

3.1. Global Climate Change

3.1.1. Evidence for Climate Change

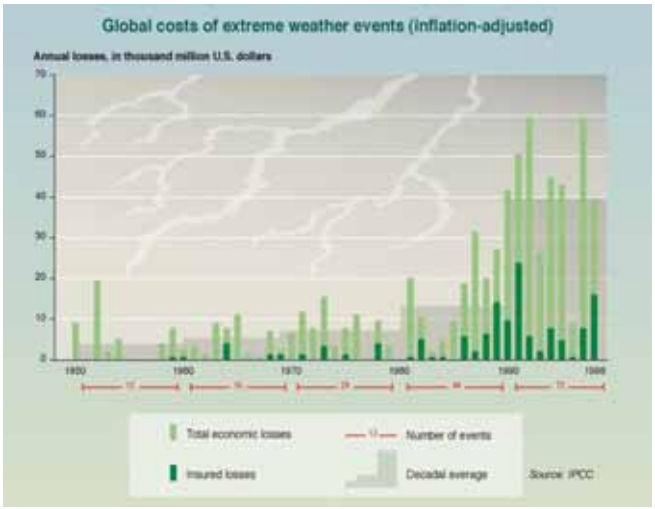
Recent years have seen a huge rise in the number of abnormal weather events. These have included summer droughts, flooding in Yorkshire, the Severn Valley and East Sussex, and even a number of small tornados in Southern England. Meteorologists agree that these exceptional conditions are signs that global climate change is happening. Scientists agree that the major cause of the changes are man-made emissions of the so-called "greenhouse gases" that can trap heat in the earth's atmosphere in the same way that glass traps heat in a greenhouse.

Although there are six major groups of gases that contribute to global climate change, the most common is Carbon Dioxide (CO_2). Of course, if there were no greenhouse gases at all, the earth would be so cold as to be uninhabitable, but the current concern is due to the fact that man-made emissions have led to atmospheric concentrations of CO_2 that have not been seen on earth for hundreds of thousands of years[1], and that periods of abnormal warmth can be correlated closely to periods with high CO_2 levels.

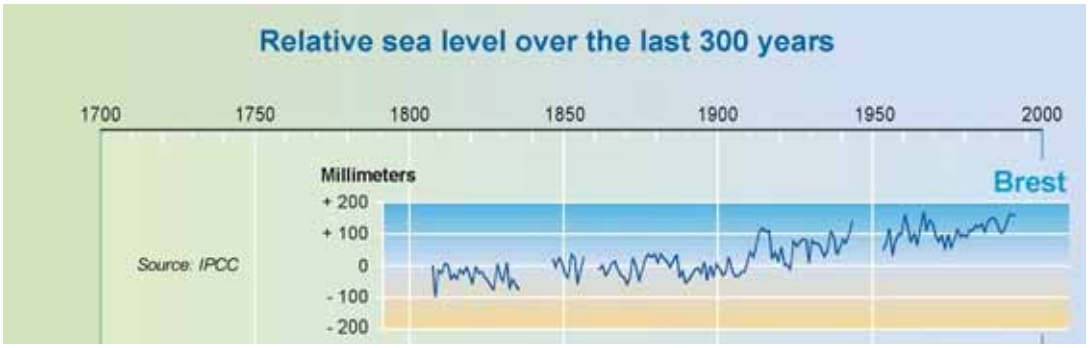
Evidence for climate change can be found across the globe, but especially in colder or Arctic regions. Glaciers are receding in the Alps and the Andes and ice caps have been lost from mountains like Kilimanjaro; there has been a significant loss of the Antarctic ice-shelf[2]; Arctic sea ice has thinned by 40% and global snow cover has decreased by 10% since the 1960s; and permafrost is melting in Siberia (which in turn is releasing significant amounts of methane – an even more powerful greenhouse gas – into the atmosphere). In warmer climates, the exaggerated cycle of drought and floods in parts of Africa and, putatively, the increase in hurricanes in the Southern USA[3] can also be attributed to climate change. And back in the UK, changes to growing seasons and the distribution of certain native species again lends evidence to a warming climate.

3.1.2. Possible Effects of Unchecked Climate Change

Although the current effects mentioned above are significant, they are not by themselves earth-shattering, and would probably only require a limited response by governments and individuals. However, they only represent the start of a likely series of changes, which are expected to include:



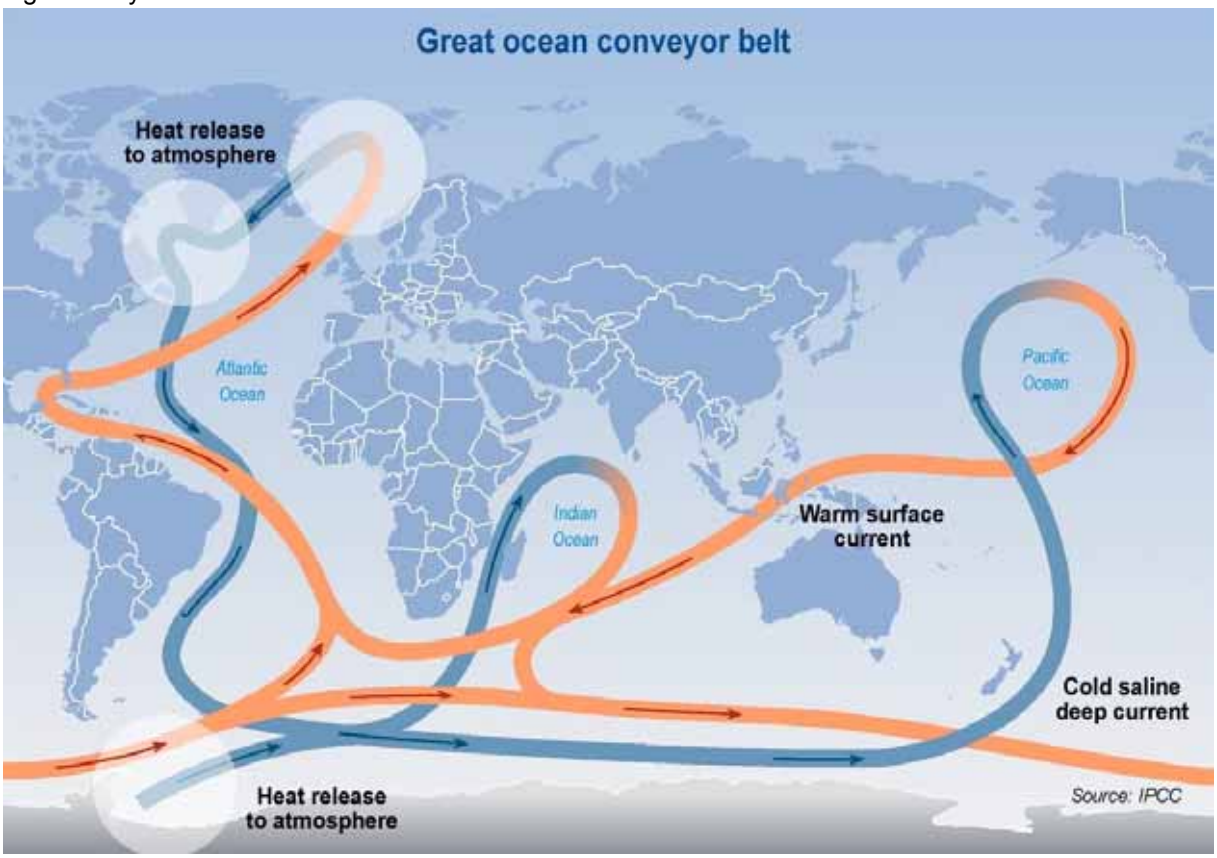
- Further severe weather related events (droughts, floods, storms, etc.) with a consequent huge financial cost: annual costs have reached $100 billion in recent years;
- Global sea level rises caused by melting ice-sheets, leading by 2100 to inundation of many of the most productive coastal plains, and large scale displacement of persons in low lying countries such as Bangladesh;



Sea Levels have been rising in Northern Europe for over a century, but are predicted to do so at a much faster rate in the future due to more rapid loss of ice sheets. Brest is used as an example of changes in the North Atlantic (Source: IPCC)

- Loss of habitat and biodiversity, affecting both wild species but also some of the major food crops (such as rice);
- Northward spread of some diseases and pests, potentially including malaria.

One extreme effect, about which there is still considerable uncertainty, is the possibility that decreasing salinity in the Northern oceans due to the melting of the ice sheet could cause the Gulf Stream (the "Great Atlantic Conveyor") to weaken significantly or even reverse. This could lead to a relatively sudden (some scientists predict over a period of 20 years or less) drop in temperatures in North West Europe including the UK, while at the same time the rest of the globe continues to warm significantly.



IPCC's diagram of the Great Ocean Conveyor Belt system, including the Gulf Stream warming NW Europe.

3.1.3. History of Awareness of Climate Change

Scientists have been aware of the greenhouse effect, by which carbon dioxide traps heat in the earth's atmosphere for over a century[4]. Arrhenius, in late 19th century, observed that changes in the atmospheric concentration of CO_2 could be responsible for changes in the earth's temperature that led to the succession of ice ages. But it was only in the 1970s that scientists started making the link between human actions, specifically the burning of fossil fuels to generate power, light, heat and in transport, with the possibility of large and disruptive changes to the earth's climate in a relatively short timescale.

Recognising the problem of potential global climate change, the World Meteorological Organization and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. This body, based in Geneva, assesses the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. The IPCC does not carry out research itself. Much of the basic research and data collection research has come from US Governmental institutions such as NASA and the various agencies of the US Department of Energy, although in the UK the Hadley Centre at the Meteorological Office, the Tyndall Centre (at Norwich/Manchester) and Oxford's Environmental Change Institute all have global reputations.

Global climate change, as a phenomenon, only entered the wider public sphere after the "Earth Summit" in Rio in 1992. Since then, most Western Governments have recognised that the risks associated with climate change are sufficient to require detailed policy responses, but much of this has been aimed at encouraging voluntary action by citizens, with less urgency being given to mandatory standards.

3.1.4. International Cooperation and Action

Following on from Rio, Governments across the world met in a series of Climate Change Conferences and set targets for the reduction of emissions of CO_2 from burning fossil fuels. The main international agreement is known as the Kyoto Protocol (after the 1996 Conference venue), under which certain industrialised nations agreed to a cap on their emissions of CO_2.

Under Kyoto, the EU committed to reducing average CO_2 emissions from the 15 member states by an average of 8% below 1990 levels by the period 2008-12. The UK Government accepted a higher Kyoto target of 12.5% savings across all greenhouse gases and at one stage set itself an even tougher non-binding target of cutting CO_2 emissions by 20% by 2010. Although most European countries have been working hard towards achieving their Kyoto targets, they only came into force in 2005 after Russia ratified the agreement.

It is true that some large emitters of CO_2 in the developing world, notably China and India, were not set targets under Kyoto, and that Australia and the USA have refused to ratify the protocol, despite signing it initially. Nonetheless, countries expected to make over half the savings have implemented the protocol, and it is expected that the follow-on agreement will include most of the large developing countries. In all, over 150 countries have ratified the agreement.

3.2. UK Government Response

Successive UK Governments have been strong supporters of the Kyoto process, and have committed the UK to domestic targets that exceeds those agreed as part of Kyoto. The UK Government lacked a formal Energy Policy, having relied instead on the market to deliver a competitive and efficient energy sector, overseen by a regulator (Ofgem[5]). Recognising that there were some imperfections in the ability of the markets to deliver energy savings, the Government supported the establishment of the Energy Saving Trust in 1993 and, following the introduction of the Climate Change Levy in 2001, the Carbon Trust. The latter body addressed the need to improve energy efficiency in industry, commerce and the public sector, and to some extent replaced the work that had been done within the Building Research Establishment (BRECSU) and Energy Technology Support Unit (ETSU) prior to their privatisation.

The Climate Change Programme and RCEP Report
In November 2000, the Government published its Climate Change Programme[6], partly as a response to the Royal Commission on Environmental Pollution's report into "Energy – the Changing Climate[7]" earlier in the year. The RCEP report had for the first time accepted that there was a real need for deep cuts in CO_2 emissions, and set out a timetable for reduction of UK CO_2 emissions by 60% by 2050. This target has since been adopted by the Government in most actions on Climate Change and Energy. The RCEP report also indicated the importance of office equipment in energy demand, noting that "the amount of electrically powered equipment used in offices, particularly computers…has been growing very rapidly and is expected to continue to do so…In offices, 10% of final energy use is devoted to computers and other information technology equipment.[8]"

The Climate Change Programme provided strong analysis of the issues, and set targets for the reductions of CO_2 emissions by business. These were:

Measure	Carbon Savings (MtC)
Climate Change Levy, including CHP and renewables	2
Climate Change Agreements with energy intensive sectors	2.5
Energy Efficiency measures under the CCL package agreed with the Carbon Trust	0.5
Voluntary reductions targets through the first stage of the Emissions Trading Scheme	At least 2
Reform of the Building Regulations in England & Wales	1.3 (incl. domestic)

In practical terms, the CCP report mainly focused on the effects of the Climate Change Levy and establishment of the Carbon Trust. These were coupled with the introduction of Enhanced Capital Allowances (ECAs) for companies investing in approved energy saving investments, but IT equipment has not generally been able to take advantage of these allowances.

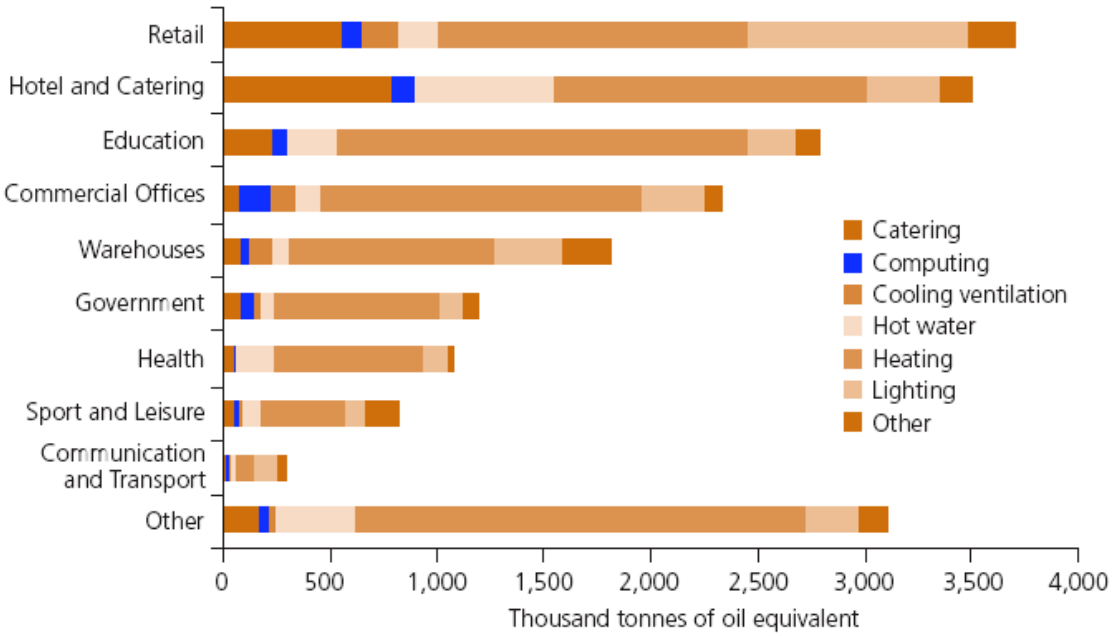
The Carbon Trust does provide some advice and information on office equipment, such as PCs. It continues to distribute some of the old Best Practice Guides and associated documents, although since the demise of its Action Energy Programme, many of these have gone out of print. At the time of writing it appears that only some relevant documents are available, including GPG 118 "Managing Energy Use: minimising office equipment and air-conditioning costs" and ECG 019 "Energy Use in Offices". The trust has introduced a new booklet "Office Equipment: Introducing energy saving opportunities for business[9]", but this is considerably less technical than some of the earlier documents. It does offer some quick wins – noting that older screens consume an average 85W and so should be switched off when users are away from their desks, and encourages IT departments to establish a policy to activate standby modes. The Trust calculates that a single computer and monitor left on 24

hours a day will cost around £45 a year[10]. It also addresses the myths that screen savers save energy and that leaving a computer on uses less energy than switching it on and off.

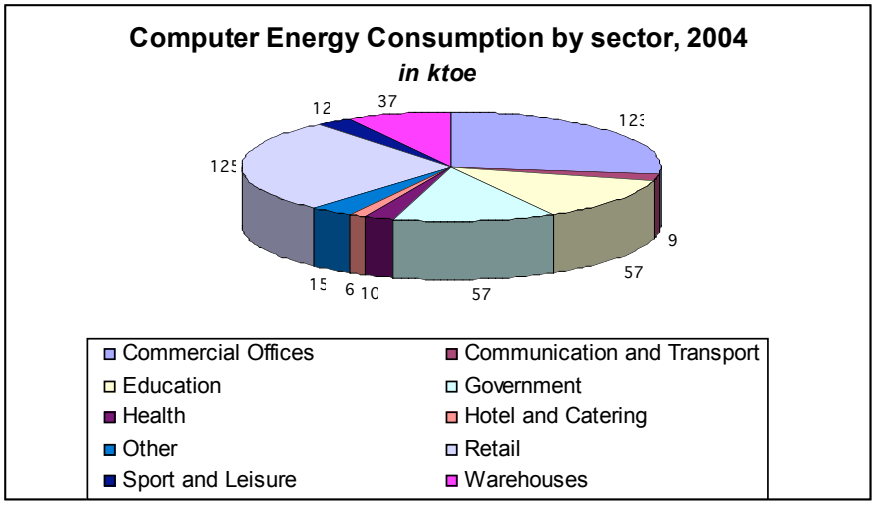
The Energy White Paper and Energy Efficiency Action Plan
The next major step was in 2003, when the Government published its Energy White Paper[11], in effect creating a formal national energy policy for the first time for over 20 years. Although reasonably comprehensive, the White Paper was criticised for a lack of firm actions, and this was especially true in the area of computers and IT equipment. It committed the Government to "push in Europe for higher energy efficiency standards in tradeable goods such as fridges and personal computers[12]", and later referred to promoting Energy Star standards and encouraging greater energy efficiency in public procurement of IT equipment[13]. But otherwise, the White Paper seemed to downplay the importance of non-domestic use appliances such as computers, noting only that increasing personal use at home was growing rapidly.

The 2003 White Paper spawned a whole range of subsequent policy documents, of which the Energy Efficiency Plan[14] (2004) is probably the most important. This correctly identified the importance of energy consumed within the services sector, including the public sector – see chart below. Among the policy options considered, but rejected, was the extension of the Energy Efficiency Commitment (EEC) to businesses. The EEC requires licensed domestic gas and electricity suppliers to make a certain level of energy savings among their customers, through grants and other support schemes. This decision may represent a missed opportunity, especially as SMEs with energy bills below £50,000 (which will include many office-based businesses with a significant energy spend on IT) fall outside the remit of either the Energy Saving Trust or the Carbon Trust. Once again, the Government placed emphasis on procurement policies in the public sector, and on using Energy Star as a marketing tool, while relying on voluntary agreements at an EU level to help deliver more efficient equipment into the market.

The Government's continuing faith in Energy Star as a marketing tool may deserve some analysis and is considered in section 3.3 below.



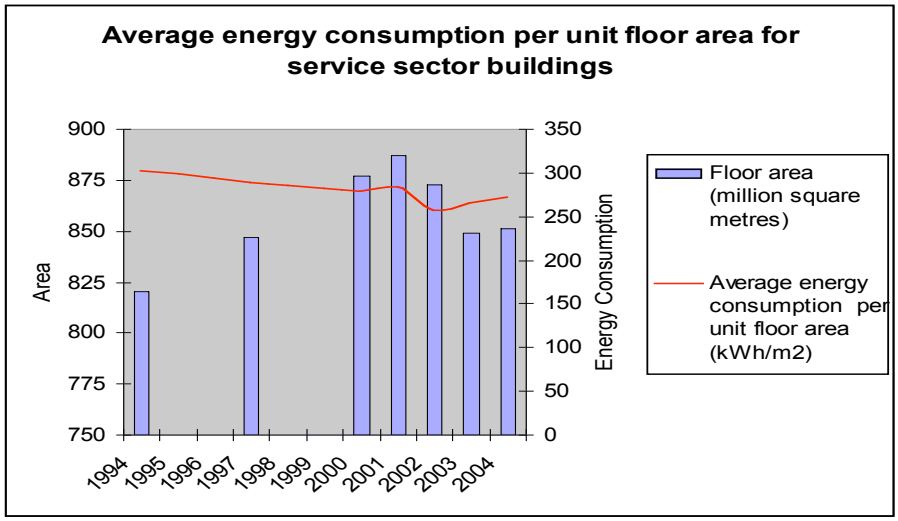
Energy Consumption for service sector buildings by end use, 2000[15]
Source: Energy Efficiency: The Government's Plan for Action (re-drawn to highlight computing)



Note: 1 ktoe = 12 x 10^6 kWh *Source DTI (from BRE)*

The data in the chart above relates to 2004, and shows an estimated total computer energy use of 451ktoe (approximately 5.4 million MWh). This excludes computer energy use in industry, including offices directly associated with industrial plants, but includes use on mainframes, data servers, and in all peripherals.

The same source shows how overall energy consumption per square metre in the service sector fell in the 1990s, but has since fluctuated in the first half of the current decade. The UK average achieved energy consumption in excess of 250kWh/m^2 per annum should be compared with a good practice figure[16] (for naturally ventilated offices) of 130kWh/m^2 and achieved net energy consumption, for example, in the National Energy Centre North Building[17] of just 55kWh/m^2.



The 2006 Energy Review

In the 2006 Energy Review[18] the Government identifies that appliances, including computer equipment, are a major contributor to CO_2 emissions, which in turn are the main UK contributor towards Global Climate Change. Of 2004 emissions totalling 151.0MtC (million tonnes of carbon equivalent), 43.1MtC (35%) came from residential users. And of these, an estimated 9.5MtC (22%) were attributable to lights and appliances[19]. The Review expects that conservatively this domestic use will rise by a further 20% by 2020, largely due to greater penetration of devices such as computers and gaming consoles. Consequently, the Review has identified five groups of products for action, one of which is described as "office equipment", such as computers, printers and photocopiers[20].

The Energy Review also draws attention to the specific issue of standby losses, noting that in 2004 an estimated 8% of residential electricity consumption was used on standby, and that the proportion was rising. In the medium term, the UK government is seeking to reduce this through two international programmes of cooperation and one domestic initiative:

- The International Energy Agency's 1 Watt initiative to reduce standby power
- Promoting high product standards under the EU framework directive on the Eco Design of Energy-Using Products (EuP)
- The "Retailers Initiative" announced in the 2006 Budget, under which major retailers will be encouraged to work with the Energy Saving Trust to introduce voluntary schemes to raise the energy efficiency of the goods that they sell, with an initial focus on consumer electronics.

However none of these initiatives will affect the current stock of appliances, nor will they have a short term effect. In the longer term, the Government hopes to avoid (rather than reduce) CO_2 emissions equivalent to 1.3MtC by 2010 and 4.7MtC by 2020[21].

3.2.1. Leading by Example

At several places in the Energy Review, the Government states its intention to lead by example, and has set itself the ambitious (and in our view misleading[22]) target of delivering carbon neutral central Government by 2012. As part of this commitment, The Government has also set an aspirational target to reduce carbon emissions from central Government buildings by 30% by 2020[23]. Nonetheless, these targets are supported by real policy initiatives that will help, as the Government (including local authorities) brings strong purchasing power to drive up energy efficiency standards. In particular, Government will focus on procurement, and – for central Government departments – develop mandatory energy efficiency and sustainability standards for goods and services, including for IT[24].

In practical terms this will mean that the Government will:

- Set and periodically raise ambitious energy efficiency standards for Government procurement of goods and services, adopting global best procurement standards for energy use wherever cost-effective;
- Extend, publish and maintain a list of forward-looking Government sustainable product standards (currently the 'Quick Wins' and other procurement guidance) to encourage market innovation and stimulate competition amongst suppliers to bring forward improved buildings, goods and services that are good value for money.

The Office of Government Commerce estimates that Government can reduce energy use by 10% through behavioural change to reduce waste and a further 5% through use of more energy efficient products and services. As an example, it estimates that, if central Government were to procure only products meeting current best practice in energy efficiency, it could cost effectively save about 40,000 tonnes of carbon per year from its use of IT equipment and lighting. Even more important will be the demonstration of the effect to business; the leverage effect of UK Government procurement power; and the dynamic effects on producers through the forward commitment – which will encourage the market to develop better performing products.

3.2.2. Backbench Parliamentary Pressure

For several years, there has been a strong backbench lobby in support of improving energy efficiency and encouraging more sustainable energy supplies. Backbenchers have successfully pilot a number of energy bills, starting with Diana Maddock (now Baroness Maddock) who was responsible for the Home Energy Conservation Act in 1995.

Most recently, the Climate Change (Commercial and Public Services Sector) Bill has been introduced into the house with the backing of, among others, the Conservative MP for South Suffolk Tim Yeo - Chairman of the Parliamentary Environmental Audit Committee. This Bill is specifically aimed at reducing carbon emissions from offices.

Mr Yeo is quoted[25] as saying "The offices sector has the fastest growing energy use apart from aviation. With the proliferation of computers and other electronics, its use of electricity, which has a

particularly high carbon footprint, is projected to increase by nearly 45% from 1990 to 2020. The Bill will set legally binding targets for reducing energy usage in the commercial sector and further targets for energy production from renewable sources, combined heat and power, and microgeneration. We hear lots about how everyone should use less energy at home but what happens in offices is just as important. This Bill would be a big step in the right direction. To back it up the Government should give discounts on the business rates to those offices which minimise their carbon emissions. The need for urgent action to cut our carbon emissions is greater than ever. The Government has rightly acknowledged that we need to do a lot more if we are to meet our climate change targets of a 20% reduction in CO_2 emissions by 2010." Among the groups supporting the initiative are Campaign for the Protection of Rural England, Friends of the Earth, the Green Party, Greenpeace, Help the Aged, National Federation of Women's Institutes, the trade union Unison, and WWF-UK. Other sponsors of the motion include two Labour former environment ministers, Michael Meacher and Elliot Morley and the former Conservative Environment Secretary, John Gummer."

3.3. The Market Transformation Programme

The Market Transformation Programme (MTP) is the UK Government's main initiative on reducing energy consumption in appliances, and supports the development and implementation of policy on sustainable products.

MTP reduces the environmental impact of products across the product life cycle by:

- Collecting information. Stock, sales, usage and resource consumption data is gathered on household and industrial products, such as televisions, fridges and electrical motors.
- Building evidence. The information gathered is used to model how products will evolve in the market place and to estimate future environmental impacts.
- Working with industry and other stakeholders. A common understanding is reached on how these impacts can be mitigated; action plans are agreed and the measures implemented.
- Working with partners in other countries to develop internationally applicable standards for traded goods.

The Market Transformation Programme produces Policy Briefs in support of the first of these functions, segmenting the market for information and communication technology (ICT) into domestic and non-domestic activities.

3.3.1. MTP Data on Non-domestic ICT energy consumption

The Market Transformation programme (MTP) aggregates all energy consumed by ICT equipment, with the exception of server and data centres[26]. This includes desktop personal PCs, monitors, laptop PCs, and commercial imaging equipment including printers (impact, laser, inkjet), photocopiers, and multi-functional devices (MFDs). According to the MTP, non-domestic ICT equipment was responsible for over 7% (16.5 TWh) of non-domestic energy consumption in 2004 (excluding servers and data centres). Non-domestic electricity use by ICT equipment has increased by over 70% between 2000 and 2006. On a business-as-usual scenario, non-domestic ICT consumption is expected to continue to increase by a further 40% between 2006 and 2020. Reasons for this continuing growth in consumption include expected increases in equipment functionality and networking capabilities, and barriers to the ability of the PC to enter low power consumption modes such as sleep. These will be offset, to some extent by more efficient design of equipment, especially in the trend towards laptops and LCD screens.

MTP Energy Consumption Model

The MTP model for non-domestic ICT appliances covers the following product groups:

- Desktop PCs
- Monitors
- Laptops

- Imaging equipment: printers (impact, laser, inkjet, thermal), photocopiers and multi-functional devices (MFDs)

In creating the scenarios shown in the MTP Policy Brief, the programme considers a baseline scenario (business as usual) including current trends and technology development plus existing UK policy measures, as well as two increasingly interventionist policy scenarios (P2 and P1), as well as an Earliest Best Practice (EBP) scenario representing the theoretical earliest possible take up of Best Practice.

MTP's approach to estimating energy consumption is based on a stock model with variables of:

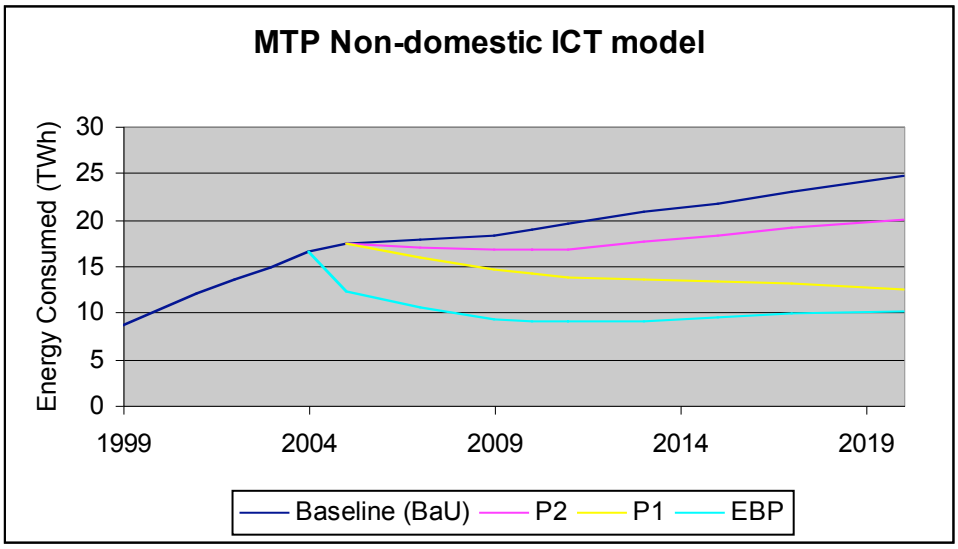
- units per employee, per square metre or per PC (for peripherals). Basic PC numbers are drawn from published data sources such as National Statistics, with new sales drawn from the industry and analysts' reports (such as those from Datamonitor). MTP note (and NEF concurs) that sales data for the non-domestic market can be "very scarce[27]"
- electricity consumption in various modes of operation
- daily average usage profile for each mode of operation

Savings in the non-domestic sector are estimated based on change in use of products (due to improved enabling rates), changes in energy consumption of new devices, and trends towards more energy efficient products.

The 'enabling rate' of power management features relates to the ability of a device to enter lower power consumption modes when not in active use, such as sleep. MTP note that PCs, monitors and Laser/MFD printers are more likely to have power management functions disabled (or at least not enabled) by end users. The model therefore applies varying 'enabling rates' to these products. Most other ICT products are assumed to have power management features enabled.

MTP Estimates of Energy Consumption

The non-domestic reference scenario predicts consumption of 18.4 TWh by 2010 and 24.6 TWh by 2020. The policy scenario (P1) accounts for considerable improvements in power management and consumption improvements (including addition of on-mode criteria to the Energy Star label for office equipment). This scenario reduces consumption to 13.9 TWh in 2010 and 12.4 TWh in 2020 – savings of 24% and 50% respectively. The Earliest Best Practice (EBP) Scenario models an immediate shift towards more energy efficient products accompanied by very high enabling rates, resulting in a 2020 consumption of 10.1 TWh - a saving of 61% on the reference scenario[28]:



The key point here is the assumption that by vigorous implementation of improved policies, it will be possible to achieve a step-change reduction in energy consumption. This assumes that, by some means, power management could be simultaneously implemented across the PC population: and this is indeed what products such as 1E's NightWatchman® seek to achieve.

The energy savings that are implicit in the MTP model on the full implementation of best practice are in the region of 5.3TWh per annum, or around 30% of the 2004 baseline value. This would be equivalent to annual savings in emissions of almost 2.3MtCO_2 per annum.

Implementation of software such as 1E's NightWatchman® would not by itself achieve all these savings, as it would only affect PCs and monitors, and not generally other equipment such as printers or copiers. But as the MTP itself notes, the latter equipment is already more likely to have power saving enabled as its factory default, and not to have been overridden by users. The savings available would also only apply to those in larger organisations, and to not to SMEs lacking a central IT function. For this reason we would discount the savings by around 50%.

MTP specifically note "***Power Management****: Power management enabling is currently very poor and will not improve drastically without intervention. A value of 5% enabling is assumed in 1999, and a figure of 6.6% is used for 2005 based on Energy Star figures from 2005 stating rates of between 6 and 7%. It is assumed that the rate of power management gradually increases into the future based on the trend between 1999 and 2005. The policy scenario assumes a linear increase in enabling rate towards 40% in 2020, whilst the EBP scenario shows the effect of 95% power management enabling being achieved immediately*[29]".

Non-domestic usage (hours)	Sleep	Mains Off	PC Off	On but Idle
1997 PM* enabled	6.12	0	15.48	2.40
1997 PM* not enabled	0	0	15.48	8.52
2005 PM* enabled	4.55	0	13.90	5.55
2005 PM* not enabled	0	0	13.90	10.10

MTP's assumption of mode are set out above. Note that it is assumed that non-domestic PCs are never switched off at the plug (unlike domestic PCs) and so would be accessible from a central server.

3.3.2. Energy Star

The UK Government has in most of its consideration of appliance energy efficiency (and in particular PCs and associated peripherals) laid great emphasis on Energy Star standards.

The Energy Star programme was instituted in 1992 by the US Environmental Protection Agency (EPA). It initially focused on office equipment, including PCs and monitors, although it has since expanded to a wide variety of business and consumer appliances, including items as diverse as battery chargers, humidifiers and vending machines, as well as to new homes. Nonetheless, the heart of the programme remains based around office equipment, and Energy Star standards are de facto standards for much of the world's production of PCs and peripherals, given the importance of the US market.

Energy Star IT specifications currently only relate to them in standby or sleep modes, and not in operational consumption. Moreover, it is not a requirement of Energy Star that equipment is shipped with power management enabled, which again reduces its effectiveness (and increases the potential benefit of a centralised power management activity). Energy Star is also a self-certification process, so not all labelled equipment has necessarily been tested by third parties to meet the requisite standards.

Computers

Energy Star claim that certified computers use 70% less electricity than computers without enabled power management features. If left inactive, Energy Star qualified computers must enter a low-power mode and use 15 watts or less[30]. Additional benefits for operating in this mode include the avoidance of the need for cooling, and that spending a large portion of time in low-power mode not only saves energy, but helps equipment run cooler and last longer.

New standards are due to be introduced from 2007[31], which, based on the latest draft, will include separate minimum standards for standby (off mode), sleep (automatic power down) and idle (in use, but not actively processing or retrieving data):

Maximum Power Consumption	Standby (off mode)	Sleep	Idle state (category A)	Idle state (category B)	Idle state (category C)
Desktop	2.7W	4.0W	50.0W	65.0W	95.0W
Notebook (laptop)	1.7W	1.7W	14.0W	18.0W	n/a

Categories A, B and C essentially relate to the size of the memory, with most current PCs falling into category B (over 128Mb memory). Vista will probably elevate the average office PC into category C.

Monitors

An Energy Star qualified computer monitor should use up to 85% less electricity than standard models. Monitors must already meet defined requirements in On, Sleep, and Off Modes in order to earn the Energy Star; in On Mode, the maximum allowed power varies based on the computer monitor's resolution; in Sleep Mode, computer monitor models must consume 2 watts or less and in Off Mode, computer monitor models must consume 1 watt or less.

Over its lifetime, Energy Star qualified equipment in a single home office (e.g., computer, monitor, printer, and fax) can save enough electricity to light an entire home for more than four years.

Energy Star standards have in the past been criticised for focusing too much on one element – the sleep mode – without a real mechanism for ensuring that this mode was ever activated. The UK Government (and EU) are now more involved in the standard setting process and these standards are improving, so earlier criticism should die down with time.

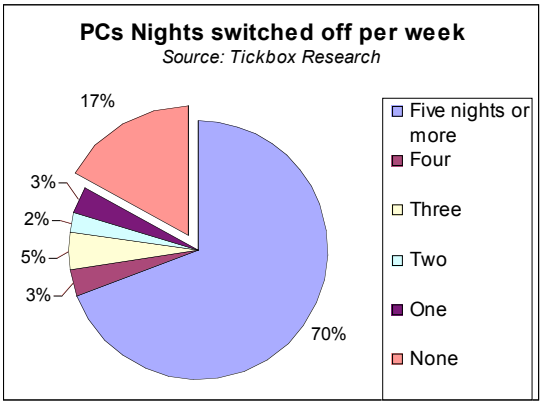
4. Behavioural aspects of PC users

1E commissioned independent research into the proportion of PCs that are switched off at night and the reasons why – or why not – PCs are switched off at night. The National Energy Foundation, in section 5, will attempt to relate some of this data into an estimate of effects of not switching PCs off when they are not in use.

4.1. Analysis of User Behaviour

The research commissioned[32] showed that 69% of workers claim to switch off their PC, whereas 16.9% admit that they never do so (although as noted in 4.2 below, there may be valid reasons for this), and that a further 5.9% (bringing the total to 22.8%) believe that they will leave it on for at least three nights per week on average:

4.1.1. Summary of research results: turning PCs off



1. Frequency of switching off their PC:
   a. 69.3% of people always do so
   b. 16.9% never do
   c. 22.8% leave it on for at least 3 nights per week
2. The main reasons for not turning off a computer are:
   a. 17.5% because it's a hassle
   b. 10.4% say no one else does
   c. 9.8% say it's not important
   d. 7.7% say they forget in the rush to leave
   e. 3.3% say they're out of the office and don't return
   f. 1.8% say they worry they'll lose work
3. The main reasons people do turn off their computer are
   a. 39.9% say they always have done
   b. 23.5% say it's company policy
   c. 17.2% say for security
   d. 6% say to reduce their company's carbon emissions
   e. 0.3% say it's because everyone else does
4. 87.7% say their boss never reminds them to shut down their PC

Generally, the results are relatively unaffected by geography, age or size of company, although there are some anomalies that are worthy of mention.

4.1.2. Demographic Analysis – Switching PCs off

Tickbox carried demographic research into switching habits, and the key finding is that men are slightly less likely to do so than women and significantly more likely to always leave their PC on (19.3% v. 15.2%). This

Break % Respondents	Base	Gender	
		Male	Female
Base	1233	503	730
Question 2			
Five nights or more	69.3%	67.2%	70.7%
None	16.9%	19.3%	15.2%
Three	4.7%	4.2%	5.1%
One	3.5%	4.4%	2.9%
Four	3.3%	3.0%	3.6%
Two	2.4%	2.0%	2.6%

may be that women are more concerned about costs or the environment, or perhaps that they are typically in more junior positions where they feel bound by a company policy to switch off. But given that in the qualitative research into reasons why they PCs are *not* switched off was that the PCs are shared (for example in a call centre), then it might be expected that the converse would be true – ie. that women would be less likely to switch their computers off. In other words, this fairly small percentage difference may hide a larger underlying difference in attitudes.

This is borne out by a supplementary question about reasons why people fail to switch off PCs; although from a small sampling base, men were much more likely to agree with the statement that it was "not something that I feel to be important" (13.3% of male respondents v. 6.9% of female), whereas women were much more likely to forget to do so through being "in a rush to leave" (10.1% v. 4.7% of men).

Tickbox's research into age showed that older and younger groups were both more likely to switch PCs off than those in the middle age bands, with those between 35 and 44 least likely to do so. However apart from the Over 55s, who appeared much less likely to leave their PC on every day (just 9.9% admitted to doing this), the age differences are probably not statistically significantly. When the supplementary motive question was matched against age, it revealed that younger people are more likely to see switching off PCs as a hassle, but older ones are (contrary to popular perception) less likely to forget to do it! However younger people were more likely to say that they always switched off their PCs as a matter of habit – possibly because they were less prepared to ascribe other motivations for it.

Dividing the research sample into size of organisation also revealed an unexpected result, as those in medium sized enterprises (50-249 employees) were more likely to switch off PCs than those in small or large ones. Possible reasons for this finding are that large organisations might have disproportionately more environments where PCs are used 24/7, or in a call-centre type of operation, and so impose a clear policy on PC use. Small organisations were shown to be much less likely to have a formal policy about what to do when leaving the office and also to be more concerned about security.

The boss's words may be less formal than a computer policy, but they can be important in smaller organisations. Although overall 87.7% of people claimed to have never been told to switch off the PC at night by their boss or manager, this fell to 77.9% in medium sized companies – too small for a formal policy, too big to rely solely on individual responsibility. (And in another surprising result, only those aged over 35 reckoned that they were told to switch off their computer "every night".)

Although there were notable differences between the regions, with the Welsh most likely to switch off PCs, but those in South-West or South-East England least likely to do so, it is less easy to attribute reasons for this behaviour. Respondents in London and Northern Ireland seemed least likely to have a company policy to switch off; and although the former case may be attributed to long hours of operation in the City, the latter can only be put down to a prevalence of smaller companies, less likely to have a policy. (Overall switch-off levels were quite low in Northern Ireland and, significantly, it was the only region to cite security as the most popular reason for doing so.)

4.1.3. Reasons why – or why not – PCs are switched off

Reasons to switch off…

The market researchers also collected the explanations as to why, or not, computers were switched off. Fewer reasons for switching off were collected than for not doing so (despite the greater prevalence of the former), perhaps as most had always done so (39.9%) or were following company policy (23.5%), thus feeling their actions needed little explanation. In one case, obeying company policy was graphically described as "Boss blows up if you don't!" and concerns about economy or safety were also high in the qualitative responses. Only one person linked safety with CO_2 emissions, noting that it was company policy to "save electricity and reduce emissions". However 6% of the

overall sample included reducing carbon emissions as one of the reasons why they switched PCs off at night.

Several people noted that they used a laptop and effectively had to switch it off before taking it home or putting it into a secure place. One person cited confidentiality and a couple of people were concerned that it might otherwise over heat or cause a fire risk. (The research had been carried out soon after the public admission from Sony that some its batteries installed into Dell or Apple laptops might constitute a fire risk).

…or not to switch off
Reasons for the converse action, leaving the computer on, were more numerous. The main reasons were simply the hassle factor (17%) and lack of peer pressure – or maybe an implicit company policy, as no-one else did (10.4%). 9.8% thought it to be unimportant.

The explanations given fell into three broad categories, plus a large number of more or less one-off reasons. The popular reasons were either that it was a shared PC, often used by a later shift or needed 24/7, or there was a company policy not to do so, or because the computer was believed to be needed for installing updates or running other functions when not in use.

Taking the last of these first, Windows xp does often give users a message about not switching off the computer because it needs to install updates, but that is only seen *after* the user has already told it to close down and in this case the computer will nearly always enter its "off" (standby) mode at the conclusion of the updates. Users polled may then have been expecting an IT department to come around and manually install updates. Linked to this was a belief that computers needed to be left on to install virus updates – without realising that almost all anti-virus software will install necessary upgrades when a machine is next on. (Another respondent seemed to believe that anti-virus scans only ran overnight.)

A variant on the "needed to run software" theme were the responses about where a computer was engaged in a background task, often linked to a downloadable screensaver. These users may have been public spirited in their Search for Extra Terrestrial Intelligence (SETI) in the past, but seem to have moved onto other public interest programs including searching for Mersenne primes and the World Community Grid. More related to business were those users whose PCs were linked to a network and hosted a shared printer. It would be interesting to discover in these cases what proportion of PCs would be switched off by a manager or administrator after the last user of the printer had also gone home. It does happen in some offices, and charitably may explain the comment that "Someone else does it".

Returning to the second main reason, company policy may seem strange, given the real financial savings that can be made in switching off PCs. It may be related to the comment made by one person that "[our] technician says it prolongs life of PC if it's not switched off"; another noted that "Old computer might not start back up!". This is largely an urban myth as in PCs failures are most frequently caused by the failure of the hard drive and this in turn is generally proportional to the period of running, and not to the number of times it is switched on or off. Indeed other components may also benefit from cooling down when not in use – as noted above Energy Star states that this is likely to prolong, not reduce, life. And monitor life – especially CRTs – is also extended by switching off.

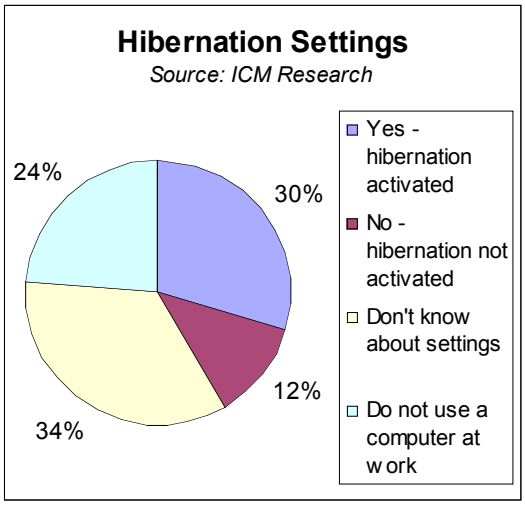
A more valid reason is that companies do indeed occasionally install bespoke updates, but in this case it should not be impossible to instruct users to leave PCs on exceptionally, rather than to set a default policy of leaving them on.

Among the lesser reasons, a couple of people expressed variations on "It's too slow logging back on in a morning", which must, I suppose be linked to the hassle factor. (But just how much hassle is it to switch off a computer).

4.2. Use of Sleep Mode (Hibernation)

Additional research was commissioned from ICM[33] into the prevalence of sleep mode, when computers will power down when not in use. The key finding was:

- 30% say hibernation mode is activated
- 12% say hibernation is not activated
- 35% don't know if hibernation is activated



At first, this data may appear surprising because it contradicts received wisdom that very few PCs actually have sleep mode activated. The Market Transformation Programme, in the research cited above, suggests that on average only 5-7% of desktops have power management enabled, although it is thought that (almost) all laptops will do so, because of the need to maximise battery life. The data sample included a mix of laptops and desktop PCs, so the net overall figure may reflect this.

It could be assumed that most people would know about it, if it were enabled, as they would periodically have to move the mouse (or hit the keyboard) to bring the computer back to life. However this may be a little misleading, as it may be that power management is quite widely enabled on monitors (where the change is immediately visible) but only rarely so on base stations. This would be much closer in line with MTP assumptions, who see 38% of monitors utilising power management. Of course, power management on monitors (where the screen will power down after a pre-set period varying between 1 minute and 5 hours, depending on how Windows is set up) is sometimes confused with the screen saver, which is almost universally used.

4.3. Demographic Analysis – Hibernation

ICM Research also carried out research into region, age, social class and working status. In contrast to switching off, which is essentially a simple process, there were large differences between men and women in identifying whether or not they used hibernation mode.

Based on computer users who work:	Male	Female
Yes - hibernation activated	44.6%	32.5%
No - hibernation not activated	29.0%	9.5%
Don't know about settings	34.4%	58.0%
Total Number of users	224	200

Essentially responses varied little with age or region, although AB social group users were much more likely to know whether they had hibernation enabled than those in groups D and E, as were full time workers compared to part time workers.

5. Analysis of findings

The National Energy Foundation has taken the findings in section 4 above, to come up with an estimate of the potential savings that could be gained as a result of the introduction of 1E's NightWatchman® software.

5.1. Electricity Prices

5.1.1. Background to Electricity Prices

Electricity prices have recently risen sharply in the UK and internationally, reflecting a number of demand drivers, but also responding to the rapid price rise in crude oil. This latter commodity has reached record peaks, due to higher demand from China and elsewhere in Asia, political uncertainty over supplies from the Middle East and Venezuela, and short-term supply problems into the US market from Alaska and the Gulf of Mexico (following pipeline closures and slow recovery from 2005 storm damage). Oil prices will remain volatile and are unlikely to fall back to the $20 a barrel level at the start of the decade.

Although little electricity in the UK is generated from fuel oil, the largest share comes from gas which follows the oil price fairly closely. The inclusion of the UK generation sector in the mandatory EU Emissions Trading Scheme has also added to the costs of generation. Generators may also be taking advantage of recent input fuel prices to drive through medium term price rises, with a view to supporting extra investment in cleaner technology or (in the case of Drax) to introducing co-firing of biomass. The Government is ambivalent about higher energy prices in general; while it can add to inflationary pressure and potentially slow down the growth of the economy, it will also make it easier for environmental objectives to be met, encouraging more investment in cleaner renewable energy. Sustained higher prices would also make nuclear power more economic, and this might permit replacement of decommissioned stations with new nuclear over the next 20 years.

Overall, in the medium term, electricity prices are likely to stabilise: the recent sharp rises will probably not be repeated. There may be some short-term falls, but energy purchasers in large companies will need to be careful in their timing of new contracts. Many energy managers have reported that new contracts are being signed at more than double the rate of expiring contracts.

5.1.2. Actual Electricity Prices

DTI publish quarterly prices[34] of average electricity prices in the UK and EU. The latest non-domestic figures available are for April 2006, in Tables 5.4.1 to 5.4.4. These show estimated average prices in pence per unit (before VAT) of:

- Small enterprises 6.08p
- Medium enterprises 5.12p
- Large enterprises 5.30p

As they reflect actual prices, they include a mix of businesses on long term fixed supply contracts, and those reliant much more on purchasing short-term. (Indeed, this probably explains why larger enterprises have higher prices than medium-sized ones, a reversal of the normal situation.)

We have reviewed some actual prices being paid over the past 12 months and actual prices paid are shown in the table to the right. It is notable that the smallest user has almost the lowest costs, as they are locked into a 4 year fixed contract.

Price in pence per kWh	Average or day rate	Night rate
Medium sized office (old contract)	5.09	3.21
Large public sector body	4.7	
Large commercial user	6.0	
Large retailer	7.5	

We have also investigated the "best" prices on offer to a SME through a web-based broker (The Power Switch[35]):

Named supplier, pence per kWh	Single tariff	Day tariff	Night tariff	Contract period
E4B Energy for Business	6.28	6.86	4.94	1 year
Powergen	7.63	8.23	4.30	2 years
npower	8.05	8.59	5.25	5 years

These costs exclude standing or capacity charges.

We suspect that an achievable target price looking forward would be in the region of 7.5p per unit (with a single 24-hour tariff), or around 8p/5p for a day/night tariff if dual fuels were used, and that these rates would be appropriate for calculation of the potential benefits of NightWatchman. The DTI average domestic electricity price is quoted as being 8.2p.

5.2. Energy Consumption by a single PC

Energy consumption varies significantly with make and model. As a rule of thumb, older machines tend to be less energy efficient, and flat screens almost always consume less electricity than the CRTs that they are rapidly replacing.

Typical Energy Consumption – new monitors[36]

Traditional CRTs	Typical W	Flat Panel Displays	Typical W
Dell M993s 19 inch	80W	Dell 1505FP 15 inch	20-56W
Dell E773 17 inch	70W	Samsung 713BM 17 inch	38W
Dell M783 17 inch	70W	Viewsonic VA503b 15 inch	23W

Data on desktop units varies similarly. Dell quote their Optiplex 210 as typically using 70.05W without enabling power management, but also say on their website that a typical system (PC plus monitor) will consume 200W when in use. Dell also have an interactive energy consumption calculator to permit users to discover how little they are using with their most energy efficient models, such as the Optiplex G620 with Intel Dual Core 2 processor (as opposed to a standard Pentium D). As noted above, although Energy Star operating standards from 2007 will set a maximum consumption for a category B unit of 65W, the introduction of Microsoft Vista, as the operating system to replace Windows xp, is likely to force a typical office based PC into a category C machine, with a limit of 95W.

1E has suggested using a Dell Optiplex 210 desktop/Dell M993s CRT as the "average" reference unit, for a total operating energy consumption of 150W. Although the monitor consumption suggested may be a little above average, we believe that the base station consumption may be below average, and we consider that this is a reasonable figure to use for a typical office configuration. However, as offices move towards flat screens (and the average in-use life of a monitor is quoted as being under 5 years), we believe that typical screen consumption will fall to around 30W. This will be offset, to some extent by increasing base unit consumption, rising to around the 95W level, for a total consumption of 125W.

5.3. Energy saveable through NightWatchman

5.3.1. Energy per PC

1E has used an estimate of 10 hours per day as an average daily use for an office PC, with no hours at weekends. This assumption is in line with the MTP estimate of 10.1 hours for 2005 (see table in section 3.1.1 above), with downtime of 14 hours per working day (24 hours at weekends). We regard this assumption as being quite conservative; many offices only operate from 9.00am to 5.30pm, which would equate to 8.5 hours use (and 15.5 in sleep mode).

The Dell website, referred to above, sets defaults of "Maximum Performance" (power use) of 1 hour per day, and "running Productivity Applications" of 7 hours per day, for a total usage of just 8 hours. This presumably allows for ½ to 1 hour of inaction over lunch.

Based on these assumptions we have:

	Current Equipment	Future Flat Screen
Operating consumption	150W	125W
Idle hours per weekday/weekend day	14hr/24hr	14hr/24hr
Idle hours per week	118hr	118hr
Typical wasted energy per week	17.7kWh	14.75kWh
Typical wasted energy per annum	920kWh	767kWh
Typical cost (single tariff)	£69.03	£57.53
Unnecessary CO_2 emissions	395kg	330kg

5.3.2. Energy per company

There is no such thing as a typical company, but large office-based company employing 20,000 staff, the savings could be significant. We may assume that one-sixth of employees fail to switch of their PC or have hibernation fully enabled (and the actual Tickbox market research figure for never switching off PCs in companies with over 250 employees was 18.1%). In a white collar operation, where perhaps 75% of employees have exclusive access to a PC (there will be some hot-desking, or shared usage, and some support employees will have no need for a PC, or will use a laptop), then there could be as many as 2,500 PCs left on each night unnecessarily. This could cost the hypothetical company almost £175,000 in electricity, equivalent to almost 1,000 tonnes of CO2 per annum.

Of course, no company will exactly meet these assumptions, and a company without an existing policy of switching off might realise much higher savings, whereas a tightly managed one may have less need to install centralised software like 1E's NightWatchman®.

5.3.3. Potential for Energy Saved in the UK

The ICM research revealed that 43.5% of respondents used a computer at work. According to National Statistics, there were 28.97 million people in work in the UK in July 2006. This would produce an estimated PC population of 12.6 million, assuming exclusive use, or around 10 million[37] units allowing for shared use, hot-desking and call centres. Again assuming that one-sixth of PCs are habitually left on overnight, and could potentially benefit from a product such as NightWatchman, the full potential savings would then be in the order of 1.5TWh[38] (1.5 billion kWh), with a value around £115 million annually. In carbon dioxide terms this would equate to potential savings of 700,000 tonnes of CO_2 (equivalent to almost 0.2MtC). As noted in section 3.2 above, total savings from the business sector under the Climate Change Programme are planned to be around 8.0MtC, so this single action could make a significant contribution to UK national targets.

6. Appendix: Reasons why – and why not – PCs are switched off

1E Q4. Which one of the following best explains why you tend to turn your computer off most nights?

So next person can log on
I have a laptop and I take it home with me
Boss blows up if you don't!
I work in a home office and always turn off any PC I've been using to save money.
Its a laptop/docking station
Someone else uses it
I work from and it is my business
For safety reasons.
I am the network manager
To give it a break - let it cool
To receive overnight software loads and to allow them to be installed correctly at start up
It tends not to work properly the next morning if I don't
Laptop
I'm the last one using it
Company policy is to save electricity and to reduce emissions. It also reduces fire risk.
So updates can be done on the server overnight
It's my own laptop and I take it home with me
Common sense
I take it home
To update from central
In case of fire
It's a laptop
Confidentiality
I work from home
To save battery it is portable

1E Q3. Which of the following explains why you do not turn your computer off every night before you go home?

We are not allowed to turn off our computers as they do not come back on again
I leave early so someone else needs it
Work policy
IT policy is to leave it on
Always turn off
Other people use it
IT Rules.
Others use this after I have left
Updates carried out over night
Someone else turns off all the computers
They must stay on as they are test PC's
Other people use it
Old computer might not start back up!
I have to leave it on standby in case of any overnight network updates
It's most likely to break when it's switched on
Shared computer
Only use it 3 days
Someone else does it.
Somebody else turns it off as I'm not in the office
Constantly used
Other people need to use it after my shift
It is in continuous use by others
Only work 3 days a week.
Why should I?
Instructed not to turn it off only to log out
It is company policy NOT to switch them off
Ask us not to
Data is backed up to it overnight
Instructed not to
Technician says it prolongs life of PC if it's not switched off
Not there every night
Other person will probably use it after me
It's on 24 hours a day
Someone else uses it after I'm gone
Someone else does it
IT policy
Because it is used 24 hours a day by other shift members
It remains on permanently for use to all staff

Part time so others use when I leave
Running http://www.worldcommunitygrid.org/ client
I only occasionally use it and somebody else uses it more than me
I work in a 24/07 emergency room so someone else takes over the computer after me
It's a web server
It needs to do things overnight
We hot-desk & someone else will use the machine after me
I access remotely
Restart to update software
The last person in the office will turn off
Always turn it off
Someone else does
I access it from home
I have a laptop and also work at night from home
It not good for PCs to be turned on and off
Not always the last to leave
I only work 3 days
Because it's needed 24/7
Company policy
Someone else will use it, then turn it off
Being used by others
Someone else is using it
Other people use it after I leave work
To have access from home
Distributed computing network
It's a pc for upwards of 30 people to use for stock info
Not good for the computer to keep turning it on and off
Not meant to
We're told not to.
Sometimes we are required to leave the computer on to receive updates
I only work 2 days
Saves internal battery
It department told us what to do
Only use on that day
Told to leave on for updates
Work from home
I work at home
Someone else does it
Got to stay on
24 hour service, other use it
In a 24 hour operation
Someone else uses it after me
Can't as it is running things overnight
Someone else takes over work
Allows quick start in morning
Overnight tasks are carried out so the PC doesn't get switched off
Other people turn it off
Only work 2 nights a week
Shared computer - staff on duty/on call 24/7
It needs to stay on to back up
I only work three days
it's a 'communal' PC in staff library
Someone else carries on using it after me
I only work 2 days a week
Network printer attached to my workstation
Has to left on
Other people use it after I leave
We are told not to!
It has to stay on for other reasons
Request us not to
Others use it after I do
I'm not in the other 3 days
last person out turns off, because phone system doesn't work if my PC off
Technician closes it down
Policy is to log off-- profiles stored

Our login/out is so slow it loses ages per day... :(
Sometimes I connect to it from home
It must not be switched of
It runs the company website
Needed for other people
When it's on it's part of the Climate Change experiment
It's the print server so has to remain switched on
Work reasons
The office I work in is open 24hrs a day so other people use the computers
IT security policy is to log off, but leave on to allow remote downloads
Software is often uploaded via the network overnight
Company Policy
Only work 2 days a week
I always turn off (work part time)
They put updates on over night
We have to leave them on overnight during the week for security updates
It's used 24/7
It is used overnight
Computers don't need to be turned off.
I have a laptop which I put on standby and take with me on the train
Other people may require it
For remote admin tasks to be performed on the PC - i.e. virus scan, patched & software upgrades
Used 24 hours a day NHS
Doesn't need to be turned off everyday
Other people use it
Work ask me to enable IT to do uploads
24 hour business, someone else uses PC after me
Work part time so switch off 100%
Another shift comes in and uses it
It is better for the computer to remain on
I do, I only work 3 days a week
It's busy, searching for Mersenne primes
It runs software overnight

Only work 3 days
Other people use after me
Have been told not to turn it off by our IT technician
Lots of people use the same computer
It is used 24/7
I work from home
Not my responsibility
Because work like us to leave on login screen
My PC controls access to the shared drive and if I close down, no-one else can access the shared drive
I'm part-time & others need to use it
I work from home
Switching PCs on & off shortens life of PC, plus it performs virus scans etc overnight
Company policy due to networking
Only work three days, turn off every day
Don't think about it
Shared computers
Boss doesn't want me to
Someone else needs to use it
Not permitted to shut down, just log off
Work tells us not to
It is used by other people who finish work later than me.
So I remember what I was doing the day before
I work from home
Leave on for others
It is in constant use
It's a network server
I log off as we have been instructed to.
Session is on security card and does not affect PC
Instructed not to
Night shift use it too
We are told not to, we just log off
Has to be left on for security updates to be loaded
Someone else uses it after me
I need it on
It is accessed remotely in the evening
When I am not in work
Work wants it left on for updates
Updates at night
Networked
Only work two days a week
I work part time
It's a shared computer and someone else is assigned to switch off all of the computers
Its too slow logging back on in a morning
I work part time! I always shut my computer down!
Work from home
I only work 3 days a week
Someone else will use it after me - different log on
Used by others 24/7
Overnight updates to systems
Linked to a network
It's used by other people
I work from home and use the PC at night too for personal stuff
If I am in the middle of something
Someone else takes over my desk
Told not to
Some one else comes in and takes over
Told not to
Turn it off every work day, only work 3 days
It has to be on
Policy to do so
Needs to stay on for communications
I work part time
I might need to remotely access it overnight when I am on callout
I work at home and use it on an evening
Work policy
Scheduled jobs during night
I shut down but do not turn off

References

[1] The science of measuring historic levels of CO_2 and temperatures has developed significantly in recent years as scientists have attempted to remove uncertainty from future climate predictions. The British Antarctic Survey has analysed bubbles of air in 800,000-year-old ice, drilled in the Antarctic, to measure levels of CO_2 changing with the climate. Results show that carbon dioxide has increased by about 35% in the last 200 years, but before the last 200 years, which man has been influencing, it was relatively constant, rarely varying by more than parts per million by volume (ppmv) in any 1,000 year period. The natural range of CO_2 over most of the past 800,000 years has been 180-300 ppmv of air. Recent measurements show levels at it is at 380 ppmv. CO_2 was close to 280 ppmv from 1000 AD until 1800 and then it accelerated towards its present concentration. Measurements of carbon isotopes confirm that the extra CO_2 comes principally from fossil sources, due to increased human activity.
[2] The largest was the collapse of around 3,250km^2 of the Larsen B ice-shelf into the South Atlantic in March 2002. This list is expanded from that in the Energy White Paper augmented by BBC reports.
[3] Global Climate Change is increasing the surface temperature of water in the Caribbean where hurricanes form; this in turn is believed to increase their intensity and destructive power.
[4] The greenhouse effect was discovered by Fourier in 1824, and first investigated quantitatively by Arrhenius in 1896
[5] Ofgem, the Office of Global Energy Markets was formed in 1999 by the Energy Act to replace Offer and OfGas, specific regulators for the electricity and gas markets that had been established following privatisation in the early 1990s.
[6] Climate Change The UK Programme, DETR, November 2000, Cm 4913.
[7] Royal Commission on Environmental Pollution 22nd Report: Energy – the Changing Climate, June 2000, Cm 4749
[8] *ibid*, paras 6.38-6.39, p93, but the data source is quoted as REAG as far back as 1992.
[9] CTV005, The Carbon Trust, March 2006
[10] *ibid*, but see section 5 for our own comments on the costs. The Carbon Trust figure appears to be based on lower historical electricity costs for large organisations.
[11] Energy White Paper: Our energy future – creating a low carbon economy, DTI, February 2003, Cm 5761
[12] *ibid*, para 1.31
[13] *ibid*, paras 3.30 (Energy Star) and 3.43 (procurement).
[14] Energy Efficiency: The Government's Plan for Action, April 2004, Defra, Cm 6168
[15] This chart is based on data originally included in *Energy Consumption in the UK*, 2002, DTI as Chart 5.4, crediting BRE (the Building Research Establishment) as the source of the information. It only relates to the services sector (public and private) which are quoted as employing some 77% of the UK workforce. The data in the pie chart is updated to 2004.
[16] Taken from the Energy Efficiency Best Practice Programme Energy Consumption Guide, ECG 019 (formerly ECON 19), November 2000 update. The data is regarded as being somewhat unambitious now, given the improvements to Part L2 of Building regulations.
[17] The headquarters of the National Energy Foundation. Data is based on monitored consumption in 2004-5, and is net of a contribution from PV estimated at 10 kWh/m^2.
[18] The Energy Challenge: Energy Review Report 2006, Department of Trade and Industry, July 2006, Cmd 6887
[19] Defra, The 2006 Climate Change Programme, quoting 2003, and re-quoted in the Energy Review para. 2.10.
[20] The Energy Challenge, paras. 2.21-2.22
[21] *ibid,* paras. 2.23-2.27
[22] The "carbon neutral target" is repeated, for example, in the Energy Review, paras 2.12 and 2.75. We say it is misleading as it can only be reached by making substantial purchases of "green electricity" from renewable sources, and these cannot be matched in timeframe available by additional zero-carbon energy capacity; instead they will merely displace other consumers from the market for green electricity, or reduce the renewables mix in residual "brown" electricity. Using green electricity allows the Government to escape the need to reduce consumption, as if the attributed CO_2 per kWh consumed is zero, it would not matter in CO_2 terms if a PC were left on 24/7. Given that the marginal

electricity supply would almost always be from fossil fuel sources (typically gas), such waste would not in reality have zero emissions associated with it.

[23] *ibid*, para 2.75. The juxtaposition of these two targets reveals that the true energy saving targets by central Government are more modest.

[24] *ibid*, paras. 2.87-2.93.

[25] East Anglian Daily Times, Online edition, 29th August 2006

[26] Data in this section is drawn largely from the MTP Policy Brief "UK Energy Consumption of Non Domestic Information and Communication Technology Equipment", MTP, June 2006, and from their briefing note BNICT01: "Underlying Assumptions for Non Domestic Information and Communication (ICT)", Version 1.0, MTP, 17 August 2006. The latter document is still officially ain its public consultation stage and subject to final revision.

[27] In writing this report, we have also found that the sensitivity of sales data means that while it can often be found at a corporate level from public companies (such as Dell's total world-wide sales), it is extremely hard to find reliable estimates of the total UK market size, let alone the proportion that is sold to the non-domestic sector. Indeed, it is often as reliable to look at total stock estimates, and then estimate average life-cycle – which in turn can be driven by software updates, with most PCs over 5 years old being unable to run the latest Microsoft software adequately.

[28] Text is adapted from BNICT01, as above; the graph is re-drawn from the June 2006 Policy Brief. Note that it draws on earlier data, as it assumes that policy shift takes place from 2004-5.

[29] *ibid*, BNITC01 p4

[30] Earlier Energy Star computers were required to power down to 15% of the maximum power consumption, and this did not in itself need to be a low absolute value. (So, for example, in May 1998 buyers' guide, Energy Star cited an example of a computer powering down from 200W to 30W.) The standards were open to the criticism that some manufacturers were gaining certification by increasing the operating energy consumption, in order to make it easier to reach the sleep standards.

[31] See ENERGY STAR® Computer Specification Revision Progress Update, Proposed Levels for Final Specification, 8/26/06. If accepted as they stand, the new standards will apply from 20 July 2007.

[32] Tickbox Research for 1E was carried out online by Tickbox.net between 25/08/2006 and 04/09/2006 amongst a nationally representative sample of 1,233 UK adults aged 16+ who use a PC at work.

[33] Undertaken by ICM Research on a sample of 1,002 adults between 1st and 3rd September 2006 of whom 560 were classed as being "working".

[34] Available via the web from http://www.dti.gov.uk/energy/statistics/publications/prices/tables/page18125.html

[35] The Power Switch, data as of 19 September 2006

[36] From Dell website. Dell equipment is generally regarded as being a "good average", and likely to perform better than the cheapest equipment.

[37] This estimate is lower than some commentators use, in order to avoid over-stating the potential benefits. National statistics (unhelpfully) state on their website "Although it is not possible to identify from the Labour Force Survey the number of people using computers in their work, it is possible to measure the numbers employed in the occupations most closely linked to Information Technology (IT)".

[38] This is lower than the MTP estimates of total savings from better management, as the latter includes the effects of activating power management during normal working hours. We have also knowingly omitted the PCs that the market research revealed were left on for one to four nights per week, partly because a more precise answer may have indicated a defined reason for the omission – such as internal software updates, or sharing of computers by part-time staff. Nonetheless, in the first instance, there is no reason why a central PC management product should not be able to be used by a centralised IT department *after* the software updates had been installed.