Power Manager – Energy costs and savings

September 2008

Overview

This document briefly describes the energy requirements, costs, environmental impact and usage assumptions that can be applied when evaluating the benefits of Remote Power Manager:

- A typical personal computer
    - Requires 150Wh (0.15kWh) of direct energy
    - Costs up to £80-100 per annum in direct energy
    - Wastes up to £60 per annum in direct energy
    - Produces up to 565 kg of CO_2 per annum
    - Equivalent to driving approximately 2100 miles
- Research based upon user questionnaires found
    - Potential savings of between £10.25 and £22.44 per computer per annum
    - Equivalent to between 4p* and 6p per computer per day
- Experience from two live sites actually found
    - Estimated savings of £72 and £74 respectively
    - Equivalent to approximately 20p per computer per day

*Based upon two different models using a five day week and a seven day week respectively

PC Energy Consumption Basics

A modern personal computer can function in several different energy consumption modes:

- **Sleep (S1-S3)** - Typically system will resume to previous state in < 2 seconds
- **Hibernate (S4)** - Typically system will resume to previous state in 30 seconds
- **Soft Off (S5)** – Typically system will boot in 2 minutes. Previous state is lost

The following table describes the power requirements of three typical computer systems:

Operating Mode / Power W	Standard Laptop	Standard desktop	Enhanced desktop
Busy > 50% CPU	30	100	160
Idle < 10% CPU	25	80	120
Sleep (S3)* Hibernate (S4) Soft Off (S5)	2	9	7
+ 17" TFT Monitor	NA	28	28
+ 17" CRT Monitor	NA	63	63

Notes: Power measurements made using commonly available plug-in power monitor. *Sleep/Hibernate/Soft Off recorded similar power consumption figures due to poorer accuracy of measurement equipment at low power consumptions. Typically Sleep (S3) consumption should be expected to be fractionally higher than S4/S5 consumption. Standard laptop was Twinhead S14Y with 1.4GHz CPU and 512MB memory. The laptop battery was removed during the test. Standard desktop was Intel Core 2 Duo 1.86GHz CPU with 1GB memory. The high performance desktop was Pentium 4 3.2GHz CPU with 2GB memory. All computers had one hard disk and were tested under the same conditions. 17" TFT display panel was CTX. 17" CRT model was Iiyama.

The calculations in this document are based upon a nominal 150W PC and monitor combination. This is the power requirement of a standard (typically 2-3 year) old desktop computer with CRT monitor or enhanced desktop with a TFT display panel.

Typical Site Costs

Based upon the above consumption figures a hypothetical site, equipped with typical 150W computers, and not using any power saving technology, would have the following power requirements per annum:

Computers / Energy Consumption kWh	Best case profile: 10 hours / day weekdays only (A)	Worst case profile: 24 hours / day all days (B)	Potential Energy Savings (B-A)
500	195,000	657,000	462,000
1000	390,000	1,314,000	924,000
5000	1,950,000	6,570,000	4,620,000
10000	3,900,000	13,140,000	9,240,000

Notes: Based upon a nominal 150W PC operating for 10 per day on weekdays compared with the same PC operating 7 days per week for 24 hours each day.

UK Electricity Costs

The Department for Business, Enterprise & Regulatory Reform (formally the DTI) publish energy pricing statistics on a quarterly basis:

- The average non-domestic electricity price in 2007 was 6.28p / kWh (http://stats.berr.gov.uk/energystats/qep531.xls)
- The estimated average price for January-June 2008 was 6.59p / kWh. This figure is based upon a medium consumer of 2000-20000 MWh per annum (http://stats.berr.gov.uk/energystats/qep541.xls)

Based upon the figure of 6.59p / kWh a hypothetical site, equipped with typical 150W equipment, would have the following energy costs per annum:

Computers / Energy Costs £	Best Case £ 10 hours / day weekdays only (A)	Worst case £ 24 hours / day all days (B)	Potential Savings £ (B-A)
100	2,570	8,659	6,089
500	12,850	43,296	30,445
1000	25,701	86,593	60,891
5000	128,505	432,963	304,458
10000	257,010	865,926	608,916

A typical 150W PC and monitor, running for 24 hours, costs £0.24 in direct electricity costs per day. This equates to a running cost of £1.66 per week or £86.59 per annum. If such equipment was used for 50 hours per week and left idle for the remaining 118 hours the waste cost would be £60.63 per annum.

Energy costs have risen very significantly in the last 12 months and it is now quite common to find organisations paying around £0.12 per KWh.

Environmental Costs

UK Government statistics are based upon the assumption that the production of one kilowatt of electricity generates 0.43 kg of direct CO_2. (There is also a higher measure that includes other environmental costs). This is explained in the following documents:

http://www.shadlock.co.uk/energy/misc/convertf.htm
http://www.nef.org.uk/greencompany/co2calculator.htm

The most popular car in the UK is the Ford Focus. The basic 1.6l petrol model produces 0.169 kg of CO_2 per km (0.270 kg of CO_2 per mile). This information is available from:

http://www.parkers.co.uk/cars/specs/summary.aspx?model=1525&page=3

BP Plc, in the BP Statistical Review of World Energy (June 2007), use the approximation that one million tons of crude oil can produce 4500 GWh of electricity in a modern power station. There are 0.1364 tons of oil in a standard barrel. This means that a barrel can be approximated to 613.8 kWh of electricity. See http://www.bp.com/statisticalreview

A typical 150W PC and monitor, running for 24 hours, will require 3.6 kWh of electricity. This can be approximated to the following:

- 1.548 kg of CO_2
- 5.73 miles in a 1.6l Ford Focus
- 0.58% of a barrel of oil (or 170 days operation per barrel)

Based upon the above statistics, the hypothetical site, equipped with typical 150W computers, would have the following environmental costs per annum:

Computers / kg CO_2	Best case 10 hours / day weekdays only (A)	Worst case 24 hours / day all days (B)	Potential Savings kg CO_2 (B-A)
100	16,770	56,502	39,732
500	83,850	282,510	198,660
1000	167,700	565,020	397,320
5000	838,500	2,825,100	1,986,600
10000	1,677,000	5,650,200	3,973,200

Computers / Focus Miles	Best case 10 hours / day weekdays only (A)	Worst case 24 hours / day all days (B)	Potential Savings Focus Miles (B-A)
100	62,111	209,267	147,156
500	310,556	1,046,333	735,778
1000	621,111	2,092,667	1,471,556
5000	3,105,556	10,463,333	7,357,778
10000	6,211,111	20,926,667	14,715,556

A typical 150W PC and monitor, running for 24 hours, produces 1.548kg of CO_2 which is the equivalent of driving 5.73 miles in a Ford Focus 1.6l. This is the equivalent of 565 kg of CO_2 or 2092 miles per annum.

If such equipment were used for 50 hours per week and left idle for the remaining 118 hours the waste per annum would equate to 397 kg of CO_2 or 1469 miles per annum.

Human Factors

Several research projects have attempted to measure the amount of waste due to human factors. This section explains the implications of two significant surveys both using a conservative methodology.

Research performed by Tickbox for the National Energy Foundation (NEF) between 25/08/2006 and 04/09/2006 questioned 1233 users and found that:

- 69.3% of people claim to always turn off equipment
- 22.8% claim to leave equipment on for at least 3 nights per week
- 16.9% claim to never turn off equipment

This research is available from: http://www.nef.org.uk/news-events/documents/1e_report.pdf

Using the very conservative scenario (16.9% of equipment left on) and ignoring all other waste this research can be translated into the following table of costs, in electrical, environmental and financial terms for the hypothetical organisation using nominal 150 W equipment:

Computers	Waste kWh *	Waste CO_2 (0.43 kg / kWh)	Waste £ (£ 0.0659 / kWh)
100	15,555	6,689	1,025
500	77,774	33,443	5,125
1000	155,548	66,885	10,251
5000	777,738	334,427	51,253
10000	1,555,476	668,855	102,506

*Based upon the calculation that 16.9% of PCs were operating 24 hours per day and in active use for 50 hours per week resulting in 118 house inactivity per week per PC.

This very conservative calculation equates to an average **waste of £10.25** per computer per annum. However, experience with two real-world test sites has shown that a waste figure of 16.9% is very conservative and that actual waste figures can be significantly higher.

The NEF research included additional detail to expand upon the above assumptions:

Nights equipment turned off	Users %
0	16.9%
1	3.5%
2	2.4%
3	4.7%
4	3.3%
5 or more	69.3%

Using a less conservative approach, and including equipment sometimes left on, would indicate that, on average, 24% of computers are left on at night. This is based upon the following assumptions:

- All equipment is still turned off at the weekends
- Equipment turned off for one night per week is left on four nights per week etc

Taking the above information into account the above waste figures can be re-calculated for nominal 150W equipment as follows:

Computers	Waste kWh *	Waste CO_2 (0.43 kg / kWh)	Waste £ (£ 0.0659 / kWh)
100	22,090	9,499	1,456
500	110,448	47,493	7,279
1000	220,896	94,985	14,557
5000	1,104,480	474,926	72,785
10000	2,208,960	949,853	145,571

*Based upon the calculation that 24% of PCs were operating 24 hours per day and in active use for 50 hours per week resulting in 118 house inactivity per week per PC.

This slightly less conservative calculation equates to an average **waste of £14.56** per computer per annum. Experience with two real-world test sites has shown that the waste figure of 24% is still relatively conservative and can often be exceeded.

Similar research for Fujitsu Siemens Computers by TNS PhoneBus of 1002 people between 9th and 11th September 2005 found that 37% of users did not turn of equipment. There is less detail in the TNS research about how the 37% figure was calculated but if this is assumed to apply seven days per week to notional 150W equipment this would translate into the following:

Computers	Waste kWh *	Waste CO_2 (0.43 kg / kWh)	Waste £ (£ 0.0659 / kWh)
100	34055	14644	2244
500	170274	73218	11221
1000	340548	146436	22442
5000	1702740	732178	112211
10000	3405480	1464356	224422

This alternative calculation equates to an average **waste of £22.44** per computer per annum.

The TNS PhoneBus research is available from the following locations:

http://www.computacenter.com/press-releases/2006/green_pc0506.asp
http://www.fujitsu-siemens.co.uk/rl/news/241005.html