Strategic Briefing Report on Personal Computers (Desktops & Laptops) and Computer Monitors

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EuP-Eco Design | ENVIRON

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1 Background

The growth in the use of personal computers and their associated peripherals has increased dramatically in the last decade. The environmental impact arising from the manufacture, use and disposal of these products is significant.

The number of products in use in the 25 EU Member States in 2005 was approximately 146 million desktops, 60 million laptops, 81 million CRT-monitors and 68 million LCD-monitors. Use of computers at home is also increasing. It is estimated that energy consumption from home computers represented 3% of the total household electricity bills in the 25 EU Member States in 2005.

Energy consumption is a key issue and is directly related to the generation of greenhouse gas emissions. In view of this the European Commission decided to address personal computers within the EuP Directive and intends to introduce EcoDesign requirements to improve the energy efficiency and environmental performance of all personal computers.

Energy consumption is dependent on power and time and so the focus of the EcoDesign requirements will be on reducing power consumption in all functional modes and decreasing time spent at high power consumption.

2 Proposed EcoDesign requirements for Personal Computers (Desktops & Laptops) and Computer Monitors

The preparatory study for how Personal Computers and Computer Monitors will be regulated under the EuP Directive was published in August 2007. The study analysed a wide range of potential EcoDesign requirements and assessed which of these would represent the Least Life Cycle Cost for the industry to implement. Based on this analysis the study proposed a number of EcoDesign requirements for consideration as regulatory requirements under the EuP Directive.

2.1 Scope

The scope of products which will be covered by the proposed EcoDesign requirements includes desktops, integrated computers, laptops and both LCD and CRT computer monitors. The following products are not included in the scope:

- Workstations
- Desktop-derived, mid-range and large servers
- Games consoles
- Thin clients/blade PCs
- Handhelds and PDAs

A personal computer is defined as:

> *A device which performs logical operations and processes data. Personal computers are composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; and (2) user input devices such as a keyboard, mouse, digitizer or game controller. Personal computers include both stationary and portable units, including desktop computers, integrated computers, notebook computers and tablet PCs. For further definitions of these computer categories, the Energy Star definitions are applicable.*

A computer monitor is defined as:

A commercially-available, electronic product with a display screen and its associated electronics encased in a single housing that is capable of display output information from a computer via one or more inputs, such as VGA, DVI, and/or IEEE 1394. The monitor usually relies upon a cathode-ray tube (CRT), liquid crystal display (LCD) or other display device. This definition is intended primarily to cover standard monitors designed for use with computers. The computer monitors included in this definition must have a viewable diagonal screen size greater than 12 inches and must be capable of being powered by a separate AC wall outlet or a battery unit that is sold with an AC adapter. Computer monitors with a tuner/receiver may be covered by this definition as long as they are marketed and sold to consumers as computer monitors (i.e. focusing on computer monitor as the primary function) or as dual function computer monitors and televisions. However, products with a tuner/receiver and computer capability that are marketed and sold as televisions are not included in the scope of this definition.

2.2 Proposed EcoDesign requirements

The study analysed a wide range of potential EcoDesign requirements and assessed which of these would represent the Least Life Cycle Cost for the industry to implement. Based on this analysis the study recommended the following measures for consideration as regulatory requirements under the EuP Directive.

The proposed EcoDesign requirements focus on setting minimum requirements for power consumption and provision of information to consumers, e.g. power consumption in different modes. Requiring manufacturers to provide detailed information to consumers may stimulate them to further reduce the power consumption of their products, beyond the minimum power consumption requirements.

2.2.1 Proposed power consumption limits

The study proposed that the following power consumption limits for sleep and off-modes should become mandatory in 2009.

Table 1: Proposed power consumption limits for sleep and off-modes

Mode	Desktops	Laptops	Monitors
Sleep (Suspend to RAM) with “Wake on LAN” function	4.7 W	2.4 W	
Sleep (Suspend to RAM) without “Wake on LAN” function	4 W	1.7 W	2 W
Off-mode with “Wake on LAN” function	2.7 W	1.7 W	
Off-mode without “Wake on LAN” function	2 W	1 W	1 W

These proposed power consumption limits are not in line with the power consumption limits contained in the draft Implementing Measure for Standby and Off-Mode Losses. In particular, the proposed power consumption limits for Personal Computers are much higher than the proposed power consumption limits in the draft Implementing Measure for Standby and Off-Mode Losses.

The draft Implementing Measure for Standby and Off-Mode Losses states that equipment must meet the EcoDesign requirements in the Implementing Measure "unless product specific implementing measures adopted after this implementing measure establish different requirements".

However, the explanatory notes to the draft Implementing Measure for Standby and Off-Mode Losses state that if a product is in the scope of both a vertical implementing measure (i.e. product specific measure such as for Personal Computers and Computer Monitors) and a horizontal implementing measure (such as the draft Implementing Measure for Standby and Off-mode Losses) then the product has to comply with **both** the horizontal and the vertical implementing measures. The note goes on to explain that vertical measures prevail in the sense that more operational modes can be addressed (e.g. networked standby, ready, sleep, etc), and that differing requirements on standby and off-mode can be defined at a later stage if appropriate. The explanatory note indicates that vertical measures will usually be more stringent than the horizontal measure unless a justification for less stringent measures is provided. The issue here is that the study has proposed less stringent standby and off-mode measures for Personal Computers and Computer Monitors, without providing a justification for this.

It is understood that more clarity on these issues will be provided as these Implementing Measures are further developed. In the mean time, designers are advised to aim for the lower power consumption limits contained in the draft Implementing Measure for Standby and Off-Mode Losses.

The study also proposed the development of additional requirements in the following areas:

- minimum requirements for power per resolution for monitors
- minimum requirements for active/on-mode power consumption for monitors

The study recommended that these requirements should be developed in conjunction with Energy Star Program Requirements for Computer Monitors version 4.1.

2.2.2 Proposed requirements for power supply efficiency

The study proposed that the following requirements for power supply efficiency should become mandatory in 2009.

Internal power supplies (e.g. for desktops and monitors) should achieve

- A minimum efficiency of 80% at 20%, 50%, 80% and 100% of rated output
- A Power Factor of $\geq$ 0.9 of rated output

External power supplies (e.g. for laptops) should achieve

- A minimum efficiency of 85%

A separate horizontal implementing measure for Battery Chargers and External Power Supplies is also currently being prepared by the European Commission. If a product is in the scope of both a vertical implementing measure (i.e. product specific measure such as for Personal Computers and Computer Monitors) and a horizontal implementing measure (such as the draft Implementing Measure for Battery Chargers and External Power Supplies currently in preparation) then it appears that the product has to comply with **both** the horizontal and the vertical implementing measures.

2.2.3 Proposed requirements for power management

Most computers have advanced, built-in, functionality for power management. The study proposed that from 2009 manufacturers should be required to supply computers with the power management system enabled at the time of delivery to the customer. Information about the power management system should be provided in a way which is easy for the customer to understand.

The power management settings (in line with Energy Star 4.0) should be:

- 15 min to monitor or display screen off
- 30 min to computer sleep (ACPI System Level S3 – suspended to RAM)

2.2.4 Proposed requirements for provision of information on the product

The study proposed that the following requirements for provision of information on the product should become mandatory in 2009. The information should be displayed on the outer surface of the product (e.g. on a sticker) and in the product manual in a highly visible place. The information on the outside of the product should be clearly visible to customers when the product is displayed in the store and to treatment facilities and recyclers when it is sent for end-of-life treatment.

Information that should be displayed on personal computers (desktops and laptops), according to the measurement methods described in Energy Star Program Requirements for Computers (version 4.0), includes:

- Power use in idle mode
- Power use in sleep mode
- Power use in off-mode
- Whether the equipment contains any of the following restricted substances: lead, mercury (e.g. in lamps to backlight the LCD display), hexavalent chromium, cadmium, PBB and PBDE
- Web address for information on energy consumption, environmental impacts and end-of-life treatment

Information that should be displayed on computer monitors, according to the measurement methods described in Energy Star Program Requirements for Computer Monitors (version 4.1), includes:

- Power use in active mode per m^2 of screen area
- Power use in sleep mode
- Power use in off-mode
- Whether the equipment contains any of the following restricted substances: lead, mercury (e.g. in lamps to backlight the LCD display), hexavalent chromium, cadmium, PBB and PBDE
- Web address for information on energy consumption, environmental impacts and end-of-life treatment

The study also recommends that the European Commission, or an impartial third party, should create a website where all manufacturers will be required to report:

- Power consumption in different modes (as outlined above)
- Instructions (or a link to instructions) for the customer to follow for end-of-life treatment arrangements in every country where the product is sold.
- Information about the power management systems available in the product

The website should enable customers to compare easily the energy efficiency of all available products.

3 Status of the proposed Implementing Measure

The preparatory study for how Personal Computers and Computer Monitors will be regulated under the EuP Directive was published in August 2007. The European Commission is currently drafting a working document on possible EcoDesign requirements for Personal Computers (Desktops & Laptops) and Computer Monitors and planning for an Impact Assessment in early 2008, followed by a Consultation Forum in mid 2008.

3.1 Consultation Forum

The Consultation Forum comprises a group of 60 experts including one representative from each Member State and acceding country (in the case of the UK, an official from DEFRA). It is also open for observers from candidate and EEA countries. The Consultation Forum reports to the Regulatory Committee, which has the final decision on implementation of the EcoDesign requirements.

DEFRA leads on the transposition of the Directive into UK legislation and on EcoDesign requirements for particular product groups such as Personal Computers and Computer Monitors, working closely with BERR and industry stakeholders.

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Once the Commission has issued its working document on possible EcoDesign requirements for Personal Computers and Computer Monitors, DEFRA will aim to consult stakeholders on their views ahead of any discussion at a Consultation forum in order to inform the UK Government's thinking. The Market Transformation Programme will assist the UK Government in managing this consultation process.

To be added to the mailing list for details of stakeholder meetings send an e-mail to sustainability@berr.gsi.gov.uk

3.2 Regulatory Committee

The next step after the Consultation Forum meeting will be to prepare a draft Implementing Measure to enact the EcoDesign requirements. This process, which includes the preparation of an Impact Assessment, usually takes 3 months. Implementing measures can take the form of

directives, voluntary agreements, decisions, or regulations. Personal Computers and Computer Monitors are already covered by the Energy Star voluntary energy consumption and labelling programme agreed between the EU and the USA and consideration will be given by the Commission to having a voluntary industry agreement based on Energy Star rather than a regulation with mandatory energy consumption requirements. This decision will be made after the Consultation Forum.

The Implementing Measure will then be submitted for approval by the EU Regulatory Committee which consists of the Commission and the 27 Member States. The first meeting of the EU Regulatory Committee was in December 2007.

It is anticipated that the EU Regulatory Committee will meet to vote on the Implementing Measure for Personal Computers and Computer Monitors in 2008. DEFRA will aim to hold a consultation meeting to discuss the draft Implementing Measure in advance of this EU Regulatory Committee meeting.

If the vote is successful, the Implementing Measure would be submitted for adoption by the European Commission and European Parliament later in 2008. This can take about 5 months to prepare the written procedure and complete the necessary translations.

The final Implementing Measure will specify:

- The products covered
- Application dates
- Generic and specific EcoDesign requirements
- Measurement standards/methods
- Conformity assessment procedures
- Information requirements

Manufacturers' obligations under the Implementing Measure will include:

- Designing the product in compliance with eco-design requirements
- Carrying out conformity assessment - generally by self assessment
- Affixing the CE mark and issuing an EC Declaration of Conformity

4 Design options for reducing power consumption

The proposed EcoDesign requirements focus on setting minimum requirements for power consumption in the areas of

- Power management
- Power supply efficiency
- Power consumption in Standby (suspend to RAM) and Off-modes
- Power consumption of LCD and CRT monitors in idle/on mode

The proposed EcoDesign requirements also require manufacturers to provide information to customers on power consumption in different modes. The study recommends that the European Commission, or an impartial third party, should create a website which will enable customers to compare easily the power consumptions of all available products. The intention is that users will start to choose products with lower power consumption and this will drive the manufacturers to

reduce the power consumption of their products, beyond the minimum power consumption requirements.

For a typical desktop Personal Computer during normal use about 40% of the supplied power is used by the processor, about 25% to 35% will be lost in the power supply, the mother board (including graphics processor) will consume about 20% and the remainder will be used by the hard drives, fans and other components, Figure 1.

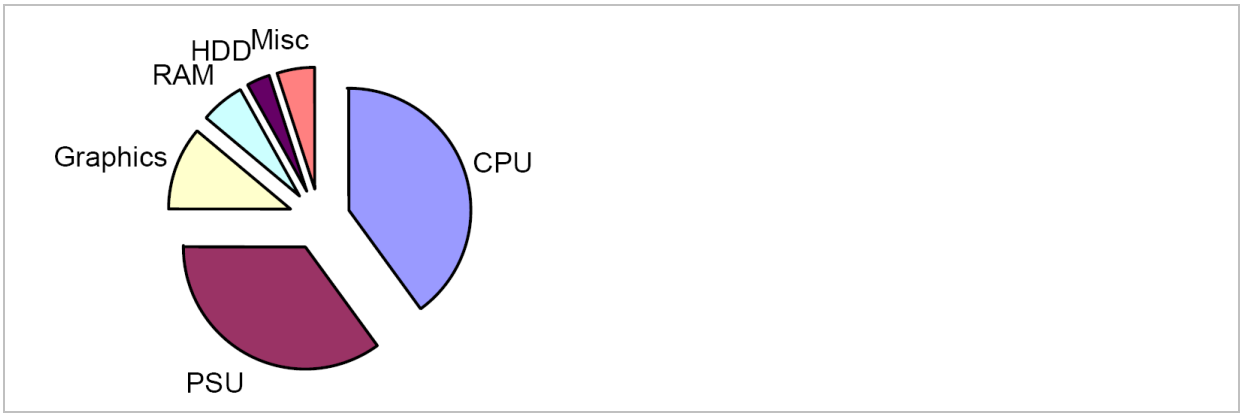

Figure 1: Power consumption in a typical desktop Personal Computer

For a typical laptop with an LCD screen the processor uses about 20% of the supplied power, as shown in Figure 2.

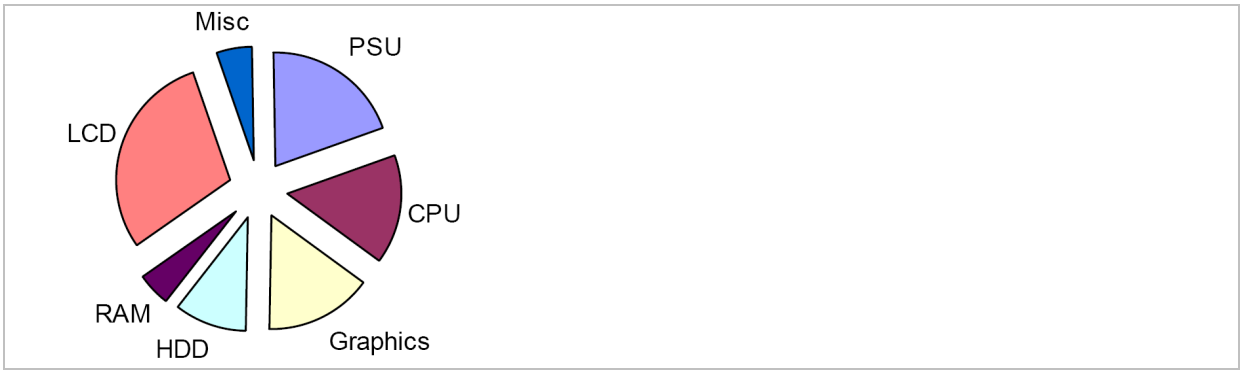

Figure 2: Power consumption in a typical laptop

The power consumption breakdowns in Figure 1 and Figure 2 provide an indication of the areas where design improvements may present the greatest opportunities to reduce the overall power consumption of the equipment.

4.1 Power Management

Power management relies on software to switch the computer and/or monitor to a power saving mode when less computing activity is needed. Power saving can be implemented after a certain period of user inactivity in several ways including:

- Stopping the disks spinning
- Reducing power to the CPU
- Turning the fans off when less heat is being generated
- Turning the motherboard off for all functions except waiting for interrupts

The Advanced Configuration and Power Interface (ACPI) specification was developed by HP, Intel, Microsoft, Phoenix and Toshiba and was released as an open industry standard in December 1996. The standard defines common interfaces for hardware recognition, motherboard and device configuration and power management. ACPI is the key element in Operating System-directed configuration and Power Management (OSPM). This is a considerable improvement on the older APM standard which placed power management under the control of the BIOS (the basic built-in firmware) and so gave much less opportunity for efficient energy usage.

ACPI defines five transition states of "sleep" mode (S1 to S5). The decision on whether to use the S3 (suspend to RAM) mode or S4 (suspend to disk) mode can have a major impact on the user's acceptance of the power management features. The S4 sleep mode involves saving everything in RAM to the hard disk and when the computer is 'woken up' information must be read back from the hard disk to the RAM. This can take up to 30 seconds or more which is often unacceptable to the user and can cause the user to turn off (or prolong the time settings) on the power saving function. In the S3 (suspend to RAM) mode the PC will start within a few seconds of the wake up call. Transitioning to S3 on the other hand will enable the equipment to awake in a few seconds, which is generally acceptable to the user.

Up to 2005, the S3 (suspend to RAM) option was not generally implemented in Personal Computers due to hardware costs. Hardware that supports the S4 (suspend to disk) option is cheaper than hardware supporting the S3 (suspend to RAM) option. However, most of the new design Personal Computers currently available today now support the S3 (suspend to RAM) option.

4.2 High Efficiency Power Supplies

The proposed requirements for power supply efficiency effectively make the use of switch mode power supplies mandatory for Personal Computers and Computer Monitors. In recent years most of the computer industry has already begun adopting switch mode power supplies, and so this should not present too much of an issue for designers. An industry initiative called "80-plus" requires power supplies to have an energy efficiency of greater than 80% at 20%, 50% and 100% of rated load with a true power factor of 0.9 or greater. Compared to an old (2005) power supply with an efficiency of 65%, using an "80-plus" power supply typically adds as little as 5 Euros cost to the computer. The standby power consumption of an "80-plus" power supply is less than 3 W.

With modern switched power technology the efficiency of the switch mode power supply can be as high as 90%.

4.3 Options for reducing monitor power consumption

4.3.1 Optimising screen efficiency for user brightness level

The power consumption of monitors is directly related to the screen size and to display brightness. Manufacturers tend to design for high brightness – the maximum brightness of many monitors is in the range of 250 to 300 Candela. However, most users set the brightness to around 125 to 150 Candela for convenient viewing.

Monitors are often designed for high efficiency at the maximum brightness, which can lead to decreased efficiency during normal use. Instead, monitors should be designed for high efficiency at the normal user brightness setting of around 125 to 150 Candela. Monitors can also be designed for a lower maximum brightness of 200 Candela.

4.3.2 LED Backlights for LCD Screens

Backlights for LCD computer monitors generally use mercury-filled fluorescent lamps. However, in 2006 a number of large manufacturers including NEC, Samsung and Sony began using LED backlights. Using LED backlights can reduce the monitor's power consumption by 25%. A further environmental benefit is the elimination of mercury from the monitor. LED backlights also have the

potential to improve the LCD's colour saturation capabilities, contrast and black levels. It is possible to dynamically dim the backlight in any part of the screen and thereby improve the black level and reduce energy consumption. According to some reports[1] the lifetime of the backlight unit could increase by 100,000 hours with little or no degradation.

Currently available LED backlit monitors are more expensive, have not yet delivered the expected lower power consumptions and appear to have a shorter lifetime. However, as this technology matures it is expected to deliver significant performance benefits and energy efficiency improvements.

4.4 Multi core processors

A multi core processor performs several tasks in parallel compared to a single core processor which performs tasks one at a time. In principle, a dual core processor is as fast as a single core processor operating at double the clock frequency. Since energy consumption is proportional to the clock frequency, a dual core processor could use half as much energy as a single core processor to perform the same tasks. In practice, computer and processor manufacturers report a decrease in energy consumption of more than 60 % for a multi core Personal Computer processor. Of course, the operating systems and applications need to be designed to optimise the use of the multi core processor.

Another benefit with multi core processors is the ability to shut down or reduce the clock frequency of one or more of the cores for specific tasks. This can be useful, for instance, when the Personal Computer performs only one simple task like streaming a video or audio file. In this case the Personal Computer can be operated in a mode with only one core running.

The typical price in 2005 for a single core processor for a desktop Personal Computer was 40 Euros and for a laptop the price was 55 Euros. Once the technology has matured, the price of a dual core processor for a desktop Personal Computer is expected to be an additional 10 Euros and for a laptop the price is expected to be an additional 15 Euros.

4.5 Adaptive clock frequency

One method of reducing the power consumption of a Personal Computer is to reduce the clock frequency of the central processor when the capacity required by the user applications drops. For example, reducing the processor speed when the graphics card is working hard. Adaptive clock frequency (also known as throttling) is often used in laptops to increase the battery time and in desktop Personal Computers to reduce heat generation in the processor.

Use of adaptive clock frequency can reduce power consumption in the processor by as much as 40%, depending on the usage pattern and the applications running on the Personal Computer.

Adaptive clock frequency could also be applied to the processor in the graphics card but this is not current practice at present.

4.6 Hybrid hard disk

A future technology which may also reduce power consumption is the use of a hybrid drive which combines a conventional hard disk with a 50 Mb flash disk. This allows the hard disk to be spun down when not in use. The flash memory is used as a Cache memory for the hard disk when it spins up again. The power consumption of the Personal Computer can be reduced because the hard disk, which consumes a few Watts of power, can be spun down more often with this type of hybrid drive. But the real benefit of a hybrid drive is that the time it would take for the Personal Computer to start from states S4 (suspend to disk) and S5 (soft off) and to boot up from a hard-off

[1] CI Displays, www.cidisplays.com

would be dramatically reduced to only a few seconds. The user would be much less likely to disable the power management functions and this would result in less time spent at higher power modes

5 Action Plan

The major impact of the proposed EcoDesign requirements will be on the design function and procurement function of the final equipment manufacturers, which in turn will impact their supply chains.

Manufacturers should assess the current sleep and off-mode power consumptions of their desktops, laptops and monitors, and identify the most appropriate design options that will achieve the proposed power consumption limits. Manufacturers should then develop a plan for how they will implement these design options to comply with power consumption limits by the proposed deadline of 2009.

Manufacturers should pay particular attention to the apparent conflict between the proposed power consumption limits for Personal Computers and Monitors and the power consumption limits contained in the draft Implementing Measure for Standby and Off-Mode Losses. In particular, the proposed power consumption limits for Personal Computers and Monitors are much higher than the proposed power consumption limits in the draft Implementing Measure for Standby and Off-Mode Losses. More clarity on these issues will be provided as these Implementing Measures are further developed. In the mean time, designers are advised to aim for the lower power consumption limits contained in the draft Implementing Measure for Standby and Off-Mode Losses.

Manufacturers should asses the performance of their internal power supplies (e.g. for desktops and monitors) and external power supplies (e.g. for laptops) to determine what changes are required to meet the proposed performance requirements by the proposed deadline of 2009. When specifying external or internal power supply modules with higher efficiencies at the design concept stage, designers must consider whether they can be sourced effectively from their existing suppliers or whether they need to identify new suppliers. Manufacturers should keep track of emerging power supply technologies that will deliver improved energy efficiency, and whether these may become commercially available in time to meet the deadline dates for the power consumption limits.

Manufacturers should also track the development of a separate horizontal implementing measure for Battery Chargers and External Power Supplies which is currently being prepared by the European Commission. If a product is in the scope of both a vertical implementing measure (i.e. product specific measure such as for Personal Computers and Computer Monitors) and a horizontal implementing measure (such as the draft Implementing Measure for Battery Chargers and External Power Supplies currently in preparation) then it appears that the product has to comply with **both** the horizontal and the vertical implementing measures.

Manufacturers should ensure that they supply computers with the power management system enabled at the time of delivery to the customer from the proposed deadline date of 2009. The power management settings should be:

- 15 min to monitor or display screen off
- 30 min to computer sleep (ACPI System Level S3 – suspended to RAM)

Manufacturers should start planning for how they would meet the requirement to display information on the outer surface of the product and in the product manual from the proposed deadline date of 2009. It is uncertain at this stage whether this particular requirement will be removed during the drafting process for the Implementation Measure. However, manufacturers are advised to start planning for this early, in case it does become a regulatory requirement.

Manufacturers of monitors should track proposals to develop additional requirements for power per resolution for monitors and active/on-mode power consumption for monitors.

Manufacturers should consider whether they have the necessary design expertise to implement the design changes that will be required to comply with the power consumption limits, or whether they should consider how they will obtain the specialized design expertise and knowledge.

It is also important to remember that this design, specification and procurement work cannot be done in isolation. Manufacturers should consider how they can implement the required design changes without prejudicing other regulatory requirements such as EMC or Safety.

Regarding supply chain issues, manufacturers should consider how and where they will source components such as high efficiency power supplies. Manufacturers will also need to ensure that any new components or materials must comply with the RoHS materials restrictions. Manufacturers will also need to monitor the implementation of any future materials restrictions. These may arise from the review of the RoHS Directive in 2008 or from the implementation of the REACH Regulations.

The final Implementing Measures for personal computers and monitors will specify any measurement standards/methods and the conformity assessment procedures, which are generally based on self-assessment. Manufacturers will be required to prepare a technical file or dossier containing a record of the design measures introduced, any harmonised standards used and any measurement or test data. The manufacturer can then sign an EC Declaration of Conformity with the implementing measure and affix the CE marking to the product. As it is likely that these products are already CE marked under product safety and EMC legislation then the manufacturer must integrate the new EcoDesign requirements into his CE marking regime without impinging on these other requirements.