Electronics KTN
Knowledge Transfer Network

Strategic Briefing Report on Imaging Equipment: copiers, faxes, printers, scanners

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EuP-Eco Design | ENVIRON

Contents

1 Background

The use of imaging equipment for printing, copying and scanning in the home and office has grown considerably in the last decade with the advent of the smaller inkjet and laser printers and copiers. These products have major environmental impacts, including significant energy consumption. Paper consumption is the biggest environmental impact accounting for some 80% of the total environmental life cycle impact. Paper and toner usage is largely in the hands of the users whereas energy consumption can be directly influenced by the design of the equipment. In view of this the European Commission decided to address imaging equipment within the EuP Directive and plans to introduce EcoDesign requirements to improve the energy efficiency and environmental performance of office imaging equipment. The preparatory study for how imaging equipment will be regulated under the EuP Directive was published in December 2007.

Two main technologies are used in office imaging equipment: Electro Photography (EP) and Ink Jet (IP). EP involves illuminating a charged organic photoconductor drum (usually a thin-walled aluminium cylinder coated with a photo-conductive substance) in a pattern representing the desired hard copy image via a light source (typically a laser or LED). The image is created with particles of (dry) toner using the latent image on the photoconductor to define the presence or absence of toner at a given location. The toner is transferred to the final hard copy medium (typically paper or foil) and cured in a thermal fusing process while applying pressure to cause the desired hard copy image to become durable. EP is used in medium and high speed printers and copiers and allows very high throughput of hardcopy images. Monochrome EP still dominates the market however colour EP is already very common for copiers and a growing segment of printers. EP accounts for 16% of the number of printers in the EU but around 85% of the total number of hardcopy images which are produced.

IJ dominates the consumer market for desktop printers due to their low cost, high quality of output, capability of printing in vivid colour and ease of use. IJ images are formed by depositing a jet of liquid ink in small drops directly to the print media in a matrix manner. The print head of the IJ printer scans the page in horizontal strips using a motor to move it back and forth, as another motor rolls the paper in vertical strips. The print head prints a vertical row of pixels at a time. Cyan, magenta and yellow inks are normally delivered through a combined print-head to form a colour image. Several small colour ink drops – typically between four and eight – can be combined to form dots of variable size and therefore provide inkjets with a bigger palette of colours and smoother images. Black ink is delivered in larger drops from a separate printhead. IP accounts for 75% of the number of printers in the EU but only about 10% of the total number of hardcopy images which are produced.

2 Proposed EcoDesign requirements for Imaging Equipment

2.1 Scope of the Implementing Measure

The preparatory study has proposed that the scope of proposed EuP EcoDesign requirements should be limited to office imaging equipment. Office Imaging Equipment is defined as

> *commercially available product which was designed for the main purpose of producing a printed image (paper document or photo) from a digital image (provided by a network/card interface) through a marking process. Office Imaging Equipment is also a commercially available product which was designed for the main purpose of producing a digital image from a hard copy through a scanning/copying process. The definition covers products which are marketed as printer, copier, facsimile machine, and (document) scanner. The definition also covers multifunction devices (MFD) which incorporate a printing function in combination with a scanning/copying function and/or facsimile function.*

Other types of imaging equipment are excluded from the scope proposed by the preparatory study. For example, production equipment such as high speed EP products (e.g. digital press), special media (e.g. medical x-ray equipment) and integrated secondary imaging equipment (e.g. ATM integrated printer).

2.2 Proposed EcoDesign Requirements

The preparatory study for how imaging equipment will be regulated under the EuP Directive was published in December 2007. This study recommended a number of EcoDesign requirements for consideration as part of an Implementing Measure under the EuP Directive. For example, power management options for improving the energy efficiency of EP products and power budget recommendations for limiting energy consumption of IJ products on standby and off-mode.

2.2.1 Default delay time settings

Bearing in mind that for EP products the user has the option to set the “ready mode” duration to 120 minutes or longer (at a power consumption of up to 250 Watts and 120 Watts on average) it becomes clear why measures should be taken to optimise this situation. The preparatory study highlighted that a simple time limit for the “ready mode” needs thorough consideration due to the different power requirements of the various marking and/or fusing technologies. For example, a solid ink printer requires preheating (at a power consumption of < 100W) in order to maintain an acceptable reactivation time. Against this background the preparatory study made the following recommendations for default delay time settings:

1. Maximum time limit of 30 minutes for devices with a power consumption in “ready mode” of > 150 Watts
2. Maximum time limit of 60 minutes for devices with a power consumption in “ready mode” of < 150 Watts
3. Adoption of “networked standby” as the power mode that is entered automatically after a maximum “transition phase” consisting of multiple “ready” and “sleep” modes, using the definitions in the Energy Star Program
4. Maximum time limit for the “transition phase” should be 240 minutes

The preparatory study recommends that the following products should be exempt from the above requirements:

- Products with an imaging speed of > 85ipm.

- Products with an image format > A3

Of course, use pattern and user behaviour are a key factor and it is important to provide education and support to users so that they do not choose to over-ride the default settings. Accordingly, the preparatory study recommends that the following energy-related product data should be published in the user manual:

1. Power consumption in individual operating modes
2. Default time settings per mode
3. Respective recovery times for mode
4. Energy consumption data according to Energy Star TEC or OM 1

2.2.2 Energy Star TEC Tier 1

In the long-term the preparatory study recommends adopting the Energy Star TEC qualification criteria Tier 1. The preparatory study recommends that the following products should be exempt from this requirement:

- Products with an imaging speed of > 85ipm.
- Products with an image format > A3

2.2.3 Network standby requirements

The preparatory study highlights that with the option for a prolonged transition phase (maximum duration 240 minutes), most imaging equipment can maintain a relatively fast reaction time of under 45 seconds, which is generally acceptable to users. After such a long period of inactivity the preparatory study recommends that the device should then reduce its power consumption to a considerably lower level of "networked standby", which might run indefinitely. Products without a "networked standby" mode should automatically go into off-mode.

The preparatory study recommends two tiers of maximum power consumption limits for the "networked standby" mode for different types of networks, Table 1.

Table 1: Two-tiered power consumption limits for networked standby

	Tier 1	Tier 2
"Type I" networked standby. Simple networks: analogue signalling and signal detection, and low speed connections (<0.5 Mbps or <5 MHz, such as IrDA or a phone line with DSL)	3 W	1 W
"Type II" networked standby. Standard range networks: standard data networks, lower speed wireless and non-continuous broadcast reception.	4 W	2 W
"Type III" networked standby. High speed networks: data networks (Gbps range or >500 MHz), higher speed wireless (all WLAN types) and continuous broadcast reception	10 W	5 W

NB. The adoption of these networked standby requirements requires further clarification on a number of issues including how to classify products into different standby types, the measurement procedures that should be applied, and the possible test conditions.

In addition, modifications or exemptions to this requirement may be necessary for

- Products with an imaging speed of > 85ipm.
- Products with an image format > A3
- Products with multiple wall plugs

2.2.4 Off-mode requirements

The preparatory study recommends two tiers of maximum power consumption limits for off-mode

- Tier 1 off-mode power consumption of less than 1 W
- Tier 2 (to be implemented at least 5 years after Tier 1) off-mode power consumption of less than 0.5 W

Modifications or exemptions to this requirement may be necessary for

- Products with an imaging speed of > 85ipm.
- Products with an image format > A3
- Products with multiple wall plugs

2.2.5 Harmonization of duplex unit and substance emissions requirements

The preparatory study recommended a detailed analysis of the current Energy Star Program and Eco-labels (e.g. Blue Angel) requirements to identify whether it would be possible to harmonize duplex requirements. For example, providing the user with the simplex/duplex option at the highest menu level on the user interface.

The preparatory study also recommended considering the adoption of the Blue Angel (RAL-UZ 122) criteria on substance emissions.

3 Status of the proposed Implementing Measure

A stakeholder meeting was held on 24th October 2007 to discuss and provide feedback on draft reports for tasks 1-7. Following this meeting the final report was published in December 2007.

The Consultation Forum is expected to be held early in 2008 but according to Martyn Webb of DEFRA he does not expect to see a Commission working document on the draft implementing measure issued for consultation before the second half of 2008.

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 Imaging Equipment, working closely with BERR and industry stakeholders.

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Once the Commission has issued its working document on possible EcoDesign requirements for Imaging Equipment, 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.

3.1 Regulatory Committee

The next step after the Consultation Forum meeting is 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. Imaging Equipment is already covered by the Energy Star voluntary energy consumption and labelling programme agreed between the EU and the USA. As a result, the Commission will consider options for a voluntary industry agreement for these products 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 Imaging Equipment 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 Environmental Design Options

For EP products the main life cycle energy consumption issue is the high power consumption required by the thermal fixing process, although the manufacturing phase is also significant particularly in the case of larger machines such as EP colour equipment and multi-function devices.

About 70% of the energy consumption of EP products in active mode is from the thermal fixing process carried out by the fuser/fixing unit. Other sources of significant power consumption include:

- motors used for the paper transport system
- scanner unit fluorescent lamps
- overall efficiency of the power supply unit

When selecting new low power fixing technologies for EP products, it is important to consider performance aspects, particularly speed. For example, fast fuser technologies are generally only applicable to low and medium speed products up to 50 ipm. Many of these technologies use thin rollers which are more prone to thermal stress when operated at high speed. High speed EP machines need reliable thermal operating conditions and so thermal insulation techniques are of particular importance.

For IJ products, although power consumption during the use phase has a considerable environmental impact, the short lifetime of IJ products shifts the impact from the use phase to the manufacturing phase. An interesting observation is that although electronic components amount to only 5% of the mass of the product, their contribution to the total manufacturing environmental impact can be up to 75% in some cases. This indicates that resource efficiency is an important factor. Regarding the use phase, the low print volume means that the main energy consumption issues arise from standby and off-mode power consumption.

4.1 Fast Fuser/Fixing Technologies for EP products

Most conventional EP products use a halogen lamp (generally 0.9 to 1.4 kW) to heat a fuser roller or fixing belt to about 180 to 200^{o}C. Due to the thickness of the roller or belt the warm-up time can be quite long (between 180 and 360 seconds) and is very energy intensive. To reduce this warm-up time manufacturers have introduced a number of different fast fuser technologies. In principle, all of these technologies are based on thinner fuser rollers/belts and alternative heating elements such as twin halogen heaters, ceramic heaters or induction heaters. Many of these energy saving technologies are proprietary and so are not generally available for all manufacturers to use.

4.1.1 Ceramic Heater Fuser Roller

The ceramic heater localizes the thermal energy to a specific area through a fixing film (flexible plastic sleeve) during printing. Equipment using this technology is promoted by Canon under the "on-demand" name and by HP under the "instant-on" name. These "on-demand" and "instant-on" fusers heat up three or four times faster than conventional halogen bulb fusers and allow a transition from a sleep state to printing in less than 15 seconds.

4.1.2 Twin Heater Fuser

This technology is used in Ricoh multifunctional digital copiers equipped with the QSU (quick start-up) feature. This uses twin halogen heaters and an ultra-thin shell fuser roller to reduce the warm-up time. Because a thin roller will cool down more quickly, the temperature is carefully adjusted by using two separately controlled heaters. Ricoh also combines the use of QSU twin heater fusers with the use of low-temperature fixing toners.

4.1.3 External Heat Roller

The Sharp proprietary external heat roller technology combines multiple heaters and thin wall rollers with thermal insulation to reduce warm-up time to less than 120 seconds.

4.1.4 Induction Heating of the Fuser

This technology uses high frequency current flowing through a coil or multiple coils to create an electromagnetic field inside the fuser roller, which has a resistive coating. The magnetic field causes eddy currents to flow in the resistive coating and this generates heat which heats up the metal fuser roller. The surface temperature of the fixing sleeve is precisely controlled.

Canon uses a proprietary induction heating fuser which consists of a thin-walled metal pipe with a thin fluororesin mould-release layer coating. This reduces the warn-up time to about 35 seconds.

The Konica Minolta uses induction heating on its bizhubC550 digital full-colour MFP, coupled with a small diameter fuser roller with a low heat capacity, and a polymerized low-temperature digital toner. The Panasonic “WORKiO” DP-CL22 / DP-CL18 colour multifunctional product uses a patented induction heating technology combined with a low thermal capacity heater belt.

4.1.5 Belt fixing

Canon’s iR C4580i and ir C4080i printers use a twin belt fusing system in conjunction with a highly efficient induction heating coil. One fixing belt heats toner from the front side of the paper and a second pressure belt applies pressure to the paper from the back. The fixing belt is made of low thermal-capacity material and heated by the induction heating coil. Similar technology is also used by Panasonic, Ricoh and Fuji Xerox.

4.2 Thermal management for EP products

High temperatures and rapid cycling of temperatures reduces the lifetime of electronic components. This in turn increases the level of maintenance and repair during life, and ultimately reduces the lifetime of the equipment. Where possible, sensitive electronic components should be located as far from the fuser unit as possible. Insulation and thermal shielding may also be required. The use of cooling fans should be avoided as this increases power consumption, noise levels and dust levels.

4.3 Efficient data processing for EP products

Data processing can be enhanced through faster CPUs, advanced memory chip-sets, advanced data compression and interface technologies. This in turn shortens the data processing time and saves energy. The Strategic Briefing Report on Personal Computers and Computer Monitors provides a range of computer design options that are applicable to the larger printers and copiers with significant data processing functions.

4.4 Reducing standby and off mode power consumption

Power consumption of IJ products in networked standby and off-modes vary considerably. The off-mode power consumption for typical IJ products ranges from 0.2W up to 3.2W. In particular, some low-end IJ printers still use less efficient liner power supply units (PSUs) instead of the more expensive but much more energy efficient switched mode PSUs. These manufacturers are advised to consult the Strategic Briefing Report on External Power Supplies for advice and guidance on design options for low energy switched mode PSUs.

The Strategic Briefing Report on Standby and Of-mode losses provides a range of design options that manufacturers should consider.

4.5 Low temperature toner for EP products

There are several proprietary low temperature toners.

- EPSON AcuBrite™ wax based toner has semi-spherical toner particles with uniform electrostatic properties. A special resin ensures that the wax melts easily during the fusing process
- Xerox Emulsion Aggregate Toner. Conventional toners are made by grinding composite polymeric materials to micron-sized particles. Emulsion Aggregate technology generates micron-sized particles in a bottom-up process from nanoscale components. This enables control of the size, shape and structure of the particles which leads to improved print quality, less toner usage and lower energy usage for manufacturing the toner. In particular, the technology enables the use of lower melt temperature resins.
- Konica Minolta Simitra toner and Canon Quick Fixing toner also have lower melting points than conventional toners.
- Ricoh has developed a toner containing 40% plant-based elements by using a newly-developed polyester resin made from corn and other materials. The toner operates at low temperatures similar to the above low temperature toners. At present, the toner is 20-30% more expensive than conventional toner. However Ricoh aims to establish a mass production system within two years which will bring the cost down to competitive levels.

4.6 Soy ink for IJ products

Conventional inks are petroleum based and contain 30-35% volatile organic compounds (VOCs) which are released as the ink dries. Inks based on soybean oil contain typically between 0 and 5% VOC content. Although soy ink is not generally used in small printers, it is widely used in many offset printing presses and newspapers.

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 proposed default time settings and identify whether there are any issues in implementing these across the manufacturer's product range.

Manufacturers should assess the current networked standby and off-mode power consumption a for their products and identify the most appropriate design options that will achieve the proposed power consumption limits. Note that the preparatory study has not proposed deadline dates for these limits. However, the draft Implementing Measure for Standby and Off-mode Losses will also apply to office imaging equipment. This Implementing Measure is likely be approved by the EU Regulatory Committee in July 2008 and may come into force from 2009, with the Tier 1 requirements applying from 2010. In view of this we recommend that manufacturers should develop a plan for how they will implement these design options to comply with power consumption limits by 2010. In the meantime, manufacturers should track the development of the Implementing Measure for Standby and Off-mode Losses as well as tracking the development of the Implementing Measure for Office Imaging Equipment.

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 Office Imaging Equipment 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.