EuP Preparatory Studies
"Imaging Equipment" (Lot 4)

Final Report on Task 1 "Definition"

Compiled by Fraunhofer IZM

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Introduction

This is the **final report** on Task 1 "definition" for the EuP Preparatory Studies on Imaging Equipment (Lot 4). The findings presented in this report are reflecting the research conducted by the IZM consortium as well as important feedback by industry and other stakeholders. The statements and recommendations presented in the final report however are not to be perceived as the opinion of the European Commission.

We like to acknowledge the fruitful collaboration and trustful working relationship with various industry partners, non-industry stakeholders and the European Commission throughout the study. We like to thank all stakeholders for their contribution and critical reviews of our reports.

12th November 2007

1. Definition

1.1. Product Category and Performance Assessment

1.1.1. Task and Procedure

1.1.1.1. Definition of Scope

In the tender for the EuP preparatory study Lot 4 the European Commission specified "imaging equipment" as a product category which consists of printer, copier, scanner, facsimile machines, and multifunctional devices (MFD)[1]. This specification is not sufficient to set clear boundaries (based on technical or performance criteria) for products that fall under the scope of the EuP preparatory study Lot 4. Therefore, the aim of the first task is to provide a more precise definition of the product category "imaging equipment" and to set herewith the scope for the products which are actually covered by the study. In this respect we should also note the requirement of Task 5 to define "base cases" which "represent the product category as a conscious abstraction of reality".

We may point out that our investigation could not so far identify a mutually understood definition of the product category "imaging equipment". Although we will present and discuss some existing classifications deriving from official EU statistics or the Energy Star Program, it became obvious that imaging equipment even under the given specification of functionality (print, copy, scan, and facsimile) is not homogeneously defined. Against this background we provide a two-level definition of scope:

- The "extended" scope of imaging equipment, describing the spectrum of applications for printing, copying, scanning, and facsimile products or modules with such functionality,
- The "actual" scope of imaging equipment, describing product groups that will be covered in the study of Lot 4.

1.1.1.2. Functional Unit and Playing field of Eco-design

The functional unit is a measure of the function of the studied products and it provides a reference to which the inputs and outputs can be related. This enables a comparison of different products. For example, the functional unit for a printer may be defined as a specific number of printouts in a specified quality and coverage. In this case the functional unit would reflect energy or colorant

[1] Call for tenders No. TREN/D140-2005 Preparatory Studies for Eco-design Requirements of EuPs.

consumption per page. However, in the case of imaging equipment we have to notice a large variety of technologies as well as performance and application criteria which determine the environmental impact of a particular product. We therefore have to investigate product specific aspects such as product design and functionalities, market dissemination, and average usage patterns. The analysis of typical distinction criteria (economical, technical, performance, etc.) will indicate access points for product optimization and through that the "playing field" for eco-design.

1.1.2. Analysis and Results

1.1.2.1. Extended Scope of Imaging Equipment

1.1.2.1.1. PRODCOM Classification

A first investigation in existing product classifications for imaging equipment deriving from PRODCOM and EU Trade Statistics did not provide an applicable definition of scope for the purpose of this study. Eurostat, the Statistical Office of the European Communities, is listing in its external trade database PRODCOM imaging equipment which comprises the functionalities printing, copying, scanning, and facsimile under two superior product categories; the 30.01 (manufacture of office machinery) and 30.02 (manufacture of computers and other information processing equipment). Under code number 30.01.21 PRODCOM classifies photo copying apparatus incorporating an optical system or of the contact type and thermo-copying apparatus. Table 1 provides an overview of products that fall under this category.

Table 1: PRODCOM classification applicable to copier

30.01.21	**Photo copying apparatus incorporating an optical system or of the contact type and thermo-copying apparatus**
30.01.21.50	Blueprint and diazocopiers (excluding ordinary photographic printing)
30.01.21.70	Electrostatic photocopiers
30.01.21.83	Blueprinters, diazocopiers and other photocopying apparatus of the contact type
30.01.21.85	Photocopiers incorporating an optical system, thermocopiers (excluding electrostatic photocopiers and thermo-printers)
30.01.21.90	Photocopiers incorporating an optical system, thermocopiers and contact type photocopiers (excluding electrostatic photocopiers, blueprinters and diazocopiers)
30.01.25.00	Parts and accessories for photocopiers incorporating an optical system, contact type photocopiers and thermocopiers

The PRODCOM code numbers 30.02.14 and 30.02.16 include printers and scanners of different types. Facsimile machines are assigned to the superior category "manufacture of television and

radio transmitters and apparatus for line telephony and line telegraphy" (32.20.20), thus not being directly categorized as imaging equipment. Table 2 below shows the particular classifications.

Table 2: PRODCOM classifications applicable to printer, scanner, and fax machines

30.02.14	**Digital data processing machines: presented in the form of systems**
30.02.14.02	Printers and plotters
30.02.14.05	Keyboards, scanners ...
30.02.14.30	Printers and plotters
30.02.14.50	Keyboards, scanners ...
30.02.16	**Input or output units, whether or not containing storage units in the same housing**
30.02.16.30	Printers
30.02.16.70	Input or output units whether or not containing storage units in the same housing (including mouse's) (excluding printers and keyboards)
30.02.16.79	Other input, output units (including mouse's, plotters and scanners)
32.20.20	**Electrical apparatus for line telephony or line telegraphy**
32.20.20.75	Fax machines

The following comments on the PRODCOM classification and data quality indicate the limited value of PRODCOM for the purpose of the EuP preparatory study Lot 4:

- 30.01.21.50 / 30.01.21.90: Data reported by the end of 2000. Instead of that data for product categories 30.01.21.83 / 30.01.21.85 have been reported since 2001.
- 30.01.25.00: No data have been reported at all. Production data are partly marked as not applicable because data is not collected for this item.
- 30.02.14.02 / 30.02.14.05: No data are available at all. 30.02.14.30 / 30.02.14.50: No data have been reported since 1996 anymore. Data are subsumed in the category 30.02.14.00 which also includes other products than printers and scanners, e.g. visual display units, keyboards, plotters, digital customer self-service devices like cash / money exchange, etc.
- 30.02.16.70: Generally, input and output devices (30.02.16.xx) cover several product groups. This could be for example text input devices (e.g. keyboards – which are included in a separate category), pointing devices (e.g. computer mouse, track- or roller ball, joystick, and touch screen), gaming devices, image / video input devices (image scanner, 3D scanner, digital camera / camcorder, webcam) and audio input devices. As there is no specific categorization for scanners which are in the scope of the EuP study, this category is not further analyzed.
- 30.02.16.79: Only few data have been reported. EU 15: 2002 production data (661,144 units; data for this item is estimated).

1.1.2.1.2. EU25 Trade Statistic Classification

In addition to PRODCOM Eurostat provides EU25 Trade Statistic whose classification is based on the Combined Nomenclature (CN). Table 3 below provides an overview on imaging equipment relevant PRODCOM-codes and corresponding CN-codes.

Table 3: PRODCOM-Codes and corresponding CN-Codes applicable to imaging equipment

PRODCOM-Code	Description of PRODCOM-Codes	Corresponding CN-Code
30.01.21.70	Electrostatic photocopiers	9009.11.00 9009.12.00
30.01.21.83	Blueprinters, diazocopiers and other photocopying apparatus of the contact type	9009.22.00 9009.22.10 9009.22.90
30.01.21.85	Photocopiers incorporating an optical system, thermocopiers (excluding electrostatic photocopiers and thermo-printers)	9009.21.00 9009.30.00
30.02.16.30	Printers	8471.60.40
32.30.20.85	Fax machines	8517.21.00

The following three tables give the EU25 trade statistic classifications corresponding to imaging equipment. Table 4 shows EU25 classification for various photocopying devices indicating a differentiation by technology features. The statistic also contains photocopying related parts and accessories like toner cartridges and paper feeders.

Table 4: EU25 trade statistic applicable to copier

9009	Photocopying apparatus incorporating an optical system or of the contact type and thermo-copying apparatus
Electrostatic photocopying apparatus	
9009.11.00	Operating by reproducing the original image directly onto the copy (direct process)
9009.12.00	Operating by reproducing the original image via an intermediate onto the copy (indirect process)
Other photocopying apparatus	
9009.21.00	Incorporating an optical system (excluding electrostatic)
9009.22.00	Of the contact type
9009.22.10	Blueprinters and diazo-copiers
9009.22.90	Photocopying apparatus, of the contact type (excl. blueprinters and diazo-copiers)
9009.30.00	Thermo-copying apparatus (excl. thermo-printers)
Parts and accessories for photo-copying and thermo-copying apparatus	
9009.90.00	Parts and accessories for photo-copying and thermo-copying apparatus, n.e.s.
9009.90.10	Parts and accessories for electrostatic photocopying apparatus or other photocopying apparatus incorporating an optical system
9009.90.90	Parts and acc. For electrostatic photocopying apparatus of the contact type and thermo-copying apparatus
9009.91.00	Automatic document feeders for photocopying and thermo-copying apparatus
9009.92.00	Paper feeders for photocopying and thermo-copying apparatus
9009.93.00	Sorters for photocopying and thermo-copying apparatus
9009.99.00	Other parts and accessories for photocopying and thermo-copying apparatus (excl. automatic document feeders, paper feeders and sorters)

Table 5 contains printers which are compiled under the term input and output units. The products covered are printers for digital automatic data processing machines with no technological differentiation. It is also interesting to notice that facsimile machines are falling under the category electrical apparatus for line telephony which indicates that the classification does reflect the telephony function higher that the capability to take an imaging from a hardcopy or create such after receiving the facsimile.

Table 5: EU25 trade statistic applicable for printer

8471.60	**Input or output units for digital automatic data processing machines, whether or not containing storage units in the same housing**
8471.60.10	Input or output units for digital automatic data processing machines, whether or not containing storage units in the same housing, for use in civil aircraft
8471.60.20	Printers for digital automatic data processing machines, whether or not containing storage units in the same housing
8471.60.40	Printers for digital automatic data processing machines, whether or not containing storage units in the same housing (excl. for use in civil aircraft of subheading 8471.60.10)
8471.60.50	Keyboards for digital automatic data processing machines (excl. for use in civil aircraft of subheading 8471.60.10)
8471.60.60	Keyboards for digital automatic data processing machines, whether or not containing storage units in the same housing
8471.60.80	Input or output units for digital automatic data processing machines, whether or not containing storage units in the same housing, (excl. printers and keyboards)
8471.60.90	Input or output units for digital automatic data processing machines, whether or not containing storage units in the same housing, (excl. for use in civil aircraft of subheading 8471.60.10, printers and keyboards)

Table 6: EU25 trade statistic applicable for fax machines

8517	**Electrical apparatus for line telephony or line telegraphy, including line telephone sets with cordless handsets and telecommunication apparatus for carrier-current line systems or for digital line systems; videophones**
8517.21.00	Fax machines

We have come to the conclusion, that although more comprehensive than PRODCOM, the EU25 trade statistic classification does not provide a basis to define a clear scope of imaging equipment. The investigation shows however that the task of product categorization is very difficult. The allocation of technically and functionally fast changing equipment to more “static” product categories is a challenge. What is interesting to notice is the fact that the statistic covers not only complete devices but parts and accessories as well. We should consider this if we define the product category imaging equipment. The term Energy-using Products (EuP) refers to complete devices. However, parts or accessories like toner cartridges or paper feeders are not necessarily covered. Due to the fact that exchangeable parts become more technically complex (e.g. by integrating an optical system or print head) and through that determine the technical performance as well (an example is toner efficiency) we should consider them in the technical and environmental analysis.

1.1.2.1.3. Extended Scope of Imaging Equipment

Official trade statistics, market research companies, product labelling schemes or consumer test magazines all provide different classifications for imaging equipment that incorporate printing, copying, scanning and facsimile functionality as shown in Table 7.

Table 7: Imaging Equipment Classifications Overview

Single functions	PRODCOM /EU trade statistic	Nordic Svan	Blue Angel	TCO'99	EU-Energy Star
Copiers	▪ **Electrostatic** o direct process o indirect process ▪ **Contact type** o Blueprinters/ diazocopiers o Other ▪ **Thermocopiers** ▪ Copiers with an optical system	▪ **Copiers**	▪ **Copiers**	▪ **Copiers**	▪ **Copiers** o Direct Thermal o Dye Sublimation o EP o Solid Ink o Thermal Transfer
Faxes	▪ **Fax machines**	▪ **Fax machines** o Laser/LED/Ink jet/Thermal	▪ ---[2]	▪ **Fax machines**	▪ **Fax machines** o Direct Thermal o Dye Sublimation o EP o Solid Ink o Thermal Transfer o Ink Jet
Printers	▪ **Printers** o Printers for digital automatic data processing machines o Parts and accessories	▪ Laser ▪ LED ▪ Ink jet ▪ Matrix	▪ Electro-photography (Laser / LED) ▪ Ink jet (ink, gel or wax)	▪ Laser ▪ Ink jet ▪ Matrix	▪ **High temperature** o EP o Solid ink o Direct Thermal o Thermal Transfer o Dye Sublimation ▪ **Lower temperature** o Ink-jet o Impact
Scanners	▪ ---[3]	▪ ---[4]	▪ ---[5]	▪	▪ **Scanners**
MFD	▪ ---	▪ MFD	▪ MFD	▪	▪ **MFD** o Direct Thermal o Dye Sublimation o EP o Solid Ink o Thermal Transfer o Ink Jet

Most products which are covered by these classifications are what we would usually call "**office imaging equipment**"; printer, copier, flatbed scanner, and facsimile machines that are used by

[2] No separate category but indirectly covered as one of the main functions: "Sending and receiving electronic messages and faxes via internal modem"
[3] No separate category; integrated in category "Input or output units, whether or not containing storage units in the same housing"
[4] No separate category but may be indirectly covered by the other technologies
[5] No separate category but indirectly covered as one of the main functions: "Digitizing of data via a scanning unit and transmission of data via interface"

costumers in private homes or in an office environment. But there are more products for which the term imaging equipment is applied.

The first category is what we like to call "**production imaging equipment"**. Products which fall under this category are applied in professional environment and are usually attended in contrast to mostly unattended usage of office imaging equipment. Production imaging equipment is based on the same digital imaging technology like office equipment however the particular functionality, use patterns, the quantity and quality (e.g. colour quality, large format, hardcopy material) of created images are different. Although in the production environment (graphics, media) offset printing is still dominating the market strongly, digital imaging equipment (Digital Press Systems) becomes an alternative due to increase of a positive price and performance ratio.

The second category is what we call "**special media imaging equipment**". Under this category we summarize a wide spectrum of products mostly in medical, industrial, and military applications. Imaging equipment of medical applications are ultrasound diagnostic systems, bone densitometry, diagnostic X-ray imaging equipment, radiotherapy quality assurance equipment. Thermal imaging equipment is used in a variety of application fields. Thermal imaging equipment is the conversion of radiated or reflected heat (e.g. infrared) into real-time pictures or images of temperature differences. Thermal imaging equipment is more closely related to photography equipment.

Herewith we address a general challenge with regards to the definition of imaging equipment. Due to the term "image", imaging equipment is also linked to photography equipment like cameras. A point of differentiation could be the general understanding that "imaging equipment" is closely related to the creation of a hardcopy image, which in turn a camera can not do. But this kind of differentiation by hardcopy is not coherent. Take the example of a flatbed scanner, a device that can create a digital image of a hardcopy but is not able to "print" this image. Another aspect is telephony and facsimile in particular. As we have seen in the previous section, fax machines are not commonly allocated to the category imaging equipment due to the technical evolution from telephony. This brings us to the third category of related products.

The third category is what we like to call "**integrated secondary imaging modules**". This category comprises products with an integrated printing functionality such as cash registers or automatic teller machines. There is a wide spectrum of products that provide a printing functionality as a secondary function. In a lot of cases this "secondary function" could be regarded as a main function when taking the amount of usage into account. It is very difficult to obtain

actual market and use data for these products. They are usually applied in a business environment with a large variety of use patterns.

Figure 1 illustrates the extended scope of imaging equipment. We must assume that the spectrum of products is wide depending on the definition we apply. As we try to indicate, the terminology imaging equipment is not uniquely applied to a specific product category or categories. If we allocate the functionalities printing, copying, scanning, and fax to the term imaging equipment, we still encounter large overlaps with product categories such as photography or telephony. Therefore it is necessary to define the scope of products which we will cover under Lot 4 study more precisely.

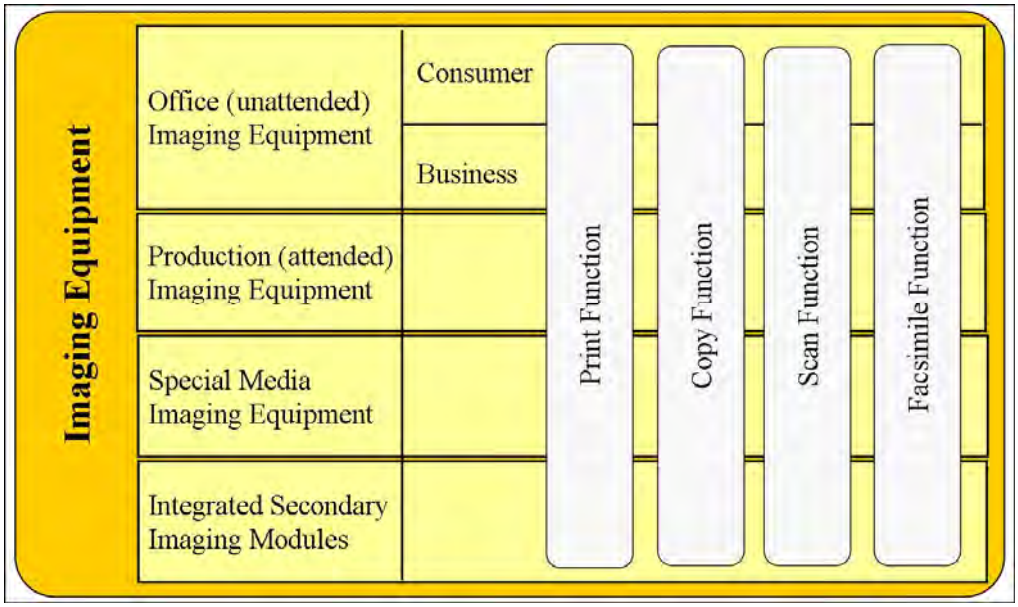

Figure 1: Extended scope of imaging equipment

1.1.2.2. Actual Scope of Imaging Equipment

1.1.2.2.1. Scope of Lot 4 Imaging Equipment

The previous analysis has shown a wide spectrum of products and product classifications that are related to the term imaging equipment. For the purpose of the EuP preparatory study Lot 4 we will focus the investigation solely on the product category that we call “office imaging equipment”. Figure 2 illustrates the actual scope of Lot 4. This focuses on office imaging equipment that is primarily used by private consumers and in business/office environment for digitally reproducing and printing hardcopy images seems to cover the scope of products that were addressed by the European Commission’s tender for the EuP preparatory study. Office imaging equipment is an economically significant product category with high annual unit sales in printer, copier, scanner

and facsimile market (cp. Task 2, market analysis). The environmental impact is determined not only by the volume of products which enter the market annually but also by the high amount of hardcopy images that are created by their application.

The following definition of **office imaging equipment** will set the particular product scope for the study.

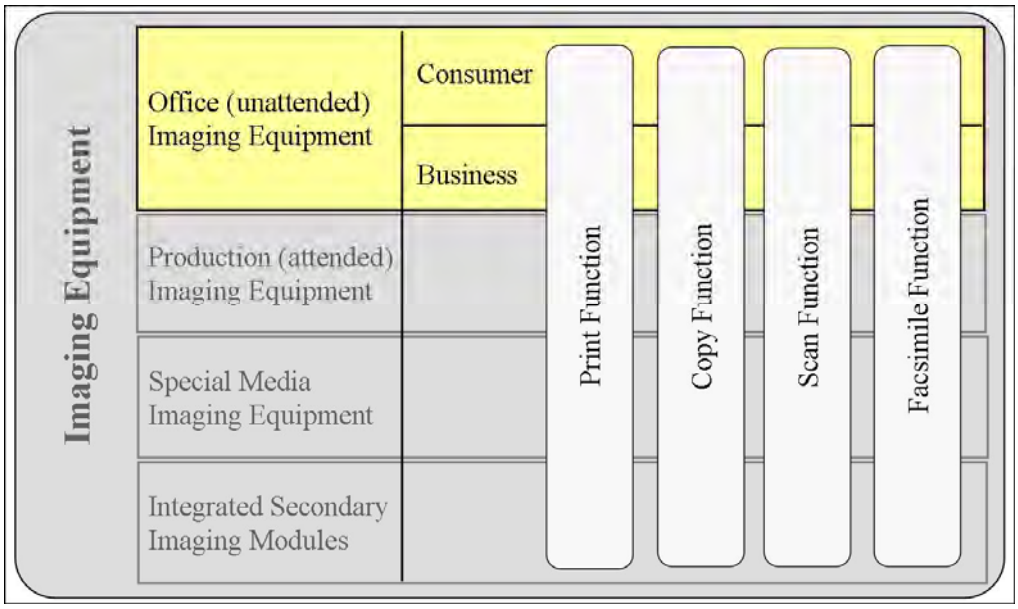

Figure 2: Actual scope of imaging equipment Lot 4

1.1.2.2.2. Definition of Office Imaging Equipment

For the purpose of the EuP preparatory study Lot 4 we define office imaging equipment as:

- **Office Imaging Equipment** is a 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 hardcopy 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.

The following definitions for products have been adopted from the current Energy Star Program for Imaging Equipment. These product definitions display a broad consensus and seem to be applicable for the purpose of this study. Please notice that we have added mailing machines and digital

duplicators to the list of products, because these two product types are in the scope of the Energy Star Program. Mailing machines and digital duplicators are not specified in our definition of office imaging equipment, however, we will include mailing machines and digital duplicators for now into the Lot 4 analyses in order to determine if these two product types should be reflected by the base cases or not.

- **Printer** is a commercially available imaging product that serves as a hardcopy output device, and is capable of receiving information from single-user or networked computers, or other input devices (e.g. digital cameras). The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as printers, including printers that can be upgraded into MFDs in the field.

- **Copier** is a commercially available imaging product whose sole function is the production of hardcopy duplicates from graphic hardcopy originals. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as copiers or upgradeable digital copiers.

- **Scanner** is a commercially available imaging product that functions as an electro-optical device for converting information into electronic images that can be stored, edited, converted, or transmitted, primarily in a personal computing environment. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as scanners.

- **Facsimile Machine** is a commercially-available imaging product whose primary functions are scanning hard copy originals for electronic transmission to remote units and receiving similar electronic transmissions to produce hard copy output. Electronic transmission is primarily over a public telephone system, but may also be via computer network or the Internet. The product may also be capable of producing hard copy duplicates, sometimes referred to as “convenience copying.” The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as fax machines.

- **Multifunction Devices (MFD)** is a commercially available imaging product which is a physically integrated device or a combination of functionally-integrated components combining two or more of the core functions of copying, printing, scanning, or faxing. The

copy functionality as addressed in this definition is considered to be distinct from single sheet convenience copying offered by fax machines. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as MFDs or multifunction products (MFPs).

- **Digital Duplicator** is a commercially available imaging product that is sold in the market as a fully automated duplicator system through the method of stencil duplicating with digital reproduction functionality. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as digital duplicators.

- **Mailing Machine** is a commercially available imaging product that serves to print postage onto mail pieces. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as mailing machines.

1.1.2.3. Main Technologies and Performance Parameters of Office Imaging Equipment

Office imaging equipment is a complex product category consisting of products which provide four main functionalities; printing, copying, scanning and facsimile function. On the product level we have the distinction of at least eight commonly used **marking technologies**[6] to create a hardcopy image:

- Electro Photographic (EP)
- Ink Jet (IJ)
- Direct Thermal (DT)
- Thermal Transfer (TT)
- Dye Sublimation (DS)
- Solid Ink (SI)
- Stencil
- Impact

From these eight marking technologies **electro photographic** (EP) printing and **inkjet** (IJ) printing are the dominating technologies in the market. Office imaging equipment developed over the past

[6] These marking technologies are specifically mentioned and defined in the Energy Star Program requirements for imaging equipment.

years from **Single Function Devices** (SFD) to **Multi Functional Devices** (MFD) including two or more of the core functions. The shift towards multi-functionality is immanent and one of the main trends in the office imaging equipment market. Technology and functionality related is the performance of an office imaging equipment. The market typically differentiates image speed (images per minute), image quality (monochrome and colour/photo colour) as well as various image sizes (e.g. standard A4). For certain products the market differentiates performance of devices in relation to fields of application. Typical segments comprises "personal" (1 – 4 users in small office or home office environment), "workgroup" (5 and more users in an unattended business office environment), and "production" (attended professional user environment).

In order to determine the source of significant environmental impacts and to identify the access points for environmental product optimization the full range of criteria – technology, functionality, performance, market volume and application – has to be taken into account. Figure 3 illustrates this set of criteria.

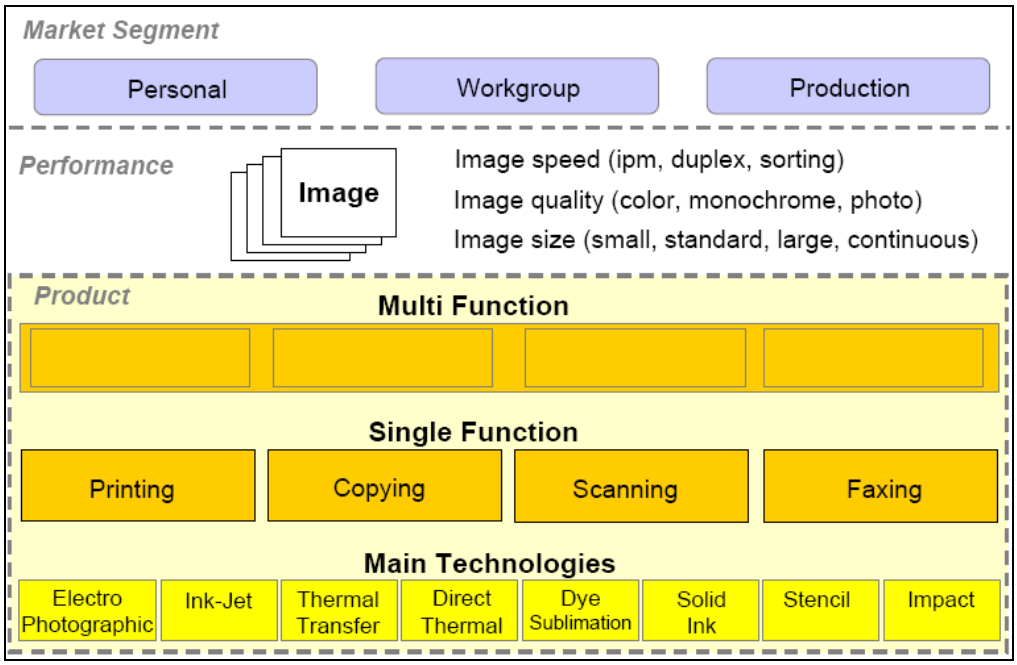

Figure 3: Office imaging equipment performance criteria

In the following sections we discuss based on a "top-down approach" environmental performance and general optimization strategies for office imaging equipment that feature EP and IJ technology. With EP and IJ products we intend to cover the two dominant marking technologies and the largest amount of products in the market (cp. Task 2, market analysis).

1.1.2.3.1. Electro Photographic Technology (EP)

EP is a marking technology characterized by illumination of a charged organic photoconductor drum[7] 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 to become durable. The process allows a very fast throughput and creation of hardcopy images. EP marking technology is applied in medium to high speed printers and copies. Monochrome EP still dominates the market however colour EP is already very common for copiers and a growing segment for printers.

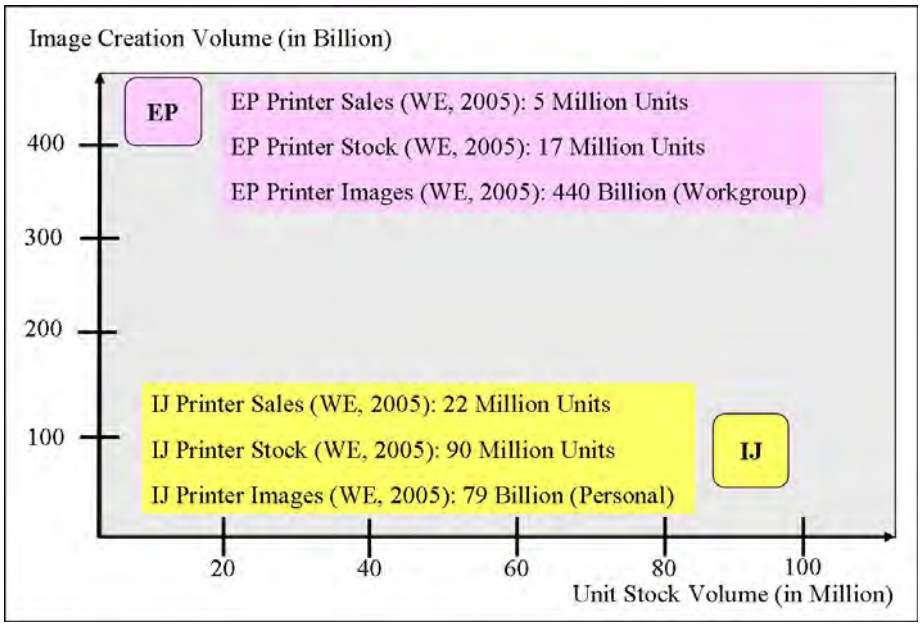

Figure 4: Market comparison of EP and IJ office imaging equipment

What distinguishes EP from other marking technologies is the good ratio of printing speed and costs per image. This aspect defines to some extent the more commercial application of EP printer and EP copier mostly in business offices and copy shops. In general EP printer and EP copier are in comparison to inkjet products technically more complex and of higher price. However, in regards to annual unit sales, existing market figures indicate a 1 to 5 ratio of EP products to IJ products. Market data based on InfoTrends suggest for Western Europe that approximately 5 million EP units were sold in 2005 in comparison to 22 million IJ units. The actual stock of EP printer in Western Europe in 2005 were 17 million and EP copier over 6 million units. IJ printer on the other hand accumulated to 90 million units. As for the annual image creation volume related to EP and IJ

[7] Usually a thin-walled aluminum cylinder coated with a photo-conductive substance.

products we have an opposite situation. Accumulated data from InfoTrends suggest that the image (page) volume in 2005 produced by EP printers was about 439 billion and EP copiers 79 billion in comparison to 103 billion from IJ printers. This situation is illustrated in the Figure 4 above.

The intended use of EP printer and EP copier for high "volume image creation" correlates with a typically longer product use/life time[8]. In that respect, it is necessary to distinguish also various business models particularly as a distinction of EP copier from EP printer. Some companies which manufacture EP copiers (e.g. Xerox, Ricoh) are not selling but leasing their products. According to this business model, EP copiers might only remain for three or five years in the market, will than be taken back by the company, partially disassembled, and their components refurbished for reuse in new products. This approach indicates a longer lifetime not for the original product but of particular components (parts) of the original product. This business approach is also related to some technical specifications of EP copier machines in comparison to EP printers. Copier machines were historically design as floor standing office/business equipment, whereas EP printers were traditionally designed as desktop devices with smaller dimensions and clean, easy to exchange cartridges for commercial and non-commercial users. The intended commercial use (fast and high volume paper output) of EP copiers is reflected by the design and price of products. Today we see a stronger market overlap of EP copiers and EP printers. Today's copiers are mostly network capable and can be used as a regular printer. In parallel the EP printers are becoming faster, larger and multifunctional (integrated scanning unit) and hereby competitive in the copier market.

However the marking technology (EP) is the same, the design approach to an EP copier and an EP printer are still different. EP copiers feature a more "open" system with the light source, photo conductor drum, toner cartridge and cleaning unit not integrated in a separate housing which is typically done in the case of EP printer. The exposure of the whole system to toner particles is higher in the case of EP copiers. However, an expected frequent exchange of consumables such as the toner cartridge due to high use intensity is made easier. The professional maintenance concept in the field of copiers is an important aspect to be recognized. EP printer manufactures on the other hand are typically selling their products and intent a low maintenance product concept. A more "contained" system is their approach. In consequence the whole system, including the drum, is exchanged, if the toner cartridge is empty. This business concept for the exchange of consumables focuses on product specific modules that can usually only be provided by the original manufacturer or by licensed contractors. Against the background of growing competition in the toner cartridge market this is a legitimate approach.

[8] We could not obtain real figures regarding typical use/life time of EP printer, however industry partners have indicated a typical five to seven year use period on average. See also report of Task 3 on consumer behavior.

1.1.2.3.2. Environmental Implications of EP Technology

EP printer and EP copier are technically complex office imaging equipment for high volume image (hardcopy) creation. Environmental impacts of EP product are deriving in general from resource, power and consumable consumption. The extent of the environmental impact is influenced by the product design, market penetration and actual use.

The functionality and performance (use specifications) of a product will be first and foremost determined by its design and applied technologies. Regarding EP copier and EP printer the intended image quality – monochrome or colour capability – is a first determining factor. A second factor is the functionality. Single Function Devices (SFD) or Multi Function Devices (MFD), the image creation speed, and duplexing capability are environmentally relevant aspects. Finally, the intended use (average use patterns) will determine the power, toner, and paper consumption of a device.

Colour Capability

Colour images are created by the precise combination (overlay) of at least three colours; cyan, magenta and yellow in combination with black (CMYK). The necessity of multiple colours increases in general toner consumption. On a technical level, colour increases the number of processes necessary to create an image. Each colour (CMYK) has to be applied in consecutive order by an “in-line” or “revolving” technology. These two technology principles have different advantages – one being faster but larger the other one being slower but smaller and less expensive. In general we have to notice that colour machines are resulting in considerable larger amounts of parts such as drums, cartridges, rollers, or motors. Colour machines are heavier and mostly of larger dimensions which indicates material consumption. Finally we have – in comparison to monochrome machines – an increase in power consumption due to the multiple image development, transfer, and fusing processes. Power consumption of EP copiers and EP printers are mostly related to the thermal fusing process. We also assume that power consumption is related to the toners technical properties (necessary thermal energy and applied pressure).

Multi Functionality

A second aspect is the differentiation of SFD and MFD device. As mentioned before most EP copiers that enter the market today are MFD due to their network capability (receiving print jobs). In the EP printer we can notice the trend towards MFD particular regarding scanning/copying capability. But they are also devices that can receive and send faxes. Whereas the environmental impact of the scanning function is mainly related to the light source (materials and power consumption) the facsimile function could be of greater concern due to the constant online

(standby/ready) necessity. If this telephony component includes the preheating of the fuser, unit we have to assume considerable power consumption in standby.

The image creation speed is one of the most important features for distinguishing products on the market. Over the past years the speed of EP copiers and EP printers increased constantly driven by market competition that focused on the speed issue in product marketing. From an environmental point of view, we have to assume that high speed has some relevance regarding power consumption. Keeping in mind, that the EP technology is based on the principle that the toner is melted and fused, or bonded to the paper, a fast image creation or paper throughput (speed) demands a very even distribution of heat (high volume of thermal energy) from the roller onto the paper. Paper – although it has not a particularly good thermal conductivity – draws also thermal energy from the fusing unit. This results in power consumption up to a couple of hundred watts in on-mode. Related to the speed issue is the intended use and average user patterns.

Intended Use

EP copier and EP printer are mainly designed for intensive use meaning a medium to high hardcopy (paper) output volume per day. We determined the use intensity by correlating the actual product stock for EP copier (monochrome and colour) and EP printer (monochrome and colour) with the output volume for these products in 2005. The data were provided by InfoTrends and cover the region "Western Europe". The quality of data cannot be assessed because other sources like GfK or IDC data are not available for the study.

Product Case	**Product Stock 2005** (in tsd. Units)	**Output Volume 2005** (in tsd. Pages)	**Output Average** single unit in 2005	**Output Average** unit/day (240d/a)
EP Printer (total)	16,654	439,000,000	26,360	110 pages
# EP-P (mono)	*14,735*			(356 days = 72)
# EP-P (colour)	*1,919*			
EP Copier (total)	6,351	103,000,000	16,218	68 pages
# EP-C (mono)	*5,970*			(365 days = 44)
# EP-C (colour)	*381*			

Table 8: EP copier and EP printer daily output volume

Table 8 comprises the main data base regarding product stock, overall output volume, the annual output per single unit and the daily output per unit. Concerning the daily output volume per unit we did not calculate 365 days per year but rather 240 days per year (20 days per month) in order to reflect the amount of average working (office) days in a year. On average the EP printer produce 110 pages per day and the EP copier 68 pages per day. If we assume an office use scenario of

12 hours “on-mode” (form 6 a.m. to 8 p.m. in active, ready, sleep, or standby), as well as the remaining 12 hours in “off-mode”, than is the actual printing time depending on the number of pages per print job quite short. That also means that the periods between the single print jobs are quite long.

Power consumption in ready, sleep or standby mode has therefore a considerable influence in the overall power consumption of the device. The power levels in various modes and the influence of the time durations between different modes (power management) need thorough investigation in the study. Furthermore it is necessary to investigate the data processing and network interaction. It has been known that constant status control has resulted in the constant reactivation of devices. Power management issues are therefore related to a feasible reactivation time, optimum default time settings for changing into lower power modes as well as the capability of a device to stay in low power mode. Most EP products have optional default time setting for ready into sleep mode from a couple of minutes up to a couple of hours. Power consumption could be reduced if a fast transition from ready mode into a low power mode (the lowest power level such as deep sleep or standby) would be achieved. This, however, also means that the device can be reactivated in a considerable fast time. Manufacturers indicate the importance of fast reactivation capability (about 10 to 15 seconds) as a main consumer requirement (product feature particular of very fast machines). The fast transition from a very low power level (standby-mode) to ready or active mode is a technically demanding task. It usually takes between 30 and 90 seconds although some manufactures have demonstrated much faster reactivation by introducing more instant fuser technology. The problem is the quick provision of a large and evenly distribute amount of thermal energy to the roller. Material costs and reliability are topics in that respect. The Task 3 report provides a more thorough analysis of this issue.

A further environmental impact is related to paper consumption. There are three factors regarding paper consumption that is influenced by the products design. A high print quality of the hardcopy image is the first aspect. If through technical means the created image has a poor quality such as scratches, spots and ghosting an image will be discarded and the customer try to print it again. A proper throughput of paper is a second aspect. Paper jams not only lead to consumption of paper but could lead to consumption of power as well. This is the case when the fuser unit is not shut down during a paper jam. Finally, duplexing capability has a high potential for reduced paper consumption. However, the user is still the dominating factor as will be shown in Task 3 report.

1.1.2.3.3. Inkjet Technology (IJ)

Apart from electro photography the most common marking technology is inkjet. IJ technology is dominating the consumer market for desktop printers due to a good price value (color image) ratio. Inkjet (IJ) is a marking technology where images are formed by depositing (jet) colorant (liquid ink) in small drops directly to the print media in a matrix manner[9]. The print head of the inkjet printer scans the page in horizontal strips, using a motor to move it back and forth, as another motor rolls the paper in vertical steps. After a strip of the image is printed the paper moves on, ready for the next strip. To speed things up, the print head doesn't print just a single row of picture elements or 'pixels' in each pass, but a vertical row of pixels at a time. Cyan, magenta and yellow inks are normally delivered via a combined print-head. Several small color ink drops – typically between four and eight – can be combined to form dots of variable size, which gives inkjets a bigger palette of colors and smoother images. Black ink is delivered in larger drops from a separate print-head. Inkjet is the most common type of PC peripheral printer for the general consumer due to their low cost, high quality of output, capability of printing in vivid color, and ease of use. There are three main IJ technologies:

- **Thermal inkjet**: To produce an image, the printer runs a pulse of current through the heating elements. A steam explosion in the chamber forms a bubble, which propels a droplet of ink onto the paper. Thermal inkjet technology is used almost exclusively in the consumer inkjet market.
- **Piezoelectric inkjet**: They use a piezoelectric crystal in each nozzle instead of a heating element. When current is applied, the crystal changes shape or size, forcing a droplet of ink from the nozzle. Piezoelectric inkjet allows a wider variety of inks than thermal or continuous inkjet but is more expensive.
- **Continuous inkjet**: A high-pressure pump directs liquid ink from a reservoir through a microscopic nozzle, creating a continuous stream of ink droplets. A piezoelectric crystal causes the stream of liquid to break into droplets at regular intervals. This method is used commercially for marking and coding of products and packages.

Thermal and piezoelectric inkjet are common technologies for single function colour desktop printers and multifunction devices in small and home office environment.

An appreciation of IJ printers form an economical point of view should be done through a direct comparison to EP printer and EP copier. As indicated earlier IJ printers are “volume products” if measured by annual unit sales. On the other hand, the images created by IJ printers are actually

[9] Definition derives from Energy Star Program.

"value products" due to the relatively high image quality (e.g. colour gamut and glossiness of image).
In contrary to EP products, which are mostly classified and marketed by speed classes, IJ products are more generally marketed by fields of application.

Typical IJ printer segments are "Personal or Consumer", "Small Office Home Office" (SOHO), or small and large "Workgroup". There is no single definition of printer segments. The here presented terminology derives from InfoTrends and industry representatives. Japanese manufacturers have suggested making differentiation by weight classes. They proposed: less than 6 kg for personal, between 6 kg and 11 kg for SOHO, and over 11 kg for workgroup printer.

A last point of differentiation is the average usage time and use intensity of IJ. The IJ printers are usually less intensively used (only a couple of prints per day in average) and tend to have shorter average usage time. The following Figure 5 shows some principal technical and economical aspects of comparison regarding EP and IJ printer.

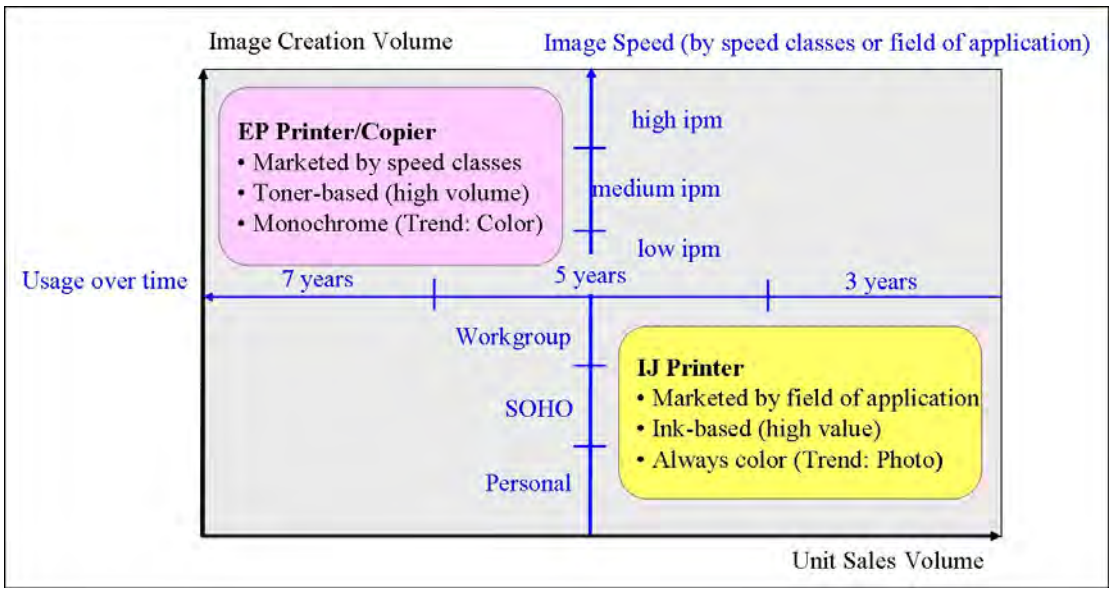

Figure 5: Aggregated technical and economical comparison of EP and IJ printer

1.1.2.3.4. Environmental Implications of IJ Technology

IJ printers are used in private homes, small and large offices for low to medium volume image (hardcopy) creation. Environmental impacts of IJ printers are deriving in general from resource, power and consumable consumption. The extent of the environmental impact is influenced by the

product design, the very high market penetration and the – in comparison to EP printer – lower use intensity.

The functionality and performance (use specifications) of a product will be first and foremost determined by its design and applied technologies. Regarding IJ printers the size, weight and intended image quality – colour and photo capability – is a first determining factor. A second factor is the functionality. Single Function Devices (SFD) or Multi Function Devices (MFD), the image creation speed, and duplexing capability are environmentally relevant aspects. Finally, the intended use (average use patterns) will determine the power, ink, and paper consumption of a device.

Miniaturization

Manufacturers of inkjet desktop printers have reduced the size and weight of their devices over the past decade. A further miniaturization can only be expected regarding the integrated electronics, electro mechanics, and perhaps ink cartridges. Through these measures material consumption was reduced. However, the high annual unit sales volume makes material oriented eco-design a reasonable improvement strategy. Material related resource consumption and possible toxicity should be addressed throughout all life cycle stages including manufacturing processes, packaging material, consumables (ink cartridges), reuse of valuable modules, and feasible product recycling. Energy conservation improvement in IJ printers has been tremendous over the past decade. Particular energy saving technologies has been introduced by most manufacturers. Miniaturization of mechanical and electronic components, smart circuitry and system integration has improved power consumption in active mode, power management and standby regarding best performing products of even lower than 1 Watt.

The IJ printer segments are currently influenced by the market move towards photo capability and compact photo printers. Inkjet technology stands in direct competition to dye sublimation (DS) and solid ink (SI) photo printing technology. A **dye sublimation** printer creates colour on the printed page by vaporizing CMYK inks in the form of either a roll or a ribbon. The colour and its intensity are determined by the amount of heat, generated by the thermal print head, to which the dye-ribbon is subjected. A **solid ink** printer use heat to liquefy wax sticks (wax-like ink) into reservoirs and on to a transfer drum. The ink then hardens in place and the image transfer happens via heat and pressure (fusing). Dye sublimation, solid ink, and inkjet are different technologies with very specific qualities and weaknesses (cost/performance ratio regarding photo printing). The environmental impact of photo printing can also be related to special photo paper.

Multi Functionality

With the trend towards more integrated functionality (MFD) such as scanning, facsimile, and digital interfaces (card reader, etc.), the amount of parts, the weight and size as well as power consumption is increasing and becomes again an important issue. Regarding facsimile capability standby (always online) should be a target for improvement. The light sources optimization is a potential strategy for the scanning unit. These aspects have been similarly addressed already for the EP products. We should consider treating the functions "scanning" and "facsimile" in the base case assessments (cp. Task 5) separately.

Intended Use

IJ printers are mainly designed for low and medium hardcopy (paper) output volume per day. We determined the use intensity by correlating the actual product stock for IJ printer (SFD and MFD) with the output volume for these products in 2005. Table 9 comprises the main data IJ printer (and facsimiles) regarding product stock, overall output volume, the annual output per single unit and the daily output per unit. Concerning the daily output volume per unit we did not calculate 365 days per year but rather 240 days per year (20 days per month) in order to reflect the amount of average working (office) days in a year.

Product Case	**Product Stock 2005** (in tsd. Units)	**Output Volume 2005** (in tsd. Pages)	**Output Average** single unit in 2005	**Output Average** unit/day (240d/a)
IJ Printer (total)	90,172	79,000,000	876	4 pages
# IJ SFD	*68,412*			(365 days = 2,4)
# IJ MFD	*2,.760*			
Facsimile (total)	20,131	29,000,000	1,440	6 pages
# Fax SFD	*13,241*			(365 days = 4)
# Fax MFD	*6,890*			

Table 9: IJ printer and facsimile daily output volume

Figure 6 shows the daily use scenario (home use) with average times for different operation modes. A daily output volume of 4 pages are created by 2 print jobs at 1 ipm. This means an actual printing time of 2 x 2 minutes. 1 image per minute (ipm) has been chosen as speed value in order to reflect a rather full paper coverage (photo) and possible duplexing. The four hour on-mode reflects an average use time of PC in personal (home) environment. Due to the fact that IJ printers are mainly PC peripherals this correlation should be feasible.

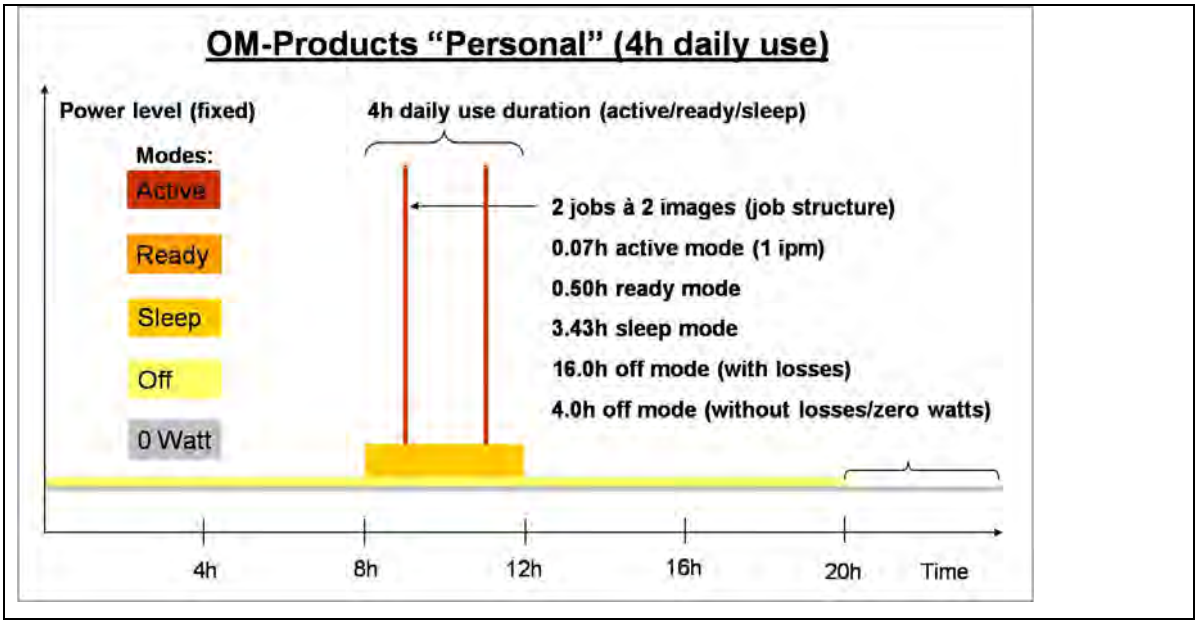

Figure 6: IJ-Printer average use scenario

What is interesting to notice is the – on average – small amount of images per day. The environmental impact of IJ printers could be characterized by the time the product is actually not in use. Therefore power management is of great importance. This aspect is further investigated in Task 3, 4, and 5.

1.1.3. Conclusion

1.1.3.1. Scope for Base Case Assessments

Office imaging equipment was defined as the scope of products covered by Lot 4 study. In obvious close accordance to the current Energy Star Program for imaging equipment this comprises commercially available products including printer, copier, scanner, facsimile machines and multi function devices that feature eight common marking technologies. In progress of the study the DG TREN requested to include mailing machines and digital duplicators into the scope in order to be more coherent with current Energy Star Program.

It was also indicated that the functionalities printing and scanning are also applicable to a range of other products which have be classified as production imaging equipment, special media imaging equipment and integrated secondary imaging modules. Products falling into these categories are expected to by specialized and applied in commercial environments. Precise product definitions and market data for these categories could not be obtained within the framework of this study.

The particular products covered under the scope of Lot 4 need further differentiation in order to determine their environmental significance and improvement potential based on representative base cases (cp Task 5). There are various factors for differentiation such as the marking technology, functionality, performance features, market dissemination and use patterns. All of these factors indicate environmental impacts. In order to determine environmentally significant products, we have combined the economical aspect of market dissemination (actual product stock) technology dissemination (EP and IJ) with the output volume form such products. This approach has lead to the following conclusion.

EP printers and EP copiers are the first important product category for assessment due to their considerable market volume (particular monetary market volume) and the intended intensive use. For EP products the use phase (energy and consumables efficiency) should be the focus of an eco-design strategy. The increasing operation speed, colour capability, and multifunction capability of EP printer and EP copier are environmentally relevant factors. Reduced power consumption and improved power management that enables fast transition into lower power levels points for investigation. That is why a “functional unit” for EP products should not only consider active operation (e.g. power or consumable consumption for the creation of a certain amount of images) but the transition phases and idle times a product regularly experiences. We therefore propose to

use an average daily use pattern (number of pages per job, number of jobs and idle time, on- and off-mode time) as a functional unit.

IJ printers are the second product category for assessment due to their high sales volume, low to medium use intensity, and assumed shorter life time in comparison to EP products. The product trend goes towards MFD and compact photo print. The average daily use pattern indicates that not so much the quantity of the image but the quality of the image determines the value of the product. This product characteristic leads to the assumption that not so much the operation phase but the full life cycle of the product must be addressed in an eco-design strategy. Although power consumption in use phase and standby should always build the focus of improvement (particular for MFD), in the case of IJ products, a resource and particular material oriented eco-design approach should be considered. A "functional unit" for IJ products is therefore not so easy to determine. Image quality and readiness for operation (after longer idle time) are critical characteristics. Further investigation is needed to define a functional unit.

The approach towards facsimile machines, document scanners, mailing machines and digital duplicators are not yet decided. Instead of a "product approach" (as in the case of printer and copier) a "function approach" might be applicable for facsimile machines and document scanners.

Facsimile machines are characterized by an "always online" operation status, a telephony interface and long product usage time. Readiness for immediate operation is therefore determined by the applied marking technology and digital data processing capability. Facsimile machines feature different marking technologies (TT, IJ, EP, etc.), which we expect to have a direct influence on the power consumption. Market analysis indicates a growing integration of facsimile function into EP and IJ printer (MFD). This does not mean that regular consumer or business facsimile machines will exit the market. However, the important aspect is the power consumption of the printing unit and the power management (lowest standby) in waiting periods. We propose to treat facsimile as a function base case.

Document scanners are not producing a hardcopy image like printers, copiers or facsimile machines. Scanners had been seen strong market dissemination in the past years. However, market forecasts predict that with the introduction of printer-based MFDs the sales of e.g. flatbed scanners will fast decline. The environmental impact of a scanner is expected to be directly linked to the power consumption of the light source. Material aspects such as glass and electro-mechanics (MEMS) might also contribute to the environmental footprint of such devices. Due to the

assumption that the scanning function gets more and more integrated into printer and is already integrated part of copier machines, we propose to treat scanning as a function base case.

1.1.3.2. Product-based Base Cases

In view of the definition of base cases (Task 5) we suggest for printers and copiers to use a product specific approach. A differentiation (possible set of criteria in parentheses) should be made for:

- **EP Copier** (max. format A3, monochrome and colour, and if applicable speed classes)[10]
- **EP Printer** (max. format A3, SFD and MFD, monochrome and colour, and if applicable speed classes or weight)
- **IJ Printer** (SFD and MFD, personal or workgroup, or by weight)
- **Compact Photo Printer** (no differentiation criteria yet decided, however maximum output format, digital data interfaces as well as the applied marking technology might indicate differences)

Separation of Digital Printing Systems

The copiers and printers covered so far are products which typically handle images up to A3 format and find application (use) in average consumer and office environment. However, there are high speed and larger format copiers and printers as well as digital duplicator in the market. They are sometimes technically based non regular office equipment and build the platform for digital printing (press) systems. The application of this kind of equipment is considerably different from average consumer or office use. Digital printing (press) systems are more typically applied in semi-production or real professional image production environment. The application is high volume document output by copying, duplicating, and printing or specialized image creation. The purchasing price or leasing costs for these kind of equipment is considerably higher that for basic office machines.

Large format printers (LFP) both monochrome and colour are a considerable market segment, which is driven by the graphic arts market[11]. Although smaller inkjet based LFPs are also common in regular offices, the product development in this segment is very diverse and features the application of different marking technologies with the capability to make prints not only on conventional paper but various substrate materials such as cloth, polymers and metals. The LFP are becoming more professional equipment in a sense of digital press systems and are of higher price.

[10] Copier are mostly sold as network capable MFD. A differentiation of SFD is not necessary.
[11] Graphic Arts Monthly 06 June 2006, in the internet:
http://www.gammag.com/BackIssues/print.php?p=/BackIssues/artbgam0606.gettingwider

Digital duplicators are at a first glance (e.g. dimension, weight, output speed, increasing multi functionality) somewhat comparable to larger EP copier or EP printer based digital printing (press) systems. But there are considerable differences. The particular functionality of a digital duplicator is the high volume duplication of a single image or document. Digital duplicators do not feature EP but some products IJ as marking technology. Digital duplicators are available in a wide price spectrum starting from a couple of thousand Euros.

Mailing machines exists in a very wide spectrum of sizes, from desktop to free standing, and functionalities for various mail requirements including the weighing and marking of envelops as well as scanning, sorting, folding, inserting of letters, etc. The marking technology (mostly inkjet) varies depending on the print volume (output speed) or quality (dpi, mono or colour) requirements. The price of mailing machines lies similarly in a wide range from a couple of hundred Euros for small office application to a couple of thousand and even ten thousand Euros for professional application.

Notice: High-end EP copier and EP printer systems, large format printer, digital duplicator, and mailing machines are products that find application in regular offices but also – and probably more frequent – in production-like environments. We therefore suggest treating such products in separate base cases or even in a specific preparatory study. This step would need thorough consideration. The main reason for a separation would be the very different use patterns that we expect to have a considerable impact on an effective eco-design.

1.1.3.3. Function-based Base Cases

In light of an increasing amount of multifunction devices which incorporate these two functions and the expected decrease of single functional facsimile machines and document scanners we suggest for facsimile and scanner to use a function-based base case approach. This means that the base case assessments (cp. Task 5)[12] should lead to general eco-design requirements in correlation to the typical use and integration of these two functions in single function and multi function devices.

Further investigation of this approach is necessary.

[12] For the purpose of the assessment we would use single function facsimile machines and flat bed scanner, as well as results form MFD with integrated facsimile and scanner function.

1.2. Test Standards

1.2.1. Tasks and Approach

The investigation in Section 1.2 has to identify and describe technical standards (existing EU and international standards and those under development) that are particularly related to environmental performance of office imaging equipment. This includes test standards for the measurement of:

- Power consumption (active or on mode, as well as in other standby modes)
- Cartridge / page yield (differentiated by technical and performance criteria)
- Safety and health (emissions, fire security)

A "test standard" is a standard that sets out a test method, but that does not indicate what result is required when performing that test. Therefore, strictly speaking, a test standard is different from a "technical standard". Namely, in technical use, a standard is a concrete example of an item or a specification against which all others may be measured or tested. Often it indicates the required performance of a product. However, "test standards" are also (but not exclusively) defined in the "technical standard" itself. A standard has a particular scope mostly product or sector specific.

Standards are documents that have been established by consensus and approved by a recognized standardization body. They provide common and repeated use, rules, guidelines or characteristics for certain activities. In the following references are made to:

- **EN**, European standard ratified by ether CEN (European Committee for Standardization), CENELEC (European Committee for Electrotechnical Standardization), or ETSI (European Telecommunications Standards Institute),
- **IEC**, International Electrotechnical Commission,
- **ISO**, International Organization for Standardization,
- **UL,** Underwriters Laboratories,
- **other**

In addition to "official" standards, there are other sector specific procedures for product testing that might have been compiled by industry associations or other stakeholders for specific purposes. These are usually labelling activities or voluntary agreements which are need of using same parameters or procedures. However, in most cases such activities refer to existing standards in order to ease implementation.

1.2.2. Results

1.2.2.1. Test Standards for Measuring Yield of Printer

The measurement of page yield of print cartridges is a common benchmark for consumable efficiency. Test standards for this purpose only exist for monochrome EP printers. Colour toner and inkjet cartridge yield measurement are under development and are expected to be published by the end of 2006. Some consumer organizations have developed own measurement methods for the purpose of consumer information.

1.2.2.1.1. ISO/IEC 19752 Toner cartridge yield for monochrome EP printers

ISO/IEC 19752:2004, information technology – method for the determination of toner cartridge yield for monochromatic electro photographic printers and multi-function devices that may contain printer components.

This standard describes the test procedures including test-page definition, statistical sampling and methods, environmental controls, and defined end-of-life conditions for the measurement of toner cartridge yield for monochrome EP printers. For the test, a defined standard test document is to be used in a controlled environment with default printer settings. This ensures that settings remain consistent across different test events, independent of platform or paper size. Therefore, the test document works with both letter and A4 paper sizes. In view of statistical reliability, nine of each cartridge is tested, allowing reliable estimates of lowest predicted yield. The cartridges are tested on three different printers (three cartridges on each printer) to avoid bias due to printer variability. The standard also includes an end-of-life criterion based on usable pages and reflecting manufacturer's recommendation on how cartridges should be handled when approaching their end-of-life (e.g. times they should be shaken). Concerning the printing environment it has to be controlled and kept consistent because temperature and humidity variations affect cartridge yield. It was pointed out by industry comments that detailed test methods for that standard are still discussed (as N662 of ISO/IEC JTC1/SC28).

1.2.2.1.2. ISO/IEC 10561 Cartridge yield for inkjet printers

ISO/IEC 10561:1998, information technology – office equipment – printing devices – method for measuring throughput class 1 and class 2 printers.

This International Standard specifies a method for measuring the throughput of class 1 and class 2 printers, as defined in ISO/IEC 11160-1. This standard specifies three different test patterns:

- a standard business letter
- a spreadsheet

- a graphic pattern

In addition, this International Standard defines a method for a performance test and one for an endurance test. These tests are intended to measure only the printer throughput for documents in the same class as the test patterns and not to evaluate any other printer features such as character shaping, print compressions, network/controller performance, colour, etc. The method is relevant to class 1 and class 2 printer types (e.g. dot matrix, daisy wheel, ink jet, thermal transfer printers) and to all configurations (e.g. tractor feed, cut sheet feed, 80-column and over 132-column print width, etc.). It is not the most suitable for comparing performance of other classes (e.g. EP printer) of printing devices such as high-speed page-oriented printers or colour printers. The standard letter is characterised through a surface coverage ratio of 2.8 % since the letter does not include any graphs, bold or big fonts and is indeed very short. However, this does not reflect coverage ratios in practice. Using a coverage ratio of 5% would better reflect the real situation of inkjet printing. Often, test are nevertheless carried out with the so called "Dr.-Grauert-Letter", since toner yield results a lot higher with a lower assumed coverage ratio. The German computer magazine c't has published a similar version (called "Dr.-Grünert-Letter") for download. Users can thus carry out there own tests if required[13].

1.2.2.1.3. ISO/IEC 19798 Toner cartridge yield for color EP printers

ISO/IEC 19798:2006 – information technology – method for the determination of toner cartridge yield for colour electro photographic printers and multi-function devices that contain printer components[14].

The purpose of this International Standard is to provide a process for determining the cartridge page yield for a given colour electro-photographic printer model (i.e. all-in-one toner cartridges and toner cartridges without a photoconductor) using a standard office consumer type test suite. This test suite is not focused on printing of photographs, but is intended to be a sampling typical office consumer pages. The scope of ISO/IEC 19798 (2006/E) is limited to evaluation of toner cartridge page yield for toner-containing cartridges (i.e. all-in-one toner cartridges and toner cartridges without a photoconductor) for colour electro photographic printers. It can also be applied to the printer component of any multifunctional device that has a digital input printing path, including multi-function devices that contain electro-photographic printer components.

Technical committee / subcommittee: JTC 1/SC 28; ISO Standards

Published date: 2006-12-15 (first edition)

[13] C't 2006: Dr.-Grünert-Brief, Testbilder & Vorlagen, http://www.heise.de/ct/ftp/02/10/200/, 25.09.2006

[14] http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=33936&scopelist=ALL

1.2.2.1.4. ISO/IEC 24711 Ink cartridge yield for colour IJ printers

ISO/IEC 24711 – Information technology – method for the determination of ink cartridge yield for colour inkjet printers and multi-function devices that contain printer components[15].

The scope of ISO/IEC 24711:2006 is limited to evaluation of ink cartridge page yield for ink-containing cartridges (i.e. integrated ink cartridges and ink cartridges without integrated print heads) for colour inkjet printers. It can also be applied to the printer component of any multifunctional device that has a digital input printing path, including multi-function devices that contain inkjet printer components. Both liquid and solid ink products can be tested using ISO/IEC 24711:2006. This standard is not for use with printers whose minimum printable size is equal to or greater than A3 size. Size of paper for this standard should be equal to or less than A4. The standard is currently in the approval stage.

Technical committee / subcommittee:	JTC 1/SC 28; ISO Standards
Published standard:	2006-12-15

1.2.2.1.5. ISO/IEC 24712 Colour test pages for measurement of office equipment

ISO/IEC 24712:2006 – information technology – colour test pages for measurement of office equipment consumable yield[16].

The purpose of this international standard is to provide a set of test pages in a common file format that are used in the testing of cartridge yield for colour toner and colour ink. The focus of this test suite is not for printing of photographs, but is intended to be a sampling typical consumer pages. This international standard provides the procedure for using these pages are detailed in ISO/IEC 19798 and ISO/IEC 24711. The proposed colour test pages available at http://www.ps.bam.de/info04/JER04.PDF show preliminary standard test patterns being considered for ISO/IEC 24712, which is currently under development by ISO/IEC JTC1 SC 28 WG2. These test patterns are currently being revised. It is expected that the revised images will include a “business letter”, “spreadsheet”, “news letter”, and “business slide” (all suitable for use in both A4 and 8.5x11 format). The standard is currently in the approval stage.

Technical committee / subcommittee:	JTC 1/SC 28; ISO Standards
ICS:	37.100.10
Status:	Under development
Current stage:	50.20 (Approval Stage: FDIS ballot)
Stage date:	2006-09-11

[15] http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=40034&scopelist=ALL.
[16] http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=40035&scopelist=ALL.

1.2.2.1.6. Independent test methods

Additionally to the ISO/IEC standards mentioned above, independent test standards are used within industry and for the purpose of consumer support. Some tests compare page yield with different test standards using different coverage ratios (e.g. Dr.-Grauert-Letter, Business Research & Test Laboratories [BERTL], IDC [market research institute]). A comprehensive set of test documents is provided by the German consumer test magazine "Druckerchannel" for download in the internet[17].
The German Blue Angel and the TCO labelling scheme do not define or refer to any standard measurement method to calculate toner / page yield of printers. Toner efficiency and yield are not part of the criteria necessary for the award of the label. Toner is only evaluated with regard to content of hazardous substances and with a view to dust emissions during use. However, toner cartridges are considered part of the equipment with regard to labelling.

1.2.2.2. Test Standards for Measuring of Power Consumption and Emissions

1.2.2.2.1. IEC/EN 62301 Measurement of Standby Power

IEC/EN 62301:2006 – household electrical appliances – measurement of standby power.
The standard specifies methods of measurement of electrical power consumption in standby mode. It specifies the general conditions for measurements (test room, power supply, supply-voltage waveform and power measurement accuracy) as well as selection and preparation of appliance/equipment for measurement, and test procedure. The standard is applicable to mains powered electrical household appliances. The objective of the standards is to provide a method of test to determine the power consumption of a range of appliances and equipment in standby mode. The standard defines "standby" mode as the lowest power consumption when connected to the mains. The standard is dedicated to the measurement of energy consumption for the use phase of the equipment.

1.2.2.2.2. Emissions Standard ECMA 328

ECMA-328 (2nd Edition / June 2006): Determination of Chemical Emission Rates from Electronic Equipment.
Following the publications of the 1st edition of ECMA-328 and the "Test method for the determination of emissions from Hard Copy Devices" (RAL-UZ 122), experts from the BAM and ECMA have collaborated to harmonize methods to determine the chemical emission rates from ICT & CE equipment in this 2nd edition. This Standard specifies methods to determine chemical emission rates of Analyte from ICT & CE equipment during intended operation in an Emission

[17] http://www.druckerchannel.de/artikel.php?ID=34&seite=1.

Test Chamber (ETC). The methods comprise preparation, sampling (or monitoring) in a controlled ETC, storage and analysis, calculation and reporting of emission rates. This Standard includes specific methods for equipment using consumables, such as printers, and equipment not using consumables, such as monitors and PC's. Annex A specifies monochrome and colour print patterns for use in the operating phase of EUT using paper consumables. Emission rates from EUT using consumables may also be determined according to additional requirements identified by "RAL-UZ 122 Option". Calculations use the generalized model and approximations thereof as developed in Annex B. The emission rates determined with this method may be used to compare equipment in the same class. Predictions of "real indoor" concentrations from the determined emission rates are outside the scope of this Standard.

Product Scope

The scope includes **Hard Copy Devices** (class of EUT using Consumables that includes printers, (Photo)copiers and Multi Functional Devices) as well as **Consumables** (toner, ink, paper and ribbon).

Annex A (normative) comprises "Print Patterns" for test procedures:

Monochrome print pattern 5% coverage: Annex A.1 illustrates the monochrome pattern, that is not to scale, with 5% black coverage; tests of EUT using paper consumables as specified in this Standard shall be executed using the pattern at:
http://www.ecma-international.org/publications/standards/Ecma-328.htm.

Colour print pattern, 20% coverage: Annex A.2 illustrates the colour pattern, that is not to scale, with 20% colour coverage (5% for black, magenta, cyan and yellow); tests of EUT using paper consumables as specified in this Standard shall be executed using the pattern at:
http://www.ecma-international.org/publications/standards/Ecma-328.htm.

1.3. Existing Legislation and Voluntary Agreements

1.3.1. Tasks and Approach

The general objective of this task is to identify and describe mandatory regulations (legislation) as well as voluntary agreements which set environmentally related obligations to manufacturers of office imaging equipment. Furthermore the investigation should check the feasibility of test procedures for the purpose of the study. European legislation, Codes of Conduct and Eco-labelling schemes will be covered. The list will be completed until the final reports.

1.3.2. Results

1.3.2.1. Existing Mandatory European Legislation

1.3.2.1.1. Directive 2002/96/EC (WEEE) and Directive 2002/95/EC (RoHS)

The European Community Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) together with the Directive 2002/95/EC on Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS) became European Law in February 2003, setting collection, recycling and recovery targets for all types of electrical goods. The directives aim on reducing the environmental impact of electrical and electronic equipment also through design measures which support disassembly and reuse.

The **WEEE** applies to office imaging equipment under category 3 of Annex IA, IT and Telecommunications Equipment, stating that the rate of recovery shall be increased to a minimum of 75% by an average weight per appliances; component, material and substance reuse and recycling shall be increased to a minimum of 65 % by an average weight per appliance. Annex II of WEEE declares selective treatment for materials and components of waste electrical and electronic equipment in accordance with Article 6(1). For office imaging equipment that applies to:

- toner cartridges, liquid and pasty, as well as colour toner,

The **RoHS** applies to televisions as well and prohibits the use of the heavy metals lead, mercury, cadmium, hexavalent chromium, and brominated flame retardants (poly-brominated diphenyl ethers and poly-brominated biphenyls) in new electrical and electronic equipment placed on the market after 1 July 2006.

1.3.2.2. Eco-Labelling

1.3.2.2.1. ENERGY STAR® Program

On May 3, 2006, EPA distributed the Final ENERGY STAR Version 1.0 Imaging Equipment specification, which provides eligibility criteria for products addressed by the Operational Mode (OM) approach and the Typical Electricity Consumption (TEC) approach. The final versions of the accompanying test procedures were distributed to stakeholders with the Final Draft Version 1.0 specification on April 21, 2006. This specification is considered final, pending adoption by the European Union. EPA will keep partners informed during this review process by the EU, particularly with regard to anticipated timeframe, as this information becomes available. The Version 1.0 specification is scheduled to go into effect on April 1, 2007. For more information, visit the Imaging Equipment Web page[18].

Product Scope

Product scope of the energy star program comprises printer, copier, scanner, facsimile machines, and multifunction devices, as well as digital duplicators and mailing machines. The specifications for all products meaning a convergence of copy, print, fax, scan. The definitions deriving form Energy Star Program are feasible definitions for the purpose of the Lot 4 studies.

Definitions of Operational Modes, Activities, and Power States

Energy Star Program provides definitions for “Active”, “Ready”, “Sleep”, “Standby”, “Off”, “Default Delay Time”, and “Automatic Duplexing”. The differentiation and definition of various operation modes or power states is useful in context of the Lot 4 study. The missing clear distinction of “standby” from sleep-mode or off-mode is however problematic due to the fact the VHK EcoReoport requires the distinction of on, standby and off-mode.

Typical Electricity Consumption (TEC)

Typical Electricity Consumption (TEC) is in conjunction with Operational Mode (OM) one of two schemes for evaluating power consumption of imaging equipment. TEC applies for standard-size format copiers, digital duplicators, fax machines, multifunction devices, and printers using high temperature marking technologies such as electro photography (EP) and solid ink (SI) and those that provide comparable functionality. With that particular scope the TEC scheme targets products of higher power consumption in the actual use phase. The higher power consumption of TEC products is related to technical aspects (high temperature marking technology) and typical use

[18] http://www.energystar.gov/index.cfm?c=archives.img_equip_spec

patter (intensive and frequent use). The TEC procedure provides specific test parameters for power measurement. The test conditions and equipment are outlined in a separated section. A main aspect is of TEC is the differentiation of a particular output volume in reference to the imaging speed of a product. The test procedure provides a structure for calculation of "jobs per day" and "images per job" as well as an accompanying table. Measurement procedures are defined for testing power consumption in various states (modes) and in accordance to the amount of jobs per day. Finally, the TEC procedure gives calculation (equations for different product types) for daily energy consumption and typical energy consumption.

Operational Mode (OM)

Operational Mode (OM) applies in comparison to TEC to products with less intensive use and lower power consumption in on-mode. Therefore the power states ready, sleep, and off are measured independently from a particular use pattern. OM test procedure sets the scope for non heat-intensive marking technologies such as inkjet, small and large format products, and scanners. The power measurement method is basically made in accordance with IEC 62301 with certain modifications regarding the kind of admissible power supply and in regards to network connectivity issues. The test conditions and equipment is separately specified by the Energy Star Program.

Two tiers for the new Energy Star Program

The current Energy Star Program intents a two tier approach with the following time schedule:
Tier I: 1 April 2007 – 31 March 2009
Tier II: 1 April 2009 →

Concluding Remarks

The new Energy Star Program for imaging equipment provides as an internationally recognized voluntary program a sound basis for definitions and power measurement procedures (particular TEC). As for the Energy Star Program compliance requirements (power consumption limit values), it is necessary to notice that the specification limits are focusing on the 25% best performing products in each segment. The values are therefore indicating good performance, and good performance only in regards to power consumption. Other eco-design related issues such as consumable efficiency or material related life cycle aspects are not in the scope of the Energy Star Program.

1.3.2.2.2. Blue Angel for Office Equipment with Printing Function

RAL-UZ 122 (June 2006): Office Equipment with Printing Function (Printers, Copiers, Multifunction Devices).

In co-operation with the German Federal Minister for the Environment, Nature Conservation and Nuclear Safety, the Federal Environmental Agency (UBA) and considering the results of expert hearings conducted by RAL[19] the Environmental Label Jury has set up these Basic Criteria for Award of the Environmental Label.

Scope

These Basic Award Criteria apply to office devices (usually referred to as printers, copiers and/or multifunction devices) which:

- at least offer printing or copying as their primary function (base unit)
- are capable of producing monochrome (black-and-white) or colour paper printouts,
- work as electro photographic devices (LED or laser technology) by using toner or as ink jet devices by using ink (or gel, or wax) and
- whose noise emissions (guaranteed sound power level) do not exceed 75 dB(A) during monochrome printing.

The requirements of the Basic Award Criteria for toner and ink modules and containers as well as for toners and inks apply to the unmodified original equipment of the respective applicant's products marked with the Environmental Label, including the materials recommended by the applicant in the product documents. The requirements of the label consist of:

General Requirements

- Recyclable Design
- Material Requirements
- Marking of Plastics
- Batteries
- Printing Paper
- Double-Sided Printing and Copying
- Photoconductor Drums
- Guarantee of Repairs
- Maintenance of Equipment

[19] RAL: German Institute for Quality Assurance and Certification.

- Product Take-Back
- Packaging

Requirements for toners and inks as well as for modules and containers for toner and ink

- Modules and Containers for Toner and Ink
- Material-Related Requirements for Toners for Use in Electrophotographic Devices and Inks for Use in Ink jet Devices

Substance Emissions

- Electro photographic Devices
- Ink Jet Devices
- User Information on Substance Emissions
- Products of Identical Design

Energy

- Definitions (standard operation mode, print mode, end of the printing process, idle mode, ready mode, energy saving mode, plug-in off mode)
- Limit Values of Recovery Times t2R and t3R
- Power Consumption Limits P1, P2 and P3
- Time Limits t1A, t2A and t3A as well as Default Times taA, tbA etc.

Noise Emissions

The declared A-weighted sound-power level LWAd shall be determined in dB(A) on the basis of EN ISO 7779:2001 (corresponds to ISO 7779:1999) in combination with ISO 9296:1988.

Concluding Remarks

The Blue Angel RAL-UZ 122 “Office Equipment with Printing Function” is an environmental label which is focusing not only on power consumption. The label addresses product longevity, the principles of recyclable design and allow for the reuse and recycling, avoidance of harmful substances if possible beyond current regulations, low power consumption especially in ready modes and low noise emission during operation. The label also addresses appropriate user information in the product documents. Users are informed about energy-saving options, possible noise generation and, where applicable, about special requirements for equipment setup as well as about handling of consumables and disposal options. Users are asked to follow all important advice and information. The label is in its environmental requirements very comprehensive and focuses on best performing products on the market

1.3.2.2.3. Nordic (Swan) Ecolabelling for Copying machines, Printers, Fax machines and Multifunctional devices

Nordic (Swan) ecolabelling of copying machines, printers, fax machines and multifunctional devices (Version 4.0; 13 December 2005 – 31 December 2007).

In the Swan criteria, version 3, for copying machines, printers, fax machines and multifunctional devices, the Nordic Ecolabelling Board and Japan Environmental Association decided to develop what were termed as core criteria. For the license applicant this means that a product that has been approved by the Japan Environmental Association and awarded the Eco Mark, does not need further documentation regarding the requirements covered by the cooperation agreement. In this criteria document (version 4) the harmonization process has been continued with Eco Mark and with Blue Angel (the German national ecolabel). The present harmonization program with Eco Mark involves the criteria for copiers and multifunctional devices. The joint program with Blue Angel involves the criteria for copiers, printers, fax machines and multifunctional devices.

Product Scope

The Swan criteria are covering copying machines, printers, fax machines and multifunctional devices, and extra equipment such as desks, sorters, feeder, units for double-sided printing and external scanners. Products also include various consumer durables, such as OPC (Optical Photosensitive Conductor) kits, drums, toner powder and residual toner cartridges. These individual parts must meet the requirements as to design, materials, chemical requirements during production, requirements as to packaging and requirements as to recycling.

Requirements

The requirements that the appliances must fulfill before a Swan label can be granted focus on following aspects:

- power consumption
- design
- plastic materials and additives, e.g. flame-retardants
- heavy metals
- recycling of discharged products
- emission of pollutants (also noise) in working areas
- performance properties e.g. duplex printing saving paper

Possible new criteria

- The possibility of further harmonisation with Eco Mark and Blue Angel and other ecolabels.
- The possibility of prohibiting PVC in cables.
- The possibility of increasing the stringency of the requirements as to the use of flame retardants, other chemicals used in the products and heavy metals.
- The possibility of increasing the stringency of the requirements of energy saving and emissions to the surroundings.
- Stricter requirements as to the use of recycled and reused materials may be considered.
- Alternative test methods will be evaluated for measuring energy consumption and emissions.

Concluding Remarks

Nordic Ecolabelling intends to revise the Blue Angel based energy requirement with the purpose of harmonization with the criteria of Energy Star. This is expected during the year of 2006 when the Energy Star criteria are revised and published.

1.3.2.2.4. Australian Voluntary Environmental Labelling Standard GECA

Good Environmental Choice Australia (GECA) May 2006: Australian Voluntary Environmental Labelling Standard for Printers, Faxes, and Multifunction Devices.

The specification has been published to take account of substances harmful to the environment, energy management, and consumption of resources and packaging. It has also drawn on environmental labelling specifications published by other members of the Global Ecolabelling Network (in particular the Nordic Swan, the South Korean Environmental Labelling Association, Environmental Choice New Zealand and the Japan Eco-Mark) and the supporting technical work on environmental and life cycle issues they have completed.

Product Scope

This standard is applicable to the following categories of multi-function, printer and fax machines:

- Matrix printers
- Inkjet printers
- Laser/LED printers
- Inkjet fax machines
- Laser/LED fax machines
- Thermal Transfer fax machines
- Multifunction machines (printer/fax combinations)

Environmental Performance Criteria

- Energy Use (power draw in sleep and off modes, power management default times)
- Noise Emission
- Designs for Disassembly
- Use of Recycled Plastic Parts
- Design and Recyclability of plastic parts
- Additives in Plastics (Ban of Polybrominated biphenyl (PBB), Polybrominated biphenyl ether (PBDE), high chlorinated, short chained chloroparaffins)
- Metals (Recycling)
- Photosensitive Layers (photo semiconductors must not contain cadmium, lead, mercury or selenium)
- Chemicals during Production (ban of CFCs, HCFCs, tri-chloro-ethane or carbon-tetra-chloride)
- Printing Paper (capable of use of recycled paper, Laser printers shall be capable of duplexing with or without an additional component attachment available from the manufacturer)
- Toner and Cartridge Specifications (marking, sealing, remanufacturing)
- Emission of Pollutants (levels using RAL-UZ 85 and levels using ECMA 328)
- Packaging of the products and components
- Takeback

This Standard identifies the environmental loads from the production, service and use of the products. The Label focuses on developing low energy products containing re-usable and or recyclable components in order to reduce the amount pollutants going into the environment and reducing the amount of energy used. The primary purpose of this standard is to define environmental performance criteria for the most harmful environmental and human hazards of printers and fax machines and to use these criteria as indicators of general environmental performance of this product group.

1.3.2.2.5. Japanese Eco Leaf, Top Runner

Eco Leaf: *Japanese Quantitative Environmental Information Label (ISO Type III Environmental Declarations) supervised by JEMAI.*

In September 1998, the Japan Environmental Management Association for Industry (JEMAI), with support from the Japanese Ministry of Economy, Trade and Industry, began developing a program

for Type III environmental declarations. Lifetime environmental impact information is declared in quantities form, based on LCA: Life Cycle Assessment technique. This type of declaration includes whole environmental impact information on raw material extraction to production, distribution, use, disposal, and recycling of a used product finally. In principle, The Type III differs from the other two in presenting lifetime and quantitative environmental impact information without any judgment. The trial phase was completed in June 2001, and official program begun in 2002.

Product Scope and Specifications

Electrophotographic Dry Process Photocopier (PSC-ID: AA)

2002/6/13 rev. 1

Product-Specific Criteria for EP and IJ Printer (PSC-ID: AD-03)

2004/09/29AD-03

2004/03/01AD-02

2002/06/13

Product-Specific Criteria for Facsimile (PSC-ID：AH-03)

2004/09/29 AH-03

2004/03/01 AH-02

2002/11/14

A complete list of products with assessments is available in the internet under:
http://www.jemai.or.jp/english/ecoleaf/pub_label.cfm

Top Runner: The top runner approach was introduced in 1999 as part of the revised Law concerning the Rational Use of Energy in Japan.

Product Scope: Copying Machines

Dry process, indirect electrostatic copying machines mainly used in offices. Colour copying machines, copying machines that can copy onto A2 or larger paper, copying machines that can print 86 sheets or more a minute, copying machines that have a printer function, and copying machines with facsimiles are excluded.

Energy consumption efficiency E (Wh) is a numeric value calculated with the following formula:
$E = (A+7xB) \div 8$.

In this formula, A indicates power consumption (Wh) one hour after being turned on and B indicates power consumption (Wh) one hour after the measurement of A.

The manufacturers, etc. of each copying machine shall ensure that for copiers to be shipped to the domestic market in the target fiscal year, a numeric value that is to be obtained by taking weighted averages of energy efficiency measured according to the method defined in (3) below, with shipments for every category of the following Table 10 will not go beyond the **target standard value**.

Table 10: Top runner programme –- target standard value

	Segment by Copying Speed (CPM)	Target Standard Value (Wh/h)
A-4 size copier	~10	11
	11~20	17
	21~30	69
	31~40	88
	41~50	123
	51~60	144
	61~70	180
	71~80	200
	81~85	258
B-4 size copier	~10	17
	11~20	20
	21~30	85
	31~40	108
	41~50	151
	51~60	176
	61~70	221
	71~80	246
	81~85	317

	Segment by Copying Speed (CPM)	Target Standard Value (Wh/h)
A-3 size copier	~10	19
	11~20	55
	21~30	99
	31~40	125
	41~50	176
	51~60	205
	61~70	257
	71~80	286
	81~85	369
A-3Y size copier	~10	27
	11~20	77
	21~30	139
	31~40	175
	41~50	246
	51~60	287
	61~70	383
	71~80	433
	81~85	483

1.3.3. Conclusion

The analysis of existing legislation, voluntary agreements, eco-labelling schemes, and technical standards indicates a variety of environmentally relevant requirements for imaging equipment. Power consumption and consumable efficiency are the two most prominently addressed eco-aspects for imaging equipment. However, eco-labels are also correctly addressing material related environmental impacts throughout the product lifecycle. These issues are of particular importance for more short lived products. Hazardous materials and waste, product take-back and recycling requirements are already covered in the European Union by existing legislation.

A single test standard or procedure for measuring power consumption (on mode and standby modes) of office imaging equipment as well as for calculation of daily or annual power consumption (VHK requirement) does not exist. The new Energy Star Program for Imaging Equipment provides a usable test procedure for the measurement of daily power consumption for imaging equipment falling TEC specification. This would include EP copiers and EP printers and should be applied as the test method in the base case assessment. Energy Star Program also provides a test procedure for measurement of ready, standby and off modes for imaging equipment falling under OM specification. This would include inkjet products. However, OM procedure does not provide a calculation of daily or annual power consumption. Therefore an average use pattern is a necessary requirement.

Furthermore, the definition of certain power levels or modes such as “on mode” (also referred to as “active mode” or “operation mode”, etc.), “ready mode” (also referred to as “waiting mode”, etc.), “sleep mode” (also referred to as “energy-saving mode” or “standby-mode”, etc.) and “off mode” is not consistent in existing standards or eco-labels and need therefore harmonization in order to be applicable.

Regarding standard methodologies for determining page yield of print cartridges various new test standards are in the approval stage and might be available for the study. It should be noticed that the test standards are making a clear distinction of two main marking technologies; electro photographic and inkjet. Industry indicates that other marking technologies (e.g. sold ink, dye sublimation) could be to some extent allocated to one or the other main technology (similar to the TEC and OM scope). However, the basic distinction of EP and IJ technology is noteworthy in regards to the definition of base cases.