Topten Product Criteria Paper on

Imaging Equipment
(Laser printers, inkjet printers and multifunctional devices)

Revised by Tobias Schleicher, Oeko-Institute e.V., June 2013

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Georgios Tragopoulos, WWF SPAIN

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Coordinated by

The Project in brief

Topten is part of the international Euro-Topten-Max initiative supported by the European programme Intelligent Energy Europe and several national institutions (energy agencies, WWF, consumer associations, research institutes). On global level, Topten is coordinated by TIG, the Topten International Group. This association promotes to the Topten Charter, TIG statutes and Rules of Procedure (www.topten.eu).

Topten is a service that supports the market for energy efficient products. It aims at making energy efficient products the first choice for consumers, by offering them a user-friendly tool for product comparison and selection. The key element is an online information platform for consumers presenting the most energy efficient appliances currently available in various product categories, including household appliances, office equipment, consumer electronics and cars. Information on energy consumption and performance of products as well as several other characteristics (i.e. brand, model, price, picture) is provided. Product data is based on labels and standardized declarations as well as tests from accepted well-known institutions. The service is independent of manufacturers and retailers.

Consortium

The project is co-ordinated by the Agence de l'Environnement et de la Maitrise de l'Energie (ADEME). The other 20 project partners are:

Project Partner	Country
Austria : Austrian Energy Agency	AT
Belgium: Bond Beter Leefmilieu Vlaanderen vzw,	BE
Croatia; REGEA,	HR
Czech Republic: SEVEn, o.p.s	CZ
Finland: Motiva Oy	FI
France, Guide Topten	FR
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Germany: Wuppertal Institute	DE
Germany: ICLEI, European Secretariat	DE
Greece: WWF Greece	GR
Italy: WWF Italia Onlus	IT
Lithuania: LNCF, consumer federation	LT
Luxemburg: Oeko-Zenter, asbl	LU
Norway: Norges Naturvernforbund	NO
Poland: FEWE Polish Foundation for Energy Efficiency	PL
Portugal: Quercus	PT
Romania: ICEMENERG	RO
Spain: ADENA / WWF	ES
Sweden : Swedish Society for Nature Conservation,	SE
United Kingdom; Waste Watch	UK

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Introduction

Criteria papers provide a central tool for the Euro-Topten Max partners to collect and analyse product data and to establish a national Topten selection. Appropriate selection criteria and technical specifications are a crucial precondition for meaningful and well-accepted Topten websites. The purpose of this criteria paper is to provide a common basis for the definition of technical specifications. Obviously, the range of products differs significantly in European member States in terms of price level, configuration, energy classes and energy consumption corresponding to levels of purchasing power and behavioural aspects (mentality, customs, etc.).

Within the European wide Topten project, an aligned approach for technical specifications for all national Topten websites is aimed at. A high level of uniformity and congruency of the different national websites will enhance the awareness amongst manufacturers. Good quality product data at national level furthermore allows to analyse the situation at European level and to make policy recommendations, which are shown on www.topten.eu.

This paper contains the product specification for Topten imaging equipment (laser prints & inkjet prints). A product should meet all criteria described in Chapter 4 in order to be listed on www.topten.eu as a Best Available Technology.

In an ideal situation, selection criteria of the laser and inkjet printer are based on international or European standards. In some cases widely accepted and strictly defined standards are missing – (e.g. for products in the consumer electronics segment). Within the methodology of WP3, it was intended to use the implementation measures of the Ecodesign directive as a basis for the criteria definition. The information in this criteria paper is therefore mainly based on the “Preparatory studies for Eco-design Requirements of EuPs".

1 Product Definition

This chapter provides an overview of imaging equipment (laser printers & inkjet printers). It also gives a technical analysis of the product and explains EU and national relevant product and test standards.

1.1 Product Category

Imaging equipment

There is not a sufficient definition that could cover the entire scope of the imaging equipment, due to the different functionalities and using purposes of the products that belong to this category. Such products are laser printers and multifunctionals, inkjet printers and multifunctionals, fax machines, scanners and copiers. In addition, there is a large variety of technologies and application criteria that determine the environmental impact of a particular product.

In the present criteria paper, the characteristics and the functionalities will be determined, as far as the requirements concerning three sub categories of the imaging equipment: laser printers, inkjet printers and multifunctional devices (MFS). The aforementioned devices belong to a broader category, office imaging equipment, which are understood to be "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" (EuP Preparatory studies: Imaging Equipment)[1] .

Laser & inkjet printers[2]

A product whose primary function is to generate hard-copy output from electronic input. A printer is capable of receiving information from single-user or networked computers, or other input devices (e.g., digital cameras). This definition is intended to cover products that are marketed as printers, and printers that can be field-upgraded to meet the definition of an MFD.

In particular, the laser and the inkjet printers are defined below.

1. Electro-photographic (EP): A marking technology characterized by the illumination of a photoconductor in a pattern representing the desired hard copy image via a light source, development of the image with particles of toner using

the latent image on the photoconductor to define the presence or absence of toner at a given location, transfer of the toner to the final print media, and fusing to cause the hard copy to become durable. For purposes of this specification, Color EP products simultaneously offer three or more unique toner colors, while Monochrome EP products simultaneously offer one or two unique toner colors. This definition includes **Laser**, Light Emitting Diode (LED), and Liquid Crystal Display (LCD) illumination technologies.

2. Ink Jet (IJ): A marking technology characterized by the deposition of colorant in small drops directly to the print media in a matrix manner. For purposes of this specification, Color IJ products offer two or more unique colorants at one time, while Monochrome IJ products offer one colorant at a time. This definition includes Piezo-electric (PE) IJ, IJ Sublimation, and Thermal IJ. This definition does not include High Performance IJ.

Multifunctional Devices (MFD)

A product that performs two or more of the core functions of a Printer, Scanner, Copier, or Fax Machine. An MFD may have a physically integrated form factor, or it may consist of a combination of functionally integrated components. MFD copy functionality is considered to be distinct from single-sheet convenience copying functionality sometimes offered by fax machines. This definition includes products marketed as MFDs, and “multi-function products” (MFPs).(ENERGY STAR - Product Specification for Imaging Equipment).

1.2 Product Types

1.2.1 Laser printers

The laser printers function under the principles of the electro-photographic technology. EP is a marking technology characterized by illumination of a charged organic photo-conductor drum in a pattern representing the desired hard copy image via a light source. 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.

The printing process of a laser printer consists of 5 steps, which take place almost simultaneously as following:[3]

- **Charging:** A uniform 600 volt charge is placed on the photoelectric drum by the primary corona.

- **Exposing:** Laser diodes write an invisible electric image on the photoelectric drum by causing the drum surface to be less negative wherever the laser beam hits.
- **Developing**: This is where the transfer roller places the toner on the drum. The toner sticks to the areas that have had the electric charge lessened due to the laser beam.
- **Transferring:** The secondary corona uses a positive charge to attract the toner from the drum to the paper. The paper gets charged by corona too.
- **Fusing:** The toner is then melted into the paper.
- **Cleaning**: Excess toner is scraped from the photoelectric drum.

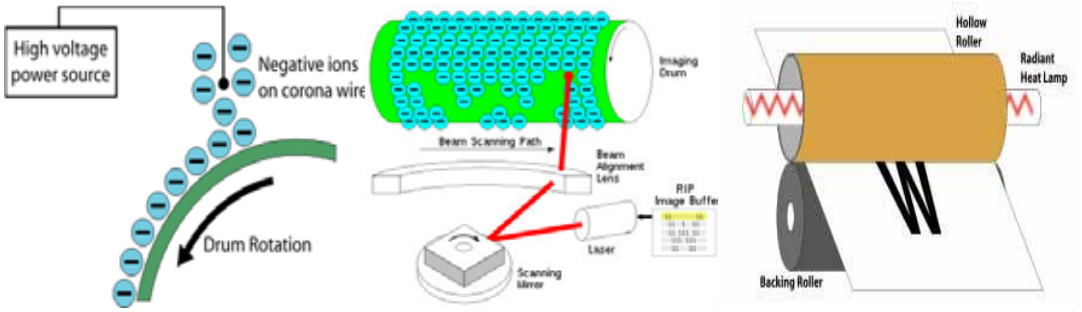


Image 1. Printing process of an electrographic technology printer (source: wikipedia http://en.wikipedia.org/wiki/Laser_printer)

Advantages of laser printers:[4]

1) High resolution

2) High print speed

3) No smearing

4) Low cost per page (compared to inkjet printers)

5) Printout is not sensitive to water

6) Good for high volume printing

Disadvantages of laser printers:

1) More expensive than inkjet printers

2) Except for high-end machines, laser printers are less capable of printing vivid colours and high quality images such as photos.

3) The cost of toner replacement and drum replacement is high

4) Bulkier than inkjet printers

5) Warm up time needed

1.2.2 Inkjet printers

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 (colour 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 does not 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 colour ink drops – typically between four and eight – can be combined to form dots of variable size, which gives inkjets a bigger palette of colours 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 colour, and ease of use. There are three main IJ technologies:

- **Thermal inkjet:** 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.

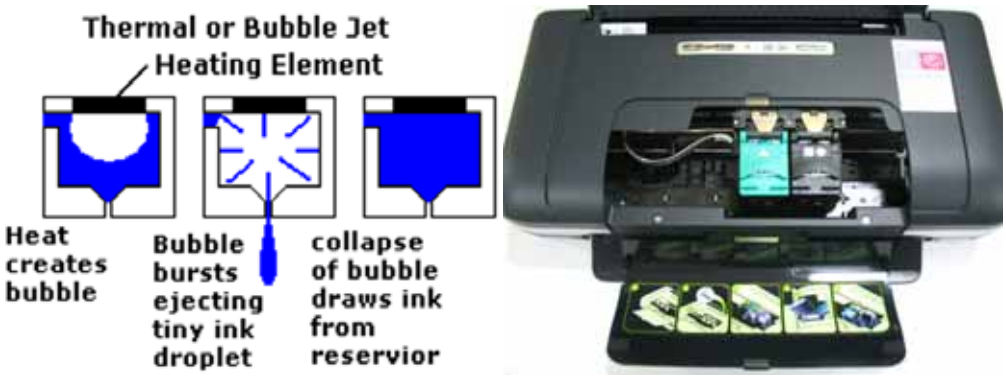


Image 2. Thermal inkjet printer

- **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.

Image 3. Piezoelectric printer

- **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.

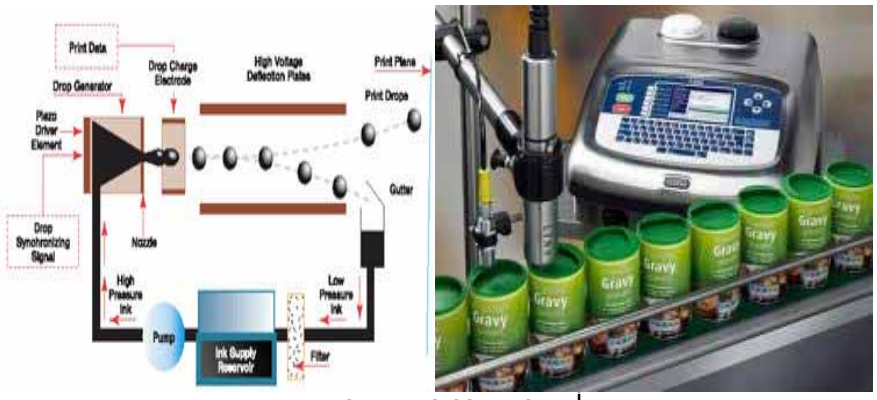


Image 4. Continuous inkjet printer[i]

Advantages of inkjet printers: [5]

1. Low cost
2. High quality of output, capable of printing fine and smooth details
3. Capable of printing in vivid colour, good for printing pictures
4. Easy to use
5. Reasonably fast

[i] http://www.packaging-int.com/article/relax-linx-promises-hassle-free-coding.html

6. No warm up time

Disadvantages of inkjet printers:

1. Print head is less durable, prone to clogging and damage
2. Expensive replacement ink cartridges
3. Not good for high volume printing
4. Printing speed is not as fast as laser printers
5. Ink bleeding, ink carried sideways causing blurred effects on some papers
6. Aqueous ink is sensitive to water; even a small drop of water can cause blurring
7. Cannot use highlighter marker on inkjet printouts

1.2.3 Multifunctional Devices (MFS)

The printing technology of MFSs corresponds to the technolgy of Laser Printers (see section 1.2.1).

1.2.4 Product lifetime

According to data sourced in literature, the product lifetime of the imaging equipment ranges between 4 and 6 years. The following table depicts the lifetime of the laser and inkjet printers.[ii]

Table 1. Inkjet & laser printers lifetime (source: EuP Preparatory studies: Imaging Equipment, T2)[6]

Specification	Product lifetime (Years)	country	sources
IJ printer & EP printer	6 (Mean age in stock: 4 years)	Australia	NAEEC 2003a
EP printer	4	US	Roth et al 2004
MFD and scanner	6	Australia	NAECC 2003b

[ii] JRC IPTS Draft Preliminary Study on the Development of an European Ecolabel and Green Public Procurement Criteria for Imaging Equipment (2011) states a 4-7 years lifetime for imaging equipment on average.

Compared with the literature data, statements from industry indicate that IJ-Printers for private use have much shorter time in service of only two to three years. Still it is expected that it takes another three to four years until the printer is disposed of, adding up to an overall time of ownership of about six years. Second hand markets are negligible. In general, the perception from industry is that products for private use are short lived (e.g. two to three years) compared with products for business use (up to 6 years) (EuP Preparatory studies: Imaging Equipment, T2).

1.2.5 Energy consumption

The energy consumption of the laser or /and the inkjet printers vary among the different products and different manufacturers. The following table is based on data that have been presented in EuP Preparatory Studies LOT 4 "Imaging Equipment".[7] In the same table data concerning the consumption of consumables is presented.

Table 2. Use phase energy & consumables consumption (source: EuP Preparatory Studies LOT 4 "Imaging Equipment")

Product	Imaging Speed (ipm)	Image Volume (page/day)	Weekly pages (page/week)	Annual pages (page/year)	Annual paper (kg/year)	Toner/ink per page (gr/page)	Annual toner/ink (gr/page)	Weekly energy consumption (kWh/week)	Annual energy consumption (kWh/year)
Laser printer monochrome	32	512	2.560	133.120	666	0,02	2.662	5,19	270
Laser printer colour	32	512	2.560	133.120	666	0,03	3.994	6,92	360
Inkjet printer "personal"	1	4	20	1.040	5	0,07	73	0,35	18
Inkjet printer "workgroup"	1	15	75	3.900	20	0,07	273	0,42	22
	Regarding the copied volume per week, it is assumed that the machine is operated from Monday to Friday, without Saturday and Sunday. Thus, the copied volume per week was calculated as "page/day x 5days								
	In order to calculate the amount of used toner, it is needed to calculate the amount of applied toner per page and then multiply it by the copied volume in a year. In order to calculate the amount of used ink, it has is assumed that 1ml equals 1gr of ink. The consumption then varies between 0,04 and 0,1gr per page. For this it is assumed an average of 0,07 gr per page.								
	Concerning the energy consumption, the value per week has been calculated within the Energy Star Criteria. In order to calculate the annual energy consumption has been considered 1 year equal to 52 weeks.								

It has to be stated at this point that the considered sample products are single function laser printers on the one hand, and multifunctional inkjet printers on the other. The reason for the selection of multifunctional inkjet printers is that it is expected that products will gain market share the coming years to become a very important segment of the EU market in comparison to the single function inkjet printers that will start to decline, as it is depicted in the following figure.

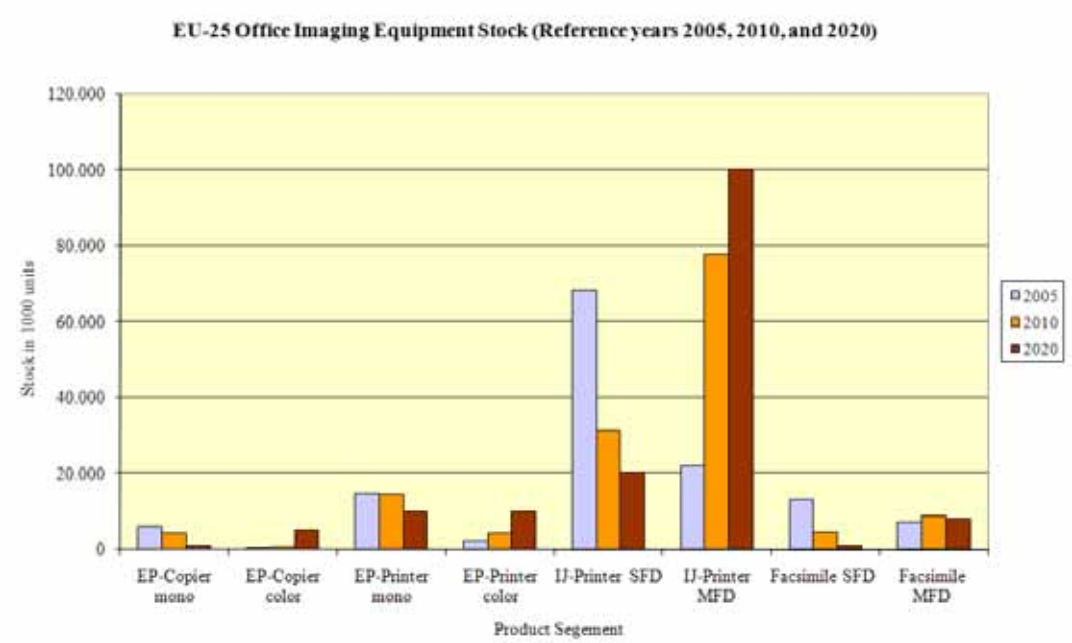


Figure 1. EU-25 Office Imaging Equipment Stock (Reference years 2005, 2010 and 2020) (source: EuP Preparatory Studies LOT 4 "Imaging Equipment", task 4. "Technical Analysis)

The above mentioned trend that fewer printers are sold in favour of more multifunctional devices (MFDs) has actually been observed in the European market: Whereas in 2003 only about 5 Mio MFDs were sold in the European Union 20 Mio MFDs were sold in 2009. The reverse effect was observed for printers: in 2003 more than 20 Mio. printers were sold, until 2009 the numbers declined to less than 10 Mio. (sources: EuP Preparatory Studies LOT 4 "Imaging Equipment", task 2 "Economic and Market Analysis; JRC 2011)

It is worthwhile to compare lifecycle costs for consumables with energy costs. This has been done by JRC/IPTS within the GPP/Ecolabel process in 2011 resulting in Figure 2. It shows a that ink jet printers tend to come with high costs of paper and ink related to energy costs whereas laser printers tend to have lower costs of consumables related to energy costs.

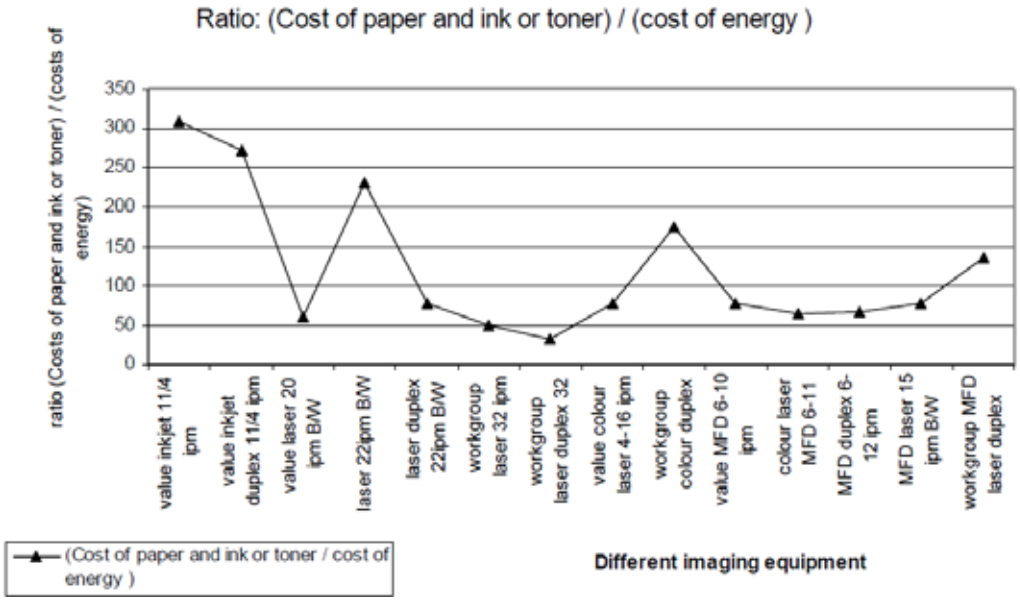


Figure 2: Comparison of the overall lifetime costs related to related to paper & ink or toner consumption versus electricity consumption. Source: Kougoulis et. al 2011 [30]

To complete the picture the following total cost comparison shows that printing with laser printers tends to be cheaper compared to ink jet printers. Secondly, faster laser printers tend to be cheaper than slow printers. An overview is provided by Koungoulis et al. 2011 summarized in Figure 3.

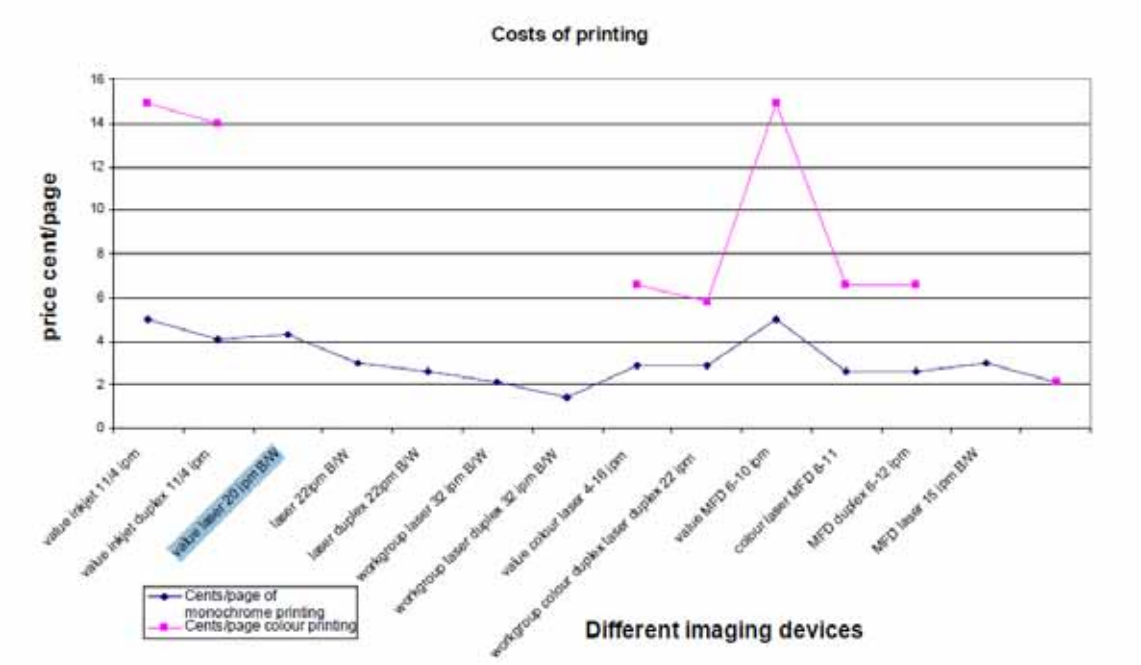


Figure 3: Costs of printing for monochrome and colour printing for several imaging equipment, Source: Kougoulis et. al 2011 [30]

1.3 Best Available Technology

1.3.1 Available technology

There is a lot of research concerning the development and the market incorporation of new technologies that will cover the entire life-cycle of the laser and inkjet imaging equipment. In this paper, we focus on the product's use phase.

For instance, within the electro-photographic (EP) process the thermal/pressure based fixing of the image requires the highest share of the energy consumption. Measurements indicate that in active mode about 70% of power consumption is related to the fuser/fixing unit. Consequently, the fixing process provides a good potential for improvement of total energy efficiency. Other sources of considerable power consumption are the paper transport (motors), the scanner unit (florescent lamp), and the overall efficiency of the power supply unit. [8]

It has to be stated here that the majority of the technologies that have been developed or are under the research and development process are not publicly available, but consist of ownership of the private image equipment companies, which develop them and have their copyright. The latter is the main reason that has led to different approaches from the different manufacturers over the amelioration of the fuser & fixing units.

Thus, there are many different proprietary fast fuser technologies in the market, which by shorting the warm-up time as low as 35 seconds from off-mode and 10 seconds from sleep-mode reduce power consumption. Energy is saved because products with fast fuser technology do not need a prolonged heating in ready-mode. These systems are mostly applied to low and medium speed EP-products up to 50 ipm. Some of the technologies are quite mature such as the ceramic heater / fixing film systems from Canon and HP, which are in the market since 90s. Multiple Heaters and Induction Heating (IH) systems are some of the most recent technologies, which have been introduced in the early years of the first decade of 2000 (EuP Preparatory Studies LOT 4 “Imaging Equipment”). The following tables are depicting the major state of the art fuser/fixing technologies (down side) in comparison to conventional technologies (upper side).

Table 3. Fuser roller fixing technologies for monochrome EP- Products(source: EuP Preparatory Studies LOT 4 “Imaging Equipment”)

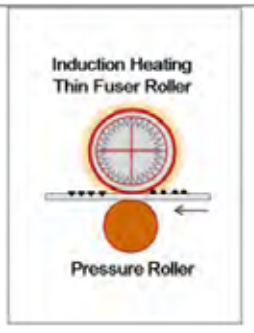
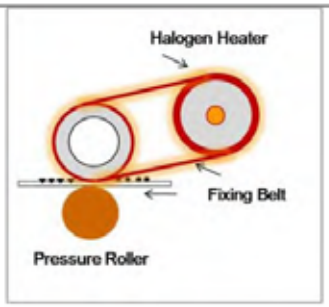
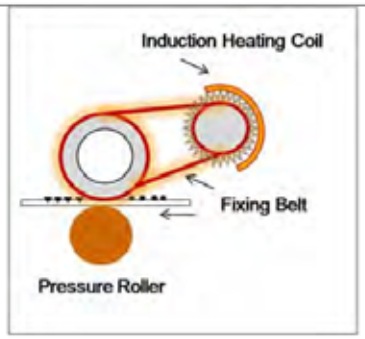
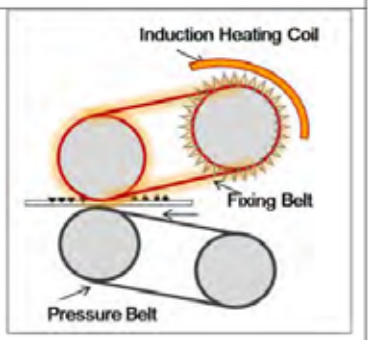
<table>
<tr><td> 
</td><td colspan="4">Conventional Fuser Roller Fixing Technology (monochrome EP-products)
Thick wall fuser roller with single halogen heater</td></tr>
<tr><td colspan="5">Fast Warm-up Fuser Roller Technologies</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td>Canon: On-demand system
HP: Instant-on system</td><td>Ricoh: QSU system
(quick start up)</td><td>Ricoh: Hybrid QSU system
(with additional capacitor)</td><td>Canon: Induction Heat (IH)
Konica Minolta: IH system
Toshiba: Twin IH fuser</td></tr>
</table>

Table 4. Belt fixing technologies for colour EP-Products(source: EuP Preparatory Studies LOT 4 "Imaging Equipment")

<table>
<tr><td> 
</td><td colspan="3">Conventional Belt Fixing Technology (colour EP-products)
Thick wall fuser roller with single halogen heater transfers heat via fixing belt to heater roller</td></tr>
<tr><td colspan="4">Fast Warm-up Belt Fixing Technologies</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td>Fuji Xerox: Free Belt Nip Fixing
Fuji Xerox: Dual heater FBNF</td><td>Ricoh: QSU, IH belt fixing system
Panasonic: IH belt fixing system</td><td>Canon: IH twin-belt fixing system</td></tr>
</table>

1.3.2 Upcoming Technologies

Could the future of imaging be inkless, 3D, or even wax? Many imaging companies have been developing systems that eventually will be diffused on the market.

- **Inkless printers**. A number of companies, such as Polaroid and Dell have invested in printing technologies that do not function under the conventional printer ink cartridges, but instead print high quality full colour images using Zink (Zero Ink) technology. In brief, the functionality of the Zink technology is based in the following procedure. Heat from the printer activates dye crystals that are embedded in a special kind of photo paper (ZINK paper) to create coloured print outs in less than a minute.[9] The ZINK paper is an advanced composite material with cyan, yellow, and magenta dye crystals embedded inside, and a protective polymer overcoat layer outside. The crystals are colourless before printing, so ZINK Paper looks like regular white photo paper.[10] DELL has already put in the market the model Wasabi Ultra mobile printer, while Polaroid has produced its own instant mobile printer pogo. More companies have been developing similar functional units.

Image 5. Polaroid GL 10, 3x4. Instant mobile printer & ZINK paper (source: Zink imaging inc.)

- **3D printers**. Although that the 3D printing technology isn't something new, its wide diffusion in the market it is, as it remains expensive and prohibited for the average user. Thus, until now the 3D printing has restricted in industrial and manufacturing design, but there are efforts of commercialize this technology. Z corporation is one strong representative of this sector.

Image 6. 3D printer and printed object (source: Z Corporation)

- **Solid ink or phaser printers.** The latter were developed by Tektronix and later by Xerox (who acquired Tektronix's printer division). Printers like the Xerox Phaser 8400 uses 1 in rectangular solid-state ink blocks (similar in consistency to candle wax) which are loaded into a system similar to a stapler magazine in the top of the printer. The ink blocks are melted and the ink is transferred onto a rotating, oil coated print drum using a piezo inkjet head. The paper then passes over the print drum, at which time the image is transferred, or transfixed, to the page. This system is similar to water-based inkjets, if the ink has low viscosity at the jetting temperature (140°C). [11] The designer Faris Elmasu has taken the technology one step beyond and while the speed lags behind laser printers and the quality lags behind inkjet printers, it's good for the environment: there's no wasted plastic and metal that you get from disposing of old ink and toner cartridges with 'traditional' printers. The Wax-On Printer takes this technology to a whole new level, however. For starters, it is vertical – taking up the absolute minimum of space on a desk while still being able to function as a printer. A paper holder in the back – with integrated USB cable tidy – feeds the sheets into a printing drum at the top, which then deposits the wax and slides the sheets vertical down the front.[12]

Image 7. The solid ink cartridges used in xerox printers & the new "wax on" project, by the designer Faris Elmasu (source: faris elmasu industrial design portfolio)

1.4 Legislations and Labels

1.4.1 International

U.S.A.

ENERGY STAR. It is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping save money and protects the environment through energy efficient products and practices. The effective Energy star programme requirements for imaging equipment version 2.0 determine the energy consumption requirements that allow a product to be labelled with the Energy Star (Effective Date: June, 2013).

The following table depicts the central eligibility criteria for imaging equipment which is evaluated either in terms of Typical Electricity Consumption (TEC) or Operational Mode (OM).

Table 5. An Imaging Equipment product must further be classified as either "TEC" or "OM" in Table 1, below, depending on the method of ENERGY STAR evaluation.

Equipment Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Copier	Standard	DT, DS, EP, SI, TT	TEC
	Large	DT, DS, EP, SI, TT	OM
Digital Duplicator	Standard	Stencil	TEC
Fax Machine	Standard	DT, DS, EP, SI, TT	TEC
		IJ	OM
Mailing Machine	All	DT, EP, IJ, TT	OM
Multifunction Device (MFD)	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large	DT, DS, EP, IJ, SI, TT	OM
Printer	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large or Small	DT, DS, EP, Impact, IJ, SI, TT	OM
	Small	High Performance IJ	TEC
Scanner	All	N/A	OM

Table 6. Eligibility Criteria for imaging equipment according to their TEC[iii] and printing speed (source: Energy Star V. 2.0)

Color Capability	Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)	TEC_{REQ} (kWh/week, to the nearest 0.1 kWh/week for reporting)
Monochrome Non-MFD	$s \leq 5$	0.3
	$5 < s \leq 20$	(*s* x 0.04) + 0.1
	$20 < s \leq 30$	(*s* x 0.06) – 0.3
	$30 < s \leq 40$	(*s* x 0.11) – 1.8
	$40 < s \leq 65$	(*s* x 0.16) – 3.8
	$65 < s \leq 90$	(*s* x 0.2) – 6.4
	$s > 90$	(*s* x 0.55) – 37.9
Monochrome MFD	$s \leq 5$	0.4
	$5 < s \leq 30$	(*s* x 0.07) + 0.05
	$30 < s \leq 50$	(*s* x 0.11) – 1.15
	$50 < s \leq 80$	(*s* x 0.25) – 8.15
	$s > 80$	(*s* x 0.6) – 36.15
Color Non-MFD	$s \leq 10$	1.3
	$10 < s \leq 15$	(*s* x 0.06) + 0.7
	$15 < s \leq 30$	(*s* x 0.15) – 0.65
	$30 < s \leq 75$	(*s* x 0.2) – 2.15
	$s > 75$	(*s* x 0.7) – 39.65
Color MFD	$s \leq 10$	1.5
	$10 < s \leq 15$	(*s* x 0.1) + 0.5
	$15 < s \leq 30$	(*s* x 0.13) + 0.05
	$30 < s \leq 70$	(*s* x 0.2) – 2.05
	$70 < s \leq 80$	(*s* x 0.7) – 37.05
	$s > 80$	(*s* x 0.75) – 41.05

Background: Calculation of the Typical Energy Consumption (TEC)

The Energy Star makes use of the energy consumption measurement method called TEC. It measures the typical weekly energy consumption according to a predefined use pattern. The use pattern takes into account the following elements:

- The daily job energy consumption E_{JOB_DAILY}
- The final energy consumption, as calculated according to the Energy Stars test

[iii] A method of testing and comparing the energy performance of imaging equipment products, which focuses on the typical electricity consumed by a product while in normal operation during a representative period of time. The key criteria of the TEC approach for imaging equipment is a value for typical weekly electricity consumption, measured in kilowatt-hours (kWh).

procedure E_{FINAL},

- The number of printing jobs per day N_{JOBS},
- The final time to sleep mode, as measured in the Energy Stars test procedure; t_{FINAL},
- The energy consumption in sleep mode E_{SLEEP}
- The time the device is in sleep mode, t_{SLEEP}
- The imaging equipment is in use during 5 weekdays and in sleep mode during the weekend (48 hours),

The formula for the calculation of TEC is provided below. For further details it is recommended to refer to Energy Star's Program Requirements and Test Procedures.

$$TEC = 5 \times \left[E_{JOB\_DAILY} + (2 \times E_{FINAL}) + \left[24 - (N_{JOBS} \times 0.25) - (2 \times t_{FINAL})\right] \times \frac{E_{SLEEP}}{t_{SLEEP}} \right] + 48 \times \frac{E_{SLEEP}}{t_{SLEEP}},$$

Figure 4: Calcultation of the TEC accroding to the Energy Star, Version 2.0.

Requirements measured in terms of OM cover (1) Maximum Default Delay Time to Sleep, (2) Sleep Mode Power Allowance for Base Marking Engine, (3) Sleep Mode Power Allowances for Functional Adders and (4) Maximum Standby Power Consumption Requirements. Maximum Default Delay Time to Sleep is depicted in Table 7. For detailed maximum values see ENERGY STAR 2.0 Program Requirements for Imaging Equipment pages 11-18.[13]

Table 7. Required Default Delay Time to Sleep for OM[iv] Products

Product Type	Media Format	Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm or mppm)	Required Default Delay Time to Sleep, t_{SLEEP_REQ} (minutes)*
Copier	Large	$s \leq 30$	30
		$s > 30$	60
Fax Machine	Small or Standard	All	5
MFD	Small or Standard	$s \leq 10$	15
		$10 < s \leq 20$	30
		$s > 20$	60
	Large	$s \leq 30$	30
		$s > 30$	60
Printer	Small or Standard	$s \leq 10$	5
		$10 < s \leq 20$	15
		$20 < s \leq 30$	30
		$s > 30$	60
	Large	$s \leq 30$	30
		$s > 30$	60
Scanner	All	All	15
Mailing Machine	All	$s \leq 50$	20
		$50 < s \leq 100$	30
		$100 < s \leq 150$	40
		$s > 150$	60

[iv] OM is a method of comparing product energy performance via an evaluation of power (measured in watts) in various operating states, as specified in Section 9 of the ENERGY STAR Imaging Equipment Test Method

Other international labels

Label	Country	Link
	Australia	Good Environmental Choice Australia (GECA)
	New Zealand	Environmental Choice New Zealand
	Japan	Eco Leaf
	Japan	The Eco Mark programme
	Korea	Korea Eco-Label
	Taiwan	The Greenmark Programme
	Singapore	Singapore Green Labelling Scheme
	Thailand	Green Label Thailand
	Canada	EcoLogo Program

Label	Country	Link
	Nordic Countries	Nordic Ecolabelling
	Philippines	Green Choice
	Sweden	TCO Development
	USA	EPEAT

1.4.1.1 European labelling

EU ENERGY STAR PROGRAMME[14]. The EU ENERGY STAR programme follows an Agreement between the Government of the US and the European Community (EU) to co-ordinate energy labelling of office equipment. It is managed by the European Commission [15].

European Ecolabel[16] The European Ecolabel is a voluntary scheme, established in 1992 to encourage businesses to market products and services that are kinder to the environment. Products and services awarded the Ecolabel carry the flower logo, allowing consumers - including public and private purchasers - to identify them easily. Today the EU Ecolabel covers a wide range of products and services, with further groups being continuously added. Product groups include cleaning products, appliances, paper products, textile and home and garden products, lubricants and services such as tourist accommodation.
Currently, European Ecolabel Criteria as well as Criteria for Green Public Procurement (GPP) for imaging equipment are elaborated by the European Joint Research Centre (JRC) in Seville under the participation of various stakeholders.[v] [17]

[v] For information in the current state of the process see: http://susproc.jrc.ec.europa.eu/imaging-equipment/index.html

1.4.2 Relevant National Criteria

Germany

Blue Angel. The Blue Angel is the first and most well known eco-label worldwide. Since 1978, it has set the standard for eco-friendly products and services selected by an independent jury in line with defined criteria. The Blue Angel is awarded to companies as kind of a reward for their commitment to environmental protection. They use it, to professionally promote their eco-friendly products in the market. The Blue Angel is an ecological beacon showing the consumer the way to the ecologically superior product and promotes environmentally conscious consumption.[18]

RAL-UZ 171 (July 2012):[19] Office Equipment with Printing Function (Printers, Copiers and Multifunction Devices)[vi]. 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[20] the Environmental Label Jury has set up these Basic Criteria for Award of the Environmental Label. 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 on standard paper with a grammage of 60-80 g/m^2
- are capable to process media of a maximum format of A3+
- 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 printing.

Nordic countries (Finland, Norway, Sweden, Denmark, Iceland)

Nordic Swan Ecolabel.[21] The Nordic Ecolabel is the official Ecolabel of the Nordic countries and was established in 1989 by the Nordic Council of Ministers with the purpose of providing an environmental labelling scheme that would contribute to a sustainable consumption. It is a voluntary, positive Ecolabelling of products and services. The Nordic Ecolabel was also initiated as a practical tool for consumers to

[vi] RAL-UZ 171 (recast of RAL UZ 122) has been adopted in July 2012. However, in 2013 RAL-UZ 122 is still effective. RAL-UZ 171 becomes effective from 01/ 2014.

help them actively choose environmentally sound products. It is an ISO 14024 type 1 Ecolabelling system and is a third-party control organ.

Today there are 63 product groups, and companies who have products within these groups and who meet the criteria requirements, can apply for a Nordic Ecolabel licence.

Each Nordic country has local national offices with the responsibility for criteria development, licensing, marketing and audits. In Denmark Nordic Ecolabel is administered by Ecolabelling Denmark at Danish Standards Foundation, in Sweden by Ecolabelling Sweden AB, in Finland by Finnish Standards, in Norway by The Foundation for Ecolabelling, and in Iceland by The Environment Agency that operates under the direction of the Ministry for the Environment.

The latest version of Nordic Swan Ecolabel is the version 5.4 that was published in June of 2007. It will be effective until June 2014. The requirements that the imaging equipment appliances must fulfil before a Nordic Ecolabel can be granted focus on the following aspects:[22]

- Power consumption
- Design and materials
- Plastic in casings and their components (covering additives, e.g. flame-retardants)
- Materials and other dangerous substances (covering heavy metals, e.g. cadmium, mercury. lead in batteries)
- Recycling of discharged products
- Other environmental requirements (supply of spare parts, Double-sided copying, traceability system)
- Emission of pollutants (also noise) in working areas
- Quality and regulatory requirements (e.g. Information to consumers, recycling and reuse of consumer durables and parts that wear out)

Austria

Austrian Ecolabel "Österreichisches Umweltzeichen"[23]. The Austrian Ecolabel is supervised by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management. the union for consumer information (Der Verein für Konsumenteninformation) is

responsible for the criteria determination. The Austrian Ecolabel was founded in 1990.

The Austrian available Ecolabel criteria "Österreichisches Umweltzeichen" for imaging equipment are based on a binational cooperation with the German Blue Angel Ecolabel scheme. The relevant Ecolabel criteria are depicted in the Richtlinie UZ 16, "Bürogeräte mit Druckfunktion (Drucker, Kopierer, Multifunktionsgeräte)", which fully adopt the aforementioned Blue Angel criteria on "Office Equipment with Printing Function (printers, copiers, multifunctional devices)". Thus, the covered imaging equipment products are the following:

• Copiers

• Printers

• Multifunctional devices (MFD) (restricted to the ones which have printing or copying as primary function).

1.4.3 VA, Legislation and test standards

Voluntary Agreement

The European Commission has accepted a Voluntary Industry Agreement to improve the energy performance of their models in January 2013: http://www.topten.eu/uploads/File/Annex_II._Lot_4_DRAFT_VA_V3_5.pdf

The Agreement is based on Energy Star V. 1.2; some 90% of the signatories' sales have to comply. In October 2013 industry will present a draft new version, which should also include non-energy criteria.

The European Commission renounced on Ecodesign requirements in favour of the VA.

1.4.3.1 Legislation

Directive 2012/19/EU (WEEE- recast)[24] *and Directive 2002/95/EC (RoHS-recast)*[25]

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. Recently, both directives were recasted: Directive 2012/19/EU (WEEE-recast) and Directive 2002/95/EC (RoHS). The directives aim on reducing the environmental impact of electrical and electronic equipment also through design measures, which support disassembly and reuse.

The **WEEE-Directive** applies to office imaging equipment under category 3 of Annex V, 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 VII of WEEE declares selective treatment for materials and components of waste electrical and electronic equipment in accordance with Article 8(2) for office imaging equipment that applies to toner cartridges, liquid and pasty, as well as colour toner.

The **RoHS-Directive** applies to all electronic and electrical appliances (e.g. printers) and prohibits the use of the heavy metals lead, mercury, cadmium, hexavalent chromium, and brominated flame-retardants (poly-brominated diphenylethers and poly-brominated biphenyls) in new electrical and electronic equipment placed on the market after 1 July 2006.

Standby regulation, including networked Standby

The Standby regulation from 2008 limits the Standby power to 0.5 / 1W since December 2012.
(http://www.topten.eu/uploads/File/Ecodesign%20Regulation_Standby_1208.pdf)

In September 2013 the amended Standby regulation, also covering networked standy, is expected to be published in the Official Journal. It will cover all imaging equipment and set minimum requirements of 6W (LoNa) and 12W (HiNa) from January 2015 and will be tightened to 3W and 8W in January 2017. Starting from tier 1 a maximum delay time to Standby of 20 minutes is required. LoNa products must comply with the normal Standby requirements if their network functions are deactivated (HiNa products are assumed to be pointless without network connection).

Some info on this:
http://www.topten.eu/uploads/File/STANDBY%20Topten%20EU%20policy%20recommendations%20Feb%2013.pdf.

1.4.3.2 Test Standards

A “Measurement standard” is a standard that sets out a test method, not indicating what result is required when performing the test. Therefore, strictly speaking, a test standard is different from a “performance 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 “measurement standard” itself. A standard has a particular scope mostly product or sector specific.

It has to be stated that concerning the imaging equipment and specifically for the purposes of the Topten network, the valid Energy Star 1.2 version should be considered as a standard, since it defines the way that the energy consumption in such devices should be measured.

Performance 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 either 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 entity**

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.[26]

Maybe you could add that Energy Star has its own test method?

2 Economic and Market Analysis

2.1 Market and Stock data

According to data that have been obtained from the EuP preparatory study as far as from the study on the development of the European Ecolabel on imaging equipment, it can be stated that between the years 2000 and 2009 the European production of imaging equipment has shrunk, while the imports have increased. The following table presents printers' production in European countries between the years 2000 and 2009.

Table 8. Production of printers in European countries between 2000 & 2009 (the blank cells mean that there are not data for the specific country in the specific year) (source: Development of European Ecolabel & green public procurement criteria for Imaging Equipment, JRC IPTS Draft preliminary study)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	0	0			0	0	0	0	0	
Belgium										
Bulgaria		0	0	0	85				2005	
Croatia		0	0	0	0	0	0	0	0	0
Cyprus										
Czech Rep.		0								
Denmark	544	445	370	294	372	395	330	4316	1112	857
Estonia	0	0	0	0	0	0	0	0	0	0
Finland	0			0	0	0	0	0	0	0
France			355014	107326	76483	98663	101570	375134	270234	226168
Germany	98719	104057	104017	104018	99955	81901	15032			32794
Greece		0		0	0	0	0	0	0	0
Hungary			4198000							
Iceland	0	0	0	0	0	0	0	0	0	0
Ireland										
Italy	1009287	829580	661065	574395	489364	353548	235952	162617	137899	81846
Latvia		0	0	0	0	0	0	0	0	0
Lithuania	0	0				82	0	0	0	0
Luxemburg	0	0	0	0	0	0	0	0	0	0
Malta				0	0	0	0	0	0	0
Netherlands					0	0	0			
Norway					0	0	0	0	0	0
Poland			20288	0	22019	25382	24107		0	30080
Portugal	0	0	0	0	0	0	0			
Romania	0				0		0		0	0
Slovakia			0	0				0	0	0
Slovenia										0
Spain	8981972	8808834	12692	8907						0
Sweden	2752									
United Kingdom	1652916	1413297	111986		603658	489227	491080	104997	79712	134739

Despite the fact that there are no data evidence during some years, it is clearly depicted the reduction in production of printers in major producer states of EU-27, such as Italy, Germany, France and United Kingdom.

Simultaneously, an increase in the stock of printers has been observed in year 2009 in correlation with 2005. This shows an upward trend of the imports, in respect to the printers, in European Union member states.

Table 9. Printers stock in EU. Years 2005 and 2007 (source: Development of European Ecolabel & green public procurement criteria for Imaging Equipment, JRC IPTS Draft preliminary study)

Product type & characteristics			Reference year	
			2005	2009
Printers	EP	Black/white	14.735.315	14.809.890
		Colour	1.919.397	3.982.691
		subtotal	16.654.712	18.792.581
	Inkjet	Single function	68.412.276	38.384.901
		MFD	21.759.956	69.442.821
		subtotal	90.172.232	107.827.722
	Overall Total		106.826.944	126.620.303

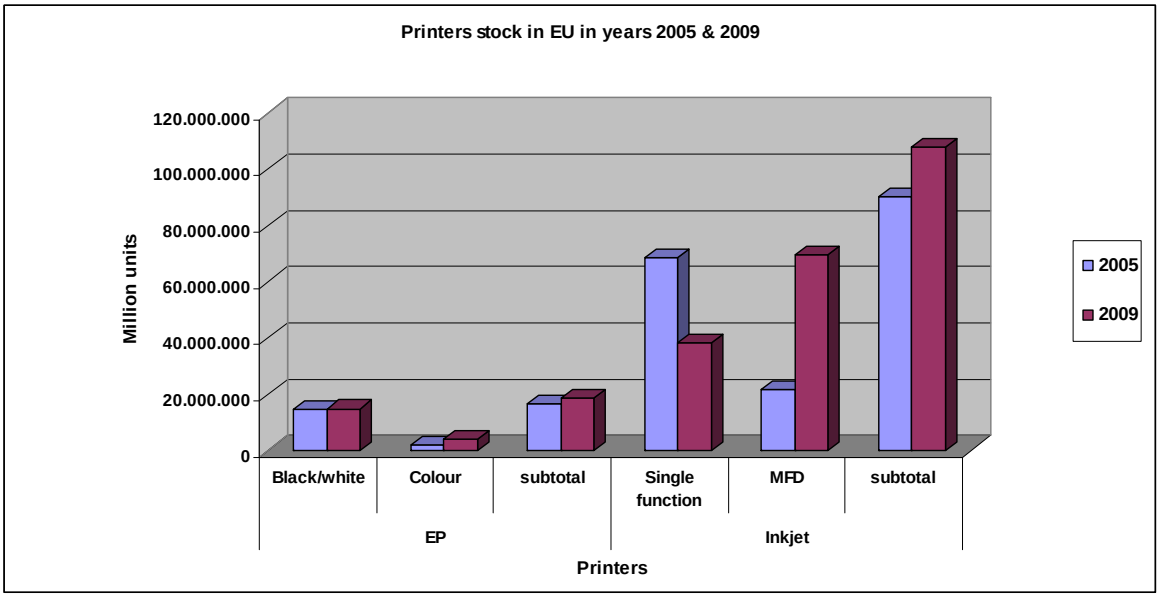


Figure 4. Printers stock in EU. Years 2005 and 2007 (source: Development of European Ecolabel & green public procurement criteria for Imaging Equipment, JRC IPTS Draft preliminary study)

The sector of imaging equipment is dominated by non-EU companies manufacturing outside Europe. The following figure illustrates clearly that the exports of printers has significantly declined from 2000 to 2009, with an exception of the years 2005 and 2006 when slight exports increases were noticed.

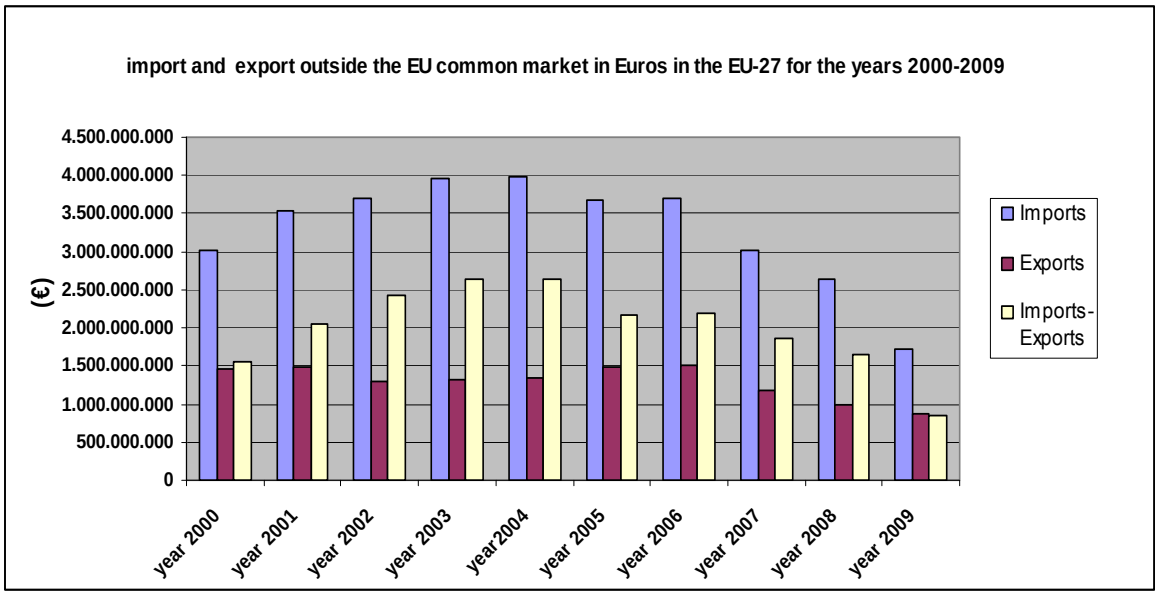


Figure 5. (Source: Development of European Ecolabel & green public procurement criteria for Imaging Equipment, JRC IPTS Draft preliminary study)

2.2 Growth and Trends

While the market of the EP (laser) printers has remained stable from 2003 to 2009, presenting a slight decrease, the market of the inkjet printers presents a strong decline, in respect to the same timeframe.

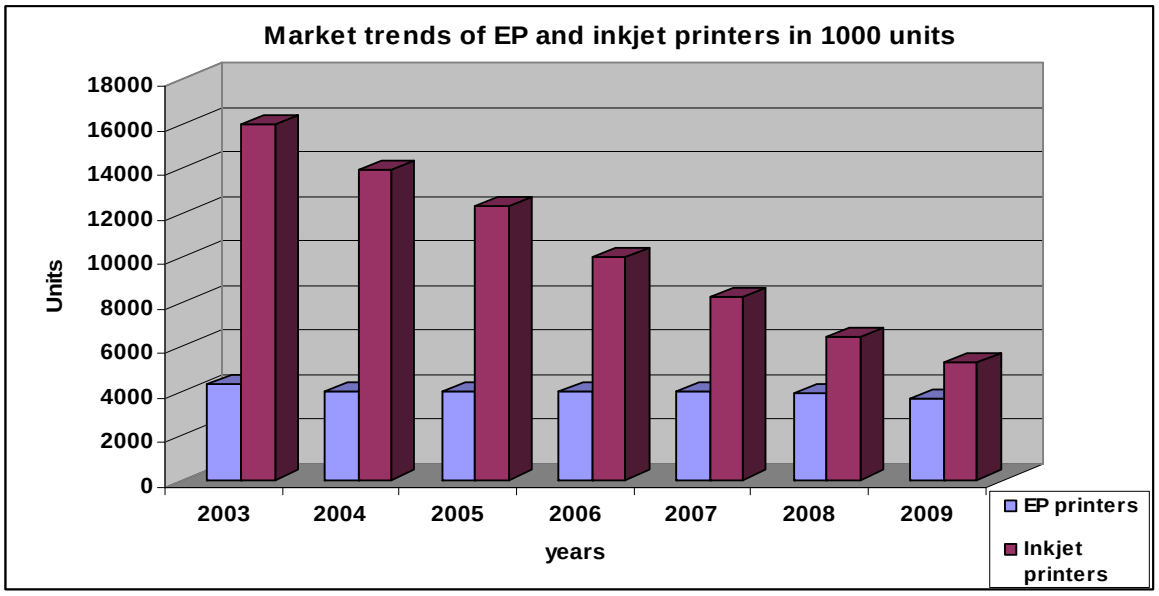


Figure 6. (Source: Development of European Ecolabel & green public procurement criteria for Imaging Equipment, JRC IPTS Draft preliminary study)

Simultaneously, in comparison to the single function printers, the market share of the MFDs with printing as their main function has significantly increased and MFDs are considered, as the dominant product of the product group.

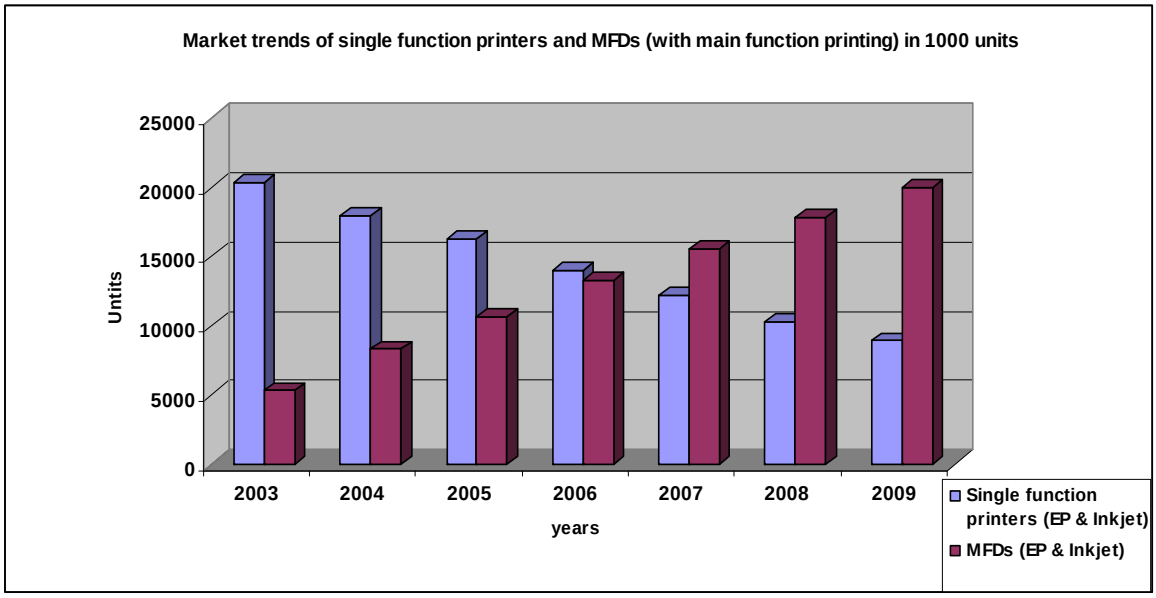


Figure 7. (**Source: Development of European Ecolabel & green public procurement criteria for Imaging Equipment, JRC IPTS Draft preliminary study**)

The technological driving forces for the increase of MFDs towards single functional devises are considered the strong trends towards digitalisation and miniaturisation in electronics. Another market trend is the increase of colour prints versus monochrome. Colour EP-printers and MFDs are gaining larger market shares. Thus, the following years can be expected a rapid replacement of monochrome devices. Nevertheless, the forecasts on the monochrome images volume suggest that it would not change significantly. Finally, the market of small colour photo inkjet printers for private use is expected to rise, similarly to the respective market in the US.[27]

2.3 Manufacturers and Distributors

The most important manufacturers and distributors of printing devices are listed below.

Table 10. List of important manufacturers & distributors

Brand	European Headquarters address	Link
Canon	3 The Square Stockley Park Uxbridge Middlesex United Kingdom UB11ET	http://www.canon-europe.com/
hp invent	Cain Road Bracknell, Berkshire, RG12 1HN	http://www8.hp.com/uk/en/home.html
EPSON EXCEED YOUR VISION	Epson Europe Atlas Arena, Asia Building Hoogoorddreef 5 1101 BA Amsterdam Zuidoost The Netherlands	http://www.epson-europe.com/
xerox	Xerox Oxford Road Uxbridge UB8 1HS UK	http://www.xerox.co.uk/
LEXMARK	2200 Lexmark International Technology S.A. Case Postale 508 CH - 1215 Geneva 15 (Switzerland)	http://www.lexmark-europe.com
RICOH	PLC. 66 Chiltern Street London W1U 4AG United Kingdom	http://www.ricoh-europe.com/
KYOCERA mita	KYOCERA MITA Europe B.V. Bloemlaan 4 NL-2132 NP Hoofddorp Holland	http://www.kyoceramita.eu/
SAMSUNG	Samsung House, 1000 Hillswood Drive, Chertsey, Surrey, KT16 0PS United Kingdom	www.samsung-europe.com/
brother	House, 1 Tame Street, Audenshaw, Manchester, M34 5JE, UK	http://www.brother.eu/
SHARP	Sonninstrasse 3 20097 Hamburg/Germany	http://www.sharp.eu/eu

3 Selection Criteria

This chapter does not define specific target values to be met by Topten products in all Euro-Topten partner countries. Nevertheless, it suggests energy efficiency guidelines, such as the registration of the Topten appearing printers in the Energy Star database or the completion of similar requirements, which are in line with the Topten concept. Thereafter, each country has to develop its specific Topten lists, which depend on the products availability on the national market. Thus, the specific thresholds for Topten lists depend on the products offered at national level and will be more or less stringent depending on the number of efficient products available.

The intention is rather to provide some recommendations regarding the criteria to be considered in Topten product listings and to give an idea of the efficiency of products currently offered on the market.

3.1 Current Criteria

3.1.1 Topten.eu criteria laser printers

Topten (Best products of Europe) presents the most energy efficient laser printers with a maximum printing speed of 100 pages per minute of Europe. [28]

In order to be displayed on www.topten.eu, laser printers must

- Actually be available in at least one European country
- Be registered at Energy Star or meet comparable requirements
- Be able to print on recycled paper
- Models with ≥ 19 ipm: offer a duplex printing function
- Have an energy efficiency index according to the following scheme:

Table 11. energy efficiency index laser printers

Laser printers	Maximum energy efficiency index
colour 1-20 ppm	40 %
Colour 21-100 ppm	40 %
monochrome	50%

The energy efficiency index is calculated by Topten and is a model's TEC relative to the Energy Star limit TEC: TEC (model) / TEC (Energy Star limit). So, a model with an energy efficiency index of 40% uses 60% less energy than required by Energy Star.

3.1.2 Topten.eu criteria inkjet printers

Topten (Best products of Europe) presents the most energy efficient inkjet printers and multifunctional devices for the standard paper size (A4 and A3) of Europe. [29]

In order to be displayed on www.topten.eu, inkjet imaging devices must

- Actually be available in at least one European country
- Be able to print on recycled paper
- Be registered at Energy Star or meet comparable requirements
- Have a maximum energy consumption of 1.5 Watt, when in Sleep mode

3.1.3 National topten websites criteria

The majority of the European countries national websites use the same selection criteria with the central European website www.topten.eu that were presented above.

Topten.eu makes a first selection for the national teams who then have to take the European list and confront it to their national markets. If producers say they have more models, national teams can check that they indeed correspond to the Topten criteria and then inform the European team – this is the quality control we mention at each meeting between the european and the national lists

Notwithstanding there are a few slight differences in some of the countries, mainly concerning the energy efficiency index of the laser printers, which are presented below.

Austria

The selection criteria in order a laser printer to be presented in the Austrian Topten webpage (www.topprodukte.at) are the following:

- To be available in Austrian market
- To be ENERGY STAR registered or meet equivalent requirements
- To have an energy efficiency index according to the following table differentiating between a certificate in Gold and Silver:

Printing speed	Maximum energy efficiency index for monochrome printers	
	top-product.GOLD	top-product.SILVER
1-30 ppm	55%%	75%
>31 ppm	55%	75%

Printing speed	Maximum energy efficiency index in colour printers	
	top-product.GOLD	top-product.SILVER
1-20 ppm	40%	60%
>21 ppm	50%	70%

Luxemburg

The selection criteria in order for a laser printer to be presented in the Luxembourgian Topten webpage are the following:

- To be available in Luxembourg
- To be ENERGY STAR registered or meet equivalent requirements
- To be able to print on recycling paper
- Power in standby-mode: max. 1.5 Watt
- Power in off-mode: 0.5 Watt
- To have an energy efficiency index according to the following table

Laser printers	Maximum energy efficiency index
monochrome	60%
colour 1-20 ppm	40%
colour 21-100 ppm	50%

3.2 New Energy Efficiency Criteria

3.2.1 Energy efficiency criteria of laser printers

The energy efficiency criteria, concerning the laser printers are suggested to be the following:

1. The laser printers that are presented in Topten need to be registered in **ENERGY STAR** database, or to meet comparable requirements.

Image 8. EU Energy Star printers' database

2. **The energy efficiency index**. The Energy Efficiency Index (EEI, in %) is calculated by Topten based on the product's Typical Energy Consumption (TEC)[vii] and Energy Star's TEC limit value, according to the following equation:

EEI= TEC*100/TEC limit value.

The lower a product's EEI, the better is its energy efficiency. The majority of the European Topten websites have set the EEI value at 75%, or higher, concerning the monochrome laser printers and 60% or higher, concerning the colour printers. The suggestion over the EEI is to be defined within the following limit values.

Laser printers	Maximum energy efficiency index
monochrome	60 %
colour	50 %

[vii] **The Typical Electricity Consumption (kWh/week) is measured according to the standardised methodology of Energy Star for office equipment (Version 1.2). Only products with a TEC below a certain value are labelled with the Energy Star.**

3.2.3 Energy efficiency criteria of inkjet printers

The energy efficiency criteria, concerning the inkjet printers are suggested to be the following[viii]:

1. The inkjet printers that are presented in Topten need to be registered in **ENERGY STAR** database, or to meet comparable requirements.

2. To present a maximum energy consumption of 1.5 Watt or less, when in Sleep mode.

3. To present a maximum energy consumption of 0.5 Watt or less, when in Off mode.

4. To present maximum energy consumption of 1 Watt, when in standby mode

Except the energy efficiency related data, the consumer will be interested to find in the Topten tables, information such as:

- Capacity of printing on recycled paper

- Printing Speed

  - *Laser printers*. monochrome/colour (ppm). Maximum number of pages (A4) to be printed per minute (pages per minute = ppm), according to the standardised methodology of Energy Star.

  - *Inkjet printers*. Printing speed, b/w and colour (ppm) Maximum printing speed in pages (A4) per minute (ppm), measured according to ISO/IEC 24734

- Paper size. Maximum standardized paper size (e.g. A3, A4 etc.)

- Paper capacity (sheets). Standard paper supply in number of sheets for the paper cassette and the multi-purpose tray, e.g. 500+100. Usually there is the option to significantly increase it for a somewhat higher price; e.g. +550.

- Print memory (MB) (Laser printers). Random Access Memory (RAM), in Mega-bytes (MB).

[viii] Sleep Mode and Standby-Mode are different modes with different criteria (see energy star for definitions). Energy Star Version 2.0 demands max. 4.0 Watt for small ink jet printers and 0.6 Watt for standard ink jet printers in sleep mode. Large ink jet printers may even have a power consumption of 4.9 W in Sleep Mode. The sleep mode of a printer is not covered by the EU Standby directive.

- Two-sided output. Also called duplexing: capability to print on both of a sheet's sides. this mode can be
  - a standard included in the product
  - not contained and cannot be integrated into this product
  - integrated into the product for a higher price
- Power Off (Watts). Power input in Watt when switched off, but not disconnected.
- Power Sleep (Watts). Power input when in the Sleep mode, in Watt. The Sleep mode is the mode of lowest power input, which can be automatically reached by a device without switching off (definition by Energy Star). To reach functionality from this mode can be connected with a time lag.
- Resolution (inkjet printers). Maximum resolution when printing or copying (dpi = dot per inch).

Annex: max. TEC values on Topten.eu, February 2013

Speed (ppm)	Max. TEC (kWh/week)		Speed (ppm)	Max. TEC (kWh/week)		Speed (ppm)	Max. TEC (kWh/week)		Speed (ppm)	Max. TEC (kWh/week)	
	b/w	Colour		b/w	Colour		b/w	Colour		b/w	Colour
1	0.50	1.16	26	1.05	2.16	51	3.78	5.06	76	8.15	10.88
2	0.50	1.20	27	1.10	2.20	52	3.95	5.20	77	8.33	11.16
3	0.50	1.24	28	1.15	2.24	53	4.13	5.34	78	8.50	11.44
4	0.50	1.28	29	1.20	2.28	54	4.30	5.48	79	8.68	11.72
5	0.50	1.32	30	1.25	2.32	55	4.48	5.62	80	8.85	12.00
6	0.50	1.36	31	1.30	2.36	56	4.65	5.76	81	9.03	12.28
7	0.50	1.40	32	1.35	2.40	57	4.83	5.90	82	9.20	12.56
8	0.50	1.44	33	1.40	2.54	58	5.00	6.04	83	9.55	12.84
9	0.50	1.48	34	1.45	2.68	59	5.18	6.12	84	9.90	13.12
10	0.50	1.52	35	1.50	2.82	60	5.35	6.40	85	10.25	13.40
11	0.50	1.56	36	1.55	2.96	61	5.53	6.68	86	10.60	13.68
12	0.50	1.60	37	1.60	3.10	62	5.70	6.96	87	10.95	13.96
13	0.50	1.64	38	1.65	3.24	63	5.88	7.24	88	11.30	14.24
14	0.50	1.68	39	1.70	3.38	64	6.05	7.52	89	11.65	14.52
15	0.50	1.72	40	1.75	3.52	65	6.23	7.80	90	12.00	14.80
16	0.55	1.76	41	2.03	3.66	66	6.40	8.08	91	12.35	15.08
17	0.60	1.80	42	2.20	3.80	67	6.58	8.36	92	12.70	15.36
18	0.65	1.84	43	2.38	3.94	68	6.75	8.64	93	13.05	15.64
19	0.70	1.88	44	2.55	4.08	69	6.93	8.92	94	13.40	15.92
20	0.75	1.92	45	2.73	4.22	70	7.10	9.20	95	13.75	16.20
21	0.80	1.96	46	2.90	4.36	71	7.28	9.48	96	14.10	16.48
22	0.85	2.00	47	3.08	4.50	72	7.45	9.76	97	14.45	16.76
23	0.90	2.04	48	3.25	4.64	73	7.63	10.04	98	14.80	17.04
24	0.95	2.08	49	3.43	4.78	74	7.80	10.32	99	15.15	17.32
25	1.00	2.12	50	3.60	4.92	75	7.98	10.60	100	15.50	17.60

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