EuP Preparatory Studies
"Imaging Equipment" (Lot 4)

Final Report on Task 8
"Scenario, Policy, Impact, and Sensitivity Analysis"

Compiled by Fraunhofer IZM

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Content

Disclaimer and Acknowledgement

This is the final report on Task 8 “Scenario, Policy, Impact, and Sensitivity Analysis” for the EuP Preparatory Study on Imaging Equipment (Lot 4). The findings presented in this report are the result of the research conducted by the Fraunhofer IZM consortium and the continuous feedback from a wide range of stakeholders.

The statements and recommendations presented in this final report should therefore not be perceived as the opinion of the European Commission.

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8 Scenario, Policy, Impact, and Sensitivity Analysis

8.0. Introduction

This Task 8 report summarizes and totals the outcome of all previous tasks. It is supposed to look at suitable policy means to achieve the potential that has been investigated on the example of improvement options for the individual base cases in Task 7. It is understood that the report should identify policy options, assess their possible impact through scenarios for the reference years 2010, 2015, and 2020 as well as verify the results with a sensitivity analysis. The impact assessment intends to quantify the environmental improvement as well as the possible cost benefits or burdens for the industry and consumers.

Imaging equipment is a product category with a wide spectrum of technologies and performance criteria.[1] The question of how to improve the environmental impact is not easy to answer as we have indicated in the extended analysis of the best available technologies and improvement options.[2] The analysis has shown that there are quite a few technology options available for the improvement of energy efficiency, but with influence on material/resource intensity of a product. In the case of imaging equipment the balancing factor seems to be the product application or use intensity. In other words, the overall environmental improvement of an individual imaging equipment is influenced by technology factors, but even more by the basic conditions of the product`s use. The Lot 4 study made an own attempt to categorize this complex interaction early in the project. The necessity for such a “framework” was apparent and derived from the task of selecting representative base cases. But the options for developing an own framework were limited by the complexity of such a task which would include precise technology and market information. In the end we settled with an existing framework – the Energy Star Tier 1 for Imaging Equipment. This framework differentiates two main product types (TEC[3] and OM[4]), respective test methods, and provides widely accepted mode definitions. We have utilized this Energy Star framework throughout the study. This experience however showed the advantages and shortcomings of the existing framework. As a result the policy options in the draft version of the Task 8 report addressed some of the critical points of the framework and introduced new ideas. The draft report

[1] The product scope of imaging equipment is analysed in Task 1 and the market segmentation in Task 2. The variety of the product group is also reflected in the derivation and discussion of the use patterns in Task 3.
[2] See the final report on Task 6 and 7 for further information.
[3] TEC - Typical Electricity Consumption
[4] OM - Operation Mode

initiated a wide variety of comments and fruitful discussion.[5] Stakeholders generally criticized the overlap of “new frameworks”, such as the introduction of network standby, in parallel with the adoption of “existing frameworks”, such as the Energy Star Tier 1. Secondly, the product scope of suggested policy options was questioned in conjunction with the industry’s concern of “generalizations of results”. This means that the industry questions the adaptability of policy options to the full product scope of imaging equipment.[6] Noticing this concern we however argued that the six bases cases, on which the policy options are based, are representative and cover the largest segments and the major part of the imaging equipment market.[7] Nevertheless, the discussion following the draft report stressed the necessity to create a harmonized long-term framework, in which requirements for energy and resource efficiency of office imaging equipment can be set, measured and declared. The policy options outlined in this final report aim at realizing the improvement potential identified in Task 7. They are grouped in four essential improvement objectives:

- Energy efficiency (power consumption and power management in the use phase)
- Consumables’ efficiency (paper utilization, toner and ink yield)
- Material/resource efficiency (e.g. electronics and bulk plastics in the manufacturing phase)
- Specific emissions (ozone and micro dust)

The report also groups the policy options in three consecutive steps:

- **First stage requirements** address mainly energy efficiency and could take effect within 1 or 2 years after the publication of the ecodesign implementing measures in the official journal of the European Union.
- **Mid-term development tasks** which should provide an adequate framework for a revised set of ecodesign requirements including aspects such as network standby, specific emissions and material efficiency. This strategic task should start immediately and provide results within the next 3 years.
- **Second stage requirements** are based on the results of the development tasks and focus on energy as well as resource efficiency. The requirements should take effect within 4 or 5 years after the publication of the revised ecodesign implementing measures in the official journal of the EU.

[5] The draft report was published on December 4th 2007. Formal written comments have been provided by UK MTP (11-12-2007), JBCE (21-12-2007), DEA (21-12-2007) and EICTA (03-01-2008) which are published with the final documents. EICTA, individual manufacturers and non-industry stakeholders provided further comments or information during discussions with Fraunhofer IZM.
[6] A policy option could be a power consumption limit for network standby.
[7] See Task 2.2 and the chapter on the selection of products in the introduction of Task 4.

8.1. Policy Options

8.1.1. Policy options for improving energy efficiency

8.1.1.1. Introduction

Energy consumption in the use phase is for the majority of office imaging equipment the primary environmental impact.[8] The energy consumption however varies largely between individual imaging equipment depending e.g. on the marking technology, imaging speed or image quality. Against this situation it is recommended for the first stage of EuP to set ecodesign requirements along the lines of the Energy Star Tier 1.[9] As a result of the improvement analysis and the stakeholder discussions this policy option would seem to be an acceptable compromise for setting short-term energy efficiency requirements taking into account that:

- The Energy Star Tier 1 provides with the distinction of TEC and OM an existing framework for setting requirements including a defined product structure, test procedures and threshold values.[10]
- The Energy Star Tier 1 criteria are already achieved by a very large number of products and can be implemented with a short transition period.[11]

In the mid-term, new framework conditions for setting energy requirements, respective test methods and relevant product declaration should be developed. The Lot 4 study comes to the conclusion that the Energy Star Tier 1 is with respect to mode definitions, test procedures and requirements not adequate for the EuP in the mid-term. It is recommended to adopt Lot 6 mode definitions and network standby for Lot 4. The Lot 6 mode definitions are currently considered for the revision of the IEC 62301. It would be preferable, if the Energy Star Tier 2, which is currently developed and should come into effect by 2009, could already adopt these new mode definitions. The harmonization of mode definitions is the first step towards a complementary set of mandatory and voluntary energy requirements.

In addition, we also recommend adopting network standby requirements, which are based on a test method. This is an important task considering the expected growing impact of "always online"

[8] See base case assessments and EU totals in Task 5.4 and scenarios in Task 7.2.
[9] Energy Star Tier 1 is effective in the EU since April 2007.
[10] See Tasks 1.1, 1.2 and 3.1.
[11] It was however not possible to establish exact achievement figures. EICTA members indicated that Energy Star Tier I could be widely achieved when some exceptions e.g. for high speed machines could be accepted.

imaging equipment. The new test method should be standardized. Again, it would be preferable to integrate network standby into the Energy Star as well. This development task will take some time. We assume that by 2011 a new set of energy requirements (referenced as Lot 4 Stage 2 in this report) could be published in the official journal of the EU. It is expected that industry has to make design and production changes in the full width of their product portfolios. Keeping in mind this product diversity a 4 to 5 years transition phase needs to be considered.

8.1.1.2. Adoption of Energy Star TEC Tier 1 as requirement for first stage EuP

In order to ensure a good level of energy efficiency for office imaging equipment that fall under the current Energy Star TEC category the following tasks would be necessary:

- Adoption of the Energy Star TEC Eligibility Criteria Tier 1 for the respective product scope as minimum requirement for the first stage of EuP
- Adoption of respective Energy Star TEC test procedures
- Adoption of justified exemptions[12]:
  - Monochrome machines with speed >65ipm[13]
  - Color machines with speed >50ipm[14]
  - Products which may have an image format >A3 are considered (semi-) professional
  - Products with multiple wall plugs
- 1 Watt off-mode requirement for TEC categorized products[15]

These requirements should be applicable in the short-term (1-2 years). Although no comprehensive market statistics are available, the large number of products which are registered under the Energy Star Tier 1 as well as industry comments indicated that a major part of the low to medium speed

[12] The Lot 4 study was limited to the assessment of typical EP-products. Because the TEC product scope is wider, exemptions might be granted to specific products of other marking technologies. This has to be investigated individually.

[13] EICTA rejected the strict >85ipm exemption that was proposed in the draft report. The former recommendation was based on the perspective that products with an imaging speed of >85ipm are considered (semi-)professional and should be exempted. These products are usually used for high volume printing and applied in professional environments or in large network environments with high job frequency. The functional and performance spectrum including data processing, human and network interfaces as well as the document output (sorting, binding, etc) are optimized for these purposes. The power demand in the individual operation modes is respectively higher and the power management optimized for the functional requirements. The Japanese Top Runner Program also exempts products >85ipm due to the same reason. The EICTA proposal of >65ipm is based on the same argumentation however on a lower value.

[14] Color machines are representing a growing market segment with fast technical improvements. The speed is increasing and energy consumption is an issue as we have shown in Task 5. Energy Star distinguishes TEC color products at a speed level of 50ipm. EICTA has proposed an exemption of TEC color products with speed >40ipm.

[15] The commission's working document on an ecodesign implementing measure on standby/off-mode suggests a horizontal ecodesign requirement for off-mode of 1 Watt for the first stage and 0.5 Watt for a second stage.

EP-products can meet these requirements already today. The exemptions cover products with a considerably smaller market share. There are no indications that such exemptions would counter balance the overall aim of this policy option. Industry should nevertheless address the issue of energy efficiency continuously for all products.

8.1.1.3. Adoption of Energy Star OM Tier 1 as requirement for first stage EuP

In order to ensure a good level of energy efficiency for office imaging equipment that fall under the current Energy Star OM category the following tasks need to be transposed:

- Adoption of the Energy Star OM Eligibility Criteria Tier 1 for the respective product scope as minimum requirement for EuP Tier I:
  - Maximum default delay times to sleep[16]
  - Maximum "sleep mode" power allowances incl. functional adders[17]
  - Maximum "standby" power level[18]
- Adoption of Energy Star OM test procedures for compliance
- Adoption of justified exemptions[19]:
  - Products with multiple wall plugs,
  - Other products with high speed non-standard formats (if applicable)

Table 1: Energy Start Eligibility Criteria OM (Tier 1)

	OM # 1	OM # 2	OM # 3	OM # 4	OM # 5	OM # 6	OM # 7	OM # 8
Products	Copier/MFD	Fax/MFD	MFD/Print	Mailing	Printers	Printers	Scanners	Printers
Format	Large	Standard	Large	N/A	Small	Standard	All	Large
Technology	Non IJ	IJ	IJ	Non IJ	various	Impact	N/A	Various
Sleep	58W	3W	13W	3W	3W	6W	5W	54W
Standby	N/A	1W 2W (fax)	N/A	N/A	1W	1W	1W	N/A

This minimum requirement should be adopted by EuP in the short-term (1-2 years). Stakeholder comments indicated no considerable difficulties with adopting the Energy Star Eligibility Criteria OM Tier 1 for the EuP.

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[16] For small and standard size MFDs and Printers a maximum default delay time of >15min is difficult to understand, particularly if we take into account that scanners have an allowance of only 15 minutes and fax machines of 5 minutes in all speed classes. A further investigation of this issue is recommended.
[17] Energy Star "sleep mode" is to some extent comparable to Lot 6 "network standby".
[18] Energy Star "standby mode" is to some extent comparable to Lot 6 "off-mode".
[19] The Lot 4 study was limited to the assessment of typical IJ-products. Because the OM product scope is wider, exemptions might be granted to specific products of other marking technologies. This has to be investigated individually.

8.1.1.4. Developing framework conditions for setting second stage energy requirements

Mode Definitions

The Energy Star mode definitions are widely accepted by industry. However, the EuP Preparatory Studies Lot 4 and Lot 6 both come to the conclusion that the existing mode definitions are not adequate anymore. This concerns especially the definition and differentiation of low power modes. Lot 6 Study therefore developed and recommended a new mode definition scheme which finds more and more acceptance. This new scheme should be used for setting energy requirements in the mid-term. It includes:

- Adoption of “transition into network standby”
- Adoption of “network standby”
- Adoption of “lot 6 standby” [20]
- Adoption of “lot 6 off-mode”

The adoption of the Lot 6 mode definitions should also be considered for the Energy Star and other voluntary labeling schemes in order to create harmonized conditions for measuring and declaring energy consumption.

Transition into Network Standby (TNS mode)

The power management mode Transition into Network Standby (from now on TNS) is an important indicator for energy consumption. The TNS mode incorporates all ready and sleep modes which have been introduced for products with marking technologies that need a higher amount of thermal energy for fast reactivation (Energy Star TEC category). Most manufacturers of EP-products have applied a tiered power management through multiple ready and sleep modes in order to maintain fast reactivation without excessive energy consumption. Other marking technologies such as solid ink (SI) require constant preheating, although on a lower thermal level, in order to maintain good reactivation performance. As we have shown in the TEC scenarios (see Task 7.2) the potentially high and prolonged ready mode power consumption in the TNS mode increases the overall energy consumption considerably. The maximum duration and average power consumption of the TNS mode is therefore one indicator for the overall energy consumption. This aspect is considered in the Energy Star TEC test procedure (see comments further below). But the maximum duration of the TNS mode also provides an option for a general product distinction. The Energy Star TEC and OM categorization is reflecting this concept in principle. But it could be used more

[20] Lot 6 Standby would only apply for non-network products such as single function scanners. This mode should be combined with a default delay time requirement for transition into auto-off.

pragmatically for setting requirements regarding the testing and declaration of typical electricity consumption (TEC).

Maximum default delay time for TNS mode ≤15 minutes

This condition would apply today to most OM products. Only very short or no ready mode is necessary for fast reactivation. In this case the energy consumption of the TNS mode is less important. A minimum requirement for "network standby" power consumption and "off-mode" (in case of non-network products) would be fully sufficient in order to address energy efficiency.

Maximum default delay time for TNS mode >15 minutes

This condition would apply today to most TEC products. A usually longer and multi-tiered ready/sleep mode phase is necessary for fast reactivation. In this case the energy consumption of the TNS mode is of high importance. We would recommend adopting the TEC test procedure and newly developed EuP minimum requirements as measure. The setting of maximum default delay times for the TNS mode is necessary and should not exceed 240 minutes.

Modification of TEC Test Standard

We recommend a new TEC test procedure for determining power consumption in network standby. The results of the Lot 4 study (scenarios in Task 7.2) indicate that the transition phase into network standby is an important aspect in the overall energy consumption of office imaging equipment that fall under the current Energy Star TEC scheme[21]. In order to reflect this aspect more adequately in the future Energy Star and in the EuP minimum requirements for energy efficiency we recommend the following investigations regarding the TEC methodology:

- Check the job structure and allocation of output volume by considering real life conditions. Single manufacturers have very different opinions about the accuracy of the job structure. Some say the TEC reflects the actual situation quite well others say that low speed product jobs are over estimated and high speed under estimated.
- Check the time durations between jobs and make sure that "ready mode" is adequately considered in the test procedure (ready mode has usually quite high power consumption)
- Check the time duration of "final time". According to industry, the delay times must be set to the "as shipped" condition for the test. The maximum time limit under Energy Star is 240 minutes. We propose that this maximum time limit is measured.

[21] The Energy Star TEC methodology is a ranking metric for typical energy consumption of high thermal marking technologies. It was never intended to be used as an energy assessment tool that provides estimates reflecting real life use conditions. Nevertheless, TEC methodology combines already important parameters such as speed distinctions and daily/weekly job structure that it can basically serve the purpose of an energy assessment.

- Check the impact on energy consumption of color printing in case that imaging speed is the same in monochrome and color. According to industry sources, the issue is not the power, but the energy per sheet. This has been shown to be equivalent for color machines with parallel printing technology regardless of the ratio of color and monochrome printing speed.
- Check the impact on energy consumption of duplex printing. According to industry sources, the energy consumption is actually less than in simplex printing, but not by much. This is because the water is removed from the paper during fusing of the first side of the paper. This water is not there when the 2nd side is fused, so less energy is needed to fuse the toner to the media.
- Check applicability of TEC and test procedure to a wider product scope (e.g. OM).

Minimum requirements and test method for network standby

The Lot 4 study comes to the conclusion that the current Lot 6 “network standby” requirements are insufficient for office imaging equipment. Most products would fall under Type II network standby (4W) which is, according to industry comments, currently not feasible for EP-products which are integrated in larger networks. A Type III (10W) is a more feasible requirement at this point of time, which indicates the more typical power consumption in network standby at the present time. Stakeholder comments indicated therefore great concern regarding the direct adoption of the Lot 6 requirements pointing not only to the power consumption value but particularly to the missing test method. The test standards should reflect different “point to point” and “point to network” conditions. The test standard should also consider the issue of false reactivation.

Following the publication of the Lot 4 Task 8 draft report and the discussions regarding network standby, the EICTA has made a preliminary proposal for developing network standby power consumption requirements further. This proposal is fully given in the following Table 2.

Table 2: EICTA preliminary proposal for developing network standby

As an illustration of the complexity of network standby definition we would like to propose a new definition of the network standby classes that takes into account the complexity of imaging equipment. If the commission feels that network standby should be addressed EICTA would like to suggest that this is discussed separately in more detail. The proposal below should only be seen as the start of these discussions, not as a final proposal:

- **Type I** should be: point to point (i.e. imaging product to computer) connections with low frequency bandwidth (Including analog connections).
- **Type II** should be: point to point (i.e. imaging product to computer) connections with high frequency bandwidth, including:

- USB (all types)
- Wireless USB
- Bluetooth
- IEEE 1394 (FireWire)
- SCSI-2
- IEEE 1284 (parallel interface).

It can be argued to include in type II networks low frequency Wireless LAN networks, because these are widely spread for household applications:

- USB (all types)
- IEEE 802.11b (11/22MBps)
- IEEE 802.11g (54 Mbps)

- **Type III** should be: point to network connections, where the imaging product is connected to an office network for multiple users:
  - 10BASE-T (wired LAN, 10 Mbps)
  - 100BASE-TX (wired LAN, 100 Mbps)
  - (etc: e.g. Gigabit LAN)
  - High frequency (> 100 Mbps) Wireless LAN: IEEE 802.11.

The rationale of this classification is the type of interface present in the imaging equipment: point to point connections allow the imaging product to virtually shut down and be woken up from the computer to which is connected: the computer can exert direct control over the imaging product.

When an imaging product is part of a network in which many products communicate (intranet), waking up from network standby requires intelligence present in the interface of the imaging product to recognize specific wake-up signals (magic packet, ARP, etc). This intelligence requires the network interface of the imaging product to be “awake”. Currently, the only way to have a reliable wake on LAN in an imaging product is to have a processor in idle mode on-board. Power consumption will require up to 30W. A new standard has been launched by Microsoft (PC99) which allows the processor to go to S3 mode and still wake up on specific signals. This standard will be generally available for application in imaging equipment in a number of years from now. Then it is possible to achieve type III network standby of approximately 10W for products up to 65-70ipm.

The development of network standby requirements and a respective test method is an immediate task which should be finished within the next 3 years. An adoption by the Energy Star would again promote harmonized framework conditions.

8.1.1.5. Adoption of new energy requirements for second stage EuP

New energy requirements including “transition into network standby”, “typical electricity consumption”, “network standby”, and “off-mode” should be adopted for the second stage of EuP in the mid-term. The following requirements are suggested:

- Adoption of mode definitions according to Lot 6
- Adoption of maximum default delay times for the TNS mode:
  - TEC categorized products (no more than 240 minutes)
  - OM categorized products (no more than 15 minutes)
- Adoption of “network standby” test standards reflecting:
  - Point to point conditions
  - Point to network conditions
- Adoption of “network standby” requirements for:
  - TEC categorized products or by network type (t.b.d.)
  - OM categorized products or by network type (t.b.d.)
- Adoption of revised “typical electricity consumption” requirement for TEC categorized products. There are two possible options:
  - According to old Energy Star TEC Tier 1 value with correction factor[22]
  - According to new Energy Star TEC Tier 2 value with correction factor[23]

A transition period of 4 to 5 years after publishing the new requirements in the official journal of the EU will be necessary because considerable efforts are needed to developed respective framework conditions and allow sufficient time for the redesign of products.

8.1.1.6. Product information disclosure of power and energy consumption

Consumer information on power and energy consumption is important and useful for improving market demand on energy efficient products. The disclosing of power and energy consumption data should be required under the EuP and possibly harmonized with labeling schemes in the mid-term.

[22] The correction factor should take two aspects into consideration. Firstly, the factor should reflect the average market level. In the BAT assessment (Task 6.1) and in the impact scenarios (Task 8.2) we noticed the good average level resembling factor 0.8 to 0.7 of Tier 1 requirement. Secondly, the EuP is not a top runner program but sets minimum requirements. The EuP therefore addresses the 25% worst performers in the market.

[23] In this case the correction factor should take a possible new Energy Star TEC Tier 2 requirement into account. The new Energy Star will address the 25% best performing products in the market.

First stage information requirement

For first stage EuP this policy option consists of the following requirements:

- Product-specific power consumption data must be measured according to their operational modes (for OM products) and additionally energy consumption data (for TEC products)
- The power/energy consumption data should be published in:
  - Printed or digital product descriptions including product manuals and manufacturers/sales websites.
  - Individually on product cardboard packaging

This first stage requirement should apply to all imaging equipment and be implemented in the short-term meaning 1 or 2 years after publication in the official journal of the EU.

Second stage information requirement

In the mid-term a policy option is an extended information requirement for more comprehensive energy data. Comprehensive consumer information is understood by the Lot 4 study as useful and easy to apply tool to promote environmental conscious purchasing. This advanced information disclosure requirement could follow along the line of the existing Blue Angel criteria (according to the standards set in Appendix 7 to the Basic Award Criteria RAL-UZ 122). The consumer information should be defined in a standard in order to promote harmonization. The policy option consists of:

- Product information definitions such as:
  - Power consumption in individual operating modes
  - Default time settings per mode
  - Respective recovery times per mode
- Information disclosure requirements for:
  - Printed and digital product information
  - Point of sales and product packaging (e.g. information on the cardboard)

A newly defined set of power and energy consumption data should be required in the second stage of EuP.

8.1.2. Policy options for improving consumable efficiency

8.1.2.1. Introduction

According to the base case assessment the use of office paper has the largest environmental impact. In terms of Total Energy 80% or 586 PJ for total EU product stock in 2005 are related to paper consumption. The magnitude of this impact correlates with the assumed image output volume. A comparison of the calculated total output according to the assumed use pattern of the base cases with the paper consumption data provided by InfoTrends indicated that the assumed paper output volume in the base case is four times larger than the market statistics suggest. According to the actual market data the Total Energy impact of paper consumption would only be 136 PJ. The Total Energy impact of 88 PJ for the use phase (excluding the paper consumption) would considerably gain in importance under these revised assessment conditions. However, we have shown in scenarios (Task 5.4.7) that the reduction of factor 4 in paper will result roughly in a reduction of factor 2 in use-phase energy consumption (44 PJ). The efficient use of paper is therefore addressed by duplex unit requirements and the general recommendation to promote the use of recycled paper in future policy.

Concerning the aspect of ink and toner consumption the MEEuP EcoReport is of limited value. The impact of ink could not be assessed due to missing data. The impact of the toner consumption was surprisingly low. Stakeholder comments indicated however the aspect of cartridge refurbishment as a means to improve the overall environmental performance of imaging equipment. The Lot 4 study could not quantify an improvement potential. Nevertheless, a recommendation is given towards consumer information and further research regarding environmental assessment data.

8.1.2.2. Duplex unit requirements

Further adoption of duplex printing is an important objective in that respect. Duplex printing has a general potential to reduce paper demand. From the user perspective duplex printing should be simple to operate, automatic at best, reliable and fast. For many EP-products automatic duplex printing is already a standard feature. For high image output machines it makes sense and it is therefore already required by the Energy Star Tier 1 and other eco-labeling schemes such as the Blue Angel.

But for slower, mostly IJ-products a duplex unit is commonly not required. This situation reflects the technical and economical side of duplex printing. An office imaging equipment with a manual or automatic duplex unit requires more complex mechanics and engine control. In order to achieve a certain imaging speed for IJ-products additional thermal energy is required in order to dry the image before the printing on the backside can start. Depending on the actual utilization of an office imaging equipment – the image output intensity – these aspects may lead in the end to higher energy consumption. The paper consumption is also influenced by the quality and reliability of the printing process. According to our investigation this aspect in conjunction with reliable duplex printing has been the focus of product improvement in the past. But it is obvious that print quality and reliability need continuous attention in all future designs.

First stage requirement

As a short-term measure we recommend to foresee ecodesign requirements following the Energy Star Tier 1 duplexing criteria for the respective TEC product scope:

- For all Color Copiers, MFDs and Printers >19 ipm: Automatic duplexing must be offered as a standard feature or optional accessory at the time of purchase.
- For all Monochrome Copiers, MFDs, and Printers >24 ipm: Automatic duplexing must be offered as a standard feature or optional accessory at the time of purchase.

Mid-term development task

Regarding office imaging equipment that is currently not covered by the Energy Star Tier 1 duplexing criteria, particular for standard format IJ-products with a speed >10 ipm, it is suggested to require a duplex unit. The exact product scope has to be defined in order to set an ecodesign requirement for the second stage of EuP.

Second stage requirement

To be defined according to the results of the development task. Due to a necessary redesign a transition phase of 4 or 5 years is needed.

8.1.2.3. Promotion of recycled paper

In parallel to technical policy options, the promotion of environmentally friendly paper use is suggested as well. Eco-labels for different kinds of paper exist already. Updated lifecycle environmental assessments from chapter 3 of the paper task force report are indicating the lower environmental impact of recycling office paper (from recycled production) in comparison to regular office paper (from virgin production with landfill and incineration).[24] According to this life cycle comparison the savings of recycled office paper in terms of solid waste and effluent flow is approx. 50% and in terms of total energy and atmospheric emissions 40%. As a rough estimate the use of recycled office paper would lead to an impact reduction by up to 30%. This potential should be addressed by policy measures which promote the actual use of recycled paper.

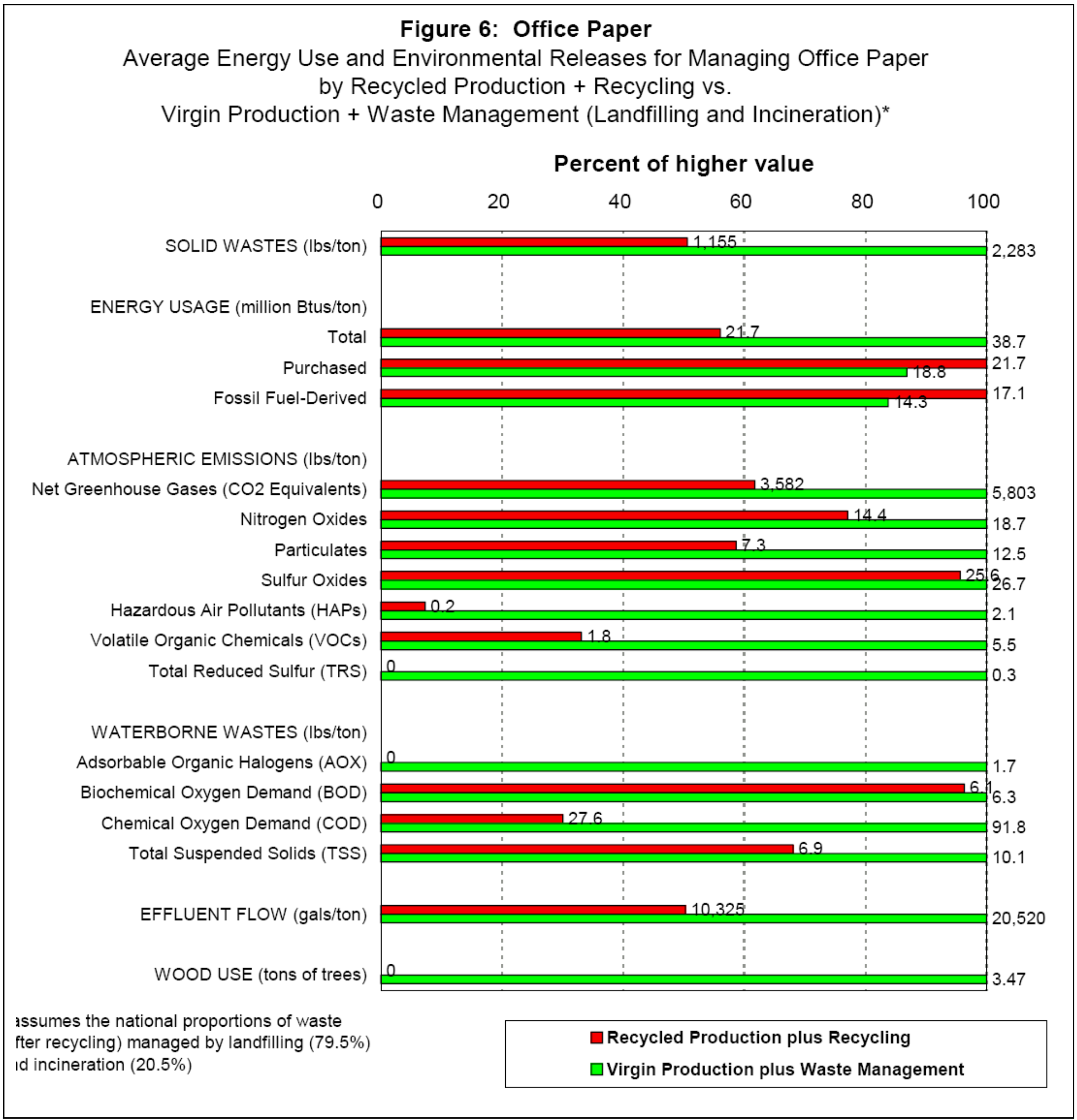

Figure 1: Office paper life cycle assessment of paper task force (2002)

[24] Paper Task Force Recommendations for Purchasing and Using Environmentally Preferable Paper, Environmental Defense Fund, Duke University, Johnson & Johnson, McDonald's, The Prudential Insurance Company of America, Time Inc., February 2002. In the internet: http://www.edf.org/documents/1687_figures.pdf

Mid-term development task

Consumer information on paper in conjunction with eco-labeling of office paper is a policy option that should be addressed in parallel to the EuP directive.

8.1.2.4. Product information disclosure for cartridge yield data

Regarding cartridge yield information, stakeholders indicated that publishing data in product manuals is an insufficient measure. EICTA states in that context: “The referenced ISO yield standard allows for publication of such information on product-related websites. Several EICTA members created yield websites on which consumers are able to look up the yield of a particular printer/cartridge combination. Most manufacturers have already agreed to display the yield URL on their printer hardware box packaging in the consumer business. The clear benefit of using the Internet is that manufacturers can provide specific yield information about their products as well as additional information to help consumers understand how yield is determined and what it means.”

First stage requirement

As a requirement that can be implemented in the short term (1-2 years) we suggest the following policy option:

- Measure ink/toner cartridge yield according to new ISO/IEC standards[25]
- Cartridge yield data on the product’s packaging[26] and respective websites

Mid-term development task

The precise toner or ink yield depends on the technical parameters of an individual product. Statistical data have not been available to investigate the option of setting minimum requirements for toner/ink yield. It is suggested to integrate this task into a new environmental impact assessment for toner and ink (missing data in MEEuP EcoReport) or as a part of an eco-profile (see Task 8.1.3.2).

Second stage requirement

To be defined according to the results of the development task.

[25] See specific standards in Lot 4 Task 1.2 report.

[26] Yield information on cartridge packaging is difficult due to the small space which is available on the package. Furthermore, the actual yield depends on the type of product (printer technology) which would lead to multiple information sets. It is therefore better to provide such information on a specific website. This URL (link) should be however printed on the cartridge packaging.

8.1.3. Policy options for improving material/resource efficiency

8.1.3.1. Introduction

The comparative analysis of the individual base case assessments that was conducted in Task 5.4.7 provides the grounds for the second stage policy options that address the issue of material and resource efficiency. According to this comparative analysis the Total Energy (GER) impact of imaging equipment on stock in the reference year 2005 amounts 148 PJ including the production and annual use impact. This figure excludes however the impact of office paper consumption which would add another 568 PJ (see Figure 2).

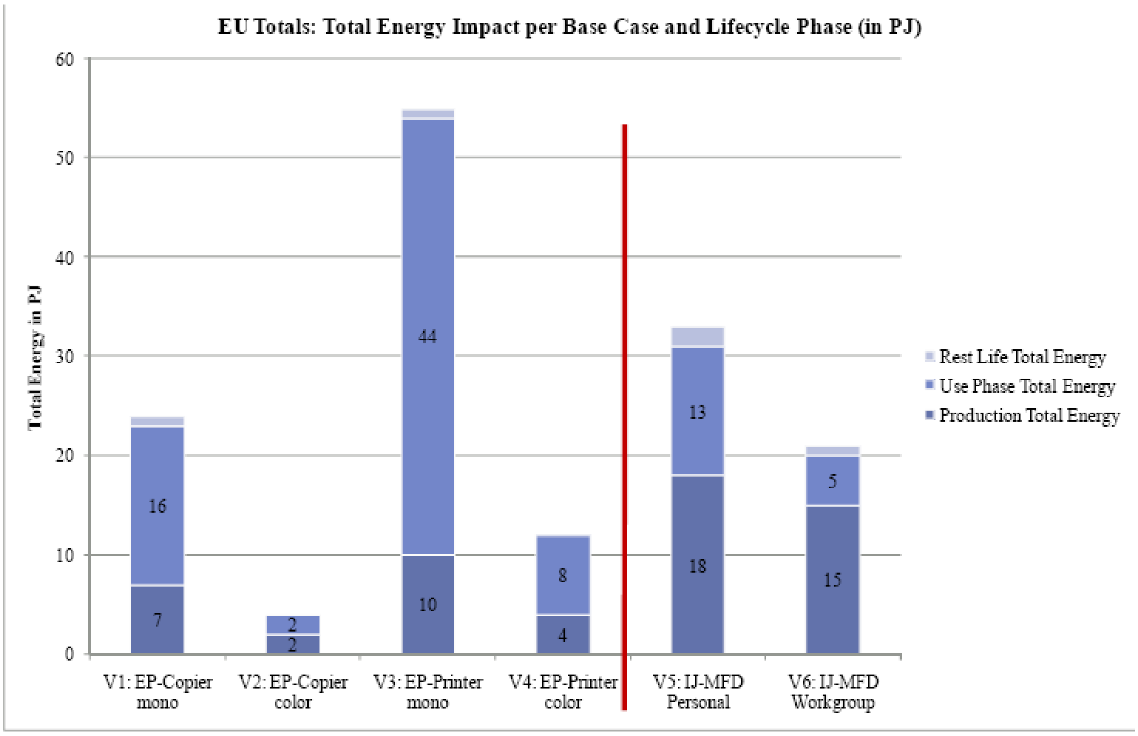

Figure 2: Total energy impact of life cycle phases according to the base cases (excl. paper consumption)

The comparison of the “use” phase with the remaining lifecycle phases “production”, “distribution”, and “end-of-life” shows an impact ratio of roughly 60% use, 38% production, and 2% others. The energy impact of the production phase is according to this assessment considerably high if compared to other consumer electronics such as TVs (Lot 5) or PCs (Lot 3) where the production phase has an overall impact of only 15% to 25%.[27] The impact of the production phase increases in

[27] The compact and advanced energy efficiency of modern laptop-PCs reduces the energy impact and shifts the ratio towards a higher percentage impact of the production phase.

the case of inkjet products which are typically not used for volume printing (low use intensity) and which stay in the market only for about 4 years. The environmental assessment determined that the Total Energy impact of the production phase is 56% for the inkjet base case V5, IJ-MFD personal, and 72% for the inkjet base case V6, the IJ-MFD workgroup (Task 5.2.5 and 5.2.6). The production phase energy impact is with 50% also relevant for the electro-photography base case V2, the color EP-copier MFD (Task 5.2.2).

These Task 5 assessment results indicate the growing importance of the materials and resource consumption in the production phase for a large part of products in the category office imaging equipment. The base case assessments with MEEuP EcoReport provide us with an approximation for an ecological profile of typical imaging equipment. The assessments give first indications for particular material and component related environmental impacts. In that respect they also show that it is important to assess the whole product life cycle including the end-of-life concept in order to put the overall environmental impact of one product into perspective to an environmental business strategy.

What are the specific environmental impacts of certain office imaging equipment? Along the line of the existing list of “ecodesign parameters of EuPs” (outlined in the Annex 1 of the EuP Framework Directive) we summarize the assessment results (based on the MEEuP EcoReport) in order to detail some specific environmental impacts of office imaging equipment.[28] The dominant impacts are related to:

- **Weight and volume of product**: IJ-products are in general more lightweight than EP-products due to the less complex marking technology. IJ-products show also in general a higher weight ratio of electronics to bulk materials and other components. Although electronic components amount only to 5% of total mass, their contribution to the total impact is more than 75% in some impact categories such as electricity use, water and hazardous waste (see Figure 3 further below). EP-products like large multifunctional copiers or printers have a high product weight which is determined by bulk materials. Their production impact correlates with specific metals such as stainless steel and copper, electronics and technical plastics.
- **Use of materials from recycling activities:** A specific characteristic of imaging equipment are consumables such as ink and toner and the recycling or refurbishment of respective cartridges. Product specific recycling is also relevant for imaging equipment due to the typical B2B market for large EP-products. These conditions

[28] For a comprehensive picture of the assessment’s results we suggest to compare the product specific input data which are detailed in the technical analysis (Task 4) additionally to the base cases assessment (Task 5).

have lead to product platforms (business concept) that foster specific recycling and reuse of components and materials.

- **Consumption of energy, water and other resources:** Energy consumption in the use phase is related to the effective utilization of paper. Regarding the production phase the impact of energy and water is considerable as well. The impact is related to the manufacturing of electronic components, stainless steel and certain technical plastics.
- **Use of hazardous substances:** Substances are regulated under RoHS and declared under REACh. Potential risk factors in the case of imaging equipment are improper handling of mercury containing scanner lamps in transport and end-of-life processes. The environmental aspect of specific emissions such as ozone and micro dust has already been discussed before.[29]
- **Ease of reuse, recycling and the incorporation of used components:** There are two aspects that need to be considered in that respect. Mass volume recycling of IJ-products with a short lifecycle requires a conscious selection of materials according to the typical recycling streams and processes.[30] There are trends to use bio-plastics in order to reduce the carbon footprint for these products.[31] For EP-products and the B2B market in particular the study confirmed a high level of industry activities regarding component reuse. Respective product design measures have been confirmed by EICTA members.[32] The information on the environmental efficiency of cartridge reuse (refill, rebuild, remanufacturing) are contradictory. The assessment with MEEuP did not allow a final statement. However ink and toner cartridges are a specific issue of office imaging equipment.
- **Extension of lifetime:** The typically short use cycle of 3 to 5 years has to be seen in conjunction with the already mentioned platform concept in the EP-product market. This business model is based on modularity, upgradeability and good maintenance. In the case of IJ-products this concept is not fully established due to the continuous miniaturization and performance enhancement of the past years. With the maturity of the inkjet marking technology and the shift to multifunctional devices a longer-term design strategy could prove economical.
- **Hazardous and non-hazardous waste and emissions:** The diversity of office imaging equipment regarding marking technologies, functionality, size, weight and

[29] See Task 3.1.3.3 for details on the ongoing research regarding toner particle emission.
[30] In Task 6.2.5 design for recycling requirements oft he Blue Angel label are detailed.
[31] In Task 6.2.4 examples of bio-polymer-based housing materials are presented. There are indications that the specific agricultural and processing conditions may counteract the eco-feasibility of bio-plastics.
[32] See Task 3.2.3.2 for details.

lifetime results in the full spectrum of environmental impacts (impact categories). The base case assessments in Task 5.2 confirm this diversity and provide details.

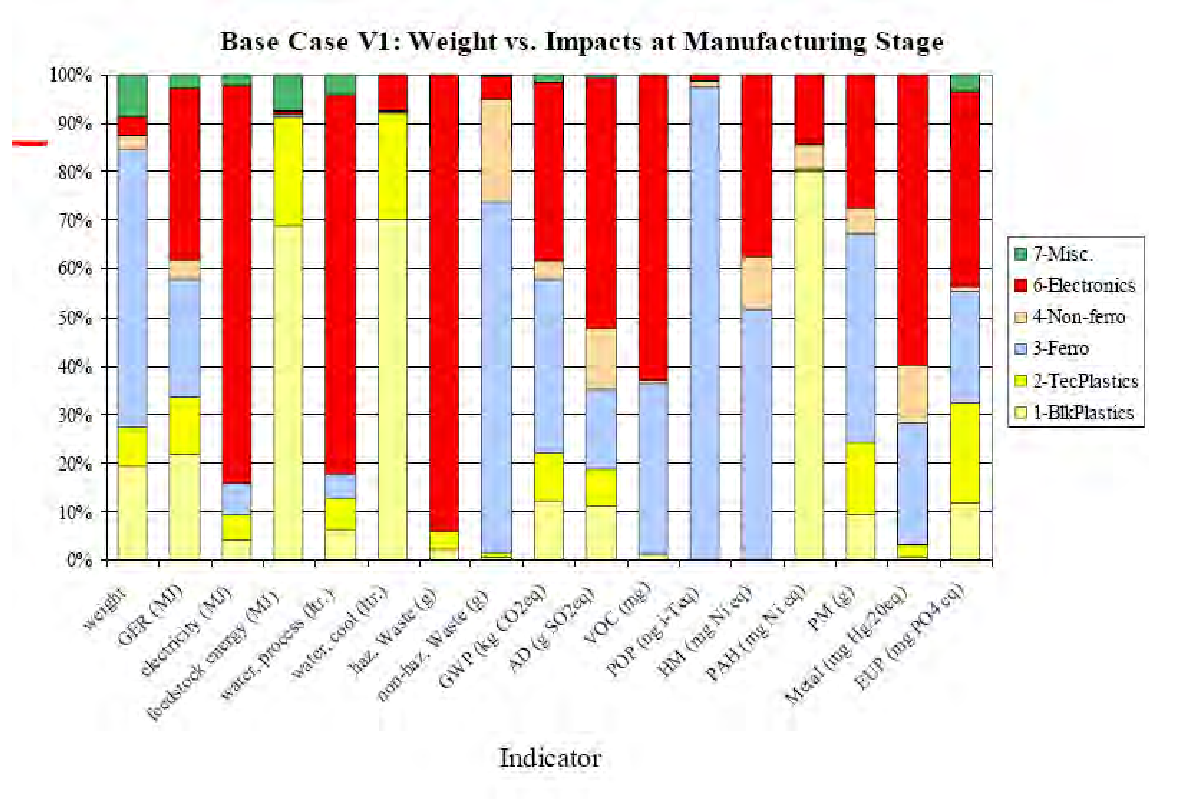

Figure 3: Manufacturing phase impact assessment of EP-Copier monochrome (base case V1)

The diversity of technologies, product designs, and business concepts in the field of office imaging equipment is a limitation that leads to the conclusion that at the present moment and for the first stage of EuP the policy option of setting specific ecodesign requirements on materials and resource efficiency is not appropriate.

8.1.3.2. Mid-term development of ecodesign requirements based on a simplified ecological profile

In order to set ecodesign requirements for material and resource efficiency in the second stage of EuP the development of a simplified ecological profile would be a precondition. As a matter of fact, a methodology which yields measurable quantified assessment data (e.g. inputs/outputs) related to significant environmental impacts on individual product or product group level, as required for an ecological profile under the EuP Framework Directive, is missing.

The existing methodologies and tools are mostly based on full life cycle assessments (LCA). LCA tools represent the most sophisticated approach to environmental assessment and ecodesign. LCAs depend however on very large data sets, numerous individual assumptions (e.g. allocations and regional specifications of data) and life cycle scenarios. This makes full LCAs not really suitable for legal compliance measures. Checklist style declarations such as ECMA-370[33] are less complex and suitable for internal ecodesign control. They deliver information on areas where more action (ecodesign) could be needed rather than quantifiable environmental data on the upstream supply chain. For the purpose of an ecological profile the ECMA-370 declaration might be a starting point, but does not cover quantitatively some of the relevant aspects. Better suited in principle are environmental life cycle screenings or performance indicator approaches such as EPIC-ICT[34] or indeed the MEEuP EcoReport – the streamlined LCA-like tool with predefined datasets which was developed for the EuP preparatory studies. [35]

The ecological profile should be developed based on the experiences of the EuP preparatory studies. The objective of the ecological profile is a comparative but fast assessment of the main material and resource impacts. This simplified assessment should reflect the characteristics of the electrical and electronic equipment, the typically high environmental impact of advanced electronic components and the widely structured upstream supply chain.[36] The ecological profile should allow a benchmark of the aggregated production, distribution and end-of-life phase in comparison to the use phase for which the electricity consumption is typically used.

This benchmark can then be used for various purposes. It can be used for setting specific ecodesign requirements, for declaring a carbon footprint, or for providing consumer information. This latter aspect is particularly interesting for inkjet products. If on the one hand the environmental impact of materials and production processes for a product is comparatively high and on the other hand the energy efficiency of the product is on a good level (as it is the case of inkjet products) then the consumer might select a product based on the material and resource impact in conjunction with electricity consumption. An aggregated material and production impact value is a policy option that could improve environmental conscious purchasing and market development. It must be noted that neither LCA nor the MEEuP method deliver such a single score value.

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[33] http://www.ecma-international.org/publications/standards/Ecma-370.htm.
[34] http://www.epic-ict.org.
[35] MEEuP was not developed as a product specific eco-profile tool and therefore lacks many characteristics of a suitable tool. Our experience with requesting from various manufacturers data entries according to this methodology as input for the base cases unveiled that in practice this methodology is not used coherently by the data providers (sufficiently coherent for this study, but not coherent enough for documentation of legally required data).
[36] The environmental data sets for electronic components in existing LCA tools are not sufficient and need improvement. As the EuP studies on imaging equipment but also on televisions show these data sets are critical for a realistic assessment of individual electronic products.

Following recommendations are given for the development of an ecological profile:

- Use a simplified system of environmental impact categories (e.g. focus on a few relevant impact indicators as shown in the comparative assessment of Task 5.4.7)
- Use a simplified lifecycle approach in order to reduce the environmental data sets to a small number (e.g. 100 instead of 10.000)
- Utilize updated reference data sets or consider umbrella specifications[37] for standard electronic components and bulk materials (e.g. similar to an extension of the MEEuP Eco Report)
- Utilize manufacturer-specific data only for very important components or processes (e.g. specific active electronic components, displays etc.) [38]
- Specify sources of energy if necessary or consider the regional differences in the energy mix (e.g. if manufacturing uses renewable energy)
- Assess only complex or large electronic components and do not count single transistors or small mechanical parts
- Assess chassis, housing, and electro-mechanical components based on bulk materials (e.g. copper, stainless steel, aluminum) but without requiring a 100% material declaration
- Consider however differences in the environmental impact of virgin or recycled production of bulk and technical materials (e.g. basic metals and plastics)
- Assess relevant end-of-life treatment options and processes (e.g. standard data sets for certain recycling options)
- Consider platform concepts and respective component reuse

Finally, the methodology for the ecological profile should be compatible with possible material declaration schemes that might be used for REACh. This would allow manufacturers to harmonize information (data) requirements along their supply chain. The industry should therefore participate closely in the development of the ecological profile. The financial resources needed to develop such a methodology are assumed to be significant, but considered worthwhile with respect to the significance of the related environmental impacts and the possible synergies.

[37] German ZVEI Umbrella Specs: http://www.zvei.de/index.php?id=1158

[38] A reference LCA could identify active and passive components that cover 70% of total electronics impact.

8.1.4. Policy options for reducing and control of specific emissions

8.1.4.1. Introduction

Regarding the issue of specific emissions and their potential health hazards, we have summarized the ongoing scientific discussion in the Task 3 report. We have stated that specific emissions such as ozone or micro dust are highly scientific matters. We also stated that our expertise does not allow a scientific judgement of the issue within the Lot 4 study (as the experts in that field still disagree). Nevertheless, regarding the ozone emissions in the draft report we had raised the issue of substituting corona wire technology. Stakeholders later indicated that a replacement of corona wire technology is not fully feasible but that filter technologies are available, which reduce ozone emissions in products that still feature corona wire.

8.1.4.2. Ecodesign requirements on ozone and other specific emissions

First stage requirement

According to stakeholder comments a general ban of corona wire technology would affect the market of high speed EP-products. A replacement of corona wire technology is a longer term task. In the short term it is suggested to require filter technologies for those printers depending on corona wire technology. A technical specification of the filter types or quality levels to be required for this policy option is not available, however.

Mid-term development task

Ozone and other specific emissions are under investigation by distinguished experts. At the present moment the “Blue Angel” environmental labeling scheme for office equipment with printing function (RAL-UZ 122) provides the best reference for threshold values and test procedures. In order to prepare ecodesign requirements for the second stage further research is needed.

Second stage requirement

To be defined according to the results of the development task. Due to possibly necessary redesign as well as investments for testing a transition phase of 4 or 5 years is needed.

8.2. Environmental impact scenarios and sensitivity analysis

8.2.1. Basic economic and product data for scenarios

8.2.1.1. Product stock data

The following basic economic data for main office imaging equipment have been obtained and comprehensively discussed in the market analysis (see Task 2). Figure 4 shows the EU-25 stock development for the reference years 2005, 2010, and 2020. IJ-products and EP-products are determining 91% of the total EU stock with respect to copiers, printers and multifunctional devices.[39] They also account for 96% of all created images.

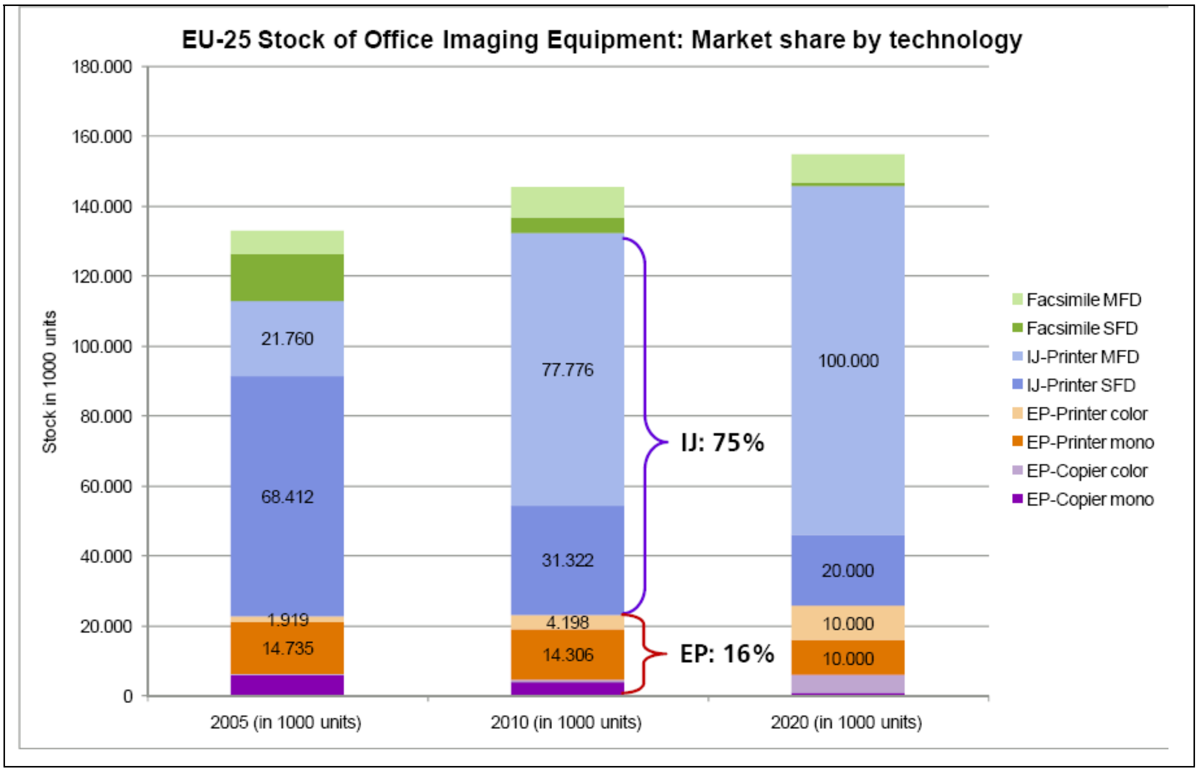


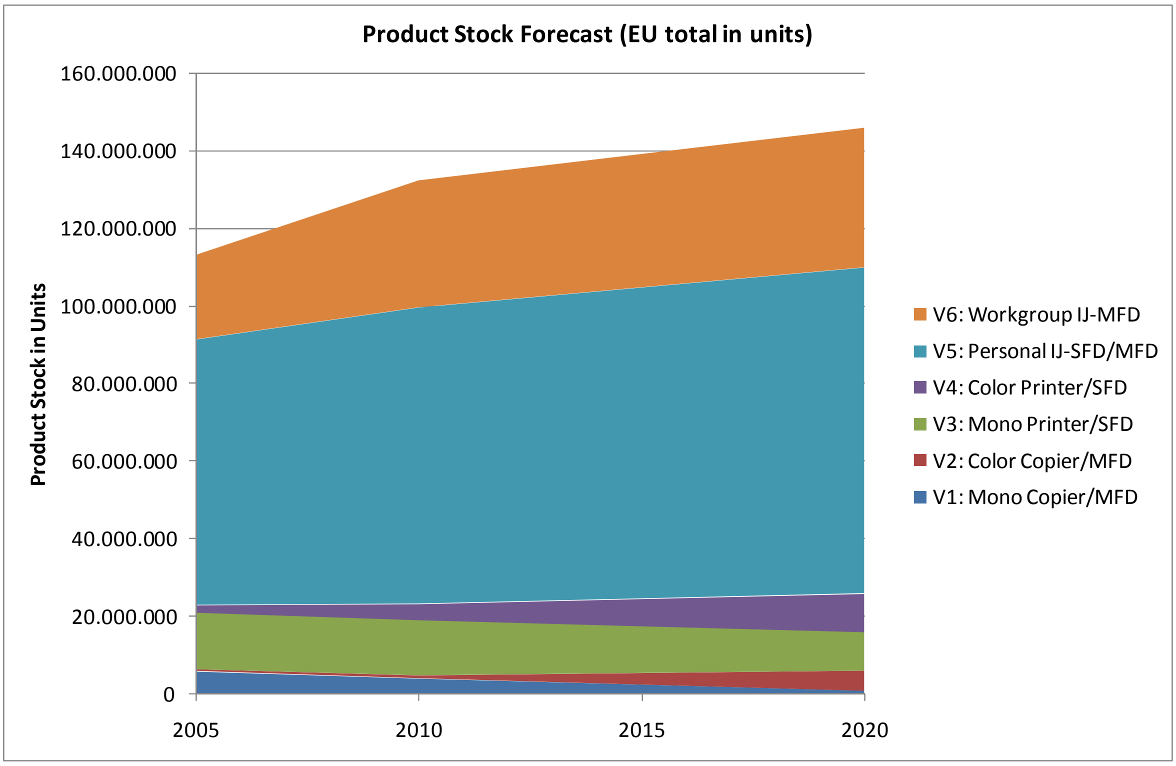
Figure 4: Office imaging equipment stock development by main products

For the purpose of the study six representative base cases were selected according to the results of the market analysis. Priority was given to product segments with the highest sales volume (see Tasks 2.2 and 4.0). Industry partners provided environmental data for a total of sixteen products from which the following six base cases were assessed:

[39] Excluding: flatbed scanner, document scanner, digital duplicator and mailing machines

- V1: EP-Copier/MFD, monochrome, 26ipm
- V2: EP-Copier/MFD, color, 26ipm
- V3: EP-Printer/SFD, monochrome, 32ipm
- V4: EP-Printer/SFD, color, 32ipm
- V5: IJ-MFD “Personal”
- V6: IJ-MFD “Workgroup”

For the purpose of the impact scenarios we have adjusted the basic economic data to the six base cases. The input data for the scenarios are given in Figure 5 below.



Stock	2005	2010	2015	2020
V1: Mono Copier/MFD	5.970.000	4.122.000	2.561.000	1.000.000
V2: Color Copier/MFD	381.000	691.000	2.845.500	5.000.000
V3: Mono Printer/SFD	14.735.000	14.306.000	12.153.000	10.000.000
V4: Color Printer/SFD	1.919.000	4.198.000	7.099.000	10.000.000
V5: Personal IJ-SFD/MFD	68.412.000	76.368.600	80.184.300	84.000.000
V6: Workgroup IJ-MFD	21.760.000	32.729.400	34.364.700	36.000.000
EU Total	113.177.000	132.415.000	139.207.500	146.000.000

Figure 5: Product stock assumptions based on Task 2

The data for the EP-product base cases V1 to V4 are the same as compiled in the Task 2.2. With respect to the IJ-product base cases V5 and V6 adjustments to the original data have been made.

The available market data distinguish inkjet single function devices (IJ-SFD) and inkjet multi functional devices (IJ-MFD).

Table 3: Product stock data for single function and multi functional inkjet printer

	2005	2010	2015	2020
IJ-SFD	68.412.000	31.322.000	25.000.000	20.000.000
IJ-MFD	21.760.000	77.776.000	90.000.000	100.000.000

For the purpose of the base case assessment however we made a distinction between “personal IJ-MFD” and “workgroup IJ-MFD” assuming that 70% of total inkjet products are used in personal (home) environments and the remaining 30% in workgroup (office) environment. Based on this assumption we adjusted the stock data for the scenario as shown in Table 3.

8.2.1.2. Electricity consumption data

According to the aggregated base cases the 2005 annual electricity consumption of office imaging equipment was surprisingly low with 6.2 TWh/a (Figure 6).[40]

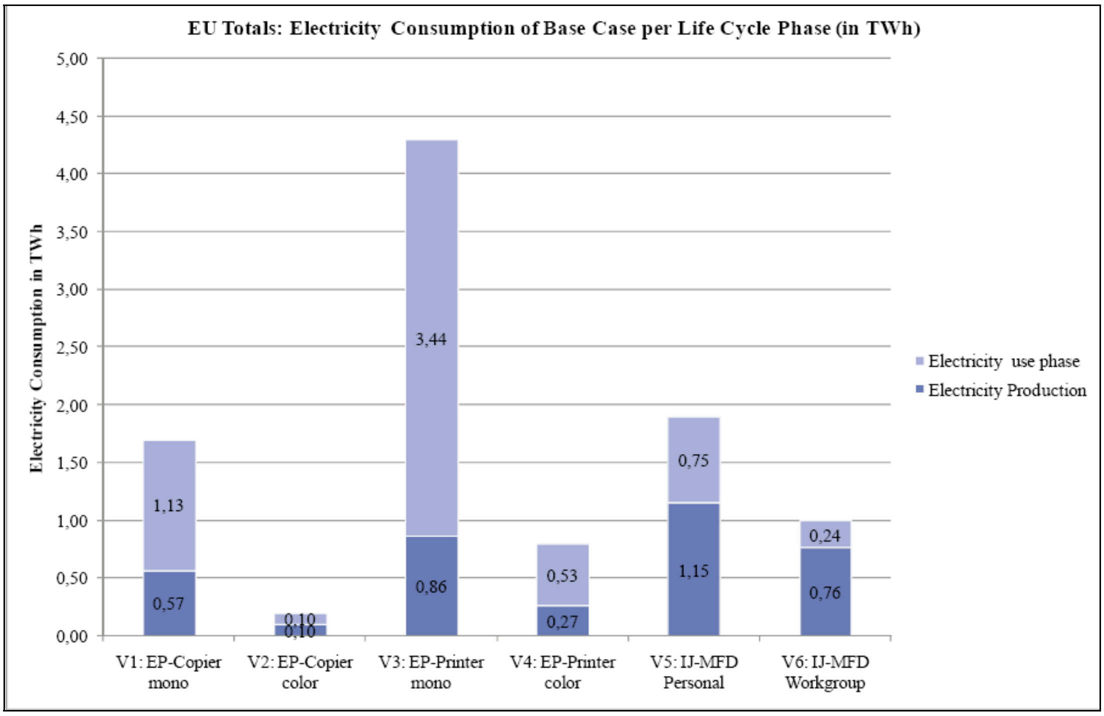


Figure 6: Annual electricity consumption of base cases (EU totals)

[40] In Task 5.4 we have discussed the parameter and data allocations issues that influence this result.

Some adjustments regarding the six base cases' annual electricity consumption were necessary for the scenarios as well. With respect to the EP-product cases (V1 to V4) the scenario's assumptions have been based on Energy Star TEC Tier 1 requirements. As discussed within Task 5.4, the base cases show for average products good energy efficiency. The particular energy performance of all EP-product cases is already much better than the current Energy Star TEC Tier 1 requirement (see Table 4).

Table 4: Electricity consumption according to Base Cases and Energy Star TEC Tier 1

No	Base Cases	Base Cases Value	TEC Classification	TEC Tier 1 Classification Formula	TEC Tier 1 Value
V1	EP-Copier MFD mono 26 ipm	250 kWh/a	TEC 3	(0,44kWh/ipm)x -2,8kWh	449 kWh/a
V2	EP-Copier MFD colour 26 ipm	370 kWh/a	TEC 4	(0,2 kWh/ipm)x +5kWh	530 kWh/a
V3	EP-Printer SFD mono 32 ipm	270 kWh/a	TEC 1	(0,2kWh/ipm)x -1kWh	280 KWh/a
V4	EP-Printer SFD colour 32 ipm	360 kWh/a	TEC 2	(0,2kWh/ipm)x +2kWh	437 KWh/a

Against that background we assume that today's average electricity consumption of EP-products (base case scenario) is factor 0.8 of the current TEC Tier 1. For the worst case scenario we based our assumption on the adjusted ready mode scenarios in Task 7.2 which showed that an extension of the ready mode from 15 minutes (TEC assumption) to 25 minutes (real life assumption[41]) results in 50% higher energy consumption in total. For the best case scenario we based our assumption on the observation that a relatively high number of products achieve already factor 0.7 to 0.3 of the current TEC Tier 1. We therefore moderately adjust the electricity consumption values in the best case scenario to factor 0.7 and continuously better. The individual assumptions for the EP-products are further detailed in the scenario descriptions.

With respect to the IJ-products we also adjusted the energy assumptions. The Lot 4 study came to the conclusion that the trend towards "always online" could lead to considerable higher energy consumption. We therefore addressed the issue of "network standby" in our recommendations. In order to argue an improvement or a decline in energy efficiency we simply adjusted the duration and power consumption of network standby for the inkjet base cases. The individual assumptions for the IJ-products are further detailed in the scenario descriptions.

[41] The real life assumption reflects the overestimation of the paper output in the TEC job structure leading in reality to less print jobs per day and therefore longer time intervals between jobs. We also argued that in the worst case the user is manipulating the ready mode setting to the maximum which counterbalances the power management.

8.2.2. Energy consumption scenarios

8.2.2.1. Base case scenario

The base case scenario is an extrapolation of the six base cases' annual electricity consumption until 2020 according to the product stock development. This scenario shows the average impact level of office imaging equipment and reflecting to some extent the already good energy efficiency of products in the market. In detail that means that the products already fulfill the Energy Star Tier 1 criteria. Table 5 and Table 6 provide the derivation of the electricity assumption data as well as the resulting values in total.

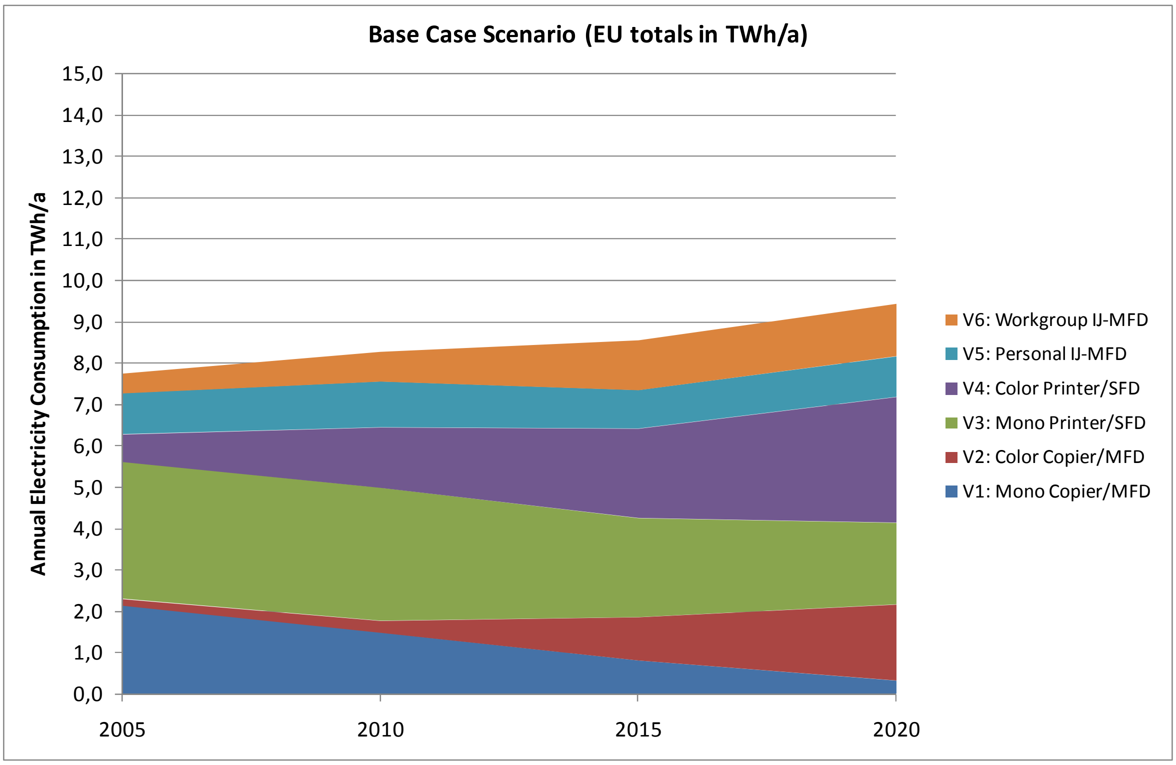
Table 5: Base case scenario – derivation of energy consumption data

Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	0.8*TEC 3	0.8*TEC 3	0.7*TEC 3	0.7*TEC 3
V2: Color Copier/MFD	0.8*TEC 4	0.8*TEC 4	0.7*TEC 4	0.7*TEC 4
V3: Mono Printer/SFD	0.8*TEC 1	0.8*TEC 1	0.7*TEC 1	0.7*TEC 1
V4: Color Printer/SFD	0.8*TEC 2	0.8*TEC 2	0.7*TEC 2	0.7*TEC 2
V5: Personal IJ-MFD	365*8h*5W	365*8h*5W	365*8h*4W	365*8h*4W
V6: Workgroup IJ-MFD	365*12h*5W	365*12h*5W	365*24*4W	365*24*4W

Table 6: Base case scenario – resulting annual energy consumption in kWh per unit

Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	359	359	314	314
V2: Color Copier/MFD	424	424	371	371
V3: Mono Printer/SFD	224	224	196	196
V4: Color Printer/SFD	350	350	306	306
V5: Personal IJ-MFD	14,6	14,6	11,7	11,7
V6: Workgroup IJ-MFD	21,9	21,9	35	35

Assumptions for base case scenario: Regarding the EP-product cases V1 to V4 we assume that in the mid-term the average energy efficiency improves from factor 0.8 TEC Tier 1 to factor 0.7 TEC Tier 1. With respect to the product assessment in Task 5 we have to notice that our EP-product base cases are already even better. This good energy efficiency of the chosen base cases reduced the total annual electricity consumption in the base case assessment to 6.2 TWh/a, whereas under the new assumption the value is with 7.8 TWh/a somewhat higher. The individual values and the overall development of the base case scenario are shown in Figure 7.



Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	2,1	1,5	0,8	0,3
V2: Color Copier/MFD	0,2	0,3	1,1	1,9
V3: Mono Printer/SFD	3,3	3,2	2,4	2,0
V4: Color Printer/SFD	0,7	1,5	2,2	3,1
V5: Personal IJ-MFD	1,0	1,1	0,9	1,0
V6: Workgroup IJ-MFD	0,5	0,7	1,2	1,3
EU Total in TWh/a	7,8	8,3	8,6	9,4

Figure 7: Base Case Scenario

Discussion of the base case scenario: The base case scenario shows an overall increase of the total annual electricity consumption by 20% until the year 2020. The following factors contribute to this situation:

- 30% increase in total unit stock until 2020
- The ongoing shift from mono EP-products to color EP-products
- No particular distinction between the improvement potential of mono or color machines
- The assumed increase in network standby duration particular for workgroup IJ-products

The base case scenario indicates a slight improvement per single unit. If we would assume an even better performance of the color EP-products, as it seems possible according to our base cases assessment, then the scenario would show a further reduction in the total energy consumption. The scenario therefore confirms our assessment that under the conditions of the Energy Star Tier 1 (and the understanding that the EP-products are on average by factor 0.8 better than that requirement) the overall good level energy efficiency is maintained in the long-term.

With respect to the IJ-products the scenario however also shows the negative impact of “network standby” on total electricity consumption. This trend is confirmed by the following worst case scenario.

8.2.2.2. Worst case scenario

The worst case scenario was created in order to show the negative impact of prolonged “ready mode” in the case of the EP-products and considerable contribution of “network standby” in the case of the IJ-products. This scenario shows the maximum impact level of office imaging equipment. Table 7 and Table 8 provide the derivation of the energy assumption data as well as the resulting values in total.

Table 7: Worst case scenario – derivation of energy consumption data

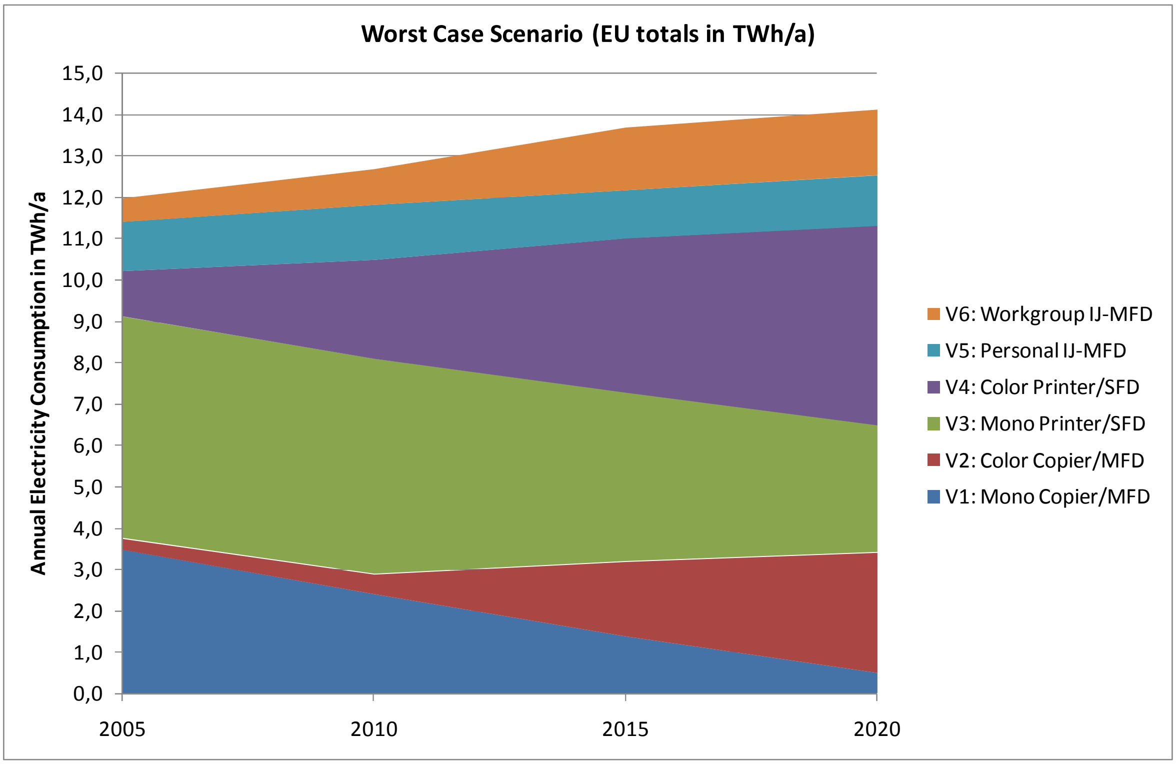
Worst Case	2005	2010	2015	2020
V1: Mono Copier/MFD	1.3*TEC 3	1.3*TEC 3	1.2*TEC 3	1.1*TEC 3
V2: Color Copier/MFD	1.3*TEC 4	1.3*TEC 4	1.2*TEC 4	1.1*TEC 4
V3: Mono Printer/SFD	1.3*TEC 1	1.3*TEC 1	1.2*TEC 1	1.1*TEC 1
V4: Color Printer/SFD	1.3*TEC 2	1.3*TEC 2	1.2*TEC 2	1.1*TEC 2
V5: Personal IJ-MFD	365*8h*6W	365*8h*6W	365*8h*5W	365*8h*5W
V6: Workgroup IJ-MFD	365*12h*6W	365*12h*6W	365*24*5W	365*24*5W

Table 8: Worst case scenario – resulting annual energy consumption in kWh per unit

Worst Case	2005	2010	2015	2020
V1: Mono Copier/MFD	584	584	539	494
V2: Color Copier/MFD	689	689	636	583
V3: Mono Printer/SFD	364	364	336	308
V4: Color Printer/SFD	568	568	524	481
V5: Personal IJ-MFD	17,5	17,5	14,6	14,6
V6: Workgroup IJ-MFD	26,3	26,3	43,8	43,8

Assumptions of the worst case scenario: Regarding the EP-product cases V1 to V4 we assume for the years 2005 and 2010 a 50% higher energy consumption or respective factor 1.3 TEC Tier 1 in comparison to our base case scenario. This assumption is based on the ready mode scenarios in Task 7.2.1. For the IJ-product case V5 and V6 we assume a quite high average network standby based on the idea that network capability will increase. This will lead not only to longer durations in which a product might be kept in standby but also to higher power consumption for the maintenance of network integrity.

The overall resulting electricity consumption is with 12.0 TWh/a in 2005 considerably higher and will further increase to 14.1 TWh/a until 2020. The individual values and the overall development of the base case scenario are shown in Figure 8.



Worst Case	2005	2010	2015	2020
V1: Mono Copier/MFD	3,5	2,4	1,4	0,5
V2: Color Copier/MFD	0,3	0,5	1,8	2,9
V3: Mono Printer/SFD	5,4	5,2	4,1	3,1
V4: Color Printer/SFD	1,1	2,4	3,7	4,8
V5: Personal IJ-MFD	1,2	1,3	1,2	1,2
V6: Workgroup IJ-MFD	0,6	0,9	1,5	1,6
EU Total (TWh/a)	12,0	12,7	13,7	14,1

Figure 8: Worst Case Scenario

Discussion of the worst case scenario: The worst case scenario shows factor 2 in annual electricity consumption in comparison to the base case scenario. This resulting increase to 12 TWh/a is mainly related to the proportionally large impact of the EP-products. The impact ratio for the IJ-products does not increase much in comparison. The IJ-products contribute therefore less to the total energy consumption. Over time the energy consumption grows until the year 2020 by 16% to a level of 14.1 TWh/a. The increase in percentage is lower than it was the case in the first scenario. This situation is caused by the improvement assumptions we integrated in the worst case scenario. If we look at the proportional development per contributing product case, we can notice that the contributing factors to the general development are similar to the base case scenario. They are related to the increase in total unit stock and to the ongoing shift from mono EP-products to color EP-products.

8.2.2.3. Best case scenario

The best case scenario has the intention to show the improvement potential that is indicated already today by many products that are registered under the Energy Star or other Eco-Labeling schemes. It is the scenario that reflects the proposed policy options of the first stage and to some extent the impact of possible mid-term policy options. The Table 9 and Table 10 provide the derivation of the energy assumption data as well as the resulting values in total.

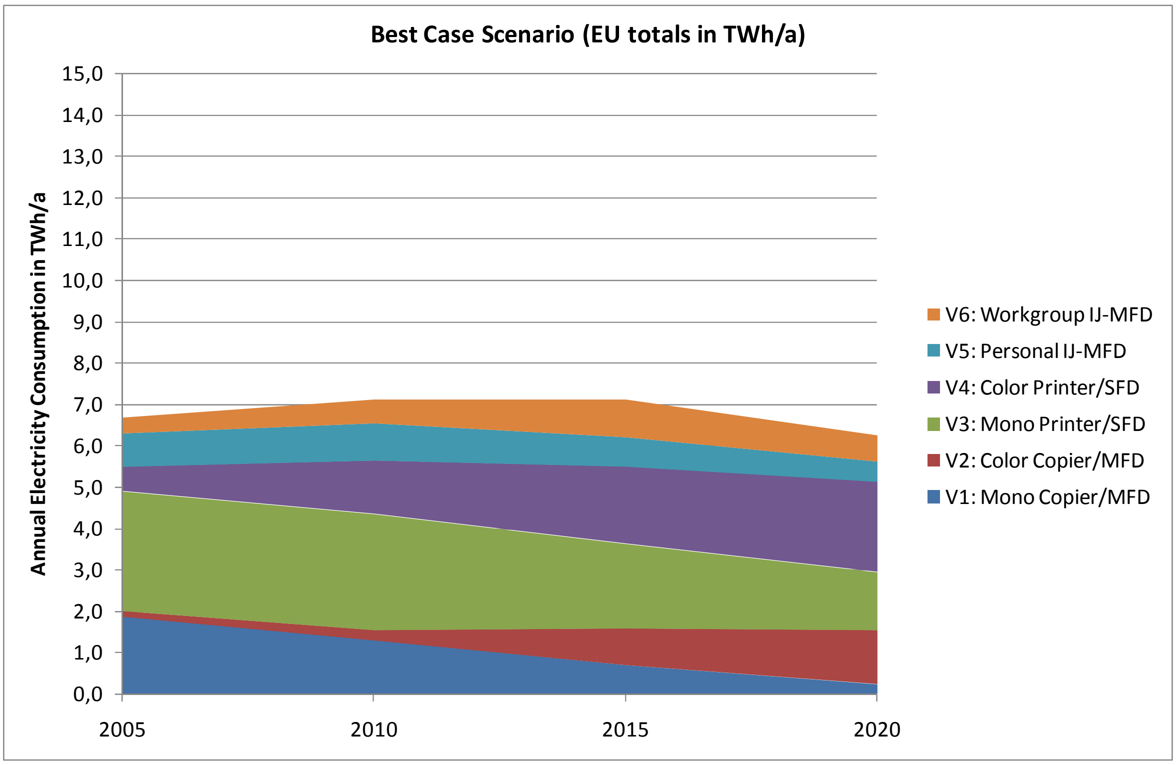
Table 9: Best case scenario – derivation of energy consumption data

Best Case	2005	2010	2015	2020
V1: Mono Copier/MFD	0.7*TEC 3	0.7*TEC 3	0.6*TEC 3	0.5*TEC 3
V2: Color Copier/MFD	0.7*TEC 4	0.7*TEC 4	0.6*TEC 4	0.5*TEC 4
V3: Mono Printer/SFD	0.7*TEC 1	0.7*TEC 1	0.6*TEC 1	0.5*TEC 1
V4: Color Printer/SFD	0.7*TEC 2	0.7*TEC 2	0.6*TEC 2	0.5*TEC 2
V5: Personal IJ-MFD	365*8h*4W	365*8h*4W	365*8h*3W	365*8h*2W
V6: Workgroup IJ-MFD	365*12h*4W	365*12h*4W	365*24*3W	365*24*2W

Table 10: Best case scenario – resulting annual energy consumption in kWh per unit

Best Case	2005	2010	2015	2020
V1: Mono Copier/MFD	314	314	269	225
V2: Color Copier/MFD	371	371	318	265
V3: Mono Printer/SFD	196	196	168	140
V4: Color Printer/SFD	306	306	262	218
V5: Personal IJ-MFD	11,7	11,7	8,8	5,8
V6: Workgroup IJ-MFD	17,5	17,5	26,3	17,5

Assumptions for the best case scenario: In this scenario we reflect the recommendations given in this report. The proposed measures should result in a constant improvement as it is already noticeable over the past years. A continuous improvement of energy efficiency with respective market dissemination is assumed. According to this assumption (which our base cases confirm) the average energy consumption of EP-products by the year 2005 has already reached a factor 0.7 TEC Tier 1. By the year 2020 the average market has reached a factor 0.5. This scenario reflects technical solutions for fast reactivation and effective power management which will reduce the overall energy consumption in the transition phase to network standby. The scenario also reflects a conscious improvement of network standby power consumption and off-mode. It reflects an expected energy improvement concerning color capable EP-products through more mature technologies. Finally we have made some more ambitious assumptions on network standby for IJ-products reflecting the best available technology. The result of this scenario is shown in the following Figure 9.



Best Case	2005	2010	2015	2020
V1: Mono Copier/MFD	1,9	1,3	0,7	0,2
V2: Color Copier/MFD	0,1	0,3	0,9	1,3
V3: Mono Printer/SFD	2,9	2,8	2,0	1,4
V4: Color Printer/SFD	0,6	1,3	1,9	2,2
V5: Personal IJ-MFD	0,8	0,9	0,7	0,5
V6: Workgroup IJ-MFD	0,4	0,6	0,9	0,6
EU Total in TWh/a	6,7	7,1	7,1	6,2

Figure 9: Best Case Scenario

Discussion of the best case scenario: This scenario shows the considerable improvement potential that has been argued throughout the Lot 4 study. Although the overall energy consumption is initially increasing until 2015, by that time the impact will bounce back despite the stock increase. In the middle of the next decade the more ambitious requirements on network standby and typical energy consumption will take effect. It will prevent a further increase by addressing the main sources of energy consumption:

- Prolonged high ready mode power consumption in the transition phase between jobs
- Generally prolonged transition phases into network standby
- High network standby of always online products
- Still considerably high off-mode losses

8.2.2.4. Summary of energy scenarios

With the three scenarios we indicated the range of the electricity consumption impact related to the use phase of office imaging equipment. The scenario assumptions are based on averaged data sets deriving from representative base cases. The comparison of the base case scenario with the worst case scenario shows that without the proposed policy measures the electricity consumption could increase by maximum of factor 2. On the other hand is the base case scenario (the current status) already on a good level of energy efficiency. This level would be secured by the proposed policy options of the first stage EuP. The best case scenario shows that in the long-term even a total reduction of electricity consumption is possible if the second stage policy options are implemented. The precise impact of the second stage can of course not be assessed. In conclusion the base case scenario and the best case scenario provide the range of improvement related to the policy options. Against the background of the current status and problem awareness of the industry the best case scenario is realistic.

8.2.3. Material and production scenarios

8.2.3.1. Production impact scenario

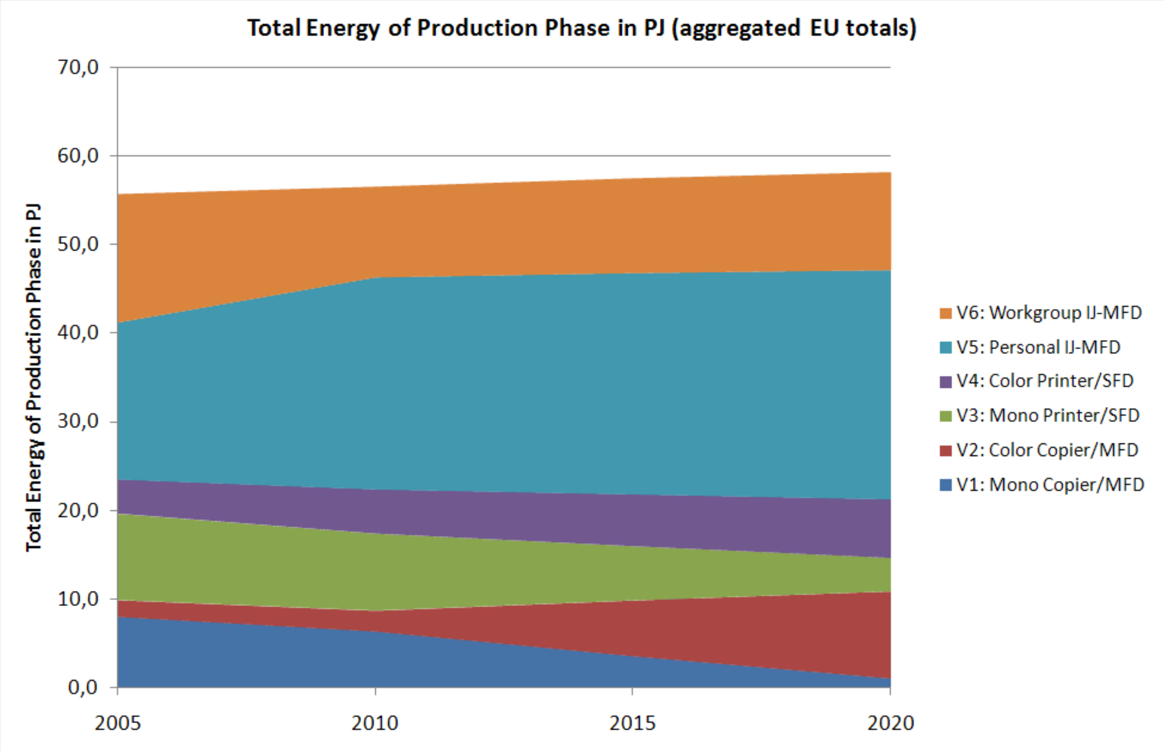
In order to show the increasing impact of materials and the production phase in respect to the single base cases and the need for specific ecodesign requirements the following production impact scenario was created.

The production impact scenario simply extrapolates the impact category Total Energy (GER) of the production phase from the base case assessment with the respective forecasted EU product sales. The overall production impact is calculated for reference years 2005, 2010, 2015, and 2020. Sales data for 2020 are approximated by dividing the predicted stock (units) by assumed product lifetime (6 years for EP products, 4 years for IJ products). Data for 2015 is the arithmetic average of 2010 and 2020 data.

Assumptions for production impact scenario: For the reference year 2005 we take the total energy consumption (in MJ) for the production phase of the respective six base cases. The data result from the environmental assessments based on the MEEuP Eco Report in Task 5.2. For the following years we assume an average annual improvement of 1%. This assumption reflects on the one hand that considerable reductions in product weight and volume have been achieved in the past years and seem to reach a plateau current. Against that background we do not expect a drastic decrease in the production impact based on weight or volume (material) reduction. But we recognize process related improvements in the manufacturing. We do believe on the other hand that the already dominant impact of the electronic components could further increase. This is due to the complexity and resource intensity of their production. But here again, we also expect that new business models which address component reuse and the resource conscious selection of components could have a positive effect leading to a continuous reduction of the production impact. The respective input assumptions and resulting figure are shown in Table 11 and Figure 10 below.

Table 11: Total energy (GER) impact of production according to single base cases (in MJ)

Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	6859	6516	6190	5881
V2: Color Copier/MFD	13752	13064	12411	11791
V3: Mono Printer/SFD	2656	2523	2397	2277
V4: Color Printer/SFD	4628	4397	4177	3968
V5: Personal IJ-MFD	1437	1365	1297	1232
V6: Workgroup IJ-MFD	1437	1365	1297	1232



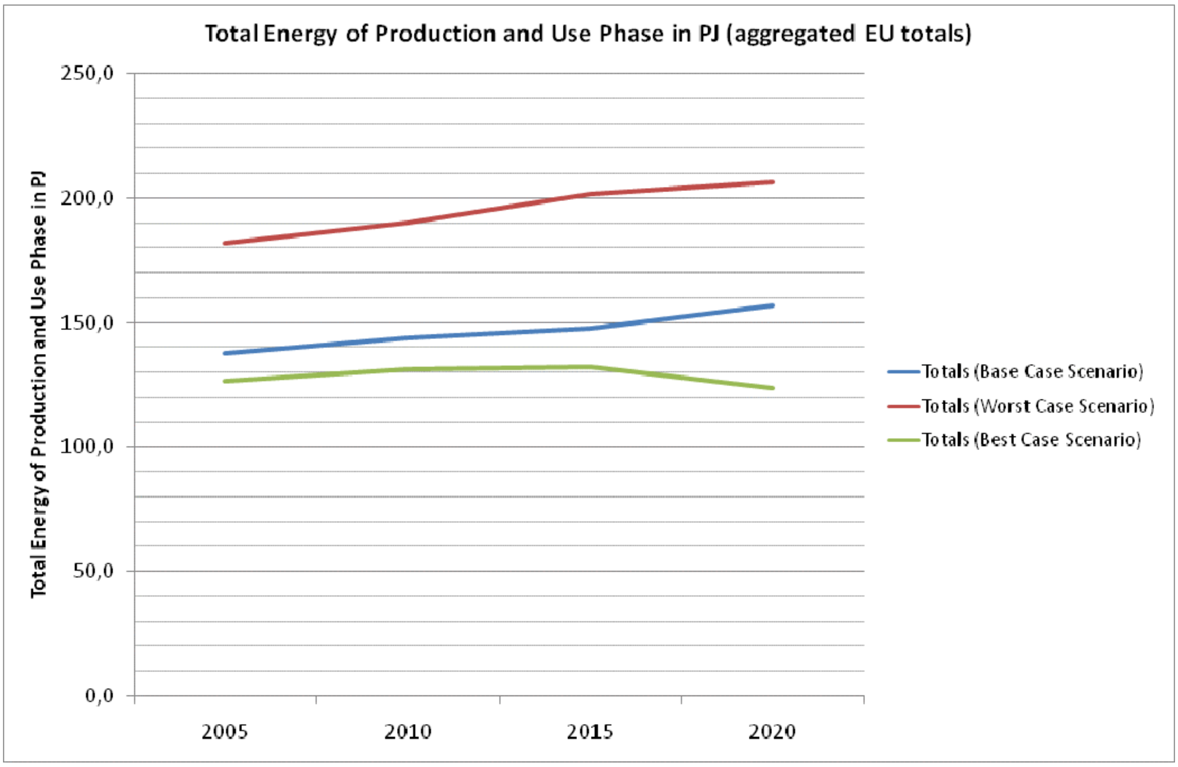
Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	7,9	6,3	3,5	1,0
V2: Color Copier/MFD	1,9	2,3	6,3	9,8
V3: Mono Printer/SFD	9,8	8,7	6,1	3,8
V4: Color Printer/SFD	3,9	5,0	5,8	6,6
V5: Personal IJ-MFD	17,7	23,9	25,0	25,9
V6: Workgroup IJ-MFD	14,5	10,3	10,7	11,1
EU Totals in PJ	55,7	56,5	57,5	58,2

Figure 10: Production impact scenario with the total energy consumption in PJ

Discussion of the production impact scenario: This scenario shows an overall increase in the production impact by 4,4% from 2005 to 2020. The interesting aspect is the allocation of this impact to the single base cases. Whereas it is obvious that impact of the larger and heavier color EP-Copier/MFD and color EP-Printer will increase in parallel to the stock increase, the total dimension in comparison to the IJ-products is of interest. The production impact scenario clearly shows the considerable resource impact of the IJ-products due to the number of products that circulate in the market. The short life cycle of only three to four years and the respective amount of electronics in the products are the main reasons for this development. The impact is again dominated by the electronics components which amount will actually increase due to the growing network capabilities and computing performance of the single devices (see Task 2.2, 2.3, and 4.2).

8.2.4. Life cycle scenarios totals

Summarizing the use phase scenarios (electricity consumption impacts only) and the production phase impacts allows a quantification of the main total impacts. The paper consumption impact is not included and also the life cycle phases distribution and end-of-life are not included in the following figure as the latter two are of minor relevancy regarding the environmental indicator Total Energy (GER).



Life Cycle Scenarios: Total Energy Consumption in PJ (EU totals)

	2005	2010	2015	2020
Production	55,7	56,5	57,5	58,2
Use (Base Case Scenario)	81,9	87,2	90,3	98,7
Use (Worst Case Scenario)	126,0	133,4	143,9	148,1
Use (Best Case Scenario)	70,4	74,6	74,6	65,1
Totals (Base Case Scenario)	**137,6**	**143,7**	**147,8**	**156,9**
Totals (Worst Case Scenario)	**181,7**	**189,9**	**201,3**	**206,2**
Totals (Best Case Scenario)	**126,0**	**131,1**	**132,0**	**123,3**

Figure 11: Production and use impact scenarios with the total energy consumption in PJ

The mid- and long-term trend regarding Total Energy consumption is dominated by the use phase as the production phase impact does not change significantly over the years. However, the impact of the production phase as such contributes significantly to the total life cycle impacts.

8.3. Cost impacts and sensitivity analysis

8.3.1. Impact on industry

The policy options recommended in this report could result in additional costs for the acquisition/development of specific materials, components or technologies, as well as for the operation or outsourcing of new test procedures. Data acquisition throughout the supply chain may include purchasing of software or additional audits.

Regarding the improvement of energy efficiency we have to distinguish the impact on EP-product and IJ-product manufacturers. The power management improvement concerning EP-products may include the adoption of fast fusing technologies which are mostly intellectual properties of individual manufacturers. It may also require the redesign, acquisition or development of new electronic components for power management (e.g. microcontroller chip). The recommendations towards lower network standby power and off-mode will make the adoption of more efficient power supply units and other network related electronics necessary. Additional costs could be related to the integration of more efficient scanner light systems (e.g. advanced LED).

The redesign of the electrical and electronic components will without doubt lead to adjustments in the supply chain. With respect to the higher cost structure of the EP-products, the financial impacts of these adjustments are mostly covered by the usual investments into new products. An exemption is the adoption of proprietary technology. A however more limiting factor for the EP-industry is the wide product portfolio and long-term (8 to 10 years) platform strategy of most manufacturers. Here the question is not so much what does a single improvement cost but what would the change of the whole product portfolio in a short time cost. A moderately timed adjustment period would be easier to handle by the industry. It is therefore highly recommended that considerable improvements are given a mid-term time horizon. This approach was reflected in the second stage of EuP recommendation.

With respect to the inkjet products the necessary adjustments have a stricter financial framework. IJ-products are competing in lower price segments with shorter (3 to 4 years) redesign cycles. This means on the one hand that adjustments could be made generally faster but on the other hand that they would probably have a slight effect on the product price. The actual cost for low network standby is determined by costs for new energy efficient components and necessary circuitry design. The Lot 6 Study already indicated the availability of such components and estimated the cost impact to be under 10 Euro. Due to the fact that duplex units are not yet required by Energy Star for regular IJ-products their integration will require for some manufacturers considerable re-designs or introduction of new technologies (e.g. thermal elements). These changes consist of an initial investment for the redesign as well as supply chain adjustments. The actual design and material costs could not be quantified.

8.3.2. Impact on the consumer

The cost impacts on the consumer consists of the purchasing costs, the electricity costs, and the consumables costs. The purchasing costs that mean the sales price or leasing costs of the product are basically determined by the technological level of the product as well as market conditions (e.g. developing market or saturated market). Technical measures that lead to an improved environmental performance (e.g. energy efficiency) may increase the price of the product. The possible reasons and impacts have been discussed in the preceding chapter. The electricity costs are a variable that usually changes according to actual geopolitical situation and macro-economical conditions with respect to the main fossil energy sources. The impact of renewable energy options on the electricity costs is difficult to say. We assume a general increase in electricity costs in the mid-term. The consumable costs are a considerable cost factor for the user. But the consumable costs are also highly variable according to the marking technology and application/use of an office imaging equipment. The environmental assessment could not determine considerable changes in the cost factor. The Task 6 assessment of BATs has shown that the technological development is focusing on the further improvement of the ink and toner quality in conjunction with a more efficient utilization. In the case of toners we observed another technical development (low melting toners) that links the toner's technical properties to the power consumption of the devices. The impact on the costs is in this case two-folded – such a low melting toner might be on the one hand more expensive but could reduce the energy consumption and therefore the electricity costs on the other hand. The following two electricity cost scenarios provide an annual cost structure for the six base cases.

8.3.2.1. Electricity cost scenario 1

For the first scenario we assumed a constant electricity price of 0.14 Euro until 2010. We calculated the respective annual consumer costs based on the annual energy consumption of each base case. The respective data and results are given in Table 12, Table 13 and Figure 12 below.

Table 12: Base case annual energy consumption (in kWh/a)

Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	359	359	314	314
V2: Color Copier/MFD	424	424	371	371
V3: Mono Printer/SFD	224	224	196	196
V4: Color Printer/SFD	350	350	306	306
V5: Personal IJ-MFD	14,6	14,6	11,7	11,7
V6: Workgroup IJ-MFD	21,9	21,9	35	35

Table 13: Base case annual electricity costs at 0.14 Euro per kWh (in Euro)

Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	50,3	50,3	44,0	44,0
V2: Color Copier/MFD	59,4	59,4	51,9	51,9
V3: Mono Printer/SFD	31,4	31,4	27,4	27,4
V4: Color Printer/SFD	49,0	49,0	42,8	42,8
V5: Personal IJ-MFD	2,0	2,0	1,6	1,6
V6: Workgroup IJ-MFD	3,1	3,1	4,9	4,9

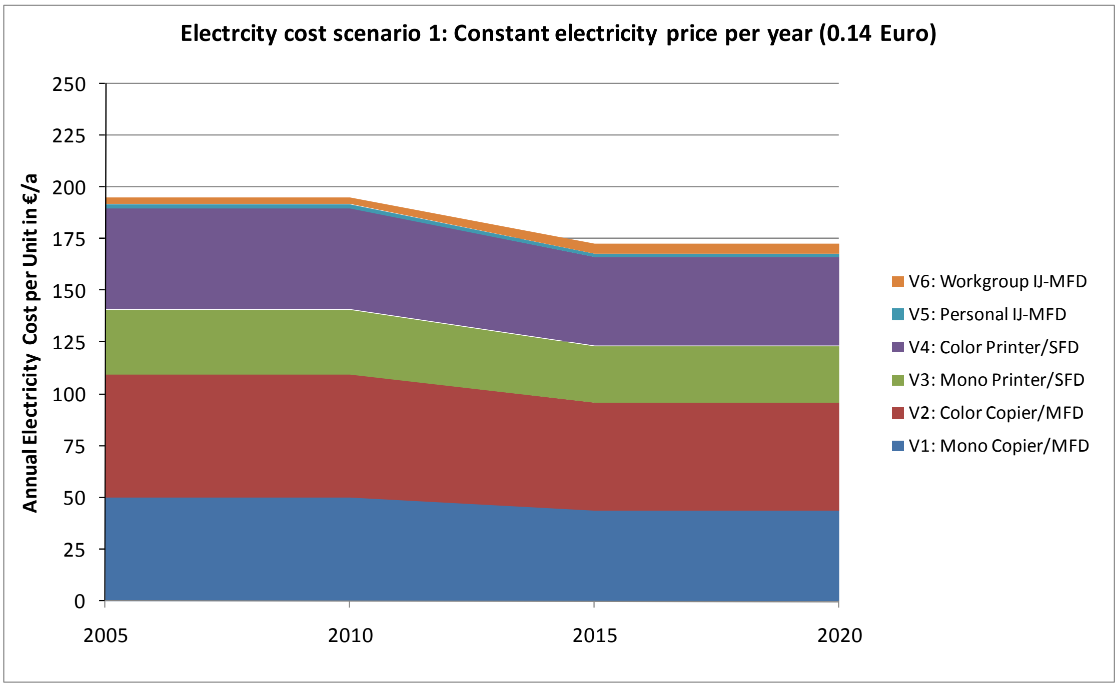


Figure 12: Electricity cost scenario 1

Discussion of the electricity cost scenario 1: The first scenario indicates the cost structure of each base case. The EP-products have a considerable high cost structure reflecting the use intensity and energy performance of the devices. The annual electricity costs are roughly 50 Euro. Considering an initial purchasing price of 500 to 5000 Euros we can conclude that an improvement of the energy performance will benefit the consumer without unreasonable increase in the purchasing price. Regarding the IJ-products the situation is different. Depending on the individual use intensity the electricity costs are on average between 2 and 5 Euros per year. Over an average product use cycle of 4 years the total electricity costs are 8 to 20 Euros. This is quite a small cost margin.

8.3.2.2. Electricity cost scenario 2

In the second scenario we assume an annual increase of the electricity costs by 1 cent. The respective data and results are given in Table 14, Table 15, and Figure 13 below.

Table 14: Base case annual energy consumption (in kWh/a)

Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	359	359	314	314
V2: Color Copier/MFD	424	424	371	371
V3: Mono Printer/SFD	224	224	196	196
V4: Color Printer/SFD	350	350	306	306
V5: Personal IJ-MFD	14,6	14,6	11,7	11,7
V6: Workgroup IJ-MFD	21,9	21,9	35	35

Table 15: Base case annual electricity costs at 1 cent increase per year (in Euro)

Base Case	2005	2010	2015	2020
V1: Mono Copier/MFD	50,3	68,2	75,4	91,1
V2: Color Copier/MFD	59,4	80,6	89,0	107,6
V3: Mono Printer/SFD	31,4	42,6	47,0	56,8
V4: Color Printer/SFD	49,0	66,5	73,4	88,7
V5: Personal IJ-MFD	2,0	2,8	2,8	3,4
V6: Workgroup IJ-MFD	3,1	4,2	8,4	10,2

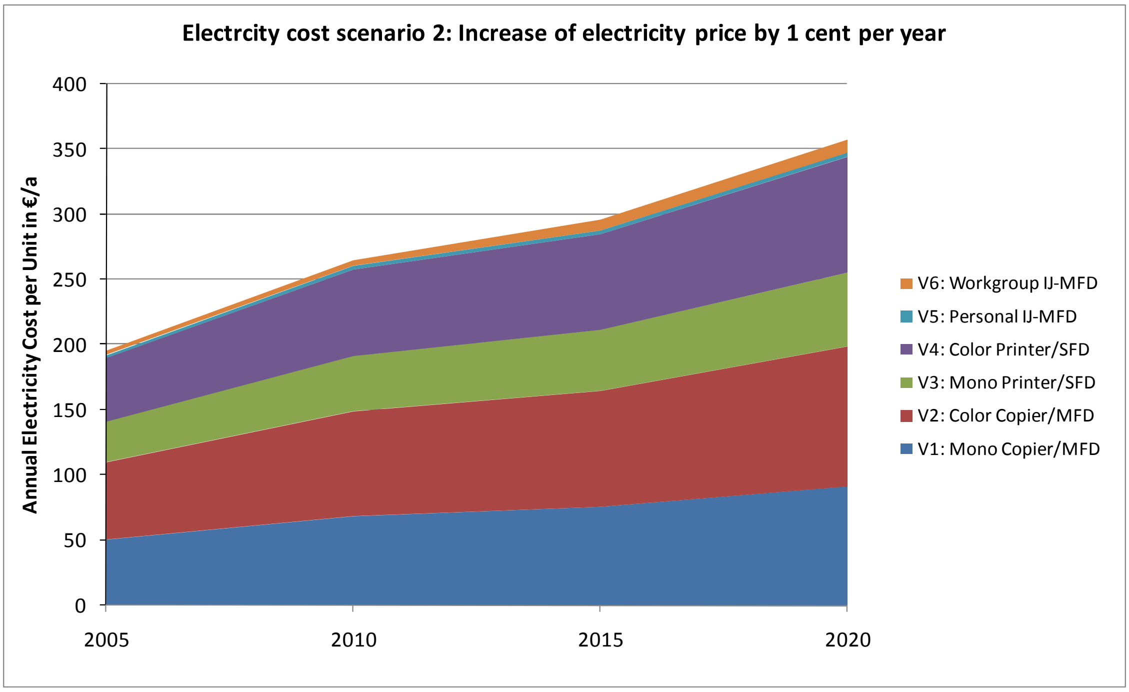


Figure 13: Electricity cost scenario 2

Discussion of the electricity cost scenario 2: The second scenario shows a proportional increase of the electricity costs in conjunction to the 1 cent price increase per year. The electricity cost margin for EP-products increase by almost factor 2 until 2020. With respect to the IJ-products the use intensity reflects more strongly on the electricity costs. For personal use IJ-MFDs the cost increase is minimal due to the assumed improvement. But for the workgroup IJ-MFDs the assumed network standby increases the annual costs from 3.1 Euros in 2005 to 10.2 Euros in 2010. With respect to an assumed product use cycle of 4 years the cost margin for improvements would increase from 12 to 40 Euros. This increase would justify additional costs for a better network standby performance.

8.3.2.3. Paper costs and duplex printing

The costs concerning paper consumption are mostly critical for EP-products due to their high image output. The costs and resource efficiency for these products have been addressed by duplex unit requirements. The cost for a sheet of regular white paper is approximately 0.010 to 0.015 Euros. The cost for a sheet of recycling paper is approximately 0.020 to 0.025 Euros. The annual image output of EP-products is approximately 100.000 pages and respective paper the costs of 1500 to 2000 Euros. Under these conditions a duplex unit is fully justified.

The justification of a duplex unit for IJ-products is more complex. Regarding personal use IJ-products with an average annual image output of approximately 1000 pages, the respective paper costs are 10 to 20 Euros. For a workgroup IJ-product with approximately 4000 pages, the respective paper costs are 60 to 80 Euros. The customer benefit of a duplex unit for the workgroup IJ-product is obvious. For the home use IJ-product we have to consider the probably higher product price and longer printing time which has an effect on the energy costs. We also have to consider the imaging speed of the device. A fast duplex printing will definitely require a more heat intensive IJ marking technology. This has definitely an effect on power consumption. Our product assessment does not allow a precise setting of a benchmark value. The recommendations for duplex unit reflect these considerations.