Intermediate step report 8 for EuP study Lot3.
Draft 070706

Scenario-, Policy-, Impact- and Sensitivity analysis

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Introduction

This is the eighth draft report within the EuP preparatory study, Lot 3, Personal Computers (desktops and laptops) and Computer Monitors. The methodology developed by VHK for the European Commission (MEEUP 2005) is followed. Please feel free to comment on this report to e-mail address: ecocomputer@ivf.se no later than 10 August 2007.

For more information about the study, please refer to www.ecocomputer.org

The objective of this part of the study and the report is to make scenario-, policy-, impact- and sensitivity analysis for possible measures by the EU to improve the energy and environmental efficiency of desktop and laptop computers and monitors.

In the previous tasks, the project team has identified a number of possible improvement options both in regulation of the hardware technologies and in the software, as well as a potential in improved user behaviour.

In this chapter the intention is to show scenarios on how the authorities could improve the environmental performance and energy consumption from computers by different measures. For selected positions in the scenarios, the impact on industry and consumers will be analyzed. However, it should be kept in mind that for fast moving technology as computers and monitors, predictions for the future are always associated with large uncertainties.

Finally the sensitivity of the study and the scenarios due to uncertainties will be considered.

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Background

In the previous tasks of this study, definitions, existing legislation and voluntary agreements have been studied. Market volumes, trade flows and projections for the future have been investigated, and accepted by the stakeholders. Base cases for relevant computers and monitors have been calculated for desktops, laptops, CRT monitors and LCD monitors. Improvement options and their improvement potential have been identified for all of the base cases, taking indicated use patterns into account. For each base case and improvement option a life cycle assessment on the basis of the MEEuP has been done.

1.1 Policy- and scenario analysis

In this chapter the intention is to show scenarios improving the environmental performance and energy consumption from computers and monitors. The task is quite complicated, especially due to the very fast advances both in technology and possible changes of usage for computers. The scenarios are to be stretched as far as 2020, thus giving quite a lot of causes for uncertainties, both due to technology and to market development.

According to previous tasks, the main environmental impact is the energy used during use. Energy use is depending on power and time, therefore different options to reduce either power in different modes or to reduce time in high power modes are considered. Currently no benchmarking method for assessing a computer's energy efficiency is available. Idle-on is currently used as an indicator for on-mode consumption. However, minimum requirements on idle-on could be problematic since the impact of future technology development, in particular software, cannot be assessed reliably. An alternative strategy for computers is to focus on “unnecessary waste” when the computer power is not needed and inefficiencies in power conversion. In order to take into account on-mode power, a scenario consisting of ecodesign requirements for low power modes complemented with Energy Star voluntary labelling based on modified values (compared to tier I coming into force on 20 July) for idle-on is considered. On the other hand, for computer monitors on-mode is considered in a scenario relating on-mode power consumption to the resolution (the approach currently implemented in Energy Star), and/or the to the screen size.

1.1.1 Estimated market data

To be able to calculate the impact from the different options as far in the future as 2020, an estimation of the installed base of computers must be done up to that date. Due to the high uncertainties of the computer market and computer usage at such a distant time, an assumption has been made based on extrapolation of the trends identified up to 2010. Economic lifetimes are considered to be the same for the whole period. Arguments can be found for both longer and shorter lifetimes.

The apparent consumption has been estimated in task 2, and is displayed for convenience again in the following graph.

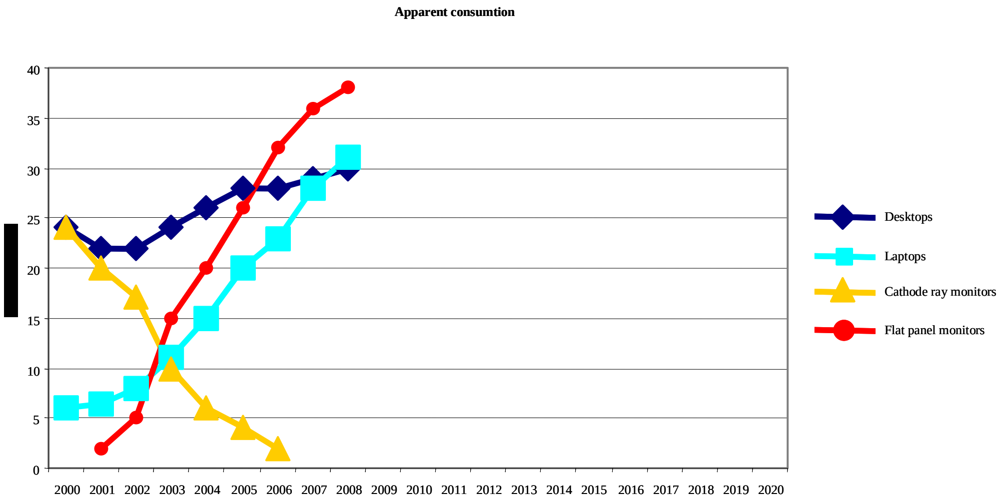

Figure 1 Apparent consumption from task 2

Due to the uncertainties of the input data and the uncertainties of technology, the apparent consumption from 2010 up to 2020 has been estimated by manual extrapolation. See the graph below.

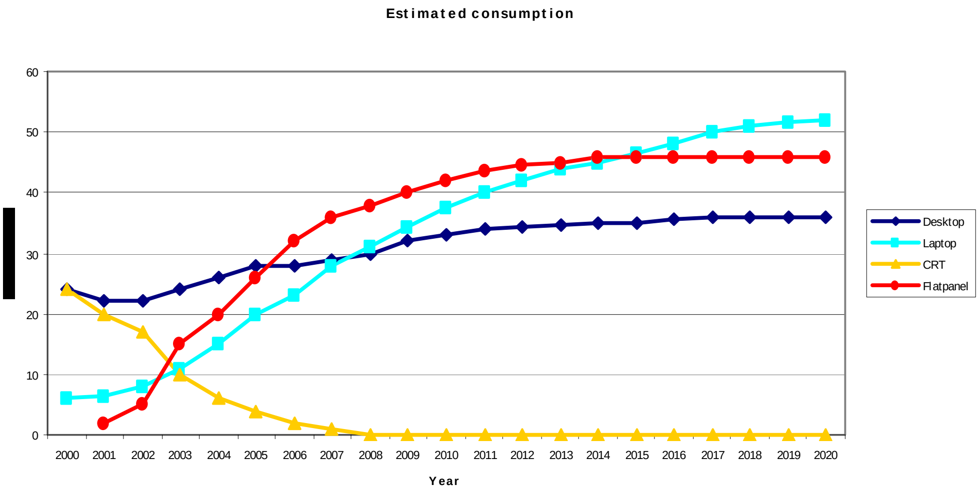

Figure 2 Estimated consumption to 2020

Integrating the consumption over the estimated lifetimes, 5 years for Laptops and 6 years for the rest, gives the installed base. See the graph below.

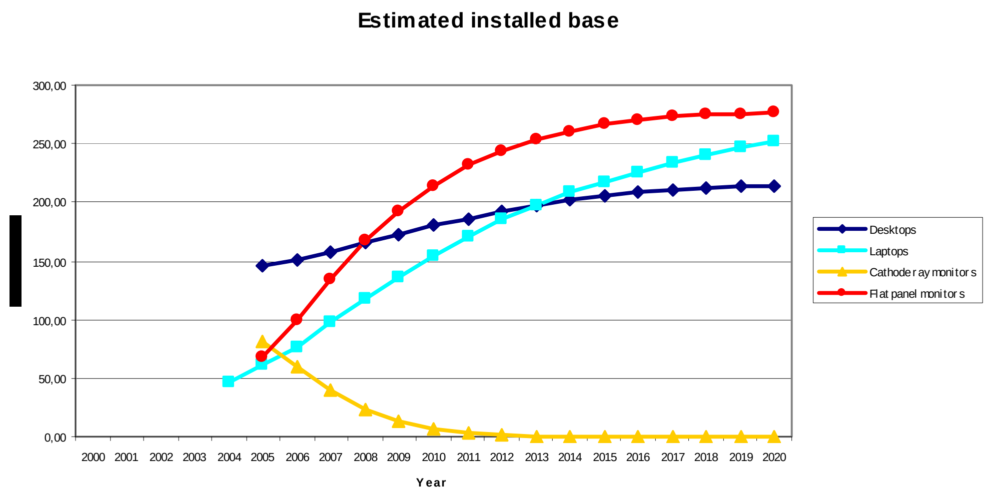

Figure 3   Estimated installed base

In the table below the figures are given in digital form.

Table 1   Estimated installed base

	Desktops (millions)	**Laptops** (millions)	**Cathode ray monitors** (millions)	**Flat panel monitors** (millions)
2000				
2001				
2002				
2003				
2004		46,50		
2005	146,00	60,50	81,00	68,00
2006	150,00	77,00	59,00	100,00
2007	157,00	97,00	40,00	134,00
2008	165,00	117,00	23,00	167,00
2009	173,00	136,40	13,00	192,00
2010	180,00	153,90	7,00	214,00
2011	186,00	170,90	3,00	231,50
2012	192,20	184,90	1,00	244,00
2013	197,70	197,90	0,00	253,00
2014	202,70	208,50	0,00	260,80
2015	205,70	217,50	0,00	266,80
2016	208,20	225,50	0,00	270,80
2017	210,20	233,50	0,00	273,30

	Desktops	Laptops	Cathode ray monitors	Flat panel monitors
2018	212,00	240,50	0,00	274,80
2019	213,50	247,00	0,00	275,80
2020	214,50	252,50	0,00	276,00

1.1.2 Overview of scenarios described

In order to get an overview of the scenarios described in the subsequent text, a table of the scenarios, and their main features is included.

Table 2 A comparison between scenarios described by the study
Note; details, about the different options, such as figures for limits, is further described at each scenario. The impact of voluntary Energy Star requirements is depending on the implementing rate, assumed to start with 10% of the new products the first year, increasing to 65% of the new products after5 years and implemented in 65% of the stock after another 5-6 years, depending on the life time for the product.

Scenario	High efficient PSU	Power management enabled	Information about power levels	Idle/active level	Sleep/off levels
1. Business as usual I	Voluntary in E* tier I for computers	Voluntary in E* tier I for computers and monitors	-	Voluntary in E* tier I for computers and tier II monitors	Voluntary in E* for computers and monitors
2 Business as usual II, including Energy Star tier II for computers as foreseen for 2009 in Energy Star Agreement	Voluntary in E* (same as tier I) for computers	Voluntary in E* (same as tier I) for computers and monitors	-	Voluntary in E* first tier I then tier II Assumption of tier II, implemented 2009 is to decrease the tier I limits by 10% on idle-on mode for the different categories of computers.	Voluntary in E* for computers and monitors
3. Possible option A for implementing measures **(base is business as usual I)**	Mandatory from 2009 for desktops and monitors	Mandatory from 2009 for computers (including power down of monitors)	-	Mandatory minimum requirements for monitors from 2009 (power/resolution) Mandatory minimum requirements for power/area for monitors from 2011 Mandatory minimum requirements for idle for computers in line with E* tier I from 2010	Mandatory minimum requirements for computers and monitors from 2009

4. Possible option B for implementing measures **(base is business as usual I)**	Mandatory from 2009 for desktops and monitors	Mandatory for computers (including power down of monitors) from 2009	Mandatory from 2009	Mandatory minimum requirements for monitors from 2009 (power/resolution) Mandatory minimum requirements for power/area for monitors from 2011	Mandatory minimum requirements on all products from 2009
5. Industry recommendation	Computers: Mandatory efficiency of 75% for desktops, 84% for notebooks from 2009 and 80% for desktops, from 2011	Computers (including power down of monitors) Mandatory from 2009	-	Voluntary in E* Monitors: Mandatory levels for monitors from 2009 (power/resolution)	Voluntary in E* Mandatory Monitorsfor computers 10W and 4 W sleep and 2W off for monitors from 2009 Computers: Mandatory 10W and 4 W sleep from 2009 4W for desktops and 1W for notebooks from 2011

1.1.3 Scenario 1, Business as usual I

To describe the improvement potential of each implementing measure, and to make a comparison, a business as usual scenario is established.

The business as usual scenario is based on the estimated installed base described above, on environmental performance of products available on the market 2005 and with the Energy Star 4.0 in place 2007 (for criteria, see task 1). Our assumption is that 10% of the new computers 2007 will fulfil the Energy Star 4.0 criteria, and that this rate will increase until 65% of new products fulfil the criteria in 2011, leading to that 65% of all computers in use fulfil the Energy Star 4.0 criteria in 2015. Note that old products already in use will not be affected causing this considerable delay. The increase in primary energy use is very much depending on the increase in the installed base of products.

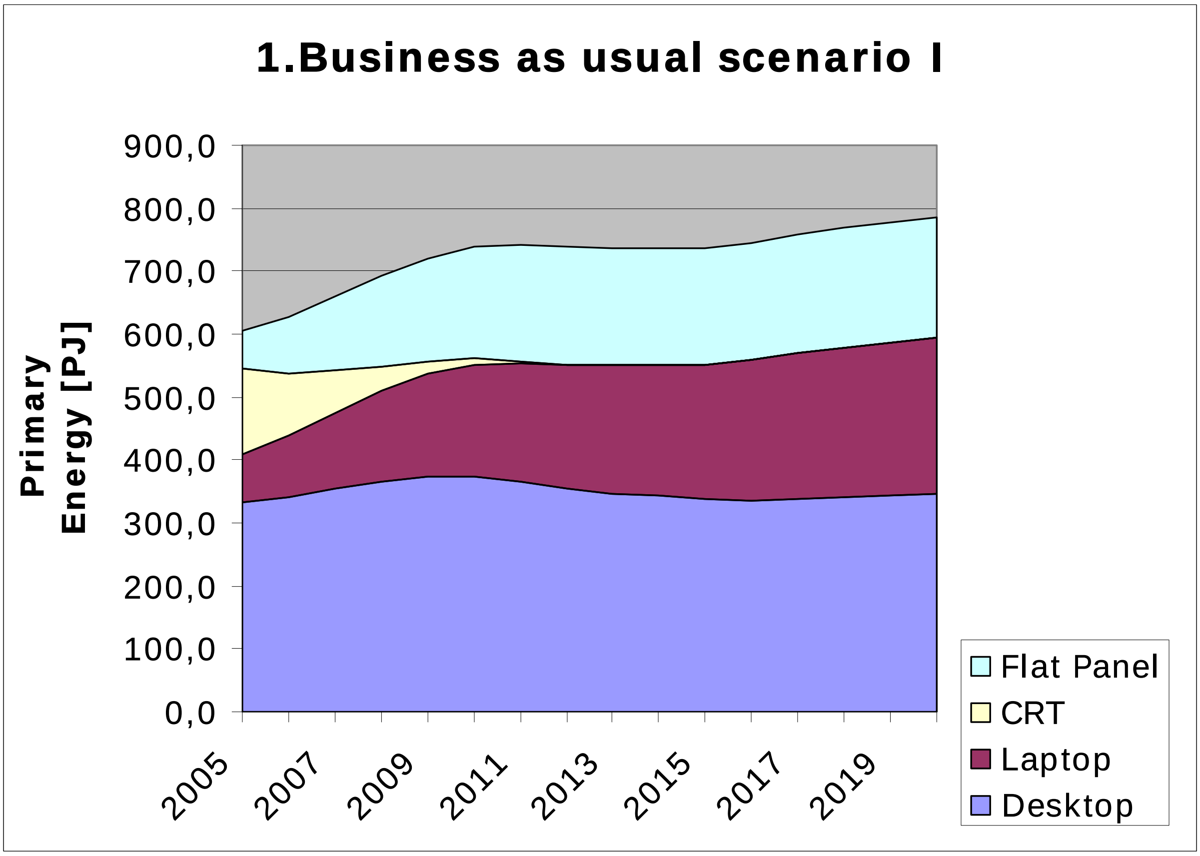

Figure 4 Primary Energy use in a Business as usual I scenario

	1. Business as usual I					
	Desktop	Laptop	CRT	Flat Panel	Monitors	Summa
2005	331,4	76,4	138,2	60,1	198,3	606,2
2006	340,5	97,3	100,7	88,3	189,0	626,8
2007	353,8	121,7	67,8	117,7	185,5	661,0
2008	364,9	144,3	38,4	144,6	183,0	692,1
2009	372,4	164,1	21,2	163,0	184,2	720,6
2010	372,3	178,5	11,0	176,4	187,4	738,2
2011	364,4	188,6	4,5	183,4	187,9	740,9
2012	355,5	195,3	1,4	185,5	186,9	737,7
2013	347,4	202,2	0,0	185,5	185,5	735,1
2014	342,6	207,6	0,0	186,1	186,1	736,2
2015	337,2	213,8	0,0	186,4	186,4	737,4
2016	336,1	221,6	0,0	187,2	187,2	744,9
2017	339,3	229,5	0,0	188,9	188,9	757,7
2018	342,2	236,4	0,0	190,0	190,0	768,6
2019	344,7	242,8	0,0	190,6	190,6	778,1
2020	346,3	248,2	0,0	190,8	190,8	785,2

Figure 5 Primary Energy use in a Business as usual I scenario

1.1.4 Scenario 2, Business as usual II

The business as usual II scenario is similar to the business as usual I scenario, but with Energy Star, tier II with more demanding criteria for idle-mode power for computers in place from 2010. Currently it is unclear how new Energy Star monitor specs will look like, therefore no "updated" BaU for monitors possible. The criteria are assumed to decrease the idle mode power by 10% for each of the categories defined for desktops and laptops. Based on the impact of on-mode (for products already provided with power management and efficient power supply units), it is assumed to cause a decrease of use energy by 7,1% for desktop office, 6,1% for desktop home, 6,2 % for laptop office and 4,7% for laptop home compared to tier

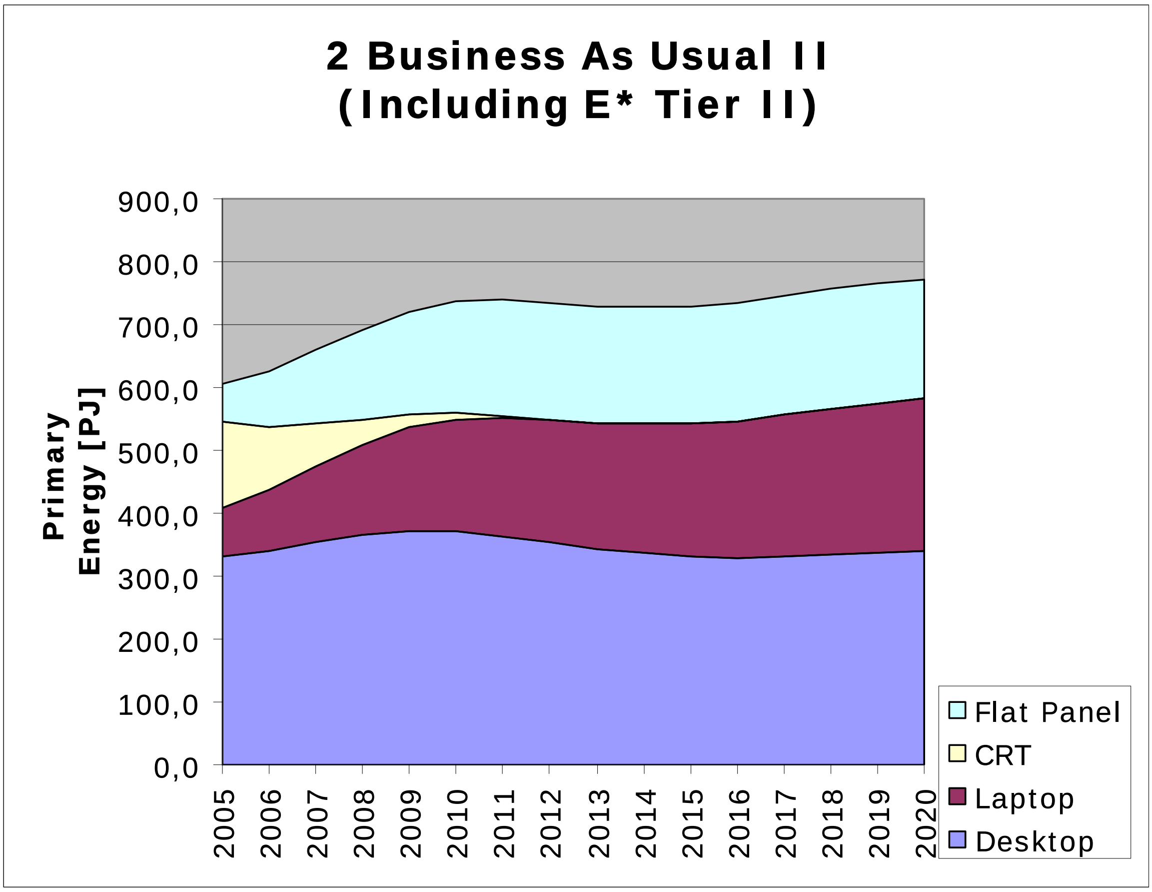

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Figure 6 Primary Energy use in a Business as usual II scenario

	2 Business as usual II (Including E* Tier II)					
	Desktop	Laptop	CRT	Flat Panel	Monitors	Summa
2005	331,4	76,4	138,2	60,1	198,3	606,2
2006	340,5	97,3	100,7	88,3	189,0	626,8
2007	353,8	121,7	67,8	117,7	185,5	661,0
2008	364,9	144,3	38,4	144,6	183,0	692,1
2009	372,2	164,0	21,2	163,0	184,2	720,4
2010	371,7	178,2	11,0	176,4	187,4	737,3
2011	363,2	187,9	4,5	183,4	187,9	739,0
2012	353,5	193,9	1,4	185,5	186,9	734,3
2013	344,1	199,9	0,0	185,5	185,5	729,5
2014	338,0	204,4	0,0	186,1	186,1	728,5
2015	331,7	209,9	0,0	186,4	186,4	727,9
2016	329,7	217,2	0,0	187,2	187,2	734,0
2017	332,3	224,6	0,0	188,9	188,9	745,9
2018	334,9	231,4	0,0	190,0	190,0	756,2
2019	337,2	237,6	0,0	190,6	190,6	765,5
2020	338,8	242,9	0,0	190,8	190,8	772,5

Figure 7 Primary Energy use in a Business as usual II scenario

1.1.5 Implementing measures in general

Implementing measures can take different forms: Legislation on minimum requirements for power consumption or technical solutions, which will be elaborated later, or measures such as requirements for information on power use in different use modes. Other options include voluntary schemes, like the current Energy Star or the TCO labelling for monitors.

Minimum requirements for power consumption are quite powerful and will have an effect on all new computers. However, there could be a risk that the requirements will become obsolete quickly due to rapid technological development. It can be difficult to make such requirements specific enough to provide desired effects, while at the same time avoiding to lock in old technology solutions.

Requirements related to provision of information of for example power consumption in different modes is another option. Such an approach fosters market transparency, and may lead to efforts from industry to improve power consumption

Several voluntary labels exist and are used regarding the products in this study. Energy Star and TCO labelling schemes are for example often used in public procurement. However, voluntary labels may lead to that some low cost producers avoid the labelling system. These could be the producers with less energy efficient products.

1.1.6 Scenario 3. Possible option A for implementing measures

According to previous tasks, the main environmental impact is the energy used during use. Energy use is depending on power and time, therefore the implementing measures are focused on minimising the power in different modes and minimising the time in high power modes.

Minimum requirements for power modes for Computers

This scenario off/standby and sleep power requirements is harmonised with Energy Star 4.0, Tier 1, for PCs. These values also correspond to the Lot 6 findings, although the definitions of modes are different.

Table 3 Comparison/correlation of definitions between Lot 6 (stand-by and off mode) and Lot 3 (personal computer and computer monitors)

Lot 6 definitions	**Lot 3 definitions**
Off-mode	Off mode (without Wake On Lan, WOL)
Passive standby	Off-mode (including WOL)
Networked standby, type II (standard rate networks)	Sleep

Sleep (S3)

- 4W/4.7W (for desktops), the higher values corresponding to allowances for wake on LAN
- 1W/1.7 W (for laptops)

Off/standby

- 2W/2.7W (for desktops)
- 1.7W/2.4W (for notebooks)

Although the base cases in this study use lower values for sleep and off, these minimum requirements will have an impact on products exceeding the base case values, e.g. from the "white box" sector. It will also have an impact when the increased use of power management transforms idle use into sleep or off/standby, and thereby make the sleep or off/standby power more important. There is also a trend to go for very powerful computers in some niches, where this limits for sleep and standby/off can have a large impact without hammering the product performance.

Idle-on mode

Currently no benchmarking method for assessing a computer's energy efficiency is available. Idle-on is currently used as an indicator for on-mode consumption. A possible option could be to make minimum requirements in line with Energy Star criteria, tier 1 for idle mode power. That would mean the following levels:

- Desktop (categories definition in task 1.3)

- Category A: ≤ 50.0 W
- Category B: ≤ 65.0 W
- Category C: ≤ 95.0 W

- Notebooks (with screen shut off)
  - Category A: ≤ 14.0 W
  - Category B: ≤ 22.0 W

This suggestion is assumed to decrease the energy use during use when applied to products that have already implemented efficient power supply and mandatory power management enabled. Some high-end products, such as gaming computers, will have difficulties in fulfilling the requirement. Adding an extra category for this kind of products could solve this. In addition, the LCC could increase with 30-100€ according to industry information e.g. due to the cost of for improved energy efficient graphic cards in order to fulfil the needs from Vista and the optional mandatory requirements at the same time. This requirement could thereby become not in line with Least Life Cycle Cost approach.

A possibly even better option could be to wait for the benchmarking tool, now developed by the industry (ECMA). If that succeeds, it will make it possible to develop requirements related to the performance of computers, so that implementing measures will surely lead to improved energy-efficiency at minimum cost. Industry and Energy Star have great confidence in the success of this endeavour.

Minimum requirements for power modes for Monitors

Active/on mode

The power consumption for a computer monitor in on-mode is related to the screen size (see background document on Monitors (to be included in task 4-5 in the final report)). Energy Star Program Requirements for Computer Monitors version 4.1 uses power per resolution as a base for the requirements. The equation Y=38*X+30 is used, where Y is the threshold limit for active/on power in Watt and X is the number of mega pixels in decimal form. With reference to the monitor background document, the Lot 3 study recommends to develop a requirement related to the area of the screen. Based on the data available, an indicative recommendation is to place the threshold limit at Y= 10+410*A, where Y is the active/on power in Watts and A is a “true” value in m^2 for the area of the screen surface. Almost all the products from the Energy Star database - products that fulfil the Energy Star Tier 2 criteria according to the Energy Star measurement method – is below the indicative Y= 10+410*A level.

The recommendation was also compared with tests made by the German Magazine Computertechnik during the years 1998 to 2006 including almost 300 monitors. The measurement standard for Computertechnik’s tests is unknown but assumed consistent. In the figure below the almost 300 LCD screens tested in Germany are plotted together with 500 LCD screens that fulfil the criteria of E* 4.1 Tier 2. As can be seen, some monitors would not comply with the threshold limit Y= 10+410*A, hence there is some potential for energy savings. The estimated improvement is a 5% decrease of energy during use.

Since Energy Star is a well-known and widely used system, the Lot 3 recommendation is to start with the industry proposal of power per resolution as a first step of implementing measures. The limits recommended by industry and in accordance with Energy Star are suitable to start with, i.e. Max power Y=38*X+30, where Y is the active/on power in Watt and X is the number of mega pixels in decimal form. The requirement is only recommended for monitors < 30”. This first step is recommended to be adopted as soon as possible (assumed to be equal to 2009).

As a second step, Lot 3 recommends to develop requirements for power per area, which will have a wider impact. Furthermore, Lot 3 recommends developing the Energy Star system so that also the future Energy Star criteria for monitors are based on power per area, but at lower values than the mandatory minimum requirements at that time. (Possibly at the level of Y=5+410*A). Preferably minimum requirements and the voluntary Energy Star use the same base. The timing of this requirement is suggested to around 2011, in order to allow for adequate adaptation to the new scheme. . At that time, it is also estimated that CRTs, which could have problems in fulfilling the requirements, will not have any market share of importance

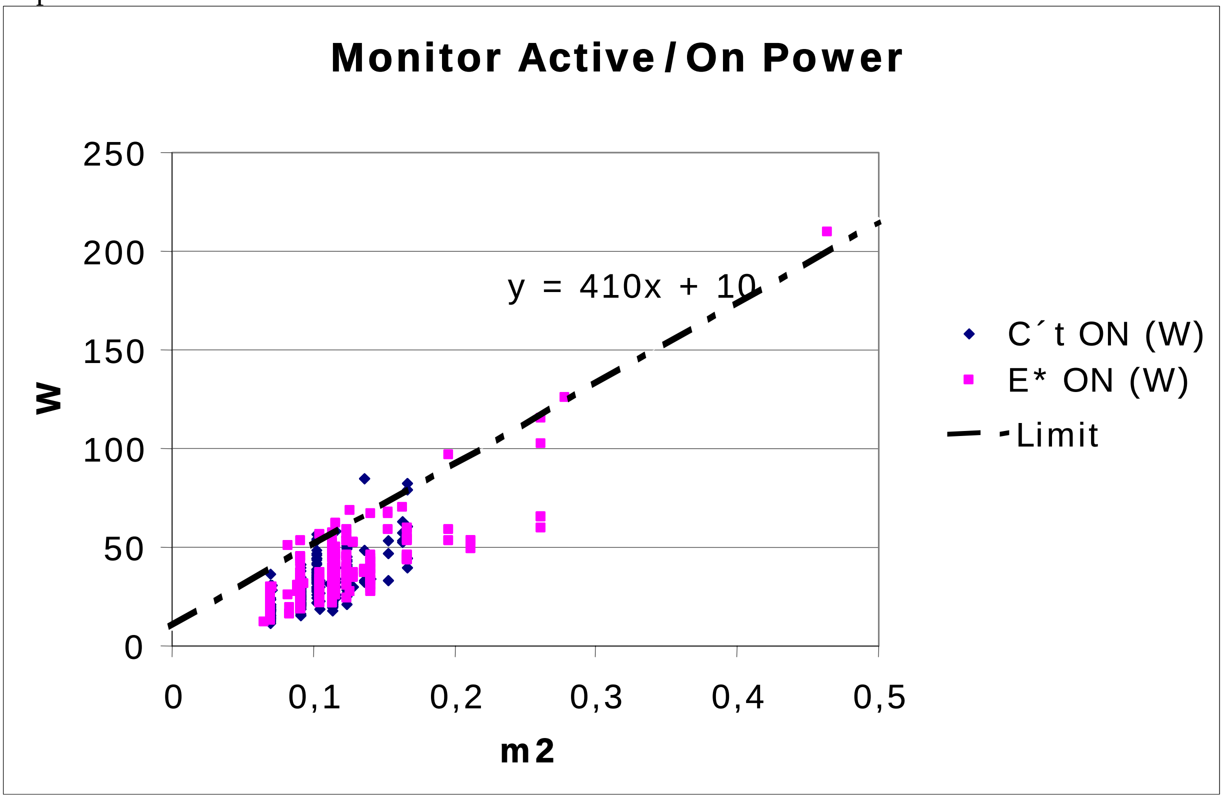

Figure 8 Suggestion for Active/on mode power for Monitors, compared to statistics available from E (Energy Star database) and C´t (Computertechnik)*

This recommendation is based on the Energy Star measurement method, but where the power is related to area and not to resolution. The Energy Star measurement method for monitors today is quite good, but can be further developed by letting the test engineer use a luminance meter and measure the difference between the grey levels, instead of the perceptual evaluation used today. The standard could for example state that the levels are considered to be different if the luminance differ more than 5 cd/m^2 between two levels. In this way the repeatability of the test method would be improved.

Sleep and off mode

In this scenario sleep and off mode power for monitors follow industry's suggestion [EICTA, AeA , JBCE, 2007], i.e. sleep mode ≤4W and off mode ≤ 2W. Viewed in the context of also requiring enabled energy management, this recommendation will also effect the power consumption presently allocated to the active/on mode. In task 7 is estimated that improved power management could result in around 40% reduction of the total power consumption.

Mandatory requirements for Power supply unit efficiency

Power supplies for desktops and laptops and for monitors in today's market, show a relatively large distribution in efficiency. It is obvious that technology is available to get efficiency in the area of 80-85% and even higher, while some units on the market have considerably less efficiency. Due to the work done in Energy Star, there is an accepted definition for efficiency, taking into account the wide variation of power consumption in the different operational modes for a computer.

Lot 3 recommends the following efficiency requirements (following the Energy Star test methods and criteria for internal power supplies and Lot 7 findings for external power supplies.)

- For Internal power supply (desktops and monitors): 80% minimum efficiency at 20%, 50%, 80% and 100% of rated output and Power Factor ≥ 0.9 of rated output

- For external power supply (laptops): 85% minimum efficiency,

The measurement methods available at Energy Star do not include internal power supplies for monitors. Such a measurement method therefore needs to be developed. This has to be done, but it should be very much the same as the one currently applied method for computers.

Suggested timing

The main difference between the Lot 3 recommendation and the recommendation made by industry is that Lot 3 includes power supply units for monitors, and the timing. The time for industry to change to more efficient power supply units depends on the availability of components, of which the industry is restrained. Since the technology is already established, it can be assumed that the availability of components will not become the limiting factor, but that the time for legislation (Consultation forum and other processes) is the limiting factor. Therefore the implementation should be as soon as possible (we assume 2009). Many persons in industry have confirmed this assumption in informal discussions.

As a second step it could also be recommended to make an even higher efficiency of power supply units, such as +85% or +90%, a mandatory requirement. This would give quite a large impact on energy use, but the measure has to be further developed.

Mandatory enabling of Power management at system level

One of the most effective measures for energy conservation in computers would be to enforce the use of power management at system or software level. Most modern computer hardware has a very advanced, built in, functionality for power management, which is often not used. Many users even actively turn off the power management function due to anticipated problems with legacy software and with network applications. The solution for a successful use of power management is almost exclusively a software (operating system) issue, but the computer manufacturers can do the enabling of the power management. Mandatory enabling of power management before shipping the product is recommended by the industry and also by Lot 3.

Some studies made by the industry (and shared with the Lot 3 under NDA) show that for products with an enabled power management system, less than 20% of the users turn it off, leading to a much higher use of such a system than if the user have to actively enable it. Estimated impact of the mandatory enabled power management, is therefore based on that 80% of the products use power management when enabled power management is mandatory.

The Lot 3 recommendation is to introduce legislation which forces the manufacturers to provide the computers with the power management system **enabled** at the time of delivery to the customers. Information about how to use the power management system should also be provided in such a way that it is easy for ordinary people to understand. (Today’s information is often hidden deep in the software or the manual, and rather difficult to understand.)

Suggested settings for the power management is (according to Energy Star 4.0 and the proposal from EICTA, AeA, and JBCE):

- 15 min to screen off (display sleep)
- 30 min to computer sleep (System Level S3, suspended to RAM)

Timing

Since power management systems are available and usually installed already, the only change would, in most cases, be to enable them, and make the description better, leading to a possibility for implementation as soon as possible.

Energy Star and other voluntary labelling schemes

Energy Star is a well-established labelling system, described in task 1, based on voluntary agreements. The business as usual comparison scenario is essentially the effects expected from Energy Star as it is today, but the requirements in Energy Star will also be developed, thus improving the effects from voluntary labelling.

Energy Star has the necessary infrastructure for maintenance of the demands for being allowed to use the label. The Energy Star system include:

- Power supply unit efficiency
- Power consumption levels
- Power management at system level
- Requirements on information

The Energy Star labelling scheme criteria is based on the performance of approx the 25% best of the available products on the market when the criteria are set. The criteria are updated, following a time plan, and for computers, the Energy Star version 4, tier 2 criteria will be effective from January 1 2009. There is a work ongoing in the ECMA group, to develop a computer performance-benchmarking test, in order to make the criteria on energy consumption depend on the computer performance.. If successfully developed, the ECMA performance measure should be used in the mandatory information suggested above, to give the energy per performance, (similar to the energy per area for computer monitors).

Furthermore, Lot 3 recommends as described above, developing the Energy Star system so that also the future Energy Star criteria for monitors are based on power per area, but at lower values than the mandatory minimum requirements at that time. (Possibly at the level of Y=5+410*A for E*, where Y is the active power in W and A is the screen area in m^2)of the monitorEnergy Star complements the implementing measures recommended by Lot 3. The combination of measures can further enhance the environmental performance of the products studied. There are also other voluntary labelling schemes, such as TCO, the EU-flower, the Swan and the Blue Angel. They have criteria for many other environmental aspects including material content and recycling, thus complementing Energy Star and the implementing measures recommended by Lot 3, by putting attention on other issues than energy.

Impact of scenario 3, Possible option A for implementing measures

The main assumptions for the calculations in scenario 3, Possible option A for implementing measures are:

- Energy Star requirements is implemented as assumed in Business as usual scenario I,

- Power management at the described settings is assumed to become mandatory enabled 2009
- High efficient power supply units for desktops, laptops and monitors becomes mandatory 2009
- Minimum requirements for sleep and off becomes mandatory 2009
- Minimum requirements for idle mode for computers becomes mandatory 2010 in line with Energy Star criteria, tier 1. It is assumed that all new products will comply with these requirements from 2010, leading to the full stock compliant in 2016.
- The requirement for active/on-mode power for monitors is estimated to become mandatory 2011 and complemented with the new developed Energy Star criteria for monitor active on-mode power. It is estimated to decrease the average power in active mode for monitors by
5%.

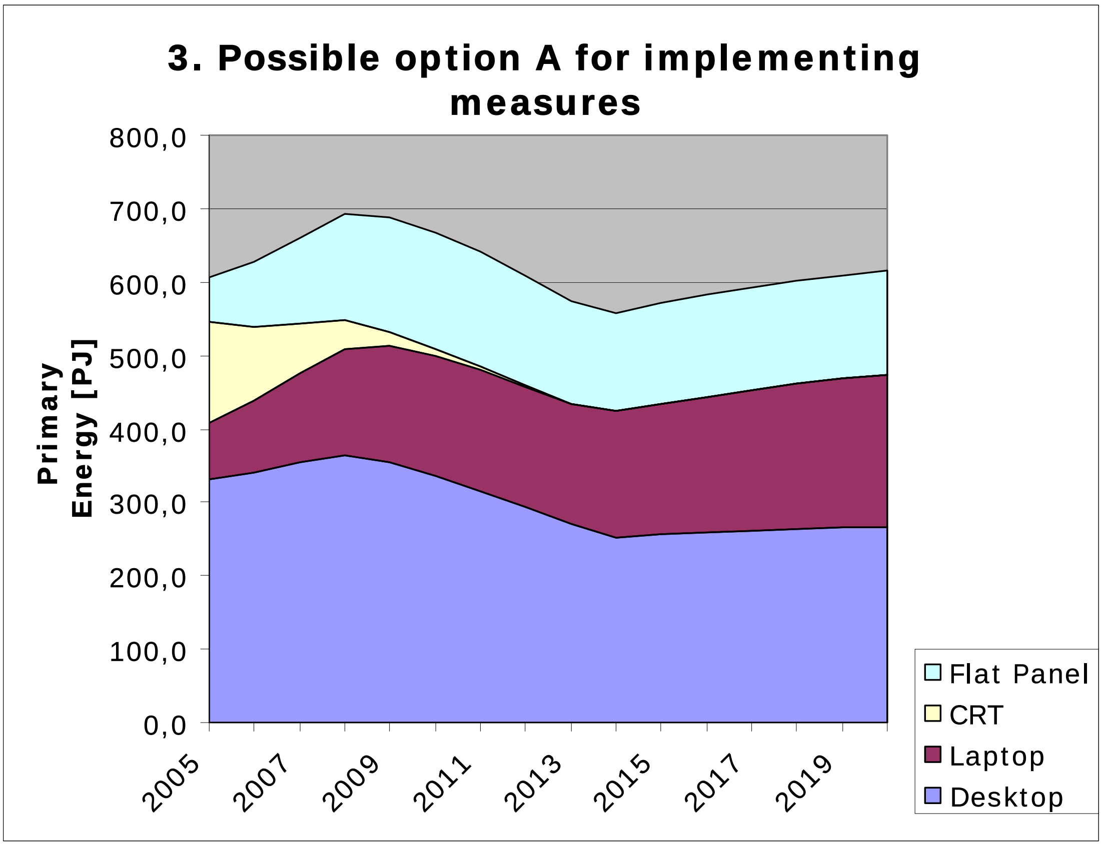

Figure 9 Primary energy use for the Possible option A for implementing measures scenario (including idle requirements for computers from 2010)

	3. Possible option A for implementing measures (incl idle limits)					
	Desktop	Laptop	CRT	Flat Panel	Monitors	Summa
2005	331,4	76,4	138,2	60,1	198,3	606,2
2006	340,5	97,3	100,7	88,3	189,0	626,8
2007	353,8	121,7	67,8	117,7	185,5	661,0
2008	364,9	144,3	38,4	144,6	183,0	692,1
2009	353,5	159,1	20,4	154,2	174,5	687,1
2010	336,3	162,4	10,2	159,1	169,4	668,1
2011	315,7	165,2	4,1	156,3	160,4	641,3
2012	293,4	164,0	1,2	149,6	150,8	608,2
2013	271,4	162,4	0,0	141,0	141,0	574,7
2014	252,3	171,1	0,0	133,2	133,2	556,5
2015	256,0	178,5	0,0	136,2	136,2	570,7
2016	259,1	185,0	0,0	138,3	138,3	582,4
2017	261,6	191,6	0,0	139,5	139,5	592,7
2018	263,9	197,3	0,0	140,3	140,3	601,5
2019	265,7	202,7	0,0	140,8	140,8	609,2
2020	267,0	207,2	0,0	140,9	140,9	615,1

Figure 10 Primary energy use for the Possible option A for implementing measures scenario (including idle requirements for computers from 2010)

This shows a large impact on the primary energy used compared to Business as usual scenarios. Approximately half of the improvement is due to implemented power management, and secondly comes the implemented high efficient power supplies (one third of the improvement).

1.1.7 Scenario 4. Possible option B for implementing measures

According to previous tasks, the main environmental impact is the energy used during use. Energy use is depending on power and time; therefore the implementing measures are focused on minimising the power in different modes and minimising the time in high power modes. Currently no benchmarking method for assessing a computer's energy efficiency is available. Idle-on is currently used as an indicator for on-mode consumption. However, as mentioned above, minimum requirements on idle-on could be problematic. We suggest the following alternative scenario without minimum requirements for idle power for computer. Information requirements are included in this scenario in order to support energy efficient products. For computer monitors on-mode is considered in a scenario relating on-mode power consumption to the resolution (the approach currently implemented in Energy Star), and/or the to the screen size.

The implementing measures are based on the Least Life Cycle Cost, LLCC, described in task 7. This means that no measures that would give a higher cost for the consumer are considered.

This scenario is very similar to scenario 3, why only the implementing measures changed compared to that scenario is described.

Information requirement

This scenario includes (with a view to article 14 in 2005/32/EC), a requirement to inform the consumer about personal computers' and monitors' power consumption in the relevant modes : idle or active, sleep and off", according to Energy Star measurement methods. Such measures enhance market transparency.

Lot 3 recommends that it should be required to present the information at the outer surface of the product, possibly on a sticker, and in the product manual in a highly visible place. It is of importance that the information is on the outside of the product (not in the software or inside the casing), so it can be seen when already on the shelf in the store, and also when the equipment is shipped to end of life treatment. The ECMA standard 370, Eco Declaration, include most of the information suggested by Lot 3 (and a lot of more detailed information). The main difference is that it is an additional document, not a sticker on the product or information included in the manual.

Lot 3 recommends that it should be required to inform the consumer about personal computers' and monitors' content of restricted substances such as mercury and lead. Since the presence of these substances is of importance in the end-of-life treatment, it is vital that the information is placed visibly on the outer surface of the product.

Information to be given for personal computers (desktops and laptops), according to measurement methods, described in Energy Star Program Requirements for Computers (version 4.0) is

- Power use in idle mode (or power per performance when the ECMA benchmarking tool is available).
- Power use in sleep mode.
- Power use in off mode
- Content of restricted substances such as mercury and lead
- Webpage address for information on Energy, Environment and End of life treatment

Information to be given for computer monitors, according to measurement methods, described in Energy Star program Requirements for Computer Monitors (Version 4.1).

- Power use in active mode per product and per area (m2)
- Power use in sleep mode per product
- Power use in off mode per product
- Content of restricted substances such as mercury and lead

- Webpage address for information on Energy, Environment and End of life treatment

Web page

The Lot 3 study recommends the establishment of a neutral web page, run by the EU, or a third party, whereto all the manufacturers have to report information about certain issues. What to report is:

- Power consumption in different modes (described above)
- Instructions (or a link to instructions) for the customer on what to do when it is time for End of life treatment. Information for all the countries where the product is sold
- Information about the power management system available in the product

The consumers shall be able to use the web page to make comparisons on energy related issues between all available products. The information should be provided in a way that makes it easy for ordinary people to understand. The website could also provide a simple tool, similar to the calculation tool available at the Energy Star web page, where people can calculate their own energy cost. That can be done from input of their own use (hours a week in idle/sleep and off), power data of the products they are looking at, and their own energy price. Connected to this tool, instructions on how to use power management (i.e time settings and how to wake up from sleep), and the consequences of that shall be described. Perhaps by default values in the tool.

Suggested timing

Since this suggestion only calls for the industry to make measurements according to established measuring methods and develop the information, we suggest this requirement to be introduced as soon as possible it is assumed that this legislation will force the manufacturers to use the better performing processors, called processor power management (power management at component level).

A mandatory information sticker is assumed to affect all new products. In the graph below the requirement is assumed to be introduced in 2009. And the full impact is reached after 5-6 years (phasing out old products).

Impact of scenario 4. Possible option B for implementing measures

The main assumptions for the calculations for scenario 4, Possible option B for implementing measures are:

- Energy Star requirements is implemented as assumed in Business as usual scenario I,
- Power management at the described settings is assumed to become mandatory enabled 2009

- High efficient power supply units for desktops, laptops and monitors becomes mandatory 2009
- Minimum requirements for sleep and off becomes mandatory 2009
- Information requirements will support the use of power management at component level (making the processors more efficient) and become mandatory 2009
- The recommended minimum requirement for active/on-mode power for monitors, is estimated to become mandatory 2011 and complemented with the new developed Energy Star criteria for monitor active on-mode power. It is estimated to decrease the average power in active mode for monitors by 5%
- No minimum requirements for idle-mode for computers is included
- The Least Life Cycle Cost calculations made in task 7 supports all the recommended implementing measures.

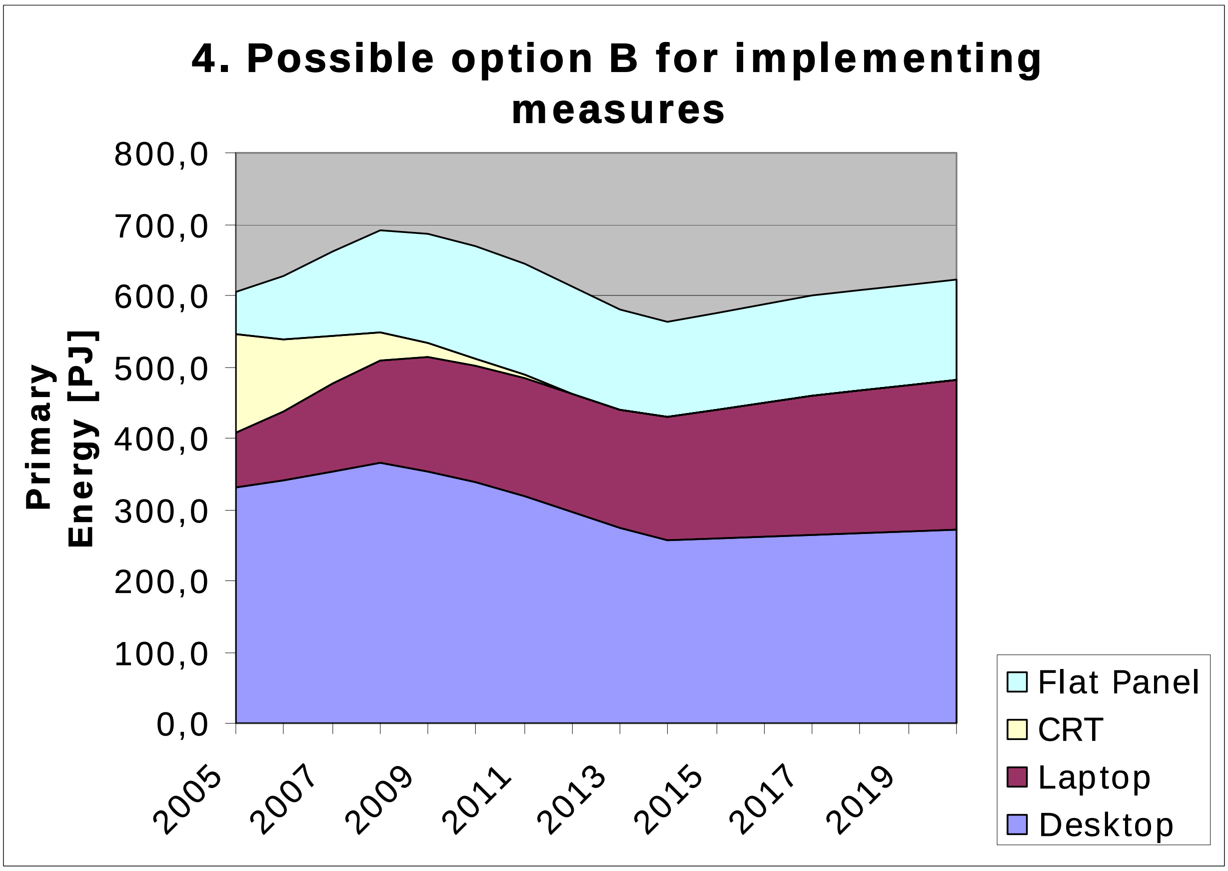

Figure 11 Primary energy use in scenario 4. Possible option B for implementing measures

	4. Possible option B for implementing measures					
	Desktop	Laptop	CRT	Flat Panel	Monitors	Summa
2005	331,4	76,4	138,2	60,1	198,3	606,2
2006	340,5	97,3	100,7	88,3	189,0	626,8
2007	353,8	121,7	67,8	117,7	185,5	661,0
2008	364,9	144,3	38,4	144,6	183,0	692,1
2009	353,5	159,1	20,4	154,2	174,5	687,1
2010	337,5	163,2	10,2	159,1	169,4	670,1
2011	317,5	166,5	4,1	156,3	160,4	644,3
2012	295,7	165,8	1,2	149,6	150,8	612,3
2013	274,3	164,6	0,0	141,0	141,0	579,8
2014	255,6	173,4	0,0	133,2	133,2	562,2
2015	259,4	180,9	0,0	136,2	136,2	576,5
2016	262,6	187,5	0,0	138,3	138,3	588,4
2017	265,1	194,2	0,0	139,5	139,5	598,8
2018	267,4	200,0	0,0	140,3	140,3	607,7
2019	269,3	205,4	0,0	140,8	140,8	615,5
2020	270,5	210,0	0,0	140,9	140,9	621,4

Figure 12 Primary energy use in scenario 4. Possible option B for implementing measures

This shows a large impact on the primary energy used compared to Business as usual scenarios. Approximately half of the improvement is due to implemented power management, and secondly comes the implemented high efficient power supplies (one third of the improvement).

1.1.8 Scenario 5. Industry recommendation

EICTA, AeA, and JBCE have submitted a suggestion for Ecodesign Requirements Options, which is included as an appendix to this report (EICTA, AeA, and JBCE 2007). The main issues are given in the following figure.

Feature	Product Category	Ecodesign requirements options (allowing for one product re-design cycle)	Ecodesign requirement options with prolonged transition time (e.g. 4+ years out)	Test procedure
Internal Power Supplier/IPS	Desktops	• 70% efficient at 20% load • 75% efficient at 50% and full load	• 80% efficiency levels (tested at 20%, 50%, and 100% loading)s • 0.9PF (Power Factor) at 100% load	http://www.efficientpowersupplies.org/
External Power Supplies (EPS)	Desktops, Notebooks	Must correspond with recommended improvement options for EuP Lot 7: • ≥84% efficiency (tested at 100%, 75%, 50%, and 25% of rated current output) • No load: 0.75 W (Harmonized with California CEC, E* Tier II for EPS)	n.a.	http://www.energystar.gov/ia/partners/prod_development/downloads/power_supplies/EPSupplyEffic_TestMethod_0804.pdf
Sleep	Desktops, Notebooks	Sleep (S3): • 10 W • Shipped w/ power management enabled • Computers enter low-power state after 30 minutes of inactivity	Sleep (S3): • 4 W/ 4.7 W (for desktops) • 1 W/ 1.7 W (for notebooks) (Harmonized with E* 4.0 Tier 1 for PCs)	http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/Computer_Spec_Final.pdf
Off / Standby	Desktops, Notebooks	Off/standby (S4/S5): • 5 W	Off/standby (S4/S5): • 2 W / 2.7 W (for desktops) • 1.7 W / 2.4 W (for notebooks) (Harmonized with E* 4.0 Tier 1 for PCs)	http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/Computer_Spec_Final.pdf
Display Energy	Displays (only LCD smaller 30")	• Maximum active power consumption equation: Y = 38X + 30. (Y is expressed in watts and rounded up to the nearest whole number and X is the number of mega pixels in decimal form) • Sleep Mode ≤ 4 W • Off Mode ≤ 2 W • Shipped w/ power management enabled • Displays enter sleep mode after 15 minutes of inactivity (Harmonized with E* 4.1 Tier 1 (covers on, sleep, and off mode))	n.a.	http://www.energystar.gov/ia/partners/product_specs/program_reqs/MonitorSpecV4.1.pdf
User Education	Desktops, Notebooks	Include with each computer information on the benefits of power management in either a hard copy or electronic copy of the user manual. At least the following information must be include: • Notice that the computer has been shipped enabled for power management and what the time settings are • How to properly wake the computer from Sleep mode (Harmonized with E* 4.0 for PCs)	n.a.	

Joint Industry Ecodesign Requirements Options for PCs and Monitors (20th March 2007)

Figure 13 Joint Industry Ecodesign Requirements Options for PCs and Monitors

A scenario based on the industry proposal is made. The proposal itself and the impact are commented below. The timing for the different requirements described are “allowing for one product redesign cycle” which in the impact calculations is assumed to come in place 2009 and “prolonged transition time (e.g. 4+ years out)” which in the impact calculations is assumed to come in place 2011.

Minimum requirements for monitors´ active power per resolution

EICTA, AeA , JBCE, 2007suggests minimum requirements on active power per mega pixel for monitors. The impact from having minimum requirements for active power consumption for monitors related to the resolution is very small if any. Power is related to screen area, as shown in the background document on monitors (to be included in task 4-5 in the final report). For some technologies, such as plasma screen it is also related to the resolution, but this is not the case for LCDs, which is the most common technology for monitors today. A requirement based on power per resolution will then possibly lead to that, for example, large monitors with low resolution have difficulties to comply. In principle a higher resolution could be provided with a view to achieve compliance. This could possibly lead to extra cost with little extra performance benefit. However, this risk is mainly related to large monitors for whom high resolution is NOT needed, e.g. products to be looked at from a distance, such as media computer monitors.

Minimum requirements for personal computers´ sleep and standby power

Industry [EICTA, AeA , JBCE, 2007] suggests the following minimum sleep and off requirements for desktops and laptops.

Table 4 Industry's suggestion for minimum requirements for personal computers´ sleep and standby power

Mode Timing	**Effective 2009**	**Effective 2011**	
	Desktops and Laptops	Desktops	Laptops
Sleep (S3)	10 W Shipped with energy management enabled, entering low power state after 30 minutes of inactivity	4 W/4.7 W	1 W/1.7 W
Off/Standby (S4/S5)	5 W	2 W/2.7 W	1.7 W/2.4 W

To get an idea of the impact of industry's suggestion for 2009, the levels suggested are compared to data from task 4 given in the tables below.

Table 5 Desktop energy consumption

Data sources / ***Operational modes***	**IVF summer survey**		**Product case data sets**	**Energy Star 2006 data**
	Office desktop	**Home desktop**		
Idle, Average (min – max) (Watt)	73,8 (70,5-78)	61 (50-79,7)	78,2	81,7 (23-221)
Sleep, Average (min – max) (Watt)	3,3 (1,2 - 4,2)	3,7 (2,61-5)	2,2	3,1 (10,1-1,4)
Off, Average (Watt)	1,4 (1 – 2,3)	1,4 (0,7-3)	2,7	2,0 (10,1-0,4)

None of the desktops in the IVF summer survey or in the Product case data sets, representing the best-sellers in 2005, are even close to exceeding the suggested minimum requirement effective 2009: 10 W in sleep and 5 W in standby mode. The Energy Star 2006 data (largely major brands/suppliers) represents more than 100 different models. Among those, only two exceed 10 W in sleep (10,1 W) and three exceed the 5 W standby level. On the other hand, the suggested minimum levels may have some effect on the 10-35% of the desktop market held by so called "White boxes", see Task 2, but due to lack of information available on this market segment it is impossible to quantify the effect. The same observations hold for the notebook market.

Table 6 Laptop energy consumption.

Data sources / ***Operational modes***	**IVF summer survey**		**Product case data sets**	**Energy Star 2006 data**
	Office laptop	**Home laptop**		
Idle, Average (min – max)	25,7 (18-	22,6 (17-	22,0	19,5 (6,8-38,1)

Data sources / ***Operational modes***	**IVF summer survey**		**Product case data sets**	**Energy Star 2006 data**
	Office laptop	**Home laptop**		
(Watt)	34,6)	34,2)		
Sleep, Average (min – max) (Watt)	3,2 (1,7-7,7)	2,3 (0,5-5,0)	4,9	1,4 (0,3-3,5)
Off, Average (Watt)	1,6 (0,3-3)	1,4 (0,28-3)	1,2	0,9 (0,1-2,4)

Industry's suggestion for 2011 correlates exactly with the criteria for Energy Star 4.0 Tier 1 becoming effective 20 July 2007 as far as sleep and standby are concerned. Wake on LAN capability gives an extra 0.7 W allowance in all modes. The Energy Star 4.0 Tier 1 levels were determined by using the Energy Star 2006 data, see tables above, in such a way that approximately 25% of the models should be able to qualify in all modes.

However, 91% and 76% of the desktop models fulfilled the standby and sleep modes; i.e. consumed less than 4 Watt in sleep (91%) and 2 Watt in standby (76%) mode respectively. The data from IVF summer survey and Product case data sets, representing the best sellers in 2005 suggest that most desktops (approx. 80%) sold that year fulfilled these criteria. Therefore minimum requirements at these levels will decrease the power consumption per desktop (in particular white box sector), but, considering that the sleep and standby phase 2005 were only 10% of the total use phase consumption, the total energy efficiency gains are limited.

The Energy Star 2006 data suggest that 81% of 2006 laptop models could meet the Energy Star low power mode criteria ; i.e. consumed less than 1,7 Watt in sleep and 1 Watt in standby mode respectively. However, the data from IVF summer survey and Product case data, representing the best sellers in 2005, suggest that the average laptop sold that year did not meet the Energy Star criteria. The conclusion is that the minimum requirements at the levels suggested by Industry for 2011 will on average decrease the power consumption per laptop in sleep and off/standby by approximately 1 Watt.

The conclusion is that industry's suggestion for 2011 regarding sleep and off, if implemented, would maintain or slightly decrease the power consumption of desktops and laptops in sleep and standby modes compared to the levels of 2005 and 2006. However, viewed in the context of also requiring enabled power management, industry's suggestion would also effect the power consumption presently allocated to the idle mode. In task 7 is estimated that improved power management could result in around 40% reduction of the total power consumption.

Minimum requirements for Power Supply unit efficiency

Most desktops currently on the market meet industry's recommendation for how efficient an internal power supply should be by 2009. There is a trend towards higher efficiency PSU. The recommendation may impact in particular the 10-35% of the desktop market held by "White boxes", see Task 2. However, again due to lack of information on this market segment it is impossible to quantify the effect reliably. The requirements suggested for the prolonged transition time (2011) are expected to lead to the energy savings for desktop computers shown in figure below. The expected energy savings for laptops applying the suggested power supply efficiency requirements for 2009 for external power supplies are also shown. Power supplies for Monitors is not included in the industry recommendation.

Mandatory enabling of Power management at system level

Mandatory enabling of power management before shipping the product is recommended by the industry. Some studies made by the industry (and shared with the Lot 3 under NDA) show that for products with an enabled power management system, less than 20% of the users turn it off, leading to a much higher use of such a system than if the user have to actively enable it. Information/User education about how to use the power management system should also be provided. Suggested settings for the power management is:

- 15 min to screen off (display sleep)
- 30 min to computer sleep (System Level S3, suspended to RAM)

Impact of the scenario proposed by Industry.

The main assumptions for the calculations are:

- Energy Star requirements is implemented as assumed in Business as usual I scenario
- Power management at the described settings is assumed to become mandatory enabled 2009, leading to that 80% of products use power management as suggested by EICTA, AeA and JBCE .
- High efficient power supply units for desktops becomes mandatory 2011, and for laptops 2009

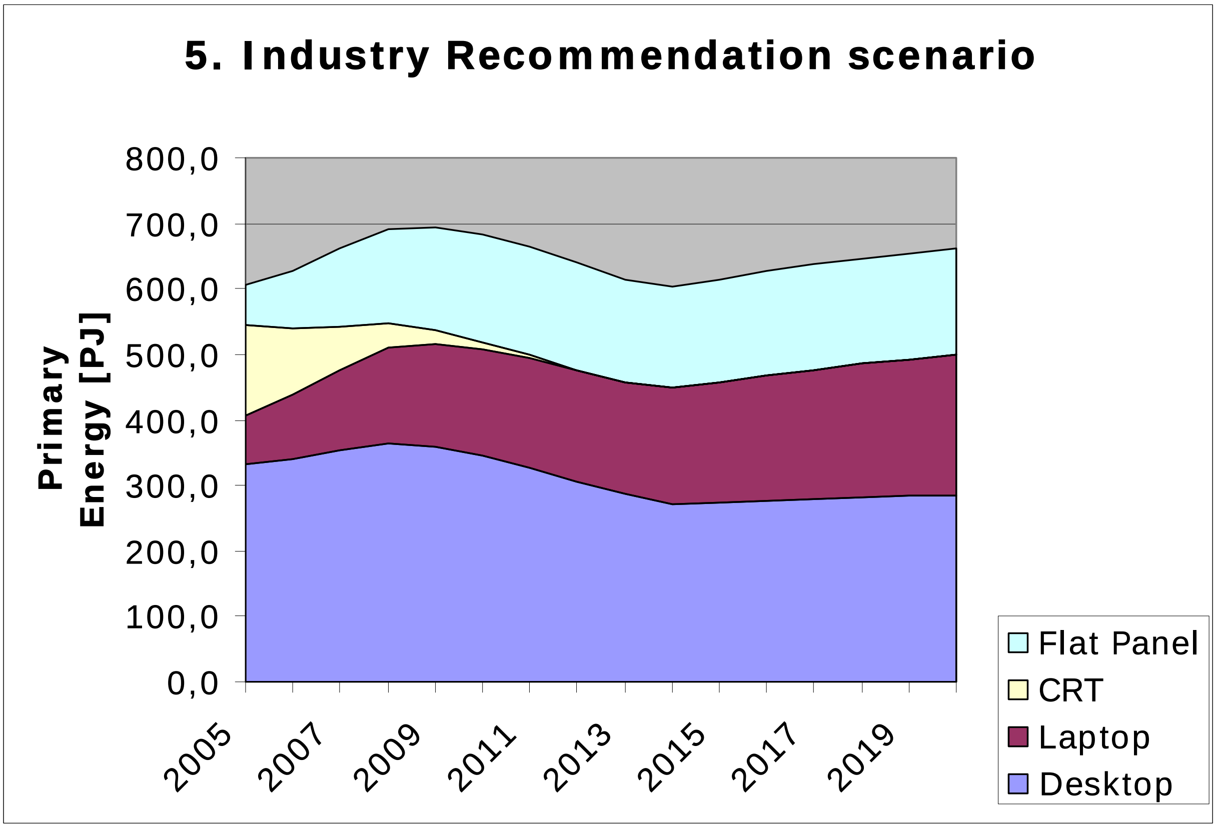

Figure 14 Primary Energy (PJ) Scenario following EICTA, AeA, JBCE 2007

	5. Industry recommendation					
	Desktop	Laptop	CRT	Flat Panel	Monitors	Summa
2005	331,4	76,4	138,2	60,1	198,3	606,2
2006	340,5	97,3	100,7	88,3	189,0	626,8
2007	353,8	121,7	67,8	117,7	185,5	661,0
2008	364,9	144,3	38,4	144,6	183,0	692,1
2009	357,6	159,1	20,3	156,8	177,1	693,8
2010	345,2	163,2	10,1	164,3	174,4	682,8
2011	326,1	168,9	4,0	166,3	170,3	665,3
2012	306,8	168,9	1,2	163,3	164,5	640,2
2013	287,8	168,6	0,0	158,1	158,1	614,5
2014	271,7	177,1	0,0	153,3	153,3	602,1
2015	273,8	184,4	0,0	156,8	156,8	615,1
2016	276,1	191,2	0,0	159,2	159,2	626,5
2017	278,8	198,0	0,0	160,7	160,7	637,5
2018	281,2	203,9	0,0	161,5	161,5	646,7
2019	283,2	209,4	0,0	162,1	162,1	654,7
2020	284,5	214,1	0,0	162,2	162,2	660,9

Figure 15 Primary Energy (PJ) for Scenario following EICTA, AeA, JBCE 2007

- From the figure above, it is obvious that industry's recommendation have an impact on the energy used, compared to the business as usual scenario. The main difference is due to power management enabling, and the more efficient power supply units.

1.1.9 Comparison between the different scenarios for the products one by one

To be able to compare the different scenarios for one product at the time, the following graphs are included.

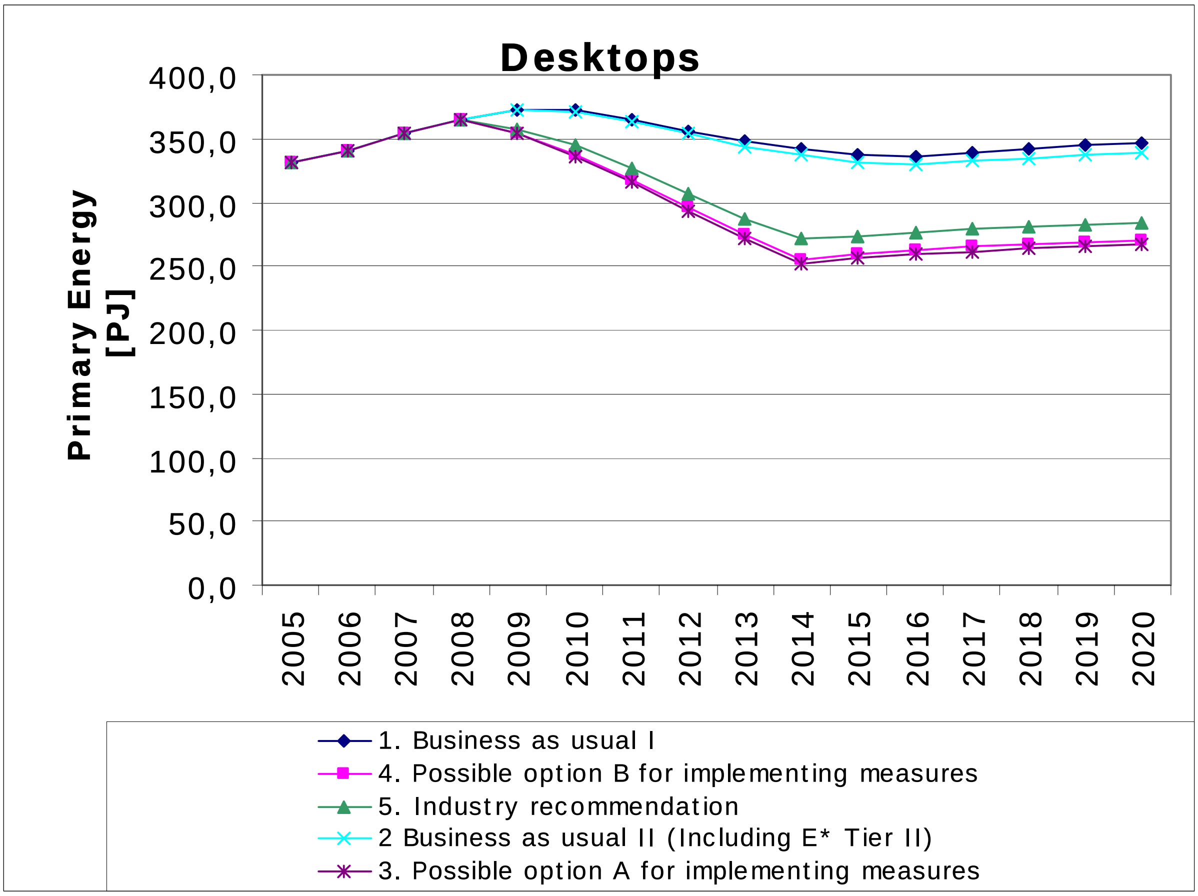

Figure 16 The different scenarios described for desktops. Note the difference in timing for implementing efficient power supply units between possible options A&B and Industry recommendation. Half of the difference between Business as usual scenarios and other scenarios is due to the implemented power management in the latter. The Discontinuities are depending on the time to implement a feature in the whole stock. The idle-on requirement for computers give the best scenario, followed by the information requirement scenario, both including enabled power management and power supply efficiency requirements. Industry recommendation does mainly include enabled power management and power supply efficiency requirements.

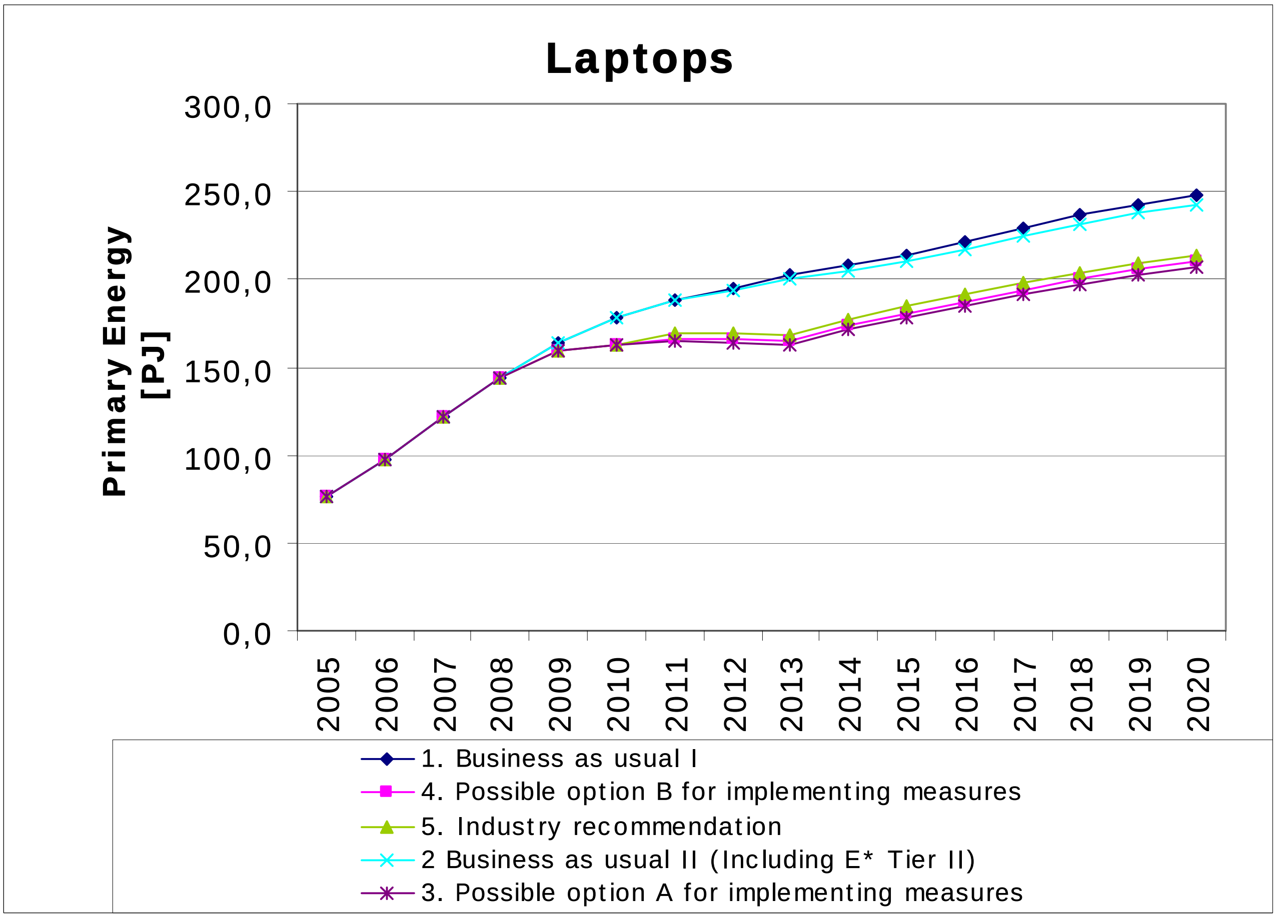

Figure 17 The different scenarios described for laptops. The main difference between the business as usual scenario and the three others is due to enabled power management requirement in the latter.

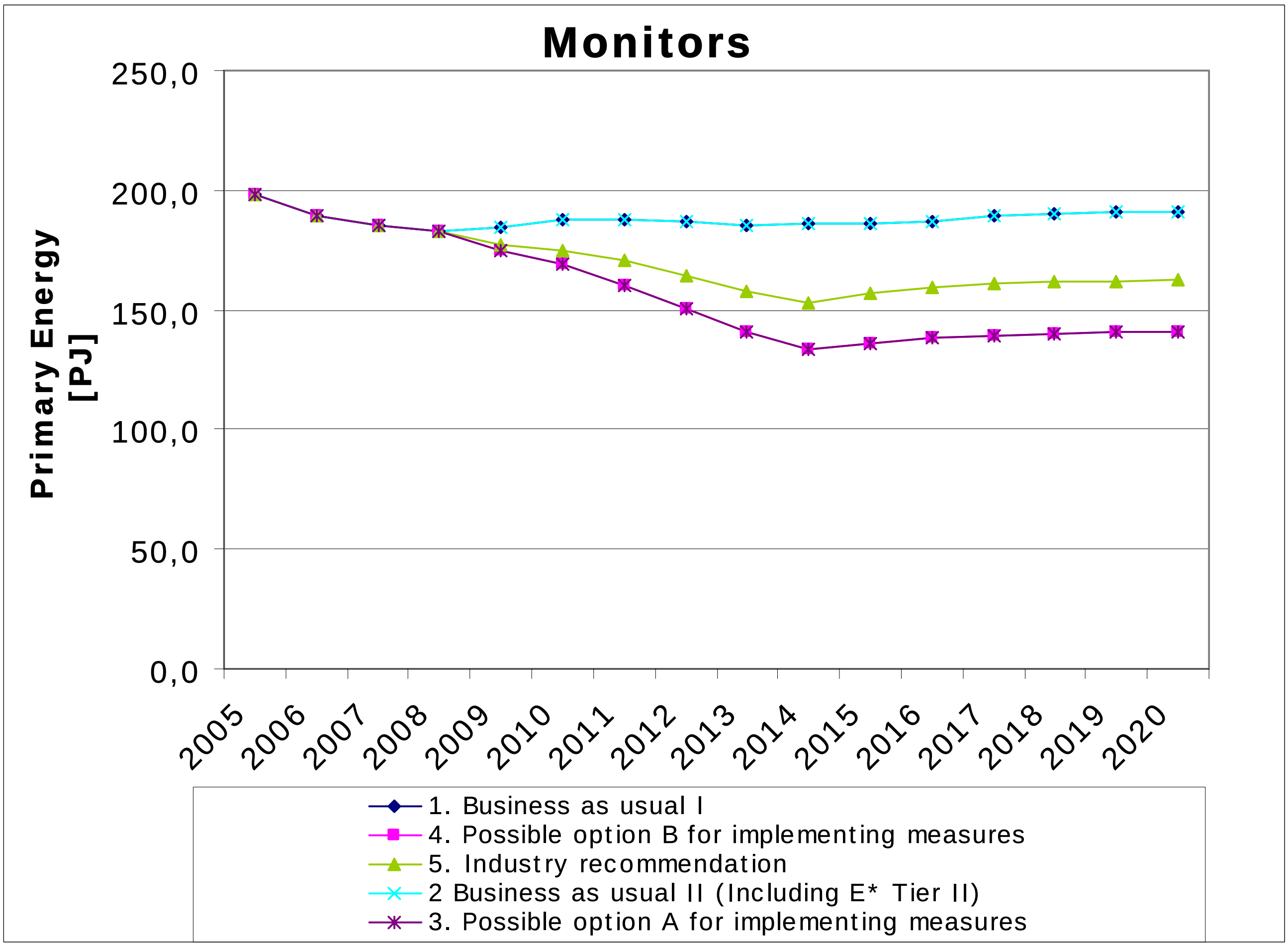

Figure 18 The different scenarios described for monitors. Note the difference between the possible options A&B and the Industry recommendation, based on that the Possible options include a high efficient power supply unit even for monitors from 2009 and a power per area requirement from 2011. The discontinuities are due to the timing from implementation until the whole stock is changed.

1.1.10 Study recommendation

The Lot 3 study recommends to implement scenario 4, Possible option B, since that scenario is based on least life cycle cost, gives a huge positive impact on energy consumption, and is not blocking technology development.

1.1.11 Possible measures not recommended by the study

In recently introduced circuit technology, several functions for saving of energy have been introduced at chip level. Examples are “reduction of clock frequency when full power is not needed”, “reduction of voltage when full power is not needed” and “multiple processor cores in one chip, of which only the necessary number are used in a specific moment”. Each of these technologies, are effective. However, requirements would be technology specific and could lead to obstacles for the development of better technologies.

1.1.12 Additional suggestions

The following suggestions are not following directly from applying the MEEuP methodology, but are anyhow based on the experiences gained when carrying out the study.

Research: User behaviour study, Personal Computers and Monitors

In order to better understand the usage pattern, and to further develop energy efficient equipment, there is a need to study the usage pattern for computers and computer monitors. Available reports are often old, and the usage tends to change when new applications are available, such as Internet gaming, online bank offices, telephoning or movie watching over the computer. Studies available is often based on questionnaires rather than measuring (logging) the behaviour, which gives less reliable results. There is at least one study of good quality available, but that study only covers a small geographic area compared to the whole EU, and only home users. Thus, there is a need to make a larger study. The suggested study should use logging methods and/or “ping” technologies in order to measure the true usage pattern in different modes. It should cover at least users in all the countries and also different kind if users, such as office/home, different age, sex, interests etc. It can be complemented with a survey where the users are asked questions, in order to better understand underlying causes of their behaviour. Such a study would aid in the development of new computer systems.

Education

The consumer behaviour has a large impact on the environmental performance of products evaluated in this study. One option with a large improvement potential not discussed earlier could therefore be consumer education. Education could help users to understand and use power management in a proper way, and could also offer guidance in purchasing choices. Education can be delivered in many ways; such as implementing easy access tutorial tools integrated in the computer software or at a website. Another solution might be to educate all pupils at school, to provide them with a “driving license for computers”. The impact of such education could be huge.

Software development

The performance of software is not within the real scope of this study, but since the effects on the environmental impact and LCC of computer products are quite significant it is still worth to comment.

The potential positive influence from power management, have been covered in several of the previous chapters, but it is also obvious that the full potentials of the hardware power management functions, very seldom are utilized due to software problems or even perceived software problems.

The recently introduced operating system Vista includes much more powerful power management functionality than the previous operating systems, but due to the increased demands for computer capacity for other functions, environmental improvements attributable to Vista is questionable.

The increased capacity and functionality from new software is obvious: more graphics, easier to use, better integration of different applications and so on. But seen from another standpoint: real improvements in capacity versus increased demands for computing power are not that positive. The documents written in a brand new word-processor are not that much better than the documents written a couple of years ago using much less computing power and energy.

The potential for better LCC from dedicated software development with energy efficiency in focus is quite high, but it has probably not yet become a strong enough selling argument, to influence the new products.

Implementing measures on other things than energy

Besides energy consumption, the further major environmental issues to deal with for the products studied are the

- Content of flame retardants in plastics and electronics
- Content of mercury in the lamps for LCD screens and laptops
- Content of chemicals in the batteries of laptops.

The analysis of the environmental parameters has shown that the by far most significant aspect is energy consumption, the improvement options and implementing measures recommended by the study are focused on reduced energy consumption. Other improvement options described in task 6-7 are concerning further impacts.regarding other things. The recommendation is to include information about specific restricted substances such as mercury and lead in the information about the product, see chapter 1.1.7. Regarding the flame-retardants, and possibly also the chemical content of the batteries for laptops, this should be handled under the RoHS-directive on a substance-by-substance basis. New chemicals should be handled by the REACH-directive.

1.2 Sensitivity analysis of the main parameters

The calculations carried out in this preparatory study should serve dual purposes: one is to assess the total energy consumption and environmental impact in EU25 from personal computers and monitors, the other is to give knowledge about design options that could reduce the environmental impact with focus on energy consumption. The most significant data aspects and assumptions and how they have been dealt with in the study are:

- Market data from different sources is not fully consistent, which required some principle estimations. However, the data has been discussed intensively with the stakeholders and they are in agreement.

- Use patterns vary a lot and there are no complete studies covering all users in EU 25. Also regarding the service life of a computer, no comprehensive data was available. The impact of uncertainties in use patterns and service life are shown below in the sensitivity calculations.
- The idle power values used in the base-case calculations are only indicators of the true power values during use of the computers and therefore uncertain. The impact of this uncertainty is shown below in the sensitivity calculations.
- The base cases are as required by the methodology a “conscious abstraction of reality” but cannot claim to be in a scientific statistical sense representative. We have used data for the best sellers, but not qualified to which degree these data really reflects the average. The chosen number of base cases contributed to the overall robustness of the results for individual segments.
- Data on power use and BOM when provided by manufacturers has not been empirically verified, but inconsistencies have been clarified with the data providers.
- The “base case” results can only reflect assessments on the level on which the EcoReport requires entries (e.g. no differentiation of substrate materials, no differentiation of electronic component compositions, no entries / analyses of hazardous materials foreseen such as flame retardants). Some basic data, e.g. for batteries, is completely missing. Correct evaluation of LCD screens without mercury (with LED-backlights) is impossible.
- Electronics design is a comprehensive task with a huge number of variables. To come to precisely quantified effects of technical improvement options taking into account the variety of possible specifications as well as of electrical parameters is not feasible. The conclusions described in task 7 should therefore be considered valid (and robust with the three exceptions described below) in the general case. For a single computer or monitor specification, deviations from the conclusions should always be expected and investigated.

1.3 Sensitivity calculations

The Ecoreport tool is not suited for common types of sensitivity analysis in life cycle assessment, e.g. how the electricity is produced or how materials are produced. Therefore the sensitivity analysis is limited in scope.

As mentioned before, the uncertainties are large concerning usage patterns. In addition, the idle power values used in the base-cases calculations are only indicators of the true power values during use of the computers and therefore uncertain. Usage pattern uncertainties, uncertainties in power values and uncertainties about the service life time can be treated together as uncertainty in the energy used when using the computer/monitor, since energy = power * time. There are also large variations in the price of electricity between different EU countries. These aspects, variations in energy and price of electricity, are highlighted below with the aid of the EcoReport tool.

For the improvement options described in task 7, the parameters are varied within the uncertainty intervals. Life cycle cost and impact is compared to the base case calculations. It is shown below that the conclusions about the improvement options are robust for all improvement options except 80+PSUs in home laptops and home LCDs, in interval –50% to +50% on the price of electricity and –50% to +100% in electric energy during use.

1.3.1 Use electricity

The energy used when using the computer/monitor is electricity taken from the national grid. It will henceforth be referred to as Use electricity. Use electricity is varied between –50% to +100%.

The reason for having an unsymmetrical span is that the idle power value is only a minimum indicator of the true power during use. It cannot be smaller, only larger. As explained above, variations in Use electricity can represent variations in power and/or time the computer or monitor is on in the different modes and/or service lifetime. Since most energy is used in the idle power mode, see figure below, there is a limit to how much of the variation that can be attributed to the sleep and off modes.

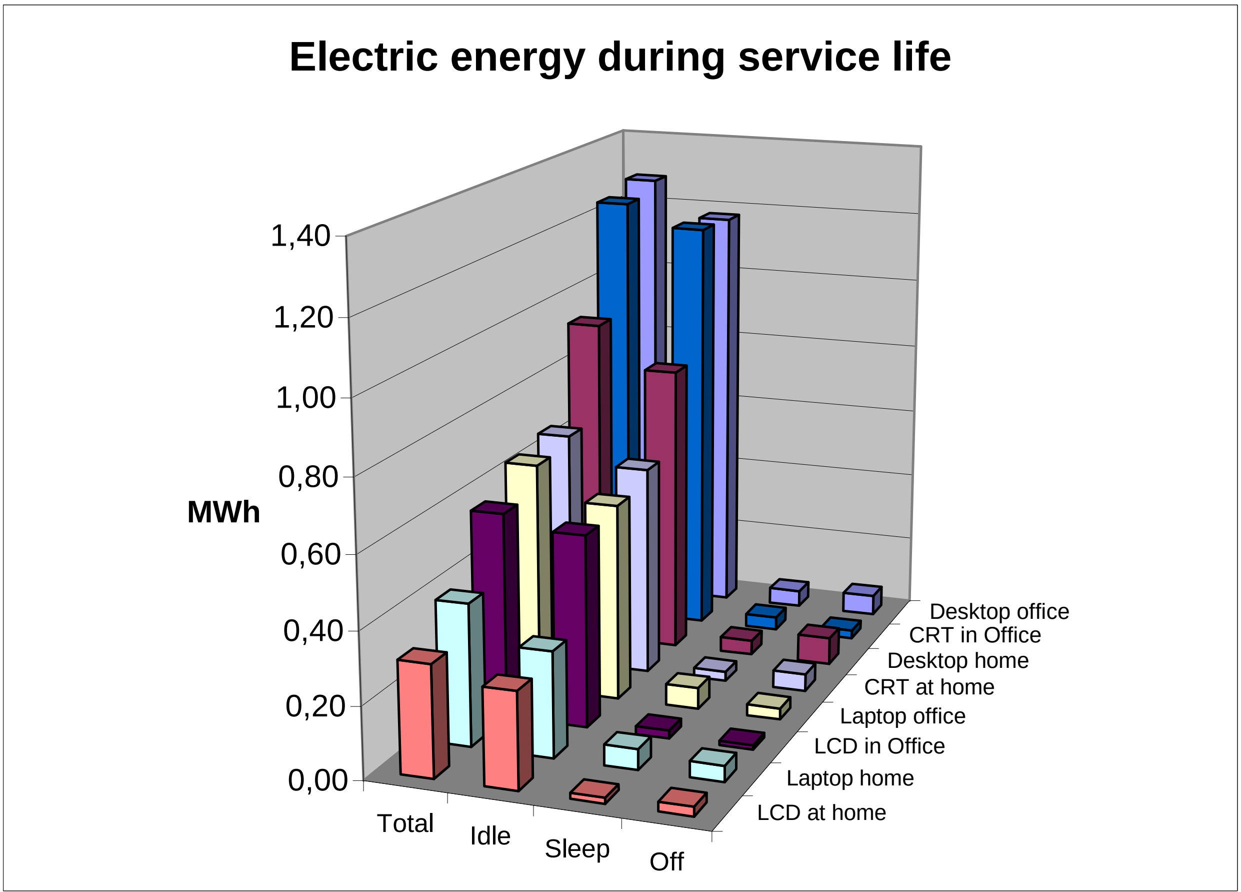

Figure 19 Energy use during service life for all the products, and use modes

The Ecoreport calculates the Use electricity as:

> Use electricity = Product life in years * (Idle/On hours per year * Idle/On power + Sleep hours per year * Sleep power + Off hours per year * Off power)

In the table below is shown in absolute figures for an office LCD-display how much the parameters Product life, On power and On hours can vary (everything else remaining constant) to depict –50% Use electricity and +100% Use electricity. Variation between usage pattern studies, see Task 3, is in that order of magnitude. Variations in Product life and Idle/On power are assumed to be in the order of plus/minus 10-20%, i.e. much less.

Table 7 Example of what the Use electricity uncertainty span may represent

	-50%	**Base case**	**+100%**
Product life (years)	3,3	6,6	12,4
On power (kW)	~15	31,4	~64

	-50%	Base case	+100%
On hours per year	~1200	2586	~5400

In the sensitivity calculations, Use electricity is modelled by varying the hours in the modes idle/on and sleep. Results for the improvement options are given in the table below.

Since all improvement options reduce the amount of Use electricity needed and thus save more electricity cost the more energy is used, the plus 100% alternative would always make the improvement options more attractive both economically and environmentally. Therefore the improvement options are not calculated with the plus 100% alternative. Furthermore, since there is no extra cost associated with improved power management, this option would always (both at minus 50% Use electricity and at plus 100% Use electricity) be more attractive both economically and environmentally. Therefore, the power management option is excluded from the sensitivity calculations.

When the Use electricity is decreased the improvement options gets less economically and environmentally attractive. Cases where the improvement option with the minus 50% alternative does not get least life cycle cost are highlighted in the table below. This happens only for home laptops and LCDs fitted with 80+ PSU and the difference is very small. This means that the conclusions about 80+ PSU in home laptops and LCDs giving least life cycle cost are not as robust. But all the other conclusions about the improvement options are robust, at least in the interval –50% to +100% Use electricity.

Table 8 Sensitivity calculations at product level varying Use electricity

Improvement	**Parameters**	**Use electricity (MWh)**			**Life cycle cost (Euro)**		
		-50%	**Used values**	**+100%**	**-50%**	**Used values**	**+100%**
Office desktops	No option (base case)	0,64	1,28	2,56	818	900	1062
	Power management	NA	NA	NA	NA	NA	NA
	80+PSU	0,52	1,03	2,06	808	873	NA
	Improved processor	0,50	0,99	1,98	811	872	NA
	PM at processor level	0,54	1,08	2,16	806	875	NA
Home desktops	No option (base case)	0,47	0,93	1,86	697	756	NA
	Power management	NA	NA	NA	NA	NA	NA
	80+PSU	0,38	0,75	1,50	690	738	NA
	Improved processor	0,37	0,73	1,46	694	740	NA
	PM at processor level	0,40	0,8	1,60	688	738	NA
Office laptops	No option (base case)	0,28	0,55	1,10	1396	1430	1501
	Power management	NA	NA	NA	NA	NA	NA
	80+PSU	0,21	0,42	0,84	1392	1419	NA
Home laptops	No option (base case)	0,17	0,34	0,68	1129	1151	1195
	Power management	NA	NA	NA	NA	NA	NA
	80+PSU	0,13	0,25	0,50	1130	1145	NA
Office LCD	No option (base case)	0,29	0,57	1,14	238	274	NA
	Power management	NA	NA	NA	NA	NA	NA
	80+PSU	0,23	0,46	0,92	236	265	NA
Home LCD	No option (base case)	0,16	0,31	0,62	221	240	280
	Power management	NA	NA	NA	NA	NA	NA

Improvement	Parameters	Use electricity (MWh)			Life cycle cost (Euro)		
		-50%	Used values	+100%	-50%	Used values	+100%
	80+PSU	0,13	0,25	0,50	223	238	NA
Office CRT	No option (base case)	0,63	1,25	2,50	154	232	391
	Power management	NA	NA	NA	NA	NA	NA
	80+PSU	0,50	1,00	2,00	142	205	NA
Home CRT	No option (base case)	0,34	0,67	1,34	116	158	243
	Power management	NA	NA	NA	NA	NA	NA
	80+PSU	0,27	0,53	1,06	112	146	NA

The table above shows that all the conclusions about the improvement options in Task 7 are robust, in the interval –50% to +100% Use electricity, except the conclusions about 80+ PSU in home laptops and LCDs (highlighted) which are robust until very extreme values.

1.3.2 Electricity price

Electricity prices are varied 50% up and down to reflect price variations in Europe. The electricity price for the base-case was 0,136 Euro/kWh. The uncertainty interval is thus in absolute figures 0,136 +/- 0,068, i.e. 0,068 Euro to 0,204 Euro per kWh. The results for the improvement options are given in the table below.

Since all options reduce the amount of Use electricity needed and thus save more electricity cost the higher the electricity price is, the plus 50% alternative would always make the improvement options more attractive economically. Therefore the improvement options are not calculated with the plus 50% alternative. Furthermore, since there is no extra cost associated with improved power management, this option would always be more attractive economically as long as something is paid for the electricity. Therefore, the power management option is excluded from the sensitivity calculations.

When the electricity price is decreased the improvement options gets less economically attractive. Cases where the improvement option with the minus 50% alternative does not get least life cycle cost are highlighted in the table below. This happens only for 80+PSUs in home laptops and home LCDs. This means that the conclusions about 80+ PSU in home laptops and LCDs giving least life cycle cost are not that robust. But all the other conclusions about the improvement options are robust in the interval –50% to +50% on the price of electricity. This is the same robustness result as for uncertainties in Use electricity above.

Table 9 Sensitivity calculations at product level varying electricity price

Improvement	Parameters	Life cycle cost (Euro) at varying electricity price	
		-50% (0,068 E/kWh)	Used values (0,136 E/kWh)
Office desktops	No option (base case)	818	900
	80+PSU	807	873
	Improved processor	810	872
	PM at processor level	806	875
Home	No option (base case)	696	756

Improve ment	Parameters	Life cycle cost (Euro) at varying electricity price	
		-50% (0,068 E/kWh)	Used values (0,136 E/kWh)
desktops	80+PSU	690	738
	Improved processor	693	740
	PM at processor level	688	738
Office laptops	No option (base case)	1395	1430
	80+PSU	1392	1419
Home laptops	No option (base case)	1129	1151
	80+PSU	1129	1145
Office LCD	No option (base case)	237	274
	80+PSU	235	265
Home LCD	No option (base case)	221	240
	80+PSU	222	238
Office CRT	No option (base case)	152	232
	80+PSU	142	205
Home CRT	No option (base case)	115	158
	80+PSU	112	146

1.3.3 EU-25 level

In the Table below is shown how variations in Use electricity would influence the results at EU-25 level at present.

Table 10 Sensitivity calculations at EU-25 level varying Use electricity

Improve ment	Parameters	Use electricity per product (MWh)			Total primary energy (PJ)		
		-50%	Used values	+100 %	-50%	Used values	+100 %
Office desktops	No option (base case)	0,64	1,28	2,56	67	112	202
	Products with LLCC	0,21	0,42	0,84	38	52	82
Home desktops	No option (base case)	0,47	0,93	1,86	129	204	354
	Products with LLCC	0,17	0,34	0,68	80	108	164
Office laptops	No option (base case)	0,28	0,55	1,10	36	54	92
	Products with LLCC	0,13	0,26	0,52	26	35	53
Home laptops	No option (base case)	0,17	0,34	0,68	19	26	42
	Products with LLCC	0,10	0,19	0,38	16	20	28
Office LCD	No option (base case)	0,29	0,57	1,14	19	28	47
	Products with LLCC	0,13	0,26	0,52	14	18	27
Home LCD	No option (base case)	0,16	0,31	0,62	34	46	69
	Products with LLCC	0,08	0,15	0,30	28	34	45
Office CRT	No option (base case)	0,63	1,25	2,50	26	49	97
	Products with LLCC	0,27	0,55	1,10	12	23	44
Home CRT	No option (base case)	0,34	0,67	1,34	35	64	126
	Products with LLCC	0,16	0,32	0,64	19	33	62
Total	No option (base case)				**365**	**583**	**1029**
	Products with LLCC				**233**	**323**	**505**

In the figure below is shown how variations in Use electricity would influence the results at EU-25 level from 2005 to 2020 assuming a business as usual scenario.

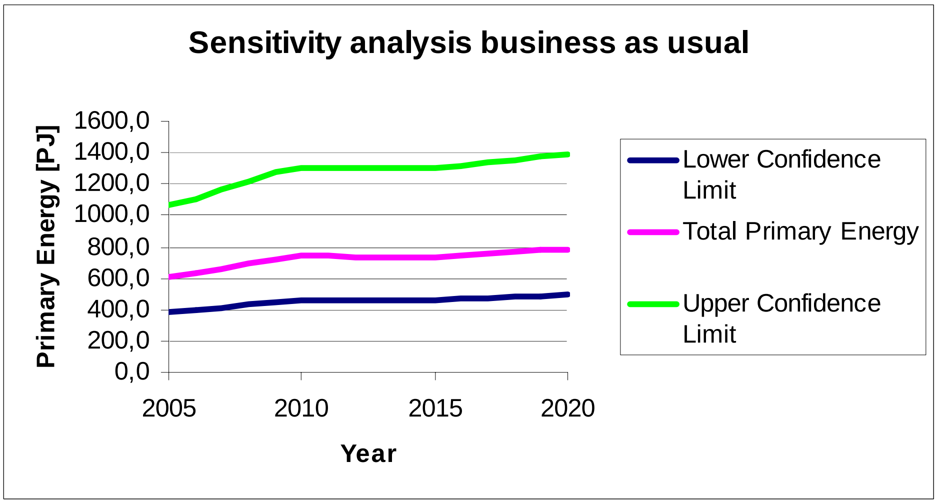

Figure 20 Sensitivity to variations in Use electricity assuming a business as usual scenario

1.3.4 Conclusions from the sensitivity analysis

The most significant data aspects and assumptions have been identified and discussed. To check the robustness of the results against the major insecurities, all conclusions regarding LLCC options, have been recalculated varying the price of electricity between –50% and +50% and the electric energy during use between –50% and +100%, and in general found robust. The results also show that when recalculating the total use of primary energy at EU-25 level for 2005 changing the parameters as described above, the total primary energy consumption from personal computers and monitors will differ between 365 and 1029 PJ. All suggested options for LLCC are robust, and will remain LLCC even if the parameters price and energy use are changed within large ranges as described above.

References

- Computertechnik, Monitor statistics during the years 1998 to 2006 (German Magazine)
- Energy Star database for monitors, may 2007
- ENERGY STAR® Program Requirements for Computer Monitors Eligibility Criteria (Version 4.1)
- ENERGY STAR® Program Requirements for Computers. Version 4.0
- Implementing measures recommended by the industry; Joint Position paper: Ecodesign Requirements for EuP Study on PCs and Monitors (Lot3). Brussels, March 20th 2007) by EICTA, AeA and JBCE.

- Personal Computers (desktops and laptops) and Computer Monitors Draft Final Report (Task 1-7)

1.4 Appendix 1: Joint Industry Ecodesign Requirements Options for PCs and Monitors (Lot3)

Brussels, March 20th 2007

Joint Position Paper: Ecodesign Requirements Options for EuP Study on PCs and Monitors (Lot 3)

For many years the electronics industry has been committed to putting on the market environmentally conscious designed products as part of their sustainability policy. The electronics industry believes that environmental regulation, if necessary, should favour a level playing field and support industry moves towards continuously improved products. EICTA, AeA Europe and JBCE have welcomed the EuP ecodesign framework Directive as an opportunity for our industry to see further stimulation of our already comprehensive ecodesign efforts.

The electronics industry supports voluntary, market oriented programs and initiatives, including industryled standards, such as Energy Star, which highlight and sustain energy efficient product design and purchasing.

However, voluntary initiatives may contain aspirational elements and should not be used to regulate products. Legal requirements should complement and build on existing voluntary efforts to the maximum degree possible.

Legal requirements are most effective as an instrument to protect public health and the environment and to establish a minimum acceptable performance level while voluntary programs should provide direction to those seeking to go beyond baseline performance levels.

In the case the European Commission decides to propose legislation for PCs and monitors through an implementing measure of the EuP ecodesign framework Directive, EICTA, AeA Europe and JBCE would be in favour of the adoption of ecodesign requirements options similar to the ones specified below. We believe that these options will enable the European Union to meet the goals of the EuP ecodesign framework Directive while simultaneously driving measurable innovation within the IT industry at a manageable cost.

It is important however to take into account that these ecodesign requirement options are very much dependent on the actual implementation date of the EuP implementing measure. The IT industry has fixed redesign cycles and would need at least 12 months from adaptation to implementation of an EuP implementing measure. If this transition timeframe is prolonged, EICTA, AeA Europe and JBCE are of the opinion that ecodesign requirement options similar to the existing voluntary programs, such as Energy Star, could be envisaged.

Feature	Product Category	Ecodesign requirements options (allowing for one product re-design cycle)	Ecodesign requirement options with prolonged transition time (e.g. 4+ years out)	Test procedure
Internal Power Supplier/IPS	Desktops	• 70% efficient at 20% load • 75% efficient at 50% and full load	• 80% efficiency levels (tested at 20%, 50%, and 100% loading)s • 0.9PF (Power Factor) at 100% load	http://www.efficientpowersupplies.org/
External Power Supplies (EPS)	Desktops, Notebooks	Must correspond with recommended improvement options for EuP Lot 7: • ≥84% efficiency (tested at 100%, 75%, 50%, and 25% of rated current output) • No load: 0.75 W (Harmonized with California CEC, E* Tier II for EPS)	n.a.	http://www.energystar.gov/ia/partners/prod_development/downloads/power_supplies/EPSupplyEffic_TestMethod_0804.pdf
Sleep	Desktops, Notebooks	Sleep (S3): • 10 W • Shipped w/ power management enabled • Computers enter low-power state after 30 minutes of inactivity	Sleep (S3): • 4 W/ 4.7 W (for desktops) • 1 W/ 1.7 W (for notebooks) (Harmonized with E* 4.0 Tier 1 for PCs)	http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/Computer_Spec_Final.pdf
Off / Standby	Desktops, Notebooks	Off/standby (S4/S5): • 5 W	Off/standby (S4/S5): • 2 W / 2.7 W (for desktops) • 1.7 W / 2.4 W (for notebooks) (Harmonized with E* 4.0 Tier 1 for PCs)	http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer/Computer_Spec_Final.pdf
Display Energy	Displays (only LCD smaller 30")	• Maximum active power consumption equation: Y = 38X + 30. (Y is expressed in watts and rounded up to the nearest whole number and X is the number of mega pixels in decimal form) • Sleep Mode ≤4 W • Off Mode ≤2 W • Shipped w/ power management enabled • Displays enter sleep mode after 15 minutes of inactivity (Harmonized with E* 4.1 Tier 1 (covers on, sleep, and off mode))	n.a.	http://www.energystar.gov/ia/partners/product_specs/program_reqs/MonitorSpecV4.1.pdf
User Education	Desktops, Notebooks	Include with each computer information on the benefits of power management in either a hard copy or electronic copy of the user manual. At least the following information must be include: • Notice that the computer has been shipped enabled for power management and what the time settings are • How to properly wake the computer from Sleep mode (Harmonized with E* 4.0 for PCs)	n.a.	

Joint Industry Ecodesign Requirements Options for PCs and Monitors (20th March 2007)

AeA Europe

AeA Europe represents leading European high-tech operations with American parentage. Collectively we invest Euro 100 bn in Europe and employ approximately 500,000 Europeans. Member companies are active throughout the high-technology spectrum, from software, semiconductors and computers to Internet technology, advanced electronics and telecommunications systems and services. Our parent company, AeA, is the oldest and largest US high-tech association (2500 + companies).

EICTA

EICTA, founded in 1999 is the voice of the European digital technology industry, which includes large and small companies in the Information and Communications Technology and Consumer Electronics Industry sectors. It is composed of 55 major multinational companies and 38 national associations from 27 European countries. In all, EICTA represents more than 10,000 companies all over Europe with more than 2 million employees and over EUR 1,000 billion in revenues.

JBCE

The Japan Business Council in Europe was founded in 1999 as the representative organisation for Japanese companies operating in the European Union. Our members consists more than 60 leading multinational corporations for electric, electronic, automobile and chemical sectors in the world. The JBCE's key objective is to contribute to EU public policy issues in a positive way, drawing upon the experience gained in Japan and other countries and utilizing the expertise developed in specific fields, such as environmental protection and technological innovation.