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Revision of the EU Green Public Procurement (GPP) Criteria for Computers and Monitors

TECHNICAL REPORT

Final criteria

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Abstract

Revision of the EU Green Public Procurement (GPP) Criteria for Computers and Monitors, Technical report: final criteria

The revision of the Green Public Procurement (GPP) criteria for Computers and Monitors is aimed at helping public authorities to ensure that computers and monitors are procured in such a way that it delivers environmental improvements that contribute to European policy objectives for energy, chemical management and resource efficiency, as well as reducing life cycle costs. In order to identify the most significant improvement areas for criteria development an analysis has been carried out of the environmental and health impacts of manufacturing and using computers and monitors. The most commonly used procurement processes for computers and monitors have been also identified and are further addressed in the separate criteria document (published as a Staff Working Document of the Commission). Together these two documents aim to provide public authorities with orientation on how to effectively integrate these GPP criteria into the procurement process.

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1. INTRODUCTION

This document is intended to provide the background information for the revision of the Green Public Procurement (GPP) criteria for Computers and Monitors. The study has been carried out by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) with technical support from the Oeko-Institut. The work is being developed for the European Commission's Directorate General for the Environment.

1.1 The criteria revision process and evidence base

The main purpose of this document is to evaluate the current criteria and discuss if the criteria are still relevant or should be revised, restructured or removed. It also identifies, based on the background technical analysis, new criteria areas for consideration in order to better address key environmental impacts of the product group.

This document is complemented and supported by a set of preliminary technical reports addressing[1]:

- Scope and definitions (Task 1 report),
- Market analysis (Task 2 report),
- Technical analysis (Task 3 report),
- Improvement potential (Task 4 report),
- EU Ecolabel criteria proposals (Task 5 report).

Furthermore, during the course of the revision process three general questionnaires on the scope, improvement potential and public procurement experience, as well as queries specific to certain criteria proposals, were sent out to selected stakeholders. The target groups were industry, Member States, public bodies, NGOs and research

[1] The previous Task 1-5 reports and further information can be downloaded at http://susproc.jrc.ec.europa.eu/computers/stakeholders.html

institutions. The specific information, views and suggestions arising from questions about the scope, improvement potential and procurement experience are reflected in both the EU Ecolabel criteria proposal document (Task 5) and this criteria document.

The draft version of the EU Ecolabel technical report (Task 5) built the basis for the first Ad-Hoc Working Group (AHWG) meeting which took place in October 2013.

A first version of this document, together with the April 2014 drafts of the EU Ecolabel criteria for the product groups 'Personal and notebook computers' and 'Displays' were presented at a second AHWG in May 2014. The subsequent feedback from the meeting and in written form, together with follow-up research, has been used to revise this document and the associated criteria proposals.

For each of the criteria areas, the current criteria and the most up to date revised criteria proposal (yellow) are presented. A supporting discussion of the rationale for the proposed changes (or not) to the criterion is also provided, based on the stakeholder feedback and technical background research. In some cases proposals for *new* criteria have also been made.

1.2 Criteria definition and scope

Present scope, **EU GPP criteria for Office IT Equipment**
Office IT equipment as dealt with in this document covers two sets of products: - Computers - covering both PCs and notebooks - Monitors For the purpose of defining these green public procurement criteria (guidelines), this product group includes six categories: - Personal computer (Desktop Computer, Integrated Desktop Computer, Thin Client) - Computer display (where supplied with a computer) - Keyboard (where supplied with a computer) - External power supply (where supplied with a computer) - Notebook computers (includes tablet personal computers) - Discrete graphics processing unit (where supplied with a computer) Criteria for PCs, notebooks and monitors are grouped together.

1.2.1 Stakeholder feedback to date

In the initial phase of the revision stakeholders were asked to provide feedback on whether the proposed scope reflects Computer and Monitor Equipment procurement priorities and if there is a need for a clearer definition of computer displays due to their increasing overlap with television displays.

Feedback from GPP stakeholders earlier in the EU Ecolabel revision process (March 2013) and from a GPP specific questionnaire revealed that the proposed scope was widely accepted. Beyond that, the following points were raised:

- The suggestion was made that mobile phones should be added to the list as the line between tablets and mobile phones is increasingly narrow.
- A contracting authority had procured tablets and telephones together as mobile devices, from mobile service providers, but it was noted that others may have divided their contracts differently.
- Another stakeholder proposed that tablet computers not be included in the scope.
- The demand for desktop PCs has declined and the requirement for notebooks has increased within contracting authorities.
- Like other mobile devices, notebooks are subject to rougher treatment and are reliant on battery power for much of the time. Therefore, the need to ensure that equipment is robust is much more important than it used to be.

With regard to a clearer definition of computer displays due to their increasing overlap with television displays, according to those that responded, there is generally no need for this to be reflected in the scope:

- However, one stakeholder remarked that the current EU GPP criteria for IT products are unclear regarding the scope which refers to “computer display (where supplied with a computer)”. For the revised criteria it is asked to clarify if the criteria do not apply when displays are purchased separately, i.e. without a computer which is very frequent.

- A stakeholder commented that displays sold separately or with a computer may differ from each other. In this regard there is a difference in special purpose displays and “normal” displays used with computers. Special purpose displays (e.g. stereo displays, small size displays) tend not to fulfil the current GPP criteria.
- Another stakeholder shared experience of the last time they had put televisions into a tender specification, with it being apparent that the display resolution, screen size and technological platform (plasma, LCD, LED, OLED) can all cause significant differences in energy efficiency.
- Newer developments such as touchscreens, curved displays and ultra-high definition 4K and 8K displays, may be relevant to either TV’s or displays. The relevance of increasing display resolution increases with screen size, so it may be that the two types of display screen will be divided by resolution, rather than by fundamentally different technology.

1.2.2 Revised criteria proposal

Based on the definitions provided by Energy Star v6.1 for Computers and v6.0 for Displays the revised scope of the EU GPP criteria is proposed to encompass the following products:

Proposed revised scope of the GPP criteria (final proposal)
Stationary computers • Desktop Computers (incl. Integrated Desktop Computers and Thin Clients) • Small-scale servers • Workstations Display devices • Computer monitors Portable computers • Notebook Computers (including subnotebooks) • Two-In-One Notebook • Tablet Computers • Portable All-In-One Computer • Mobile Thin Client

These product definitions are inclusive of any external peripherals (e.g. mouse, track pad, keyboard) and power supplies that are supplied with the product, with the criteria instead focussing on the main computer product component. Moreover, it is proposed that displays remain separately defined as a specific sub-category which may be procured either with a computer or separately.

1.3 Market analysis

This section provides an overview of the market and the most significant trends. The Task 2 Preliminary report provides for a more detailed background assessment of the economic relevance of the product group, as well as relevant trends, drivers, innovations and market segmentations. Only generalised conclusions can be drawn on public procurement because of the lack of procurement-specific data at EU-28 level.

1.3.1 Stationary and portable computers

In Western Europe, PC shipments totalled 13.6 million units in the second quarter of 2012, a 2.4 percent decline compared with the equivalent period in 2011, according to Gartner. While mobile PC shipments grew 4 percent, desk-based PC shipments declined 12.8 percent in the second quarter of 2012 in Western Europe.

The professional PC market declined 5.3 percent, while the consumer PC market was almost flat, with 0.4 percent growth[2]. Figure 1.3.1 provides global shipment data for desktop PCs, notebook PCs, and tablets from 2010 to 2012 and also offers a forecast until 2017[3].

Portable devices

Currently, notebook PCs account for the highest proportion, but are expected to be overtaken by tablet PCs from 2014. In 2010, around 19 million tablets were sold worldwide, while in 2012 the amount reached 128 million units, 6.7 times larger than

[2] Source: http://www.gartner.com/newsroom/id/2112815

[3] Source: http://www.statista.com/statistics/183419/forecast-of-global-sales-of-pcs-by-category/

2010. It is predicted that the number of worldwide shipped tablet PCs will increase to 352 million by 2017.

Figure 1.3.1: Forecast for global shipments of tablets, notebook PCs and desktop PCs from 2010 to 2017 (Source: Statista)

Tablets

In Western Europe, sales of media tablets have recorded the most dynamic growth of 142 percent according to GfK. Although it is mostly private customers who are buying these devices, they are also being increasingly bought by business and the public sector, with schools being a good example in some Member States. In fact, in the first half of 2013, businesses and the public sector accounted for more than 13 percent of the total sales of media tablets.

Integrated desktops

According to NPD DisplaySearch[4], all-in-one (AIO) PCs historically have amounted to no more than 2% of the total desktop display market. A former forecast until 2012 predicted the worldwide shipments of desktop PCs with built-in displays to be around

[4] Source: Display Search, Accessed in 2014 http://www.displaysearch.com/pdf/090407_increased_outlook_for_low_cost_all_in_one_lcd_pcs_not_enough_to_lift_lcd_desktop_display_market.pdf

8 million units which would be around 5% of the total number of desktop PCs based on the data given in Figure 1.3.1.

Thin clients

Dickinson[5] reported that in 2012 thin client shipments across the EMEA region (Europe, the Middle East and Africa) reached 1.7 million units, which represents an increase of 9.2% compared to the year before. The market is expected to remain growing, with shipments rising by 6.2% in 2013. A study by IDC[6] shows that the enterprise thin client market grew by 13.8 % in 2011, and the growth is forecast to be even higher during the period 2012–2016 due to increasing interest in cloud computing.

Workstations

According to Statista / Jon Peddie Research[7] the number of workstation shipments worldwide increased between 2009 and 2011. About 2.5 million, 3.2 million and 3.8 million workstations were shipped worldwide in 2009, 2010 and 2011, respectively. This shows a continuous increase in shipment numbers, although worldwide workstation shipments fell back to 3.500 million units in 2012.

Small-scale servers

Figure 1.3.2 provides an overview of the server market, providing a general overall picture for servers[8]. Unfortunately, the desk research revealed no sources providing explicit data regarding the small-scale server market. Further input from the stakeholder group would therefore be appreciated.

[5] Source: Misco, Accessed in 2014, http://www.misco.co.uk/blog/news/00795/emea-shipments-of-enterprise-thin-clients-rise-9-point-2-percent-in-2012

[6] Source: IDC, Accessed in 2014, http://www.idc.com/getdoc.jsp?containerId=235691

[7] Source: Statistica, Accessed in 2014, http://www.statista.com/statistics/157940/workstation-shipments-worldwide-since-the-3rd-quarter-2008/

[8] Source: Statistica, Accessed in 2014, http://www.statista.com/statistics/219596/worldwide-server-shipments-by-vendor/

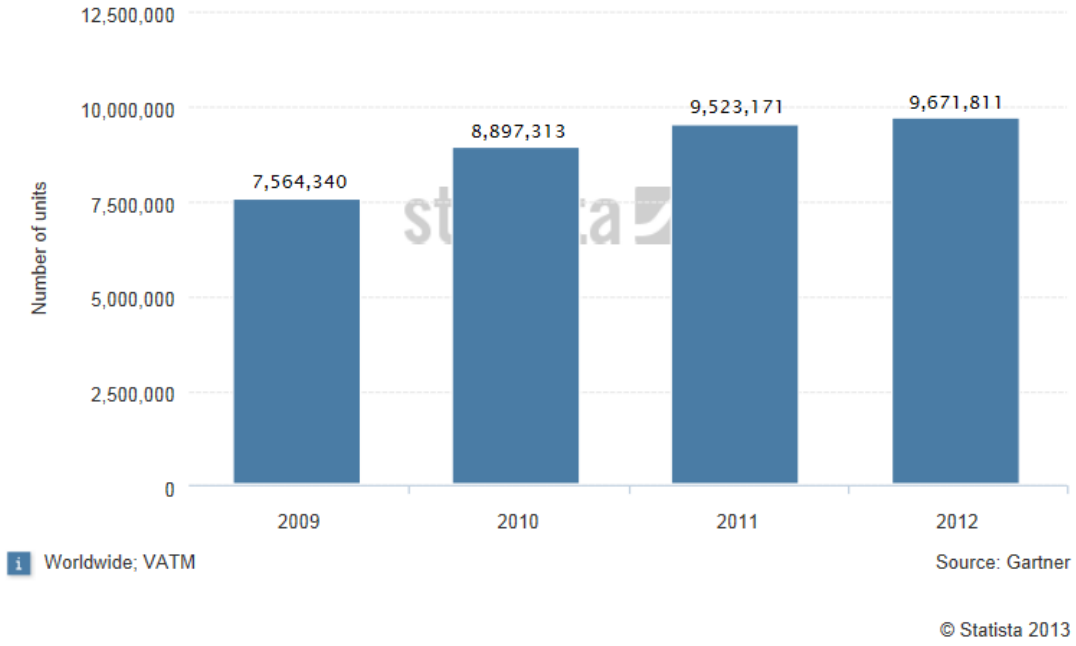


Figure 1.3.2: Worldwide server shipments from 2009 to 2012 (Source: Statista)

1.3.2 Computer displays

Figure 1.3.3 illustrates the global large-area (9"+) TFT LCD monitor shipments from 2009 to 2011[9]. It can be seen that there is a slight growth from 2009 to 2010 whereas the number of shipments has remained at a rather stable level between 2010 and 2011. In 2010, the average diagonal size of LCD computer displays was 17 inch. According to iSuppli[10], in 2012 the average monitor sold worldwide was already 21 inches, indicating the trend towards increasing screen sizes.

[9] Source: http://www.statista.com/statistics/221640/global-large-area-tft-lcd-monitor-shipments-since-2009/

[10] Source: New York Times, Accessed in 2014, http://www.nytimes.com/2012/02/08/technology/for-multitaskers-multiple-monitors-improve-office-efficiency.html?pagewanted=all&_r=0

Figure 1.3.3: LCD monitors shipments from 2009 to 2011 (Source: Statista)

Display technologies

Within desktop displays, LCD monitors with LED backlight technology now dominate, accounting for nearly 100% of all desktop displays shipped worldwide while CRT monitors are nearly completely obsolete from the mainstream worldwide computer monitor market. Also within notebook PCs, LED backlit technology was forecast to reach 98% of the market by the end of 2010. Notebooks with CCFL backlight were expected to almost be phased out with only 1.6% of the total market by 2011 (see Table 1.3.1)[11].

[11] Source: Display Search, accessed in 2014, http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/100610_slim_led_backlit_notebooks_rapidly_gain_market_share.asp

Backlight Type		Q1'09	Q2'09	Q3'09	Q4'09	Q1'10	Q2'10	Q3'10	Q4'10	Q1'11
LED	Slim Type	5.0%	6.8%	7.6%	8.5%	15.9%	22.6%	26.7%	31.1%	34.9%
	Wedge Type	31.0%	49.3%	58.8%	63.7%	65.6%	67.9%	69.5%	66.7%	63.5%
CCFL		64.0%	43.9%	33.6%	27.8%	18.5%	9.5%	3.7%	2.3%	1.6%

Note: Actual results up to Q1'10; data from Q2'10 based on panel makers' shipment targets

Source: *Quarterly LED Backlight Panel Shipment & Forecast Report*

Table 1.3.1: Notebook backlight penetration percentage (Source: NPD DisplaySearch)

In notebook applications there are two types of LED backlighting systems: slim and wedge type. Slim LED backlights for notebooks require thinner components, such as LED array and LGP (the light guide plate) compared to the wedge type. According to NPD DisplaySearch[12] the slim type will continue to grow despite higher costs and assembly issues, as a result of notebook manufacturers' priorities for slimmer form factors despite cost premiums.

1.4 The key environmental impacts of computers and displays

Based on the review of Life Cycle Assessment (LCA) studies and evidence in the Task 3 Preliminary Report, the overall findings indicated that the manufacturing of computers and displays and their use are associated with the most significant environmental impacts during the life cycle of Computers and Monitors.

Seventeen LCA studies carried out between 2007 and 2013 were reviewed for their relevance according to the product sub-categories they analysed and the robustness of the methodology used and results (boundaries, data quality, age, impact methods etc.). The main reference point for the critical review were the ISO standards for life cycle assessment (ISO 14040 and 14044) and the European Commission's Product Environmental Footprint (PEF) methodology [13].

[12] Source: Display Search, accessed in 2014, http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/100610_slim_led_backlit_notebooks_rapidly_gain_market_share.asp

[13] Commission recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations (OJ L-124 4.5.2013 p-1)

A new LCA standard which seeks to support the implementation of ISO 14040 and 14044 for *ICT Equipment, Networks and Services* has been developed by the European Telecommunications Standards Institute (ETSI) [14] and the International Telecommunication Union ,ITU-T, with the involvement of the European Commission in its pilot phase [15]. This standard may be an appropriate reference point for future LCA studies in the sector.

Products for which the use phase is most significant

The relative importance of the manufacturing phase and the use phase varies depending on the product. For stationary computers and their displays the use phase is the most significant. Desktop computers, of all the computer products proposed within the scope, require the most electricity to run.

Within the manufacturing phase of desktop computers, specific environmental 'hot spot' components identified as being of significance are the motherboard (including the Central Processing Unit) and other Printed Wiring Boards of the desktop unit, the screen (LCD panel), as well as the power supply, CD ROM and the hard disk drive (HDD) units.

Products for which the manufacturing phase is most significant

For notebook and tablet computers the manufacturing phase is relatively more significant because these devices use less electricity. Within the manufacturing phase for notebook and tablet computers, as well as standalone displays, production of the motherboard and the Thin Film Transistor (TFT) display unit are associated with the most significant environmental impacts, followed by production of the battery for notebooks and tablets.

[14] ETSI, *Environmental Engineering (EE): Life Cycle Assessment (LCA) of ICT equipment, networks and services - General methodology and common requirements*, TS 103 199 V1.1.1 (2011-11)

[15] European Commission (2013) *ICT testing - Pilot testing on methodologies for energy consumption and carbon footprint of the ICT-sector*, Final report, http://www.ecofys.com/files/files/ec-ecofys-quantis-bis-2013-ict-footprint.pdf

Factors influencing manufacturing phase impacts

One of the main factors influencing these manufacturing phase environmental impacts is that Critical Raw Materials are concentrated in these components. Their extraction and processing is associated with a number of different impacts including raw material extraction, land transformation and the consumption of energy.

Specific metals are associated with particularly severe environmental impacts related to their extraction and processing, primarily silver, gold and palladium. These three metals are required in the motherboard and other Printed Circuit Boards. In addition, indium and gallium are required in the display and background illumination, and cobalt is present in lithium ion batteries.

How can GPP criteria influence the key impacts?

The potential for the direct influence of the EU GPP criteria on the production of single computer components is considered to be limited. This is in part because of the difficulty in identifying the potential for improvements because of confidentiality, for example, in the case of CPU and motherboard production.

A different focus is therefore required. By improving product design life (e.g. design for durability and upgrading), indirectly extending the lifetime of products by facilitating re-use and by enabling Critical Raw Materials to be easily extracted and recovered from products at the end of their life, the impacts of the manufacturing phase can be reduced as impacts associated with primary production stages and resource extraction can be avoided. Thus, the allocation of benefits from product lifetime extension and recycling is an area specifically highlighted in the Task 4 Preliminary Report (Improvement potential) and in the criteria proposals.

Product lifetime extension and dismantling are also, as a result of this analysis, a specific new area of focus for both the EU Ecolabel and GPP criteria. Evidence relating to the reasons for early failure or replacement of devices, together with common specifications brought forward by manufacturers with the specific intention of offering customers extended product lifetime and durability, therefore inform the proposals.

The potential for the extraction and recovery of Critical Raw Materials from computer and display products at the end of their life is now a focus of attention for EU Ecodesign implementing measures. Proposals have therefore been developed that seek to harmonise with the state-of-the-art in this area, with a focus on components which have the greatest material and environmental significance.

2. DRAFT CRITERIA AREAS AND PROPOSALS

2.1 Criteria area 1 – Energy Consumption

2.1.1 Summary of stakeholder comments received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
With regards to *Technical Specification* A1 a concern was raised by a Member State that EU Ecolabelled products may not comply with the proposed Comprehensive criterion. This is because the Ecolabel is proposed to align with Energy Star v6.0, but in the GPP proposal this would be a Core requirement. A general concern was raised at the GPP Advisory Group about the market penetration of Energy Star being higher than 20-25%. It was queried by a manufacturer whether test reports could be submitted upon award of a contract as a Contract Performance Clause. The example of Germany's Federal procurement guidelines for notebooks was cited (Bitkom, UBA and Federal Procurement Office). Common practice is cited as being the request of verification documents only upon demand before award or at any time during performance of the contract. A supplier self-declaration, being in line with Energy Star practices, would be preferable. In relation to displays, the types of displays covered needs clarification. Several comments highlighted concerns relating to the fact that Ecodesign EEI formulas are used for displays and the Regulation is still in draft form. There may still be changes during and after inter-service consultation. Several stakeholders highlighted that under the Energy Efficiency Directive central government must purchase Energy Star registered products. A stakeholder expressed the need to link to Energy Star for computer monitors. In relation to computers concern was, however, expressed that tablet computers are currently excluded from Energy Star v6.0. Some public authorities and procurement experts commented that 'all equipment' on the European market fulfills Energy Star. Thus the effect on the market of this

procurement criterion would be minimal. Whilst it is common to use the Energy Star E_{TEC_MAX} or P_{ON_MAX} values as an award criterion, in practice this can be challenging as the retailers may not have that information easily available from the producers.

LCC-calculations have also shown that differences in energy consumption are now very small if not insignificant. Thus, as has also been identified by JRC, the environmental benefits from energy criteria for computers and displays are decreasing in importance and the environmental benefits of the criteria may be reduced.

The scope of different forms of tablets that may be procured and variabilities in energy consumption may require further consideration. For example, Panasonic's tablets have high end performance. It was proposed that the tablet requirements be revised if new requirements are brought in under Energy Star.

With regards to the proposed cap on computer graphics capabilities in *Technical Specification* A1 a Member State considered that this should be more ambitious, but other stakeholders noted that high end capabilities may be required for some functions.

The performance of Graphics Processing Units could be made an Award Criterion to encourage lower consumption. It was highlighted by a manufacturer that only a small proportion of discrete GPU's in portable devices are not switchable i.e. they consume no additional energy whilst the capability is not required. This is to preserve battery power. Because the GPU is integrated within the product and its efficiency will also depend on the system and power supply efficiencies, it is not therefore considered possible to verify a GPU's performance.

As regards *award criterion* A1 on minimum energy performance a key stakeholder from the advisory group suggested referring to Energy Star TEC limits instead of individual energy modes.

With regards to the power management *award criterion* A2 a representative from the GPP Advisory Group suggested to specifically restrict the fast start mode. Moreover, in reference to Automatic Brightness Control it was claimed that although it is tested

for in Energy Star the saving potential is considered to be low because of office lighting conditions.

2.1.2 Technical discussion and rationale for the criteria revision

2.1.2.1 Computer products

Energy consumption during the use of Computers and Monitors accounts for the main environmental impacts of desktop computers and displays. Moreover, these products are the most energy intensive computer form factor as illustrated in Table 2.1.1. The product categories relate to the processing power of the computer as defined in Energy Star and also the EU Ecodesign Regulation No 617/2013.

Table 2.1.1: Maximum Typical Energy Consumption (TEC) allowances for desktop PCs and notebook PCs according to Energy Star Version 5.2

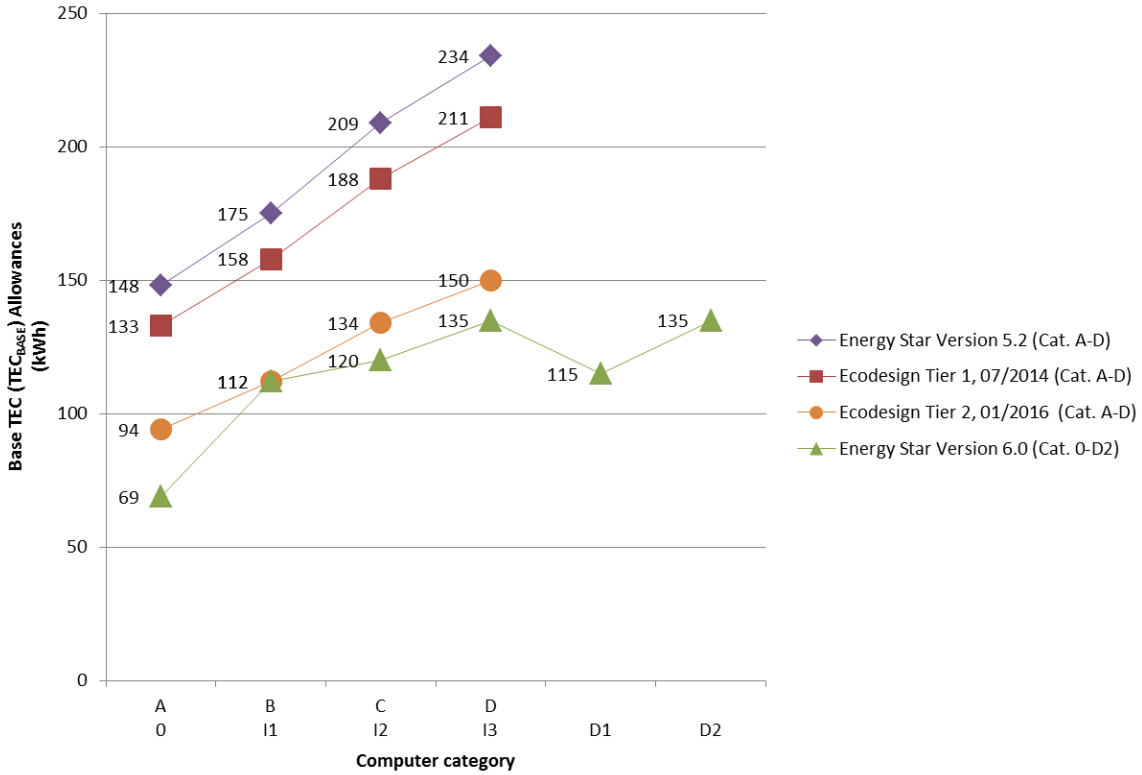
Energy Star Product Category	TEC_{BASE} Desktop PCs (kWh)	TEC_{BASE} Notebook PCs (kWh)
A	148	40
B	175	53
C	209	88.5
D	234	n.a.

A requirement to comply with the latest version of Energy Star is the main current GPP Technical Specification addressing the energy consumption of Computers and Monitors. The Energy Star Program Requirements for computers were used to define the binding implementing measures under the Ecodesign Directive which are broadly identical to those of Energy Star v5.2. The Ecodesign Tier 1 efficiency requirements use the same benchmarks and TEC-calculation formulas. These Tier 1 requirements entered into force on 1 July 2014. Tier 2 (entering into force on 1 January 2016) also uses the same calculation formulas but sets stricter requirements.

The v6.0 revision of Energy Star came into effect in the USA from the 2nd June 2014 and was subsequently updated with v6.1. The underlying TEC calculations did not change but the scope of products covered by the criteria was broadened- notably tablets, hybrid notebooks and, a new product form factor to have emerged, portable

all-in-one computers. These requirements aimed to target the top 25% of models currently on the market (Energy Star 2011). Following approval by the EU Energy Star Board v6.1 was adopted in July 2015 [16].

Comparing the Base Allowances for the Typical Energy Consumption (TEC_{BASE}) of Desktop and Notebook computers within the current Energy Star and Ecodesign versions it can be seen from Figure 2.1.1 and Figure 2.1.2 that Energy Star version 6.0 (and 6.1) is between 0 - 27% stricter for desktops and 39 - 60% stricter for notebooks than Ecodesign Tier 2 (in force 1 January 2016) for product sub-categories IA-I3 and G1-G3. Some higher performance D1 and D2 graphics specifications are exempted from requirements in Ecodesign but are addressed under Energy Star, so a comparison is not possible.



[16] Commission Decision (EU) 2015/1402 of 15 July 2015 determining the European Union position with regard to a decision of the management entities under the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment on the revision of specifications for computers included in Annex C to the Agreement (OJ L 217, 18.8.2015, p.9)

Figure 2.1.1: Comparison of TEC_{BASE} Allowances of Energy Star versions 5.2 and 6.0 with Ecodesign Tier 1 and Tier 2 for Desktop and Integrated Desktop Computers

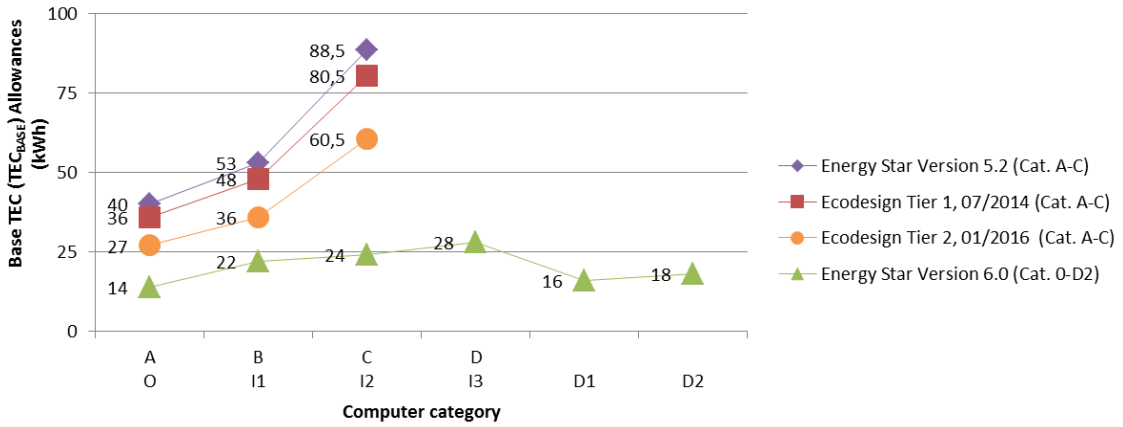


Figure 2.1.2: Comparison of TEC_{BASE} Allowances of Energy Star versions 5.2 and 6.0 with Ecodesign Tier 1 and Tier 2 for Notebook Computers

Analysis of the Energy Star 6.0 database (January 2015) highlights that many registered models already improve upon their TEC_{BASE} performance threshold (see **Error! Reference source not found.**) [17]. Nearly a third of registered desktops and ver two thirds of registered notebooks are able to perform 20-39% better. It is important to note, however, that no intelligence is currently available on the market penetration of the Energy Star v6.0 models as a whole.

Precedent from Energy Star 5.0 suggests that in the USA market notebooks are quicker to respond than desktops and within two years of adoption can obtain a significant market share (75%). However, market penetration and the ability to obtain models can be significantly lower in the EU, with desktops and notebooks representing only 6% and 33% respectively of models sold in 2012.

[17] Analysis carried out by Jonathan Wood from Tenvic (2015)

Table 2.1.2 Energy Star v6.0 TEC_{MAX} improvement potential for registered models

Improvement potential (Power consumption compare to TEC_{MAX})	Models (US Energy Star database as of January 2015)	
	Desktops	Notebooks
20-39% lower	*32%*	*69%*
40-59% lower	*17%*	*11%*
60-79% lower	*4%*	*4%*
over 80% lower	*-*	*-*

Source: Tenvic (2015)

Allowances for discrete graphics processing units (GPUs)

Graphics capabilities are the most significant influence within the overall E_{TEC_MAX} calculation that sets the qualifying energy benchmark for each computer. The TEC_{BASE} allowance may be between 57% and 96% higher for desktops and integrated desktops and between 14% and 100% higher for notebooks. A further $TEC_{GRAPHICS}$ allowance for *discrete graphics processing units* (categories D1 and D2) may then provide a further uplift of between 52% and 188% for desktops and integrated desktop and between 100% and 429% for notebooks.

Discrete graphics are used for high performance professional applications (HD video, 3D rendering etc.) providing better picture quality and speed compared to integrated graphics, where the GPU is attached to or integrated into the computer's motherboard sharing resources with the central processing unit and system memory. Those are typically less powerful and slower, being sufficient for basic office applications, web browsing etc.

According to written stakeholder feedback, allowances for discrete graphics processing capacity of the kind that may be used to run Computer Aided Design or multi-media applications can sometimes be substantial and can represent as much as the core consumption of the computer in idle mode. Thus it is important to

consider to what extent this capacity is required and if possible to limit its use, particularly in desktops. Options initially explored included:

1. Setting a maximum for the total amount of allowances to ensure a highly consuming PC with several graphic cards is not compliant. This maximum was proposed to be set at 90 kWh for Desktop PCs and 33 kWh for Notebook PCs. This would prohibit the use of G5-G7 discrete graphics cards under Energy Star.
2. Allow for discrete graphics units only if they are switchable or highly scalable i.e. they are consuming minimal energy when the computer does not need them. This approach is now implemented by Energy Star v6.0/6.1 although an allowance of 18 kWh is given for desktops where switchable graphics are enabled by default.
3. Set stricter allowances for discrete graphics units than those defined in the Energy Star requirements. This would reflect innovation by graphics card manufacturers. However, stakeholders noted that it is very difficult to verify the performance of an individual graphics card because additional energy use is not just associated with the card but the whole computer system.

Analysis of the US Energy Star v6.0 database (January 2015) indicates that 261 desktop models currently qualify in the discrete graphics D1 and D2 category, equating to 19% of models. In contrast only 10 notebook models currently qualify in the D1 and D2 category, equating to 0.4% of models.

A study carried out in 2012 by CLASP and NRDC in the USA looked at the impact of discrete graphics cards on desktop energy consumption [18]. Tests were carried out in order to compare the additional energy consumption of graphics cards. The study suggested that for high end (G6 and G7 capabilities) energy consumption related to the unit can vary considerably and does not always increase in function of the capability. An indicative level of performance improvement is reflected in

[18] CLASP and NRDC, *The impact of graphics cards on desktop computer energy consumption*, September 2012.

NRDC/CLASP's recommendations for the 10th and 20th percentile of the market in Table 2.1.3, which are notable for the lower G6 and G7 allowances.

Moreover, mainstream manufacturers such as AMD and NVIDIA are bringing forward units that demonstrate a significant improvement in performance over the Energy Star v6.1 allowances. This is supported by manufacturer claims, which focus on reducing idle power consumption, for example by powering down the GPU in long idle mode[19]. This additional requirement is estimated to have the potential to increase the improvement potential for high end GPUs from 15% to 20%.

Table 2.1.3. CLASP/NRDC recommended Energy Star v6.0 target adder levels for desktops

dGfx category (Gigabytes/second) [1]	**TEC Allowance (kWh/year)**	
	20th percentile	**10th percentile**
G1 (≤16)	32	30
G2 (16<FB_BW≤32)	40	37
G3 (32<FB_BW≤64)	51	47
G4 (64<FB_BW≤96)	67	62
G5 (96<FB_BW≤128)	82	76
G6 (FB_BW>128) with data width <192 bit)	82	76
G7 (FB_BW>128) with data width ≥192 bit)	97	90
Notes: 1. Categories are defined according to the frame buffer bandwidth in gigabytes per second (GB/s)		

An analysis of the improvement potential from applying the 10th percentile dGfx allowances recommended by CLASP/NRDC is presented in Table 2.1.4. The

[19] AMD, *ZeroCore Power technology*, http://www.amd.com/en-us/innovations/software-technologies/enduro

improvement potential has been calculated and compared for Energy Star v6.1 category D1 and D2 computers and Ecodesign category C and D on the basis of comparative TEC specifications.

Table 2.1.4 Indicative TEC improvement potential of dGfx graphics allowances proposed for the EU Ecolabel versus Energy Star v6.1 and Ecodesign Tier 2 allowances

Category D1 Desktop TEC_{MAX} improvement [1]					
Graphics category	**Energy Star 6.1 TEC_{MAX} (kWh)**	**EU Ecolabel TEC_{MAX} (kWh)**	**% improvement**	**Ecodesign category C E_{TEC} (kWh)**	**% improvement**
G1	179.5	173.5	***3.3%***	179	*3.1%*
G2	194.5	180.5	***7.2%***	191	*5.5%*
G3	207.5	190.5	***8.2%***	199	*4.3%*
G4	226.5	205.5	***9.3%***	215	*4.4%*
G5	248.5	219.5	***11.7%***	233	*5.8%*
G6	258.5	219.5	***15.1%***	251	*12.6%*
G7	273.5	233.5	***14.6%***	283	*17.5%*
Notes: *1. Base case used: 2 GB memory, 1 ethernet port, 1 HDD, no EPS allowance*					
Category D2 Desktop TEC_{MAX} improvement [1]					
Graphics category	**Energy Star 6.1 TEC_{MAX} (kWh)**	**EU Ecolabel TEC_{MAX} (kWh)**	**% improvement**	**Ecodesign category C E_{TEC} (kWh)**	**% improvement**
G1	201	195	***3.0%***	197	*1.0%*

G2	216	202	***6.5%***	209	*3.3%*
G3	229	212	***7.4%***	217	*2.3%*
G4	248	227	***8.5%***	233	*2.5%*
G5	270	241	***10.7%***	251	*4.0%*
G6	280	241	***13.9%***	269	*10.4%*
G7	295	255	***13.6%***	301	*15.3%*
Notes: *1. Base case used: 4 GB memory, 1 ethernet port, 1 HDD, no EPS allowance*					

2.1.2.2 Computer display products

The European Commission is currently preparing a new Ecodesign and Energy Labelling Regulation for Electronic Displays, bringing televisions and displays into one Implementing Measure. The discussion paper on the review of the Ecodesign and Energy Labelling Regulation for TVs proposed to apply different calculations according to display size also to the setting of labelling classes. However, in order to avoid a full re-classification of displays on the market, for the Energy Label only the EEI values associated with the energy classes from *A+* upwards have been adapted and not the underlying equations used to calculate the EEI [20]. This also means that the Energy Labelling classes will still be based on a linear regression line in the future.

The Topten catalogue is a project funded by Intelligent Energy Europe [21]. Some of the best appliances on the market were selected from the Topten catalogue and

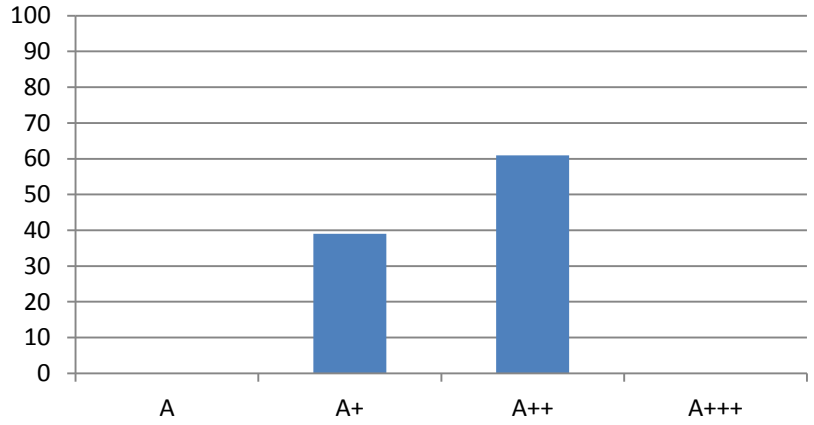
[20] Source: Draft Version of Commission Regulation with regard to Ecodesign requirements for electronic displays; not published yet

[21] Topten is a consumer-oriented online search tool, which presents the best appliances in various product categories. Because only the best-performing products are listed, the selection is much narrower than typical labelling systems, making it easier for

were analysed in order to explore the proportion on new Energy labelling classes. Energy labelling classes have been calculated using the EEI threshold proposed at the draft Regulation.

The following Figure 2.1.3 represents the results of the indicative calculations of 64 appliances. More than 50% of best appliances selected by Topten showed an *A++* energy class. The distribution of energy classes was found to be equally distributed along the different screen sizes.

Figure 2.1.3: Energy labelling classes (draft regulation) of 64 monitor models from Topten.



Stakeholders highlighted that under the Energy Efficiency Directive [22] central government must purchase either products meeting the highest energy efficiency labelling class or Energy Star requirements. Moreover, it can be seen that for computer monitors, all relevant eco-labels (EU Ecolabel, Nordic Ecolabelling, TCO, Blue Angel, and EPEAT) refer to a specific version or, more generally, to the most recently published Energy Star program requirements for displays.

Unlike televisions, external computer displays are included in the Agreement between the Government of the US and the European Community (EU) to co-

consumers to choose from among the thousands of products available. The selection is based on existing regulations and international energy measurement standards.

[22] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012

on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC

ordinate the energy labelling, thus Energy Star criteria on displays are also valid in Europe[23].

The Energy Star Program Requirements for Displays (Version 5.1) [24] have been the most established benchmark for the energy requirements of computer displays. In 2011, on average 85 % of all new computer displays sold in the USA were already certified according to this specification. In general, the experience shows that approximately two years after a new Energy Star version becomes effective, a large proportion of devices fulfils the energy requirements, especially when they build the basis for Green Public Procurement (e.g. computer displays).

The new Energy Star Program Requirements for Displays, Version 6.0 became effective from June 2013 (Energy Star Displays 2013 [25]). Energy Star Version 6.0 specification establishes a number of new requirements including:

- On Mode power consumption requirements for displays with a viewable diagonal screen size from 12 to 30 inches and for computer displays greater than 30 inches.
- A new maximum Sleep Mode power requirement of 0.5 watts for all displays, and a power management requirement that all computer displays must enter Sleep Mode after the connection to a host is discontinued.

[23] Commission Decision of 26 October 2009 determining the Community position for a decision of the management entities under the Agreement between the Government of the United States of America and the European Community on the coordination of energy-efficiency labelling programmes for office

equipment on the revision of the computer monitor specifications in Annex C, part II, to the Agreement (Text with EEA relevance) (2009/789/EC)

[24] Energy Star Program Requirements for Displays (Version 5.1) https://energystar.gov/products/specs/sites/products/files/Version_5.1_ENERGY_STAR_Displays_Program_Requirements_Post-Clarification.pdf

[25] Energy Star Program Requirements for Displays (Version 6.0) http://energystar.gov/products/specs/sites/products/files/Final_Version_6%200_Displays_Program_Requirements.pdf?8a38-1944

- A hierarchy under the Test Method for testing network connected products in Sleep Mode and lighting conditions for testing products with automatic brightness control (ABC) enabled by default.

The US Energy Star database as of July 2015 for computer monitors (1512 models) have been analysed in order to determine the improvement potential of on mode energy performance when compared to the limit allowed ($P_{on\ max}$). . The $P_{on\ max}$ limit has been calculated for each model and compare to the power consumption.

The database suggests that 28% of the models have the potential to demonstrate the basic level of improvement suggested (10-19% lower consumption) upon the P_{ON_MAX}. while the 33% of the models have a further improvement potential reaching 20-39% lower power consumption (see Table 2.1.5), The average improvement calculated for compliant models was found to be of 37% with respect the Pon max, reaching values of 65% of improvement for more efficient appliances.

Table 2.1.5 Energy Star 6.0 P_{ON_MAX} improvement potential for registered models

Improvement potential (Power consumption compare to Pon-max)	Models (US Energy Star database as of July 2015)
10-19% lower	*28%*
20-39% lower	*33%*
40-59% lower	*5%*
60-79% lower	*1%*
over 80% lower	*-*

A reading across to the Draft Energy labelling measure has been carried out in order to determine the equivalent energy Classes for several of the more efficient models for different size categories (See Table 2.1.6).

Table 2.1.6. Efficient models equivalent energy classes (source energy star)

Model	Resolution (pixels)	Screen Size (in.)	Screen Area (sq. in.)	Power Consumed in On	Equivalent Energy Class	Calculated Pon max	Equivalent Energy Class (Draft)	Meets ENERGY STAR Most

				Mode (Watts)	(Draft)		to Pon max	Efficient 2015 Criteria
1	800 x 600	8	30.51	4.17	A+	7.4	A	yes
2	1024 x 600	10.1	43.25	4.34	A+	8.84	A	yes
3	768 x 1366	15.6	103.4	4.65	A++	12.82	A	yes
4	1600 x 900	14	84	5.43	A++	14.98	B	yes
5	1600 x 900	17.3	127.5	8.03	A++	12.52	A	yes
6	1366 x 768	18.5	146.51	9	A+	13.12	A	yes
7	1920 x 1080	23.5	236.9	14.2	A+	22.65	A	yes
8	1920 x 1080	23.6	236.92	14.85	A+	22.65	A	yes

It was found that 84 models in US Energy Star database as of 07/07/ 2015 already meet the more efficient Energy Star v6.1 criteria. In order to recognise this potential in the market, it is possible to either increase the ambition level of the comprehensive criterion or award extra points if energy consumption is lower than Energy Star requirements. A good example of how to award points can be found in the approach proposed by the Sustainable Procurement Guidelines of United Nations (UNSP) for IT Equipment which weights the points awarded in order to incentivise greater reductions in energy use [26].

Power management requirements

With regards to Automatic Brightness Control (ABC) literature was consulted in order to estimate the improvement potential of the criteria. A recent article on ambient light levels during Television viewing[27] analysed the ambient light levels during television viewing in 60 homes over seven days. The study revealed that the vast majority of viewing (79.5%) occurred at illuminance levels below 50 lux, while very little viewing (3.6%) occurred at illuminance levels greater than 300 lux. Advanced Brightness

[26] UN Sustainable Procurement Guidelines, https://www.ungm.org/Areas/Public/Downloads/ UNSP_Computers%20and%20Monitors_Product%20Sheet.pdf

[27] Invited Paper: Ambient Light Levels During Television Viewing. Kyle Sills, Konstantinos Papamichael, Keith Graeber, My Ton and Chris Wold (2014 Society for Information Display, SID Symposium Digest of Technical Papers, San Diego, CA, June 1–6, 2014, Volume 45, Issue 1, pages 599–602, June 2014

Control is a feature which, if calibrated correctly to reflect the real-life lighting conditions that users may experience, has been estimated to have the potential to save 20-30% of display energy use. However, as noted by a stakeholder, this might not be of such relevance for computer monitors as working conditions at an office are normally over 300 lux.

With reference to “Quick Start” functionality a report created by Defra’s Market Transformation Programme in 2011[28] showed that there appear to be two current means of achieving the “quick start” function in Televisions. Where power is maintained to the processor, additional power consumption requirements (above the 1W regulatory level) may be around 11 to 12 W, but could be as high as 30 to 38W for high specification products. However where additional memory (NVRAM) is provided, the additional power consumption can be negligible (fractions of a watt).

This functionality was found by DEFRA to be only present in the high-end models of three manufacturers. There is no available representative data of the proportion of televisions that currently present such function and their power demand to establish a threshold. Moreover, no information on the relevance of fast start function on computer monitors could be found.

For more details see the EU Ecolabel and GPP for displays Technical report, Criteria Proposals – Revision v3 (October 2014).

2.1.2.3 Life Cycle Costing (LCC)

As an alternative to awarding points for greater energy efficiency, procurers can opt for an LCC approach whereby more than only the purchase price is included in the costs when assessing the tenders. The rules for the use of LCC are set out in article 68 of Directive 2014/24/EU on public procurement. Procurers have to indicate the data to be provided by the tenderers and the method which the contracting authority will use to determine the life-cycle costs on the basis of this data. It is necessary that the monetary value of the cost elements can be determined and verified.

[28] BNCE TV07: Power Impacts of “Quick Start” Standby Functionality in Televisions

In the case of Computers and Monitors, one option could be to determine the costs of the offer by adding the electricity costs over the expected life-time of the IT product to the purchase price. In this case, in order to avoid double-counting, no extra points must then be given for higher energy efficiency.

The Commission is currently working on an LCC tool for selected products, to be used on a voluntary basis, which will help public authorities to take costs that go beyond the purchase price into account, thus favouring products with lower running costs. The tool is expected to be published in 2016.

2.1.3 Final proposals for revised criteria – Minimum energy performance

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
TS1. Minimum Energy performance for computers The energy efficiency performance of computers shall meet the energy efficiency requirements of the latest version of the Energy Star standard. *The version in force at the time of publication is 6.1 and updates can be followed at this weblink:* *http://www.eu-energystar.org/specifications.htm* *Annex III of Directive 2012/27/EU on energy efficiency, requires that computers purchased by central government shall meet the latest EU version of Energy Star.* **Verification:** The tenderer shall provide test reports carried out according to the test methods laid down in the latest version of the Energy Star. These shall be provided upon award of the contract or prior to that upon request. Models that have qualified for EU Energy Star and are registered on the programme's database shall be deemed to comply. Energy Star registrations under the latest version in the USA shall also be accepted provided that testing according to European input power requirements has been carried out. Products holding the EU Ecolabel for personal, notebook and tablet computers or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.	**TS1. Minimum Energy performance for computers** The energy efficiency performance of computers shall meet the energy efficiency requirements of the latest version of the Energy Star standard. *The version in force at the time of publication is 6.1 and updates can be followed at this weblink:* *http://www.eu-energystar.org/specifications.htm* *Annex III of Directive 2012/27/EU on energy efficiency, requires that computers purchased by central government shall meet the latest EU version of Energy Star.* **Verification:** The tenderer shall provide test reports carried out according to the test methods laid down in the latest version of the Energy Star. These shall be provided upon award of the contract or prior to that upon request. Models that have qualified for EU Energy Star and are registered on the programme's database shall be deemed to comply. Energy Star registrations under the latest version in the USA shall also be accepted provided that testing according to European input power requirements has been carried out. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

TS2. Minimum energy performance of monitors The energy efficiency performance of monitors shall meet the energy efficiency requirements of the latest version of the Energy Star standard. *The version in force at the time of publication is 6.0 and updates can be followed at this weblink:* *http://www.eu-energystar.org/ specifications.htm* *Annex III of Directive 2012/27/EU on energy efficiency, requires that office equipment purchased by central government shall meet the latest version of Energy Star.* **Verification:** The tenderer shall provide test reports carried out according to the test methods laid down in the latest version of Energy Star. These shall be provided upon request *prior to or following [to be specified*] award of the contract. Models that have qualified for EU Energy Star and are registered on the programme's database shall be deemed to comply. Energy Star registrations in the USA shall also be accepted provided that testing according to European input power requirements has been carried out. Products holding a relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.	**TS2. Minimum energy performance of monitors** The energy efficiency performance of monitors shall meet the energy efficiency requirements of the latest version of the Energy Star standard. *The version in force at the time of publication is 6.0 and updates can be followed at this weblink:* *http://www.eu-energystar.org/ specifications.htm* *Annex III of Directive 2012/27/EU on energy efficiency, requires that computers purchased by central government shall meet the latest version of Energy Star.* **Verification:** The tenderer shall provide test reports carried out according to the test methods laid down in the latest version of Energy Star. These shall be provided upon request *prior to or following [to be specified*] award of the contract. Models that have qualified for EU Energy Star and are registered on the programme's database shall be deemed to comply. Energy Star registrations in the USA shall also be accepted provided that testing according to European input power requirements has been carried out. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
AWARD CRITERIA	
AC1. Improvement in the energy consumption upon the specified Energy Star standard *It is recommended to use this criterion in conjunction with TS1 for desktop computers if the products specified are for graphics intensive uses.* Points will be awarded If the product is more energy efficient than the E_{TEC_MAX} value for computers and the P_{ON_MAX} value for monitors. These shall be calculated in comparison with the minimum performance required under Energy Star (see Criterion TS1 and TS2). A maximum of x points [*to be specified*] may be awarded. Points shall be awarded in proportion to the improvement in energy efficiency as follows: • over 80% lower: x points • 60-79% lower: 0.8x points • 40-59% lower: 0.6x points • 20-39% lower: 0.4x points • 10-19% lower: 0.2x points *Alternatively, instead of using the E_{TEC_MAX} value for computers or the P_{ON_MAX} value for monitors a Life Cycle Costing calculation could be requested, whereby the offered improvement potential would lead to a*	**AC1. Improvement in the energy consumption upon the specified Energy Star standard** *It is recommended to use this criterion in conjunction with TS1 for desktop computers if the products specified are for graphics intensive uses.* Points will be awarded If the product is more energy efficient than the E_{TEC_MAX} value for computers and the P_{ON_MAX} value for monitors. These shall be calculated in comparison with the minimum performance required under Energy Star (see Criterion TS1 and TS2). A maximum of x points [*to be specified*] may be awarded. Points shall be awarded in proportion to the improvement in energy efficiency as follows: • over 80% lower: x points • 60-79% lower: 0.8x points • 40-59% lower: 0.6x points • 20-39% lower: 0.4x points • 10-19% lower: 0.2x points For computers with discrete graphics processing units the overall points available for criterion AC1 shall be awarded in the proportion 60:40. *Alternatively, instead of using the E_{TEC_MAX} value for*

relative decrease in the overall running costs of a product compared to a less energy efficient model. **Verification:** The tenderer shall provide test reports carried out according to the test methods laid down in the latest version of the Energy Star. The E_{TEC_MAX} value or the P_{ON_MAX} value for qualified models as entered on the EU Energy Star database shall also be accepted. These shall be provided upon award of the contract or prior to that upon request.	*computers or the P_{ON_MAX} value for monitors a Life Cycle Costing calculation could be requested, whereby the offered improvement potential would lead to a relative decrease in the overall running costs of a product compared to a less energy efficient model.* **Verification:** The tenderer shall provide test reports carried out according to the test methods laid down in the latest version of the Energy Star. The E_{TEC_MAX} value or the P_{ON_MAX} value for qualified models as entered on the EU Energy Star database shall also be accepted. These shall be provided upon award of the contract or prior to that upon request.

Summary rationale for the proposals

Computer devices

- The criteria for energy savings are proposed to be aligned to the latest version of the Energy Star requirements for computers, which at the time of publication will be version 6.1. This will reflect the often dynamic response of the market.
- Energy Star v6.1 includes tablet computers within its scope, responding to a specific point raised by stakeholders who noted that some tablets may have high end performance and so energy criteria should apply to them.
- The potential for improvement in the E_{TEC_MAX} between Energy Star 6 and the legal minimum from January 2016 (Ecodesign Tier 2) is estimated to be between 0 - 27% for desktops and 39 - 60% for notebooks.
- The US Energy Star database suggests that 53% of desktops and 84% of notebook models have the potential to demonstrate a reduction in energy consumption upon the Energy Star E_{TEC_MAX}. of at least 20%.
- Requirements for power management such as display sleep mode being activated after 10 minutes of user inactivity have become legally binding under the Ecodesign regulation from 1 July 2014. These requirements are already strict and no evidence could be found for significant further improvement potential of criteria of the kind currently specified in the EU Ecolabel.
- Verification shall be based on testing of the model(s) in accordance with Energy Star's testing specification and method (IEC 62301).

- Evidence suggests that the market and technology can adapt quickly, so an award criterion is proposed for products that are able to perform better than Energy Star.
- Whilst discrete graphics card energy allowances can be significant for some high performance computers, it is not possible to verify in a standardised way a cards performance, so instead a note has been added to the award criteria for E_{TEC_MAX} recommending that it be used by procurers in order to stimulate further energy savings, which are mainly likely to result from graphics capabilities.
- At the high end (G6 and G7 graphics capabilities) the improvement potential is estimated to be up to 20% upon Energy Star v6.1 and is therefore an area of innovation in the market.

Display devices

- The core criteria for energy savings are proposed to be aligned to the underlying performance requirements of the latest version of the Energy Star requirements for displays, which at the time of publication will be version 6.0.
- Award criteria would give extra points if energy consumption is lower than Energy Star requirements, in proportion to the improvement in energy efficiency.
- The US Energy Star database as of July 2015 for computer monitors (1512 models) have been analysed in order to know the improvement capacity of on mode energy performance when compared to the limit allowed (Pon max). The database suggests that 39% of the models have a further improvement potential in power consumption of greater than 20%. The average improvement calculated for compliant models was found to be of 37%, with values of 65% achievable for more efficient models.
- Additional criteria on power management have not been proposed. Requirement for Automatic Brightness Control is addressed within the Energy Star standard and no evidence could be found for significant further

improvement potential from stricter power management requirements for displays.

- Verification shall be based on testing of the model(s) carried out in line with Energy Star's testing specification.

2.2 Criteria area 2 – Hazardous substances

2.2.1 Summary of stakeholder comments received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
With regard to the mercury content requirement a Member State claimed that it should not be of relevance given the prevalence of LED technology. While another stakeholder suggested keeping it as a safety net given the potential for mercury backlit LCD's to still be on the market. It was also commented that 'Mercury free' shall be defined and a test method specified. In terms of the components covered, it was felt by one stakeholder that external cables should be a core criterion. An award criterion was proposed by industry stakeholders for excluding halogenated flame retardants in motherboard laminate material. The test method IEC61249-2-21 can be used for verification. In terms of the hazards restricted, permitted substances used to define the derogations shall be provided. At the moment the hazards listed would be too restrictive. The hazard based approach is self declared and verification by analytical testing of some kind would be preferred. In some cases such as the motherboard hazards related to flame retardants are not considered relevant because the substances is reacted into the epoxy resin. It was felt by industry representatives that the proposed approach was on the borderline of what a procurer could understand and verify. Procurers like to 'check boxes' and prefer to specify materials that can be used/not used. Are there resources/websites that could be provided with supporting information? With regards to chemical management systems, it was felt by manufacturers it is the decision of each individual supplier to set up internal processes to ensure identification of Candidate List substances. These processes may include the listed elements but also other means of control exist. With regards to the request for a REACH Article 33 declaration, this is a legal requirement which would not differentiate suppliers. GPP criteria should go beyond regulation.

With regards to the specific test proposals for plasticisers a number of concerns were raised by manufacturers. Four phthalates out of those proposed will be restricted by RoHS and it was considered that by restricting additional phthalates, this would be an additional burden and could lead to substitutions being made without consideration of their hazards – so-called 'regrettable substitutions'. The concentration limit should be aligned with the RoHS restrictions at 0.1% w/w. The test methods require further attention to ensure they are appropriate, cover all materials and verification should be more general to accept different equivalent methods.

With regards to the proposed end of life emissions testing, this proposal was felt by manufacturers to be overly complicated. Moreover, the restriction of halogenated flame retardants and materials was instead suggested, as this controls the propensity to produce hazardous emissions, in line with the approach in some other labels and standards. The cost and complexity of this criteria would limits its use and uptake. Consideration is needed as to whether alternative materials would function as safely and economically as those currently used by the industry.

In general GPP should not be the instrument to address illegal shipment of WEEE. Polyaromatic Hydrocarbons (PAHs) should also be taken into account in this test. PAHs are formed in much higher concentrations (the order of magnitude is 1 million times) than dioxins/furans under open burning and could lead to serious health effects even though their absolute toxicity is lower than that of dioxins.

2.2.2 Technical background and rationale for the revised criteria proposal

A range of hazardous substances are used in the manufacturing of Computers and Monitors that may be present in the final products. A specific background report was prepared to for the EU Ecolabel and GPP to scope and identify hazards that may be

present[29]. This scoping identified the following broad forms in which hazardous substances may be present in the final product:

- Metals and alloys that are used in solders, connectors, switches and relays *e.g. lead solder, cadmium in metal contacts, nickel scratch proof coatings*;
- Plastic additives that impart a function that may be physical/mechanical, safety or design related e*.g. colourants, fillers, plasticisers, stabilisers, flame retardants*;
- Materials, solvent and salts that together serve a function as part of the design and chemistry of sub-assemblies *e.g. lithium ion batteries, liquid crystals in display units;*
- Contaminants and process residues in plastic and glass e*.g. Polyaromatic Hydrocarbons in plastic and man-made rubber, arsenic in screen glass;*
- Intentionally added biocides that address consumer hygiene issues associated with day to day use of a computer *e.g. biocide added to keyboard plastic;*

A number of substances formerly used in electrical devices, or that are being phased out, including the flame retardant decaBDE, plasticiser DEHP and lead solder are now classified in the EU as Substances of Very High Concern or are restricted under the RoHS Directive 211/65/EU which applies to electronic equipment.

In some cases specific substances are required to be used to ensure products can meet regulatory standards. So, for example, flame retardants are required to meet EN 60065 which stipulates that TV and display casings shall achieve a V1/FR4 fire protection rating, requiring the use of brominated or phosphorus-based flame retardants. In this case brominated substances such as TBBPA are widely used because alternatives may not yet provide technically equivalent substitutes.

[29] JRC-IPTS, *Findings of the EU Ecolabel Chemicals Horizontal Task Force – Proposed approach to hazardous substance criteria development*, 24th February 2014

The presence of mercury in computer displays

A substance of significant concern during the production stage and during the disposal/recycling of products with older LCD backlight units is mercury. The Energy Star database for computer monitors was reviewed in order to check for the prevalence of old mercury technologies amongst current efficient products. No models with LCD backlights that would be likely to contain mercury were found. All computer monitors on the Energy star database are now LED technology, which does not incorporate mercury.

Moreover, the draft Ecodesign Regulation for televisions and displays will introduce a reporting requirement for displays containing mercury. It defines mercury-free as follow:

> *"Mercury Free" shall mean a product in which concentration values of mercury (Hg) by weight in homogeneous materials do not exceed 0.1% as defined in Directive 2011/65/EU of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.*

The current Ecolabel for personal computers, which includes computer monitors, includes a 'safety net' by not permitting the RoHS exemption for backlighting containing mercury. Other schemes as Swedish public procurement program[30] and United Nations green procurement guidelines also restrict the use of mercury lamps.

Stakeholders commented that they would like to see 'mercury-free' defined by a threshold and test method so that it could be verified. The UNSP **Error! Bookmark not efined.** sets a limit of 3 mg of mercury on average per lamp and restricts the number of lamps to a maximum of 8. Points are awarded if background lighting of LCD monitors does not contain mercury and the following verification referring to the US Ecolabel EPEAT is required:

[30] http://www.konkurrensverket.se/en/publicprocurement/sustainable-public-procurement/use-sustainable-criteria/sustainable-procurement-criteria/it-and-telecom/

The vendor is required to submit independent certification or a self-declaration that this criterion is met, such as an EPEAT certificate that indicates compliance with the criterion 4.1.3.3 "Elimination of intentionally added mercury used in light sources", or the ECO DECLARATION (version 2006 or later) with point P7.20 marked "yes".

Cross-checking the restriction lists of a number of major manufacturers highlighted a control threshold of 0.1 mg/kg of mercury and the use of the test method EN 62321-4, which is used for RoHS compliance. An alternative option to testing could be to include within a contract a requirement for visual inspection of products supplied for LED backlights instead of cold cathode tube or gas discharge lamp technologies.

Restricting hazardous plasticisers used in power cords and casings

As part of the revision of the EU Ecolabel criteria for computer and display products a screening of the state-of-the-art in hazard substitution by leading manufacturers has been carried out. Flame retardants and plasticisers have been the main focus for planned substitutions of hazardous substances by leading manufacturers. The outcome from the EU Ecolabel screening exercise is the identification of substances that are being phased out and the identification of substitutes that are being used to replace those being phased out.

In the EU Ecolabel safer plasticisers are derogated for use based on their hazard classification. There is increasing interest from manufacturers in third party verification of substance hazard profiles to inform decisions on which substitutes to use. Leading manufacturers seek to anticipate future regulatory restrictions so as to minimise costs. However, substitutes should have a better hazard profile than those they substitute.

Concern were raised by some industry stakeholders that hazardous substance criteria should be designed to ensure that there is no risk of requiring manufacturers to make 'regrettable substitutions' of hazardous substances with known effects for substances for which there are major data gaps in their hazard profile and therefore could be proven later to have a comparable or worse hazard profile.

An example are flame retardants in plastic casings, where alternatives to the Candidate List substance decaBDE (for example, BPADP or RDP) offer only a modest improvement, if any, in their hazard profile and, moreover, in some cases may give rise to 'breakdown products' that are of a similar level of concern to those of decaBDE [31]. This is further supported by JRC-IPTS's provisional screening of alternative flame retardants and plasticisers for the EU Ecolabel computer and display hazardous substance criteria.

Third party certified schemes such as the US Green Screen are being used as an internal tool by some manufacturers to make comparisons of alternatives and inform decision-making. Green Screen benchmark levels are currently being introduced into the electronics Ecolabel TCO [32].

However, according to stakeholders' feedback, this approach as presented in the first revision proposal is complex for procurers and public authorities to verify. Moreover, verification based on hazard classifications would not verify the actual chemistry of the product supplied, i.e., whether a safer plasticiser had actually been used.

It is therefore proposed for GPP to identify and request verification for the plasticisers that are being phased out by leading manufacturers. The following substances were identified from the restriction lists of major manufacturers:

- Phthalates: DEHP, BBP, DBP, DIBP, DMEP, DIPP, DPP, DnPP and DnHP
- Medium Chained Chlorinated Paraffins (MCCP's) Alkanes C14-17

Taking the example of Dell, verification may take the form of random analytical testing of components from different suppliers. An approach based on verification for restricted substances would be a familiar format for manufacturers who generally have more extensive restriction lists which they communicate to suppliers.

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[31] Clean Production Action, *Evaluating flame retardants for TV enclosures*, Version 1.0, USA, March 2007

[32] TCO Development, *Criteria review: non-halogenated substances*, 14th April 2014 http://tcodevelopment.com/news/criteria-review-non-halogenated-substances-pre-draft-open-for-comment/

It is important to note that the four phthalates DEHP. DBP, BBP and DIBP will now be restricted under an amendment to the RoHS Directive, which will come into force by July 2019 [33]. An accompanying test method is currently under development by IEC Technical Committee 111. This could therefore form the basis for a GPP criterion that requests early compliance for these four phthalates. Moreover, feedback from manufacturers is that the other listed phthalates are not generally used in cables.

Cross-checking the restriction lists of a number of major manufacturers shows that a control threshold of 0.1% per substance is used. For phthalates the test methods EN 14372 for PVC cables and EPA 8270D for non-PVC cables are specified. For MCCPs EPA 3550C or EPA 8270D are used. The new standard to accompany the RoHS amendment will be IEC 62321-8 [34].

Addressing hazardous emissions from the improper disposal of products

A number of stakeholders highlighted the need to address the improper disposal of computers in the end of life phase. The environmental impacts associated with the informal recycling and improper treatment of printed circuit boards and cables to recover precious metals and copper [35] are of particular concern. Moreover, concerns relating to the end-of-life phase of electrical products has driven action by computer manufacturers to phase-out those materials and flame retardants for which evidence exists of the potential for toxic emissions [36].

[33] Commission delegated Directive (EU) 2015/863 of 31 March 2015 amending Annex II to Directive 2011/65/EU of the European Parliament and of the Council as regards the list of restricted substances (OJ L 137, 4.6.2015, p.10)

[34] IEC, TC111 Environmental standardisation for electrical and electronic products and systems, http://www.iec.ch/dyn/www/f?p=103:23:0::::FSP_ORG_ID,FSP_LANG_ID:1314,25

[35] Oeko-Institut, *Recycling critical raw materials from waste electronic equipment*, Commissioned by the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection, 24th February 2012 *and* Oeko-Institut, *Informal e-waste management in Lagos, Nigeria – socio-economic impacts and feasibility of international recycling operations*, UNEP SBC project, June 2011

[36] Chem Sec, *Leading Electronics companies and Environmental organisations urge EU to restrict more hazardous substances in electronic products in 2015 to avoid more global dioxin formation*, 19th May 2010, http://www.chemsec.org/images/stories/publications/ChemSec_publications/ RoHS_restrictions_Company__NGO_alliance.pdf

In terms of the scale of the issue the European Environment Agency estimate that 16-38% of the EU 's WEEE waste (between 550,000 and 1,300,000 tonnes) was exported in 2008 [37]. Moreover, whilst illegal WEEE shipments are classified as hazardous waste under the Basel Convention and are the subject of controls under the recast WEEE Directive, the EEA highlight that there are no restrictions on the export of goods for re-use, for which the end of life phase may not comply with expected EU norms for WEEE disposal.

Analysis of emissions from fire simulations and samples of environmental pollution from WEEE treatment sites has shown that there is the potential for a range of toxic emissions to arise from unregulated treatment processes, including species of Polychlorinated and Polybrominated dibenzo-p-dioxins and furans (PCDD/DF and PBDD/DF) [38] [39] and carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs) [40]. These uncontrolled emissions have led to the exposure of communities and the pollution of local environments, as evidenced by studies that have sampled the environment around WEEE treatment sites [41] [42], and by programmes of the UNEP and the World Health Organisation developed under the auspices of the Basel

[37] European Environment Agency, *Movements of waste across the EU's internal and external borders*, Report No 7/2012

[38] Gullett, B.K.; Linak, W.P.; Touati, A.; Wasson, S.J.; Gatica, S.; King, C.J *Characterisation of air emissions and residual ash from open burning of electronic wastes during simulated rudimentary recycling operations*, Journal of Material Cycles & Waste Management 9: 69-79, 2007

[39] Duan et al, *Characterization and Inventory of PCDD/Fs and PBDD/Fs Emissions from the Incineration of Waste Printed Circuit Board*, Environmental Science & Technology, 2011, 45, 6322–6328

[40] Blomqvist,P et al, *Polycyclic Aromatic Hydrocarbons (PAHs) quantified in large-scale fire experiments*, Fire technology, 48 (2012), p-513-528

[41] Sepúlveda,A et al, *A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India*, Environmental Impact Assessment Review 30 (2010) 28–41

[42] Wang,Y et al, *Polycyclic aromatic hydrocarbons (PAHs) in soils and vegetation near an e-waste*

recycling site in South China: Concentration, distribution, source, and risk assessment, Science of the Total Environment 439 (2012) 187–193

Convention that aim to monitor e-waste movements and to protect the health of workers and communities[43] [44].

LCA modelling carried out for the FP7 ENFIRO project provides for a comparison of the potential for hazardous emissions from improper WEEE disposal scenarios for a notebook computer (see Figure 2.2.1). The aggregated, normalised results illustrate the significance of the contribution of dioxin and furan emissions to the human toxicity midpoint for a notebook incorporating mainly brominated flame retardants within the plastic casing, circuit boards and cable sheaths. The contribution of plastics incorporating non-halogenated flame retardants to the human toxicity midpoint is also evident in the results, reflecting high TEQ emissions from carcinogenic PAHs.

Some stakeholders emphasised the importance of considering PAHs alongside dioxin and furan emissions. PAHs may arise from the combustion or pyrolysis of aromatic substances and polymers such as polyolefins and epoxy resins. Evidence from WEEE sites in China, India and Africa appears to support this assertion and highlight the significance of emissions to air and fly ash. Simulated fire test data arising from studies in the US and Sweden enables a contribution analysis of PxDD/DF and PAHs emissions to human toxicity under simulated improper conditions to be made.

[43] UNEP, *E-waste in Africa*, Accessed October 2015 http://www.basel.int/Implementation/Ewaste/EwasteinAfrica/Overview/tabid/2546/Default.aspx

[44] World Health Organisation, *Childrens environmental health: Electronic waste*, http://www.who.int/ceh/risks/ewaste/en/

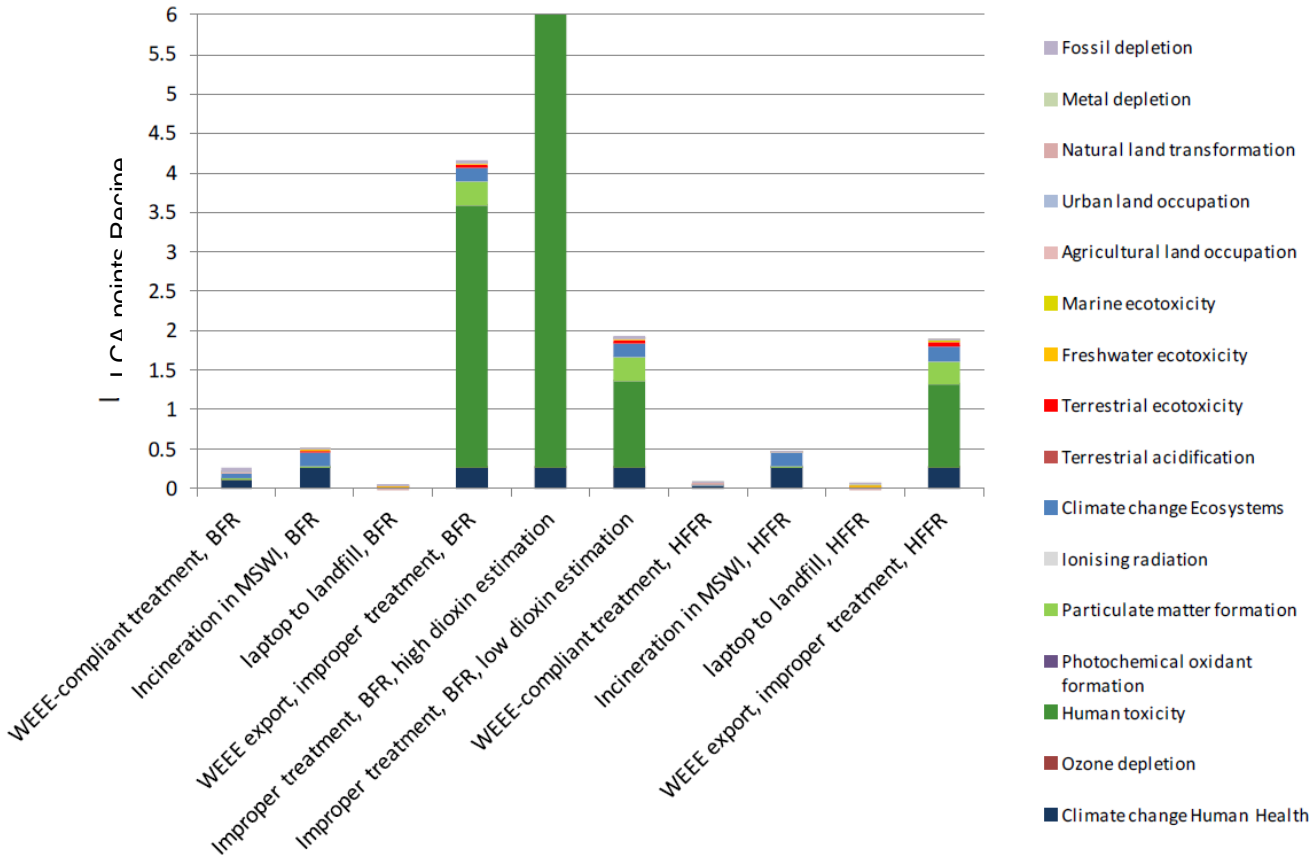

Figure 2.2.1. Influence of dioxin formation during improper WEEE treatment on the total environmental impact of the waste treatment of one laptop.

Source: ENFIRO project (2013)

Emissions data for PCBs and cables was chosen for further analysis to determine the relative contribution of dioxin and PAHs species to the toxicity of the emissions. The findings are presented in Table 2.7. For PCBs they show that PAHs make a significant contribution, in the region of 24%, whilst for cables they show that PCDD/DF are more relevant than PAHs, which in the worst case scenario contribute less than 1%.

Table 2.7 Contribution analysis of PxDD/DF and PAHs emissions in Comparative Toxic Units for Human Health (CTUh) per kg component tested

Hazardous emissions	Printed Circuit Board laminate (brominated FR)	Electrical cable (polymer and conductor)	
		Polyvinyl chloride insulation	Polyethylene insulation
PCDD/DF	-	2.19E-08 (99%)	2.16E-09 (96%)
PBDD/DF	1.79E-08 (76%)	-	-
PAHs	5.75E-09 (24%)	1.71E-10 (1%)	8.80E-11 (4%)

Data sources: US EPA (2013), SP (2001)

As previously referred to, concerns relating to toxic emissions from improper treatment in the end-of-life phase of electrical products has driven action by computer manufacturers to phase-out those materials and flame retardants for which evidence exists of the potential for greater toxic emissions [45]. A related proposal was received from three major computer manufacturers that low halogen components should be made an EU GPP Award Criterion. The following text was proposed:

> *Additional points will be awarded for computers that have low bromine and chlorine content in the product motherboard laminate, excluding components, with the maximum substance concentrations as defined in IEC61249-2-21*

This proposal reflects industry's progress in moving away from brominated flame retardants, even for Printed Circuit Boards, although it is understood that for some electrical products this continues to pose a technical challenge. IEC 61249-2-21 defines a concentration limit for 'low halogen' claims of 900ppm for bromine present in the resin of a PCB.

[45] Chem Sec, *Leading Electronics companies and Environmental organisations urge EU to restrict more hazardous substances in electronic products in 2015 to avoid more global dioxin formation*, 19th May 2010, http://www.chemsec.org/images/stories/publications/ChemSec_publications/RoHS_restrictions_Company__NGO_alliance.pdf

Whilst IEC 61249-2-21 provides a verification option that is based on laboratory testing, this could be too restrictive if specific substances are required to still meet fire safety standards or if new chemical structures for brominated flame retardants are developed – for example, EBP (CAS No. 84852-53-9) which has been demonstrated in testing to have very low dioxin emissions.

An alternative, more technology-neutral approach, is to fire-test material and flame retardant combinations for hazardous emissions. This form of testing is already used for cables, with a standardised test for the emissions of halogen acid gases that are precursors for PCDD/DF or PBDD/DF formation (EN 60754-1) and is used to support product claims made for '*halogen free low smoke'* cables according to IEC 61249-2-21.

Laboratory testing of components for toxic emissions of high concern for the environment - notably PCDD/DFs, PBDD/DFs and PAHs – has been carried out on Printed Circuit Boards for the US EPA's Design for the Environment programme [46] and on cables by the Swedish National Research and Testing Institute [47], as well as in studies by, amongst others, Gullett et al (2007), Hull et al (2008) and Li et al (2009).

The potential for a criteria to address end of life emissions from PCBs

As already highlighted, computer manufacturers are now able to make claims for 'low halogen' PCBs according to IEC 61249-2-21. Whilst this move may lead to reduced PBDD/DF emissions, this does not necessarily ensure that emissions of PAHs are minimised. The EU Ecolabel for computers has therefore introduced a fire test for PAHs emissions where such a claim is made.

[46] Sidhu.S, Morgan.A, Kahandawala.M, Muddasani.K, Gullett.B and D.Tabor, *Use of cone calorimeter to identify selected polyhalogenated dibenzo-p-dioxins/furans and polyaromatic hydrocarbon emissions from the combustion of circuit board laminates*, Final Report prepared for the U.S. Environmental Protection Agency by the University of Dayton Research Institute, October 22, 2013

[47] Simonson et al, *Fire LCA model: Cables case study*, SP Report 2001:22 *and* Simonson et al, *Cable case study II – NHXMH and NHMH cable*, SP Report 2005:45

Given that data is not available for PAHs emissions from PCB resins incorporating the most common substitute flame retardant Dihydrooxaphosphaphenanthrene (DOPO) an initial safety limit of 0.1 mg TEQ/g was established based on the best performing brominated PCB laminate with low halogen components (e.g. CPU) as tested in the 2013 US EPA study.

The EU Ecolabel also provided an alternative compliance route. This combines the need for the flame retardant to be reacted into the resin, thereby preventing potential migration from the laminate material in the end of life phase, and for a fire test to determine both PBDD/DF and PAHs emissions. An initial safety limit of 0.4 ng TEQ/g was set for PBDD/DF emissions was set based on the best performing brominated PCB as tested in the 2013 US EPA study. Based on the results of that study this would achieve a reduction in emissions of 50%.

The potential for a criteria to address end of life emissions from cables

As already highlighted, cable manufacturers are able to make claims for 'halogen free low smoke' cables according to IEC 62821. This specifies that emissions resulting from a fire test of the power cord polymer shall show halogen acid gas emissions of less than 5.0 mg/g. The EU Ecolabel introduced this as a safety limit where a *'halogen free low smoke'* claim is made.

The EU Ecolabel also provided an alternative compliance route for where more hazardous flame retardants or inherently flame retardant materials are used. The comparative results from Swedish cable fire testing using a large chamber test method (IEC 60332-3-10) were used to establish a threshold safety limit for cable emissions, recognising that low halogen cable materials may still produce dioxin and furan emissions.

An emissions limit of 0.3 ng TEQ/g cable was set, reflecting the highest reported results for substitute cable typologies that claim lower emissions, but with a margin applied to take into account higher potential emissions from the smaller scale, but more commonly used and cost effective ISO 19700 tube furnace test method.

Candidate List 'Substances of Very High Concern'

In the EU Ecolabel criteria a restriction is made on the presence of SVHCs identified under the REACH system in Europe. A threshold of 0.1% for the non-presence of SVHCs is set, reflecting the legal requirements and threshold for notification in Article 33(1) and (2) of the REACH Regulation, which manufacturers and their suppliers are familiar with as they are under a legal requirement to provide such declarations.

Given that many manufacturers import products that are assembled outside of the EU, it is understood that some also screen major sub-assemblies and components for the presence of SVHCs – as reflected by the EU Ecolabel criteria, which lists specific sub-assemblies and components for which declarations shall also be provided.

Following a ruling in September 2015 by the European Court of Justice [48], the extent of the 'producer' obligation to declare the presence of SVHCs in sub-assemblies and components of a complex article ('once an article, always an article') has been given further legal definition. The Court's ruling stated that:

> *'…each of the articles incorporated as a component of a complex product is covered by the relevant duties to notify and provide information when they contain a substance of very high concern in a concentration above 0.1% of their mass.*
>
> *The Court finds that the producer's duty to notify covers only those articles which the producer itself has made or assembled. That duty is therefore not applicable to an article which, although used by that producer as input, was made by a third party. Nonetheless, that third party is also subject to the duty to notify in respect of the article which it makes or assembles.*

[48] Court of Justice of the European Union, *Articles incorporated as components of a complex product must be notified to the European Chemicals Agency when they contain a substance of very high concern in a concentration above 0.1%,* Judgment in Case C-106/14, Press release No 100/15, Luxembourg, 10 September 2015 http://curia.europa.eu/jcms/upload/docs/application/pdf/2015-09/cp150100en.pdf

Similarly, the importer of a product the composition of which comprises one or more of the objects coming within the definition of the term 'article' must also be considered to be the importer of that article or those articles.'

Following the ruling ECHA is to publish new guidance on the correct legal interpretation of REACH Articles 33(1) and (2) and how this shall be enforced in each Member State.

A further practical issue faced by manufacturers is that not all Candidate List substances are relevant for electronics. The IEC 62476 standard describes control systems for chemicals in products [49] and has a supporting substance declaration list [50], which is used as a tool to pre-screen the Candidate List for relevance. This list includes notes on what functions substances serve and in which products and/or components they may be present. This is then provided to suppliers who must then provide declarations down to concentration limit of 0.1%. The IEC list is updated in line with updates to the Candidate List.

On this basis, it is therefore proposed to introduce a selection criterion which requires bidders to have a control system in place for chemical substances that reflects the basic elements of the systems described in IEC 62476. This would also have the benefit of promoting better management of hazardous substances beyond those that have been entered onto the Candidate List.

Whilst suppliers must, according to the law, provide a notification of the presence of SVHC in articles placed on the EU market, it would be prohibitive to verify such a notification, because analytical testing would be required for all substances on the Candidate List, or at least those identified as being relevant to the product. It is therefore considered that at this stage only the act of providing the declaration would be required as a technical specification. This is still considered to be a useful step in

[49] International Electrotechnical Commission (IEC),*Guidance for the evaluation of products with respect to substance-use restrictions in electrical and electronic products*, IEC/TR 62476, Edition 1: 2010-02

[50] International Electrotechnical Commission (IEC), *IEC 62474: Material declaration for products of and for the electrotechnical industry, http://std.iec.ch/iec62474*

raising awareness in public authorities of the availability of this information and how it can be used to identify the presence/non-presence of Substances of Very High Concern.

2.2.3 Final proposals for revised criteria

Core criteria	Comprehensive criteria
SELECTION CRITERIA	
	SC1. Restricted substance controls The tenderer shall demonstrate implementation of a framework for the operation of Restricted Substance Controls (RSCs) along the supply chain for the products to be supplied. Product evaluations according to the RSCs should, as a minimum, cover the following areas: - Product planning/design; - Supplier conformity; - Analytical testing. The RSCs shall apply, as a minimum, to REACH Candidate List substances and RoHS restricted substances. The IEC 62474 material declaration database [51] shall be used as the basis for identifying, tracking and declaring specific information about the composition of the products to be supplied. The RSCs shall be used to ensure that the tenderer is aware of the presence or non-presence of substances that are listed in the IEC 62474 database. Supplier declarations of conformity with the RSCs shall be collected and maintained up to date for relevant materials, parts and sub-assemblies of the products to be supplied. These may be supported, where appropriate, by supplier audits and analytical testing. The RSCs procedures shall ensure that product and supplier compliance is re-evaluated when: - restricted substance requirements change; - if supplied materials, parts and sub-asemblies change; - if manufacturing and assembly operations change. Implementation of the RSCs shall be with reference to

[51] International Electrotechnical Commission (IEC), *IEC 62474: Material declaration for products of and for the electrotechnical industry, http://std.iec.ch/iec62474*

	the guidance in IEC 62476 or equivalent and the IEC 62474 material declaration database.. **Verification:** The tenderer shall provide documentation, which describes the system, its procedures and proof of its implementation.
TECHNICAL SPECIFICATIONS	
TS3. Declaration for REACH Candidate List substances The tenderer shall declare the presence of any REACH Candidate List substances at a concentration of greater than 0.1% (weight by weight) in the whole product and in each of the following sub-assemblies - Populated motherboard (including CPU, RAM, graphics units); - Display unit (including backlighting); - Casings and bezels; - External keyboard, mouse and/or trackpad; - External AC and DC power cords (including adapters and power packs) **Verification:** The tenderer shall provide a declaration identifying specific substances that are present.	**TS3. Declaration for REACH Candidate List substances** The tenderer shall declare the presence of any REACH Candidate List substances at a concentration of greater than 0.1% (weight by weight) in the whole product and in each of the following sub-assemblies: - Populated motherboard (including CPU, RAM, graphics units); - Display unit (including backlighting); - Casings and bezels; - External keyboard, mouse and/or trackpad; - External AC and DC power cords (including adapters and power packs) **Verification:** The tenderer shall provide a declaration identifying specific substances that are present. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
	TS4. Plasticisers in external cables The following plasticisers shall not be present in external AC and DC power cords. (i) Phthalate plasticisers: DEHP, BBP, DBP, DIBP *Maximum allowable concentration limit*: 0.1% by weight of the polymer cable sheath per phthalate (ii) Medium Chained Chlorinated Paraffins (MCCP's) Alkanes C14-17 *Maximum allowable concentration limit*: 0.1% by weight of the polymer cable sheath. **Verification:** Verification shall be according to the specified test method and control concentration limits:

	(a) Phthalate plasticisers: DEHP, BBP, DBP, DIBP *Test method:* EN 14372, EPA 8270D or equivalent [52]. (b) Medium Chained Chlorinated Paraffins (MCCP's) Alkanes C14-17 *Test method*: EPA 8270D, EPA 3550C or equivalent The tenderer shall provide upon award a test report for the power cords of each distinct product family supplied. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
AWARD CRITERIA	
	AC2(a) Hazardous end of life emissions from the main Printed Circuit Board (motherboard) *This criterion shall not apply to monitors.* Points shall be awarded where the main Printed Circuit Board is *'halogen free'* in conformance with IEC 61249-2-21 and a fire test simulating improper WEEE disposal shows carcinogenic Polycyclic Aromatic Hydrocarbon (PAHs) emissions to be ≤ 0.1 mg TEQ /g. **Verification:** Test reports for the board composition and emissions shall be provided upon award for the ready-to-install motherboard. The fire test shall be carried out according to ISO 5660 in oxidative pyrolysis conditions (IEC 60695-7-1 fire type 1b with a heat flux of 50 kW/m^2). Quantification of the PAHs emissions shall be made according to ISO 11338 (PAHs). Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
	AC2(b) Hazardous end of life emissions from external power cables Points shall be awarded where the external power cables are *'halogen free low smoke'* in conformance with IEC 62821 whereby a fire test of the power cord polymer shows halogen acid gas emissions to be less than 5.0 mg/g. **Verification:**

[52] A new standard is under development to support implementation of Commission Delegated Directive (EU) 2015/863 of 31 March 2015. IEC 62321-8 *Determination of specific phthalates in polymer materials by mass spectrometry* will provide a harmonised test method and should be referred to in place of the listed standards once published (anticipated June 2017).

	A fire test report with the emissions results shall be provided upon award for the power cables. The fire test shall be carried out according to IEC 60754-1 in under-ventilated conditions (IEC 60695-7-1 fire type 3a with a heat flux of 50 kW/m^2). Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

Summary rationale:

- A comprehensive selection criterion has been added requiring implementation of a control system for chemical substances based on IEC 62476. This reflects the best practice of major computer and display manufacturers.
- All tenderers would be required to provide a declaration of the presence of Candidate List substances in accordance with the legal requirements in Article 33(1) of REACH. Declarations are also requested for specific 'sub-assemblies' of the products supplied, which may be coming from manufacturers outside of the EU and would fall outside of the requirements of REACH.
- A criterion restricting mercury is felt to now be of less relevance due to the significant market decline of cold cathode tube or gas discharge lamp technologies, which on the basis of evidence from Energy Star database would not be able to meet modern energy efficiency standards, and on this basis it is therefore proposed to delete the restriction.
- It is proposed that a comprehensive criterion is specified to test for the non-presence of hazardous phthalates in power cords that will be restricted from 2019 under an amendment to the RoHS Directive, some of which are Candidate List SVHCs, and for Medium Chain Chlorinated Paraffins (MCCPs), which are being restricted by front runner manufacturers. A threshold limit and test methods are specified for these two types of plasticisers.
- Recognising the potential for *toxic emissions from the improper disposal of circuit boards and cables outside of the EU*, where they may be burnt or pyrolysed to recover metals and critical raw materials, award criteria are

proposed to encourage manufacturers to use materials and chemistries that minimise the most hazardous end-of-life emissions.

- The criteria selected for GPP at comprehensive level reflect those specified for *low hazard materials and flame retardants* in the EU Ecolabel for 'personal, notebook and tablet computers'.
- To be awarded points, suppliers would need to demonstrate through the means of fire tests of motherboard and cable materials that precursors for the formation of polybrominated dibenzo-p-dioxin and polybrominated dibenzofuran (PBDD/DF) and polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD/DF) emissions are minimised through the selection of flame retardants and cable materials.
- Recognising the significance of carcinogenic polycyclic aromatic hydrocarbon (PAHs) from the improper disposal of printed circuit boards, these emissions shall also minimised, with a fire test and emissions thresholds specified.
- An approach based on emissions testing is considered to have the advantage of being a technology-neutral means of encouraging safer chemistry.

2.3 Criteria area 3 – Product lifetime extension

The research results of Task 3 (Life Cycle Assessment evidence) and Task 4 (Improvement Options) revealed that attention should be paid to the extension of the lifetime of computers in order to reduce the overall environmental impacts caused by shorter lifespans, raw material extraction and manufacturing processes. In the current criteria requirements that influence the lifetime of computers are very limited in their scope, addressing only upgradeability and the future availability of spare parts. A number of potential new criteria addressing product lifespan are proposed for discussion.

2.3.1 Criterion 3.1 – Upgradeability, replaceability and repairability

2.3.1.1 Summary of stakeholder comments received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
A Member State asked whether batteries provided can be easily changed on site by the contracting authority/their IT services. Battery replacement services could be considered. The requirement should include an exception for products with batteries that are designed to outlast the product. This is because there is a tendency towards miniaturisation and integration of internal components in order to achieve thinner and lighter devices. This leads in turn to resource efficiency benefits. According to manufacturers, user replaceability is discouraged for safety, environmental and performance reasons. It was proposed that the criterion on the ease of replacement be exempted for batteries with a cycle performance of greater than 1,000. Moreover, 'subnotebooks' shall be defined. Manufacturers commented that they could not support a battery replacement requirement unless it was for a defined time period. This is because the 50% capacity loss would happen sooner or later. Moreover, a battery defect shall be defined. A manufacturer did not see expansion ports as a significant issue. Their *performance* is, however, important in some procurement exercises. It was queried as to whether a wireless solution would be permitted. This would, for example, support next generation display and keyboard connectivity. Tablet micro-USB ports should be specified. A stakeholder stated that they would support the proposal if it were to be clear that early failure is an issue that affects product lifetime. A Member State proposed that upgradeability and guarantee periods be dealt with as part of a Whole Life Costing approach within the ITT. It was queried by DG ENV to what extent Life Cycle Costing was really used by Member States or public authorities.

A stakeholder questioned why the GPP proposal varied from the Ecolabel's 5 year parts availability. The wording relates to the time of purchase whereas the Ecolabel proposal relates to when production of the model ends. Feedback from manufacturers suggested that backwards compatability could limit the advancement of technology. The term 'previous model' requires clarification.

With regards to the cost competitiveness of spare parts, some manufacturers were not clear as to the environmental benefit. The total cost of replacing the part should include labour costs because these may be high. Clarification is needed as to what is meant by competitiveness.

Concerning reparability a manufacturer stakeholder expressed initial support for the criteria and the aim to provide more information. A Member State highlighted the relevance of the availability of repair manual and availability of spare parts to lifetime extension. A stakeholder requested that diagnostic tools (in addition to repair manual) be made publicly available. Manufacturers emphasised that instructions shall be provided to professional service providers and that these may be in hard copy or on a website. The term 'commercially available tools' should be used instead of 'universal tools'.

The criterion should not dictate which 'modules' or parts should be replaceable. Every design is different and modules may integrate a number of the listed parts e.g. SSD + memory + CPU. A proposal was made by a manufacturer to have an award criterion for sockets that enable upgrades beyond the integrated module. It was proposed that stands integrated with the enclosure of monitors should be excluded or exempted.

However, manufacturers saw an issue on making such a manual publicly available. They showed a preference to provide the manual on a web interface or upon request. Industry stakeholders stated that they have contracts with several service centres to guarantee quality. There was concern on the difficulty of estimating the use/storage capacity required for spare parts.

In relation to warranties a Member State expressed that if a commercial warranty is

finally proposed it needs to be clear if is paid or not. It was queried by manufacturers what was meant by 'pickup and return' and such criteria should not be so prescriptive in how the service is provided. Moreover, the option for repairs to be carried out on-site should be given. Manufacturers proposed greater alignment with the label EPEAT.

2.3.1.2 Technical background and rationale for criteria revision v2

Upgradeability and the availability of spare parts feature in the current criteria set and were cited by stakeholders as an important consideration for the public sector in seeking to extend the lifespan of computer products. To avoid an early replacement of the whole computer in the case of poor performance or worn-out or defective single components, the upgradeability and reparability of products are major factors to consider.

Provision of product warranties

Regarding longer product warranties, research by WRAP[53] concluded that the provision of longer standard guarantees or warranties reflects on manufacturer's confidence in the lifetime of their product. An overview of standard warranties provided by a sample of manufacturers is presented in Table 2.3.1.

In the EU Ecolabel criteria reference is made to Directive 99/44/EC which addresses the sale of goods to consumers. In the case of GPP conformity will be with the contractual terms and conditions, although reference is also possible to Member State or international law on contracts of sale, for example the UN Convention on Contracts for the International Sale of Goods[54].

Stakeholders asked for it to be clarified that the warranty period referred to would be included in any legal period of conformity (for example two years under the UN

[53] WRAP, *Electrical and electronic product design: product lifetime*, UK, January 2013; http://www.wrap.org.uk/sites/files/wrap/WRAP%20longer%20product%20lifetimes.pdf

[54] UN (2010) *Convention on Contracts for the International Sale of Goods*

Convention), and the nature of the services provided. Generally the warranty is for a period of time commencing from purchase/delivery. The potential for longer warranties to be provided is possible in the market, for example to 4 years taking the examples of Toshiba and Samsung, and so can be encouraged with an award criterion. 3 years is a requirement in the EPEAT Ecolabel.

It should also be clarified whether warranties are to be provided at additional cost. Generally, warranty extensions beyond 1 year come at an additional cost. Pick-up and return and battery replacement are services offered in many warranties at a further additional cost, so they are proposed as an added value to be offered by potential contractors.

Table 2.3.1: Overview of commercial warranties provided by different manufacturers

Manu-facturer	Commercial warranty provided by product form factor				Opening of hardware allowed?
	PCs	Notebooks/ Netbooks	Notebook battery	Monitors	
Acer	• Consumer PCs: 1-2 years • Business PCs: 1-3 years	• Notebooks: 1-2 years • Netbooks: 1 year	6 months	• Consumer LCDs: 2 years • Professio-nal LCDs: 3 years	Upgrade of hardware not generally forbidden, but defects caused by improper repairs or incorrect components not covered by warranty
Apple	Generally 1 year				Allowed, when in handbook the exchange of components like RAM or HDD are described explicitly; if not in the manual, hardware may only be opened by Authorized Apple Service Provider (AASP)
Asus	2 years	2 years	1 year	3 years	Exchange of RAM and HDD allowed
Dell	Service against payment of a fee: 1 year				Components like RAM, HDD or cards are allowed to exchange
Fujitsu	2 years	2 years	1 year	3 years	Yes, e.g. RAM; generally warranty covers only original configurations

Manu-facturer	Commercial warranty provided by product form factor				Opening of hardware allowed?
	PCs	Notebooks/ Netbooks	Notebook battery	Monitors	
HP	2 years for certain product series	2 years for certain product series	Excluded from standard warranty	n.a.	Upgrade of hardware not generally forbidden, e.g. RAM, but defects caused by improper repairs or incorrect components not covered by warranty
Lenovo	1-3 years depen-ding on model	1-3 years depending on model	1 year	n.a.	Yes, e.g. RAM
LG	2 years	2 years	6 months	3 years	No, only by authorized / specialized dealers
Toshiba	n.a.	1-3 years depending on model	1 year	n.a.	Upgrade of hardware not generally forbidden, e.g. RAM, but defects caused by improper repairs or incorrect components are not covered by warranty

Commercial battery guarantees

Stakeholders to the EU Ecolabel commented that, in contrast to the one year battery guarantee generally offered by manufacturers, the guarantee must not be shorter than the legal guarantee period for the whole product, which is a minimum of 2 years.

In practice manufacturers distinguish between physical defects that may occur – for example if the battery does not accept charge or prevents the computer switching on[55] - and a gradual reduction in the charge capacity of the battery, which is an inevitable function of the chemical nature of batteries. For a typical lithium ion battery with a capacity of 300-500 cycles the decline will, in the majority of cases, occur within the first two years of ownership.

Some manufacturers offer a three or four year commercial warrantee with the option for battery replacement in the event of a defect occurring and, where longer cycle prismatic batteries are provided, there is a reduction in charging capacity below a

[55] Asus, *Battery information centre*, http://www.asus.com/us/support/Article/604/

stated threshold[56]. It should be noted, however, that the customer must pay for this replacement service because it extends the legal minimum coverage (if this is considered to be 2 years) beyond what could be defined as a defect.

Upgrading, repairability and spare parts

The nature of the requirements will depend on the form of the computer. For the public sector it must be possible to update and adapt to new software. This can, to some extent, now be addressed via thin clients and remote connections to servers, but memory must still be readily upgradeable. With 'the cloud', the use of mobile thin clients and external drive capacity certain memory upgrades for portable applications may no longer be needed, but this will to a greater extent depend on security considerations.

Stakeholders highlighted the importance of spare parts being available. Many large public bodies will have in-house IT teams with the capability to carry out repairs that do not invalidate product warrantees. It has been suggested that it is important that spare parts do not have to be those originally designed for the product but that "backwardly compatible" parts are also acceptable. Regarding the current criterion on the availability of spare parts general feedback from stakeholders suggests that 3 instead of 5 years may be more realistic, so this is proposed as a core requirement. 5 years is set as an optional requirement in the EPEAT criterion and is used in the EU Ecolabel proposals for both computers and monitors.

Regarding the pricing of parts it was agreed in discussions that it is not possible to dictate this in criteria. The price of parts is a concern because OEMs may maintain prices for specific or compatible parts at levels that may discourage replacement or repair. There was, however, support for the initial proposal to request indicative pricing so as to encourage competitive responses from potential contractors.

[56] Toshiba, *Toshiba EU warranty extensión*, http://www.toshiba.eu/services/warranty-extension/laptops-tablets/ext103eu-vba/tab/terms-and-conditions/

Research by WRAP highlights that with rapidly changing technology repairs become difficult as parts are not always easily available or interchangeable. Repair costs tend to be high, relative to residual value, because of the high proportion of devices suffering screen damage across all the model types.

Upgradeability applies specifically to computer products, where the potential can be seen to differ significantly depending on the form factor:

- Desktop computers, desktop workstations and small scale servers: Certain components can more or less be easily upgraded (HDD, SSD, memory) or expanded by additional slots (graphics),
- Notebooks:
  - HDD/SSD, memory, CD/DVD/Blu-ray drive, rechargeable battery: Some are easily upgradeable, some are now glued into the casing.
  - Videocards for notebooks are not exchangeable as mainly on-board graphic processing unit (GPU) are now used, i.e. integrated on the motherboard
- Ultrabooks as sub-category of notebooks: The thinner and smaller the form factor makes upgrades more complicated.
  - In general, neither HDD/SSD nor RAM are exchangeable against new components; either being secured with special screws or soldered to the motherboard[57].
  - Rechargeable batteries are mostly glued in and are only replaceable by manufacturers.
- In general: The motherboard and CPU are difficult to upgrade; whilst exchange of the CPU is theoretically possible it is often soldered to the motherboard to facilitate better heat dissipation.[58]

[57] Sources: www.com-magazin.de/praxis/hardware/20-fakten-zu-ultrabooks-7388.html; www.heise.de/newsticker/meldung/Oeko-Logo-EPEAT-winkt-Ultrabooks-durch-1729666.html 15.10.2012

[58] www.gamestar.de/hardware/praxis/notebooks/2323984/notebook_tuning_teil_1.html

- A case study by WRAP (2011)[59] of three LCD models to illustrate and encourage the durability and repair summarizes the following most common faults that cause failure and shorten the product's lifetime:
  - Screen faults – due to damage, sometimes caused by impact;
  - Power circuit board faults;
  - Main circuit board faults – including hardware and microchip software;
  - Damage to connections – often between circuit boards; and
  - Damage to television stands.

Tablet batteries, and in some cases ultrabook batteries, were identified by stakeholders as being an issue. They often cannot be easily removed to replace them, often requiring return to a dealer or IT provider in order to change batteries, costing time and money. Battery replacement is now specifically dealt with in the EU GPP and Ecolabel criteria proposals, the basis for which is discussed in the next section.

Ensuring that batteries can be easily changed

Consideration of how easy it is for a notebook or tablet battery to be changed was raised by a number of stakeholders and is now considered by the Ecodesign Regulation for computers which imposes a requirement that from July 2014:

> *'If a notebook computer is operated by battery/ies that cannot be accessed and replaced by a non-professional user….manufacturers shall provide in the technical documentation, and make available on free-access websites and on the external packaging of the notebook computer, the following information 'The battery[ies] in this product cannot be easily replaced by users themselves'.'*

[59] Cf. http://www.wrap.org.uk/sites/files/wrap/TV%20case%20study%20AG.pdf

Moreover, Annex VII of the WEEE Directive and the Battery Directive 2013/56/EC require Member States to ensure that manufacturers design appliances to allow the readily removal of waste batteries by end-user or by qualified professionals that are independent of the manufacturer.

In order to define 'ease of extraction' benchmarks for the EU Ecolabel a sample of sub-notebook and tablet computers were analysed by JRC-IES. Based on Intel Corporation's Ultrabook™ and the characteristics of products on the market, the following definition is proposed:

> *A form of notebook that is less than 21mm thick and that weighs less than 1.8kg. Two in-one notebooks (see the separate definition in Article 2(4)b of Decision (EU) 2016/1371) with a subnotebook form are less than 23mm thick. Subnotebooks incorporate low power processors and solid state drives. Optical disk drives are generally not incorporated. They provide longer rechargeable battery life than notebooks, usually more than 8 hours.*

The analysis of sub-notebooks took as its starting point the 28 models addressed by the Electronics Takeback Coalition in their 2012 briefing [60]. The analysis of tablets took as its basis a study published by Fraunhofer IZM which disassembled and analysed 21 models [61]. In both cases JRC-IES analysed the steps required to access and extract the battery packs. The steps required were codified and the number of models falling under each code determined.

Table 2.3.2 presents the results of the analysis carried out for the 28 subnotebook models. In addition to the number of steps, the tools required to extract the battery and the number of units from the sample found with such features are also included. The last column refers to the units (in percentage) that meet each of the dismantling codes defined.

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[60] Electronics Takeback Coalition, *Ultra-inconvenient*, 15th August 2012

[61] Fraunhofer IZM, *Disassembly analysis of slates: Design for repair and recycling evaluation*, Final report, August 2013.

A small number of subnotebook and tablet units on the market have battery packs that are easily removed by spring load release, most require the use of universal tools and/or the removal of glued or soldered-in contacts and fixings. The most common number of steps needed to extract battery packs *using only universal tools* are three for subnotebooks, and four for tablets.

For 46% of the subnotebook models studied, the battery can be extracted by removing the base cover, unplugging the battery from the main printed circuit board (PCB) and then unscrewing it from the laptop chassis. Among the tablet models studied, 20% could be opened by using a spudger and screwdriver to open the casing, followed by unscrewing up to three connectors.

Table 2.3.2. Steps required to extract batteries in selected sub-notebook models

Code	Embedded battery?	Steps	Number of steps	Tools	Number of units	% units
A	No	Spring-loaded release	1	none	1	4
B	No	Unscrew battery pack	1	Screwdriver	1	4
C	Yes	Remove base cover, unscrew and unplug battery pack	3	Screwdriver	13	46
1+C	Yes	Steps described in C plus one pre-step. For example, remove rubber feet and connector cover on the side	4	Screwdriver	2	7
2+C	Yes	Steps described in C plus two pre-step. For example, remove rubber feet, connector shell on the side and remove additional screws	5	Screwdriver	2	7
1+C+1	Yes	Steps described in C plus one pre-step and one post-step. For example, remove rubber feet, connector shell on the side, remove adhesives and unplug additional cables	5	Screwdriver	2	7
D	Yes	Remove base cover, remove adhesive, unscrew and unplug battery pack	4	Screwdriver	2	7
2+D	Yes	Steps described in D plus two pre-steps. For example, remove rear panel and HDD unit	6	Screwdriver	1	4
E	Yes	Remove base cover, connectors, lift tape, unscrew and unplug battery pack, and pull without disconnecting speakers cables	6	Screwdriver	2	7
F	Yes	Unscrew base cover, turn the computer and press the tab in to loosen the keyboard, unplug the keyboard cable, unplug and remove the palm rest, unscrew battery and lift it out of the laptop	6	Screwdriver	1	4
5+F	Yes	Steps described in E plus 5 pre-steps. For example, remove SD blank, unscrew and remove access door, remove the memory and remove screws	11	Screwdriver	1	4

Source: JRC-IES (2014 draft). *Analysis of material efficiency for EU Ecolabel criteria: the example of two product groups. Environmental Footprint and Material efficiency support for product policy*.

Hardware interfaces and connectors

The integration of sufficient hardware interfaces and connectors such as USB was included in early proposals for the EU Ecolabel for computers and in the first proposal for revised GPP criteria. Stakeholders did, however, question the benefit and need for these criteria and suggested that it should only be addressed if early failure of connectors is a constraint on the lifespan of products.

In some cases mass storage expansion or USB type A interfaces for tablets may be overly selective in the market, and in practice wireless capabilities and/or cloud computing may be used instead.

Further feedback in relation to the proposed parts list for repairability highlighted the potential for an award criterion for smaller devices where the memory and data storage may be integrated on the main board to achieve a thin form factor. In this case upgrading is more difficult and so improved soldered-on RAM capacity, socketed memory design to facilitate replacement/upgrading, expansion slots and the potential for additional mass storage in separable keyboards were proposed as options available in the market that could be encouraged.

With regard to improved RAM capacity, feedback from a leading supplier of tablets to public clients highlighted the potential to encourage capacity of greater than the quoted market standard of 2GB, with 4GB and 8GB proposed. It was noted that additional RAM would not be necessary in the case of product concepts such as Chrome (provided by a number of manufacturers) which are designed to run applications and make use of mass storage in the 'cloud'.

No evidence could be found to substantiate potential problems identified with the susceptibility of multiple USB connections to faults on the mainboard.

2.3.1.3 Final criteria proposals

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
TS4. Warranty and service agreements The tenderer shall provide a minimum two-year warranty effective from delivery of the product. This warranty shall cover repair or replacement and include a service agreement with options for pick-up and return or on-site repairs. The warranty shall guarantee that the products are in conformity with the contract specifications at no additional cost. This shall cover battery defects [62]. **Verification:** The tenderer shall provide a written declaration that the products supplied will be warrantied in conformity with the contract specifications and service requirements.	**TS5. Warranty and service agreements** The tenderer shall provide a minimum three-year warranty effective from delivery of the product. This warranty shall cover repair or replacement and include a service agreement with options for pick-up and return or on-site repairs. The warranty shall guarantee that the products are in conformity with the contract specifications at no additional cost. This shall cover battery defects [62]. **Verification:** The tenderer shall provide a written declaration that the products supplied will be warrantied in conformity with the contract specifications and service requirements.
TS5(a) Continued availability of spare parts The tenderer shall guarantee the availability of spare parts, including as a minimum those identified in criterion TS5(b), for at least three years from the date of purchase. **Verification:** The tenderer shall provide a declaration that compatible spare parts, including rechargeable batteries (if applicable), will be made available to the contracting authority or through a service provider. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.	**TS6(a) Continued availability of spare parts** The tenderer shall guarantee the availability of spare parts, including as a minimum those identified in criterion TS6(b), for at least five years from the date of purchase. Compatible parts with improved capacity or performance, where relevant, shall be made available. **Verification:** The tenderer shall provide a declaration that compatible spare parts, including rechargeable batteries (if applicable), will be made available to the contracting authority or through a service provider. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
TS5(b) Design for repairability The following parts, if applicable, shall be easily accessible and replaceable by the use of universally available tools (i.e. screwdriver, spatula, plier or tweezers): Computers (i) HDD/SSD, (ii) Memory, (iii) Rechargeable battery, Displays (i) Screen assembly and LCD backlight (ii) Power and control circuit boards	**TS6(b) Design and support for repairability** The following parts, if applicable, shall be easily accessible and replaceable using universally available tools (i.e. screwdriver, spatula, plier or tweezers): Computers (i) HDD/SSD, (ii) Memory, (iii) Rechargeable battery, (iv) Screen assembly and LCD backlight, (v) Keyboard and mouse pad,

[62] Defects shall be considered to include failure to charge as well as detection of the battery's connection. A progressive drop in battery capacity due to usage shall not be considered to be a defect unless it is covered by a specific warranty provision (see criterion C6).

(iii) Stands (excluding those integrated with the enclosure) Tablets and two-in-one notebooks shall be exempt for computer parts (i) and (ii). *For these products award criterion C7 shall be used to encourage better design.* The tenderer shall provide clear disassembly and repair instructions (e.g. hard or electronic copy, video) to enable a non-destructive disassembly of products for the purpose of replacing key components or parts for upgrades or repairs. This shall be made available in hard copy or via the manufacturer's webpage. **Verification:** A manual shall be provided by the tenderer, which shall include an exploded diagram of the device illustrating the parts that can be accessed and replaced, and the tools required. It shall also be confirmed which parts are covered by service agreements under the warranty. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.	Displays (i) Screen assembly and LCD backlight (ii) Power and control circuit boards (iii) Stands (excluding those integrated with the enclosure) *Tablets and two-in-one notebooks shall be exempt for computer parts (i) and (ii). Award criterion C7 shall be used to encourage better design.* The tenderer shall provide clear disassembly and repair instructions (e.g. hard or electronic copy, video) to enable a non-destructive disassembly of products for the purpose of replacing key components or parts for upgrades or repairs. This shall be made available in hard copy or the manufacturer's webpage. **Verification:** A manual shall be provided by the tenderer which shall include an exploded diagram of the device illustrating the parts that can be accessed and replaced, and the tools required. It shall also be confirmed which parts are covered by service agreements under the warranty. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
TS5(c) Ease of replacement for rechargeable batteries Rechargeable batteries shall not be glued or soldered into portable products. It shall be possible for a professional user or repair service provider to replace the rechargeable battery. Instructions on how the rechargeable battery packs are to be removed shall be provided in the user instructions or via the manufacturer's webpage. **Verification:** The tenderer shall illustrate how the battery is installed in the product, the steps required to remove and cover markings. A copy of relevant user instructions shall also be provided. The Contracting Authority reserves the right to request a visual inspection of a random selection of the supplied products. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.	**TS6(c) Ease of replacement for rechargeable batteries** Rechargeable batteries shall not be glued or soldered into portable products. It shall be possible for a professional user or repair service provider to replace the rechargeable battery. If the rechargeable battery has a performance of less than 800 endurance cycles when tested according to IEC EN 61960, it shall be possible to extract it from the product according to the following requirements : • For notebooks and portable all-in-one computers manually without tools; • For sub-notebooks in a maximum of three steps[63] using a screwdriver; • For tablets and two-in-one notebooks in a maximum of four steps using a screwdriver and spudger; Instructions on how the rechargeable battery packs are to be removed shall be provided in the user instructions or via the manufacturer's webpage. **Verification:** The tenderer shall illustrate how the battery is installed in the product, the steps required to remove it and

[63] A step consists of an operation that finishes with the removal of a component or part and/or with a change of tool.

	cover markings. A copy of relevant user instructions shall also be provided. The Contracting Authority reserves the right to request a visual inspection of a random selection of the supplied products. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
AWARD CRITERIA [64]	
AC2. Cost competitiveness of spare parts The tenderer shall provide a price list for, as a minimum, the following component parts: [*the parts list to be provided here, with the TS5(b) list to be provided as a minimum*] For the component parts listed above indicative labour costs for replacements carried out by the tenderer's authorised service providers shall be provided. Points shall be awarded according to the most cost-competitive offers. *Additional component parts, if considered important to the price comparison, should be added to the list provided.* **Verification:** The tenderer shall provide a price list for original or compatible spare parts and indicative labour costs for their replacement, including rechargeable batteries (if applicable).	**AC3. Cost competitiveness of spare parts** The tenderer shall provide a price list for, as a minimum, the component parts listed in TS6(b) together with indicative labour costs for replacements carried out by the tenderer's authorised service providers. Points shall be awarded according to the most cost competitive offers. **Verification:** The tenderer shall provide a price list for original or compatible spare parts and indicative labour costs for their replacement, including rechargeable batteries (if applicable).
AC3. Longer warranties and services agreements Additional points shall be awarded to each additional year of warranty and service agreement offered that is more than the minimum technical specification. A maximum of x points [*to be specified*] may be awarded. • +4 years or more: x points • +3 years: 0.75x points • +2 years: 0.5x points • +1 year: 0.25x points **Verification:** A copy of the warranty and service agreement shall be provided by the tenderer. They shall provide a declaration that they cover the conformity of the goods	**AC4. Longer warrantees and service agreements** Additional points shall be awarded to each additional year of warranty and service agreement offered that is more than the minimum technical specification. A maximum of x points [*to be specified*] may be awarded. • +3 years or more: x points • +2 years : 0.6x points • +1 year: 0.3x points For portable devices 0.3x additional points shall also be awarded where during the first three years of the warranty, rechargeable battery replacement is provided free of charge in the case of a capacity loss of more than 50%. *The contracting authority may wish to specify the battery life benchmarking software that shall be used to evaluate the loss of battery life.*

[64] Instead of setting two separate award criteria on spare parts and warranties, this could be merged into one criterion, evaluating the overall offer including the length of the warranty, its comprehensiveness and the spare parts offer.

with the contract specifications.	**Verification:** A copy of the warranty and service agreement shall be provided by the tenderer. They shall provide a declaration that they cover the conformity of the goods with the contract specifications. Details of the battery capacity loss software shall additionally be provided.
AC4. Tablet and all-in-one notebook memory and storage Points shall be awarded for products that incorporate the following features: (i) RAM memory - Soldered RAM with a minimum capacity of 4GB, or; - The potential to replace and upgrade the RAM (socketed design). (ii) Mass storage - The potential to expand the storage by using slots supporting mass storage media, or - Additional mass storage incorporated into the keyboard (*for all-in-one notebooks*). *The RAM memory sub-criteria are not suitable for devices designed to run their main applications from the cloud. This criterion should not be used to compare bids that offer differing solutions i.e. integrated or cloud storage.* **Verification:** The tenderer shall provide details of the physical design of the memory and/or storage capacity of the model(s) to be supplied.	**AC5. Tablet and all-in-one notebook memory and storage** Points shall be awarded for products that incorporate the following features: (i) RAM memory - Soldered RAM with a minimum capacity of 8GB, or; - The potential to replace and upgrade the RAM (socketed design). (ii) Mass storage - The potential to expand the storage by using slots supporting mass storage media, or - Additional mass storage incorporated into the keyboard (*for all-in-one notebooks*) . . *The RAM memory sub-criteria are not suitable for devices designed to run their main applications from the cloud. This criterion should not be used to compare bids that offer differing solutions i.e. integrated or cloud storage.* **Verification:** The tenderer shall provide details of the physical design of the memory and/or storage capacity of the model(s) to be supplied.

Summary rationale for the final proposal

- A technical specification for the provision of a warranty with a minimum period of 2 years (core) and 3 years (comprehensive) is proposed in line with current practices in the market that are intended to reflect confidence in products, but to be provided at no extra cost (to those included in the bid). It is proposed that this explicitly covers the replacement of defective batteries.
- A new award criterion is proposed inviting manufacturers to offer extended warranties. This shall include battery replacement within the first three years in the case of capacity loss of greater than 50%.
- With regards to spare parts, the periods of 2 years (core) and 3 years (comprehensive) during which parts shall remain available have been retained as technical specifications.
- For the comprehensive criterion backward compatibility is addressed by requesting that parts with an improved capacity or performance, such as storage or batteries, shall be made available. This would reflect advances in technology and avoid the need to stock older parts.
- An award criterion would encourage tenderers to put forward prices for spare parts and to include indicative labour costs for replacements carried out by the tenderers authorised service providers, thereby encouraging competition to drive down prices in support of repairs and upgrading.
- A technical specification is proposed detailing the major components that shall be easily upgradeable or repairable. The focus is on those components that appear to have a high failure rate or tend to have a strong influence on the lifespan of the whole product. This listing also forms the basis for a minimum requirement for the criterion on spare parts availability (C2).
- Recognising that there is a move towards the miniaturisation and integration of some parts (e.g. main board with RAM memory and even mass storage), tablets and all-in-one notebooks are proposed to be exempted for memory and

storage. Instead an award criterion would reward internal upgradeability of expansion potential.

- The proposed criterion would offer a choice between greater soldered-in RAM, with 4GB and 8GB identified as best practice, and upgradeable RAM sockets. It also reflects the potential for mass storage to be placed in the keyboard of all-in-one notebooks.
- At a core level of ambition a technical specification is proposed that places requirements for rechargeable batteries to be easily removed (extracted) for replacement and recycling, i.e., they shall not be glued or soldered into the product. At a comprehensive level of ambition, and reflecting the EU Ecolabel, the maximum number of steps is defined reflecting the results from the disassembly steps for samples of subnotebook and tablet products on the market.
- However, reflecting industry concerns that this was too prescriptive the benchmarks for disassembly would not apply where the battery is considered to be high performance (>800 endurance cycles), thereby reducing the need for replacement during the lifespan of the product.
- *A criterion on a minimum number of interfaces has been deleted. This is because of general feedback that it is not a significant issue influencing the lifespan of products.*

2.3.2 Criterion 3.2 – Notebook battery quality and lifetime

2.3.2.1 Summary of stakeholder comments received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
A manufacturer highlighted the different physical forms and performances of lithium ion batteries, which can by cylindrical or prismatic. One is larger/cheaper the other thinner/lighter but more expensive. Further definition is needed for how the battery time will be measured. The performance requirements for public tenders can vary, for example schools may only require 5 hours and a warranty may be requested for the battery. A proposal was made by a manufacturer for a technical specifications of 80% charge retention after 300 cycles (core) and 500 cycles (comprehensive). This would be raised to 500 cycles and 800 cycles respectively where the battery is considered to be 'built-in'.

2.3.2.2 Technical background and rationale for the final criteria proposal

For notebook computers and tablet computers, the lifetime of the rechargeable batteries has been identified as a potential limiting factor to the overall lifetime of the whole product. This is particularly the case where the battery cannot easily be removed and replaced, as is the case for some notebooks and tablets. Battery replacement incurs additional costs and sending a device for battery replacement incurs both downtime and cost.

The influence of user behaviour

User behaviour is also an important factor in battery life. So-called 'intelligent charging' has been identified by stakeholders as an important feature. If a notebook is plugged into the mains power a long time then this may deteriorate the battery. It is understood that most modern notebooks now take power directly from the mains once the battery is fully or, if set accordingly, to a partial charge.

Nonetheless there may be scope to provide guidance to users on how to maximise battery life. Factors that can be controlled including ensuring the computer is well

ventilated and doesn't overheat, that power management settings are used when unplugged and that partial charging systems are used where available.

Battery life and cycle length within today's market

Battery lifetime declarations are now required to be made for notebooks under the non-energy related requirements of the Ecodesign Implementing Measure Regulation (EU) 207/2013 Annex II Part 7.1 'Information to be provided by manufacturers' (from 1st July 2014) which requires a declaration of:

> *(o) the minimum number of loading cycles that the batteries can withstand (applies only to notebook computers);*

Cycles are the number of times a battery can fully charge and discharge power before they start to deteriorate and hold less charge. Battery life generally refers to how long the user can work in hours before needing to recharge the battery.

Early declarations under Ecodesign provide an indication as to the standard cycles and the main test method used by manufacturers. For example, Dell declares that all their notebook and tablet batteries meet the accelerated endurance procedure of IEC EN 61960[65] retaining 60% capacity over 300 cycles. Commentators suggest that 300-500 cycles is the de facto standard for lithium ion batteries[66]. The ITU (International Telecommunication Union) recently published Recommendation L.1010 on 'Green Batteries' which proposes retention of 80% of capacity after 500 cycles as a benchmark for a long lasting battery[67]. Industry stakeholders proposed that the minimum performance threshold for GPP should be 80% retention after 300 cycles.

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[65] Dell (2014) *ErP Lot 3 Technical documentation*, http://www.dell.com/downloads/global/corporate/environ/comply/ErP_Lot_3_Public_Information.pdf

[66] Battery University, *How to prolong lithium based batteries*, http://batteryuniversity.com/learn/article/how_to_prolong_lithium_based_batteries

[67] ITU, *Green batteries solution for mobile phones and other hand-held information and communication technology devices*, Recommendation ITU-T L.1010, February 2014, http://www.itu.int/rec/T-REC-L.1010-201402-P

A closer look at the market, however, reveals that longer battery life and cycle claims appear to be increasingly important, particularly for computers sold to public organisations and private enterprises. A review of leading products on the market, together with feedback from leading manufacturers, suggests that *battery life* claims are the most frequently communicated to and valued by users, so this should be balanced against any cycle performance specifications.

Of the notebook manufacturers that dominate the EU market share Acer, Dell, Asus, HP and Toshiba offer business models with 800 or 1000 cycle batteries. In some cases this also allows the OEM to provide an extended warranty for the battery itself of up to 3 years. Notable amongst the leading OEM's is Apple who offers 80% retention of charge after 1,000 cycles as standard on new MacBook Pro and Air models[68]. However it is considered that Apple may represent a niche product for public procurers.

In terms of battery life in hours, for 15 inch+ screen desktop replacement notebooks battery life can now extend to an estimated 7-8 hours+ (dependant on hardware combinations). For Ultrabook notebook forms it can extend from an estimated 8-9 hours to up to 16 hours in one example. Industry stakeholders commented that requirements on battery life will vary depending on the specific end-use of a product. An example was cited of tablets for schools, which would probably not need more than 5 hours.

Consultation with selected notebook and battery manufacturers highlights that the cost of these batteries is higher, in some cases up to 80% more expensive than 300-500 cycle performance. A leading lithium ion battery manufacturer suggested that it is more important to specify longer cycle endurance for notebooks where the battery cannot be readily changed by the consumer e.g. in some Ultrabook and Tablet models.

[68] Apple, *Determining battery cycle count*, Accessed March 2014, http://support.apple.com/kb/ht1519

Extending battery life using intelligent charging

The battery life cycle can be extended through the use of 'intelligent charging' systems that control how a battery is charged and discharged. Battery life span degrades more rapidly if there is a deep charge and discharge i.e. if a battery is charged to near 100% capacity and is then subjected to near full discharge. Minimising the 'depth of discharge' will therefore extend the lifespan of the battery, as illustrated in Table 2.3.3.

Pre-installed software is now provided with some notebooks, for example with Apple, Asus and Toshiba products, limiting the charging to approximately 80% of battery capacity. This has the potential to extend the battery life cycle by approximately 50%, although in practice this reduces battery life, which we have already highlighted as being important for consumers.

Table 2.3.3: Relationship between depth of discharge and number of cycles

Depth of discharge	Discharge cycles
100% DoD	300 – 500
50% DoD	1,200 – 1,500
25% DoD	2,000 – 2,500
10% DoD	3,750 – 4,700

Source: Battery University (2014)

Benchmarking and verifying battery performance

For the measurement of battery cycle endurance the industry standard is IEC EN 61960. IEC 61960 specifies both a standard endurance in cycles test at 0.2 I_t A and an accelerated endurance in cycles test routine based on increased charge of 0.5 I_t A within the tolerance of the battery.

Battery life can be verified using a range of different software packages and test routines. Two of the most commonly used software packages for benchmarking battery life are understood to be Powermark by Futuremark [69] and Mobilemark by

[69] Futuremark, *Powermark*, Accessed 2014, http://www.futuremark.com/benchmarks/powermark

BAPCo [70]. These softwares can be used to simulate combinations of different tasks using typical combinations of mainstream software on a portable computer until the battery power is run down.

Futuremark is a private enterprise with a community of developers that includes Apple, Asus, Dell, HP, Lenovo and Microsoft. BAPCo is a non-profit enterprise established to develop benchmarking tools for its members who include Asus, Dell, HP, Lenovo, Microsoft, Samsung and Toshiba – although its origins with Intel raise concerns with some commentators that it has/continues to favour products with Intel processors [71]. BAPCo has a 'government network' and claims its software is used in public procurement by 24 EU states.

2.3.2.3 Final criterion proposal

Core criteria	Comprehensive criteria
AWARD CRITERIA	
AC5. Rechargeable battery life and endurance Points shall be awarded for improved endurance greater than 300 cycles (with 80% capacity retention) respectively. A maximum of x points *[to be specified]* may be awarded. • 1000 cycles or more: x points • 800 cycles or more : 0.75x points • 500 cycles or more: 0.5x points • Up to 499 cycles: 0.25x points *The minimum battery life in hours shall be set according to the Contracting Authority's requirements.* **Verification:** The tenderer shall provide a test report for the battery cells or packs showing compliance according to the IEC EN 61960 'endurance in cycles' test carried out at 25^{o}C and at a rate of either 0.2 I_t A or 0.5 I_t A (accelerated test procedure). Partial charging may be used to comply as long as the software is factory-installed as the default setting and the tender requirements on battery life are met at the	**AC6. Rechargeable battery life and endurance** Points shall be awarded for improved endurance greater than 500 cycles (with 80% capacity retention) respectively[72]. A maximum of x points *[to be specified]* may be awarded. • 1000 cycles or more: x points • 800 cycles or more : 0.6x points • Up to 799 cycles: 0.3x points *The minimum battery life in hours shall be set according to the Contracting Authority's requirements.* **Verification:** The tenderer shall provide a test report for the battery cells or packs showing compliance according to the IEC EN 61960 'endurance in cycles' test carried out at 25^{o}C and at a rate of either 0.2 I_t A or 0.5 I_t A (accelerated test procedure).

[70] BAPCo, *Mobilemark 2012*, Accessed 2014, http://bapco.com/products/mobilemark-2012

[71] Bright Side News, Are benchmarks worthless? 19th April 2012, http://www.brightsideofnews.com/2012/04/19/opinion-are-benchmarks-worthless/

[72] The cycle performance may be achieved using software which partially charges the battery. In this case the tenderer shall pre-install the software as the default charging routine.

partial changing level complying with the cycle requirement. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.	Partial charging may be used to comply as long as the software is factory-installed as the default setting and the tender requirements on battery life are met at the partial changing level complying with the cycle requirement. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

Summary rationale:

- Given uncertainty related to price and availability it is proposed to retain only an award criterion with the main focus on battery cycle endurance.
- Points could be awarded for additional endurance cycles over and above 300 (core) or 500 (comprehensive) cycles based on an 80% capacity retention, respectively. Points shall be awarded on a weighted scale up to 1000 cycles which represents the best performance on the market.
- Battery life is an important factor in some decisions to purchase notebooks and tablets but comments suggested that it is very tender specific. It is not therefore proposed to retain a battery life requirement.
- IEC 61960 is considered to represent an international reference point for the comparable verification of battery cycle endurance. It shall be possible to verify either cells or packs. The accelerated test option offers a lower cost of verification.
- Moreover, in recognition of the importance of depth of discharge on battery lifespan it is proposed to specifically allow partial charging to be used to comply with the award criteria, as long as the minimum battery life is complied with for the declared cycle performance.
- The proposal from industry for an 800 endurance cycle performance to apply to built-in batteries has been incorporated into criterion C4, whereby this level of performance would exempt a product from the disassembly step requirements.

2.3.3 Criterion 3.3 – Disk drive reliability and durability

2.3.3.1 Summary of stakeholder feedback received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
A manufacturer highlighted that drive failure tended to be reflected in warranty claims. However, this additional cost is not always factored into decision-making. An industry stakeholder asked whether a high error rate was an indicator of better or worse performance. Would this be experienced from a consumer's point of view? A manufacturer responded that it could result in a loss of data. JRC-IPTS responded that they understood it to be more relevant to servers because they will run for longer during their lifetime. An industry stakeholder stated that the lack of market compliance data means that this should only be an award criterion. Moreover, the test specifications require further development and the proposal lacks reference to an international test specification.

2.3.3.2 Technical background and rationale for the final criteria proposal

Hard disk drives (HDD) are one of the computer components where according to WRAP (2011)[73] the most common faults are reported by several studies and product surveys. It is also understood that there can be significant variations in the reliability of HDD products. Several HDD products reviewed, as well as examples of OEM procurement procedures for HDD[74], specify the reliability of HDD using metrics such as 'Mean Time Between Failures' and 'Operating Shock'.

Summary of findings from a manufacturer enquiry and literature search

[73] See http://www.wrap.org.uk/sites/files/wrap/Laptop%20case%20study%20AG.pdf

[74] Hewlett Packard, *Hard Disc Drive quality system – the driving force for reliability*, November 2006

As a starting point a follow-up enquiry was made to OEMs with a view to gathering more information on drive quality and physical specifications to improve their durability and reliability. This included a focus on both HDD and newer Solid State Drives (SSD) which have no moving parts (i.e. they are akin to high capacity USB). The main points are summarised in Table 2.3.4.

Table 2.3.4: Summary of OEM feedback on HDD and SSD specifications

Hard Disc Drives (HDD)	
Reliability and durability specifications	Responses confirmed a set of standard OEM requirements for quality control including: • Error rate • Mean Time Between Failure • Annual Failure Rate • Load/unload endurance Operating shock, vibration and temperature range were particularly highlighted for mobile applications. Most defects are related to shock and vibration.
Physical design features	For notebooks free-fall sensors (accelerometers) are used in some drives for business models. Shock absorption is also specified, in some cases instead of free-fall sensors.
Improvement potential of features	No information was provided to verify the improvement potential of the quality control parameters.
Verification	Standard quality control and supplier qualifications processes are used, with all HDD required meeting the same requirements for each OEM. In the case of portable HDD protection by shock absorption this is verified by notebook drop and vibration tests.
Solid State Drives (SSD)	
Exemption from the criterion?	In general SSD should be exempted from general quality requirements. Most HDD failures are related to moving parts, which SSD do not have.
Reliability and durability specifications	General reliability and durability parameters are still required as part of quality control for SSD e.g. error rate, MTBF, AFR.

Although a limited response was received it was from leading manufacturers in the market. The feedback suggests that similar quality parameters are applied across all HDD purchases for specific computer form factors. For notebooks, however, two physical design features were highlighted – free-fall sensors and shock absorption – both specified in response to feedback from users on the common stresses on a drive. SSD is an alternative solution because it has no moving parts.

Technical research by drive manufacturer Western Digital and research by Strom et al (2007) for Samsung and Seagate suggested that physical protection of the HDD from external shocks that could damage the disk surface should be a priority for the EU Ecolabel and GP. This is because head clearance – the air gap (or 'headspace') between the magnetic read/write head and the surface of the rotating disk – are now the most significant physical reliability issue for HDD, as highlighted in Figure 2.3.1.

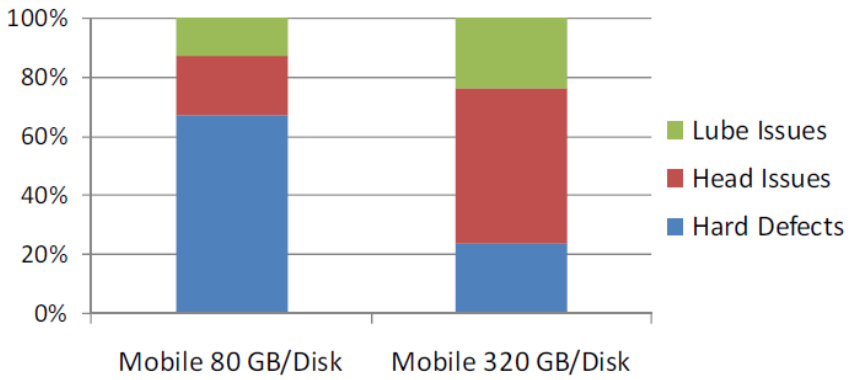

Figure 2.3.1. Reasons for field failures in notebook HDD

Source: Western Digital (2013)

Benchmarking desktop and server drive reliability

The potential to use the metric 'Mean Time Between Failure' (MTBF) was discussed and was highlighted as being based on a statistical calculation across thousands of drives. Manufacturer Seagate instead recommend the use of Annual Failure Rate as a clearer indication of the probability of a HDD failing during its lifespan[75]. The AFR is calculated as follows:

AFR = 1 – exp(– Annual Operating Hours / MTBF)

So a MTBF of 1,600,000 hours represents an AFR of 0.55% for a server HDD running 24/7.

[75] Seagate, *Diving into MTBF and AFR: Storage reliability specs explained*, 26th April 2010, http://enterprise.media.seagate.com/2010/04/inside-it-storage/diving-into-mtbf-and-afr-storage-reliability-specs-explained/

A Mean Time Between Failure (MTBF) for enterprise (server) drives of between 1,600,000 and 2,000,000 would represent a good performing drive which, based on a duty cycle of 168 hours per week, would translate into Annualised Failure Rates (AFR) of between 0.44% and 0.55%. For business or consumer desktops it is more difficult to determine a good performance based on available information, primarily because manufacturers do not tend to report MTBF for consumer or business drives. Intel suggests a MTBF of 700,000 which, assuming a duty cycle of 20% (1,752 hours) would equate to an AFR of 0.25%.

Another metric relevant to enterprise (server) drives is 'bit error rate'. It is understood that bit errors (unrecoverable data) are symptomatic of head and writing problems. Expert commentary[76] suggests that a bit error rate of 1 in 10^{14} bits would not impact on a consumer or business desktop user but would not be suitable for enterprise (server) use. Instead bit error rates in the range of 1 in 10^{15} to 1 in 10^{16} bits are highlighted for enterprise grade drives.

Notebook drive protection features

Portable drives should be protected from shock, vibration and sudden drops during use. Common features identified included shock protection, free-fall sensors and solid state drives:

- The use of *physical damping to protect against vibration and shock* was identified as a design feature of 'rugged' and 'semi-rugged' notebooks (see section 3.3.4). Specifications for operational and non-operational shock tolerance of notebook HDD of four major manufacturers – Seagate, Western Digital, HGST and Toshiba – suggests a performance range of 300-400 (operational) to 900-1,000 (non-operational) G force. Industry stakeholders highlighted the use of IEC 62131 as a test method.

[76] Newman, H, *How to choose a hard drive*, Enterprise Storage Forum, 27th February 2014, http://www.enterprisestorageforum.com/storage-management/how-to-choose-a-hard-drive-1.html

- *Free-fall sensors* (three axis accelerometers) are either fitted externally on the main board or internally to a HDD and detect a sudden motion associated with a fall. The free-fall sensor specifications of four major manufacturers – Seagate, Western Digital, HGST and Toshiba – suggest a performance range of 150 – 300 milliseconds. In the worst case, this would still protect against a drop whilst being carried by hand. Industry stakeholders highlighted the need specify a drop test and associated height for verification. IEEE 1293 is a test standard for linear accelerometers.

The increasing trend towards specification of solid state drives was also identified as a means of improving data protection because this type of drive has now moving parts. As was highlighted in the initial market analysis the price of SSD is still higher than standard drives but they are rapidly increasing market share and it is understood that prices are falling as a result of volume production.

2.3.3.3 Final criterion proposal

Core criteria	Comprehensive criteria
AWARD CRITERIA	
	AC7. Notebook computer drives Points shall be awarded where the primary data storage drive used in notebooks is tested and verified to meet at least one of the following requirements: (i) The HDD drive shall withstand a half sine wave shock of 400 G (operating) and 900 G (non-operating) for 2 milliseconds without damage to data or operation of the drive. (ii) The HDD drive head should retract from the disc surface in less than or equal to 300 milliseconds upon detection of the notebook having been dropped from desk height (76cm) and regardless of its orientation. (iii) A solid state storage drive technology such as SSD or eMMC is used. ***Verification:*** The tenderer shall provide a specification for the drive or drives integrated into the product. This shall be obtained from the drive manufacturer and for option (i) shall be supported by a test report according to IEC 62131 or equivalent and for option (ii) IEC 60068, Part 2-31: Ec (Freefall, procedure 1) in combination with IEEE 1293 or equivalent.

	Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

Summary rationale for the final proposal:

- Given the greater potential for damage caused by external forces it is proposed to focus the criterion on portable drives.
- Given concerns raised by stakeholders about the limited market insight on price and uptake of the notebook drive specifications an award criterion is proposed that invites tenderers to provide one of the three most common forms of drive protection:
  - The shock resistance method IEC 62131 was highlighted by stakeholders and is proposed as the verification for option (i).
  - The IEC standard 60068, Part 2-31: Ec (Freefall, procedure 1) in combination with IEEE standard 1293 for accelerometers, or equivalent given the need to adapt the test to the three axis devices used, is proposed as the means of verification for the free-fall sensor option (ii).
  - The SSD option (iii) has distinct physical characteristics which have the potential for visual verification.

2.3.4 Criterion 3.4 – Notebook durability testing

2.3.4.1 Summary of stakeholder comments received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
The aim of the criterion should be clarified – is it that the computer still works following each test or only that the data is protected? An industry stakeholder commented that the lack of data on market penetration suggested that this criteria area should become award criteria. A Member State queried the ability of SMEs to provide products tested to these requirements.

A local authority stakeholder highlighted tablet screen glass toughness as a factor to be addressed. Corning and Schott were highlighted as manufacturers of glass that is pressure and scratch resistance. Pressure is applied in testing to each side of the product.

An industry stakeholder highlighted the need to refer to international technical standards in order to support bid comparison. However, the criteria should allow for alternative but equivalent, or even more stringent, durability testing to be performed. For example, the US MIL810G standard was cited as being used by several manufacturers.

It was considered that not one test accounts for all the trade-offs in a product design. Manufacturers may also have a more thorough set of customised in-house durability tests.

Third party testing should not be required. In house tests with an equivalent certification (i.e. accredited laboratory) should also be allowed.

A stakeholder queries why there were no core proposals for some of the criteria.

2.3.4.2 Technical background and rationale for the final criteria proposals

Whilst criteria proposals have been put forward that address reparability and upgradeability, other key factors to consider are the durability of the product and its components and, in particular for portable products, the real-life conditions and stresses that they may be subjected to.

With notebooks computers set to shortly become the most common form factor for computers in the market, the conditions in which computers are used are changing significantly. Notebooks may be exposed to a range of stresses and environmental conditions depending on whether they are used in offices, for business travel or out in the field on, for example, site work. Tablets may be used in offices, classrooms or in the field.

In this section we therefore look at the market concept of 'rugged' notebooks, which has now been extended to include mainstream notebook products using the terms 'semi-rugged' and 'business rugged'. The term is also now being applied to tablets, given their increasing market prevalence.

Failure and repairs required as a result of common accidents and stresses

A study by US warranty providers Squaretrade of 30,000 new laptops over their first three years of ownership was referenced in the EU Ecolabel Preliminary report in October 2013[77]. The study highlighted a hardware failure rate of 20.4% and accidental damage of 10.6%. It also highlighted a significant variation in reliability between leading brands, ranging from 15.6% to 25.6%.

Market analysts IDC, sponsored by Panasonic, who manufactures popular 'Rugged' notebook models[78], carried out a survey of 300 businesses in the USA. The study found that on average each year:

- 14.2% of notebooks required repair or replacement due to physical failure,
- 9.5% of notebooks required repair or replacement due to an accident.

The most commonly damaged component was the keyboard (72%) followed by the screen (66%), battery (58%) and hard disk drive (51%). Damage could therefore encompass multiple components.

Where the damage was the result of an accident the most common causes where being dropped whilst being carried (72%), followed by some kind of liquid spillage (66%) and a fall from a desk or table (55%). Of most significance from the IDC study is the claimed extension of lifespan for a semi-rugged notebook, on average from 2 years 5 months to 3 years 6 months.

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[77] Squaretrade Inc, *1 in 3 laptops fail over 3 years*, USA, November 16th 2009 http://www.squaretrade.com/htm/pdf/SquareTrade_laptop_reliability_1109.pdf

[78] IDC, *The Business case for ruggedized PC's*, USA, June 2012

Test methods and benchmarks of durability

The terms ‘rugged’ and ‘semi rugged’ can be seen as the first attempts to define durability benchmarks for notebooks. Endpoint Technologies (2011) define them with reference to the US Department of Defence’s MIL-STD-810G test standards[79] and the IP65 (International Protection) standards[80]. The study defines a five point numeric scale which it uses to grade notebook durability. The scale relates to the level of compliance with MIL-STD-810G and the International Protection standards for dust and water ingress, as well as whether compliance has been third party verified.

The lower tiers of the range encompassing ‘semi-rugged’ and ‘business rugged’ are likely to be of most relevance to the procurers seeking greater durability, whilst ‘rugged’ and ‘ultra-rugged’ can be seen to reflect high cost products specially designed for military and field applications, such as Panasonic’s Toughbook, which is the only product to achieve the ‘ultra-rugged’ category. The tests and their associated performance benchmarks for ‘semi-rugged’ relate to:

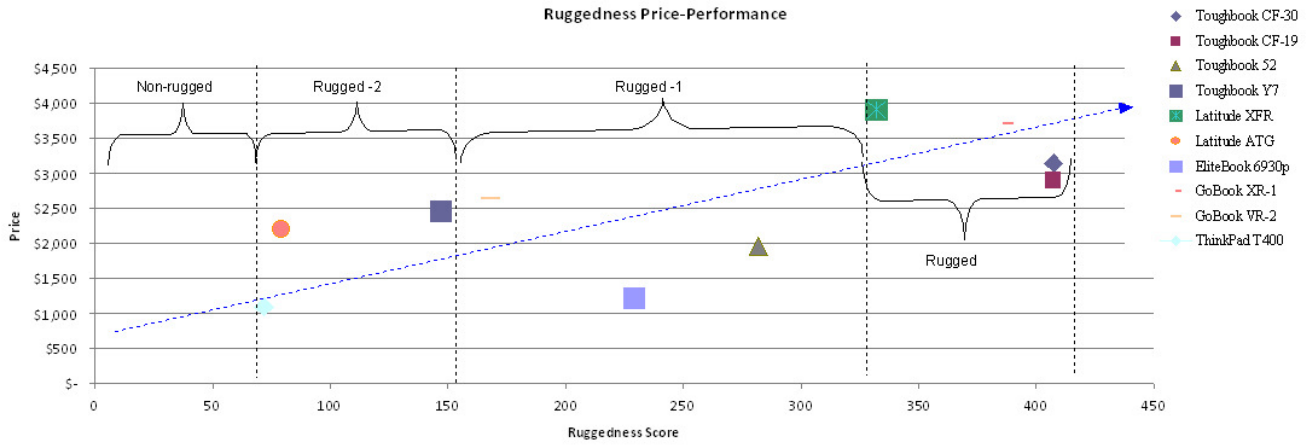
- Drop
- Vibration
- Shock
- Pressure at varying altitudes
- Temperature over a range between –29^{o}C to +60^{o}C
- Temperature shock
- Humidity

The price performance of products by Panasonic, GD-Itronix, HP, Dell and Lenovo can be seen in Figure 2.3.2. HP and Lenovo are notable for their products which meet standards 1 and 2 at a lower price point. Commentators suggest that 'business

[79] US Department of Defence, *Test method standard MIL-STD 810G*, 31st October 2008

[80] UL, *Environmental ratings for enclosures based on Ingress Protection (IP) Code designations*, http://www.ul.com/global/eng/pages/offerings/services/hazardouslocations/ref/ingress/

rugged' specifications can attract up to a 50% premium on comparable computing specifications.



Source: Endpoint Technology Associates (2011)

Figure 2.3.2: Price versus performance of products assessed on the rugged scale

The Endpoint study defines high end specifications for notebooks with a focus on environmental stress. A scoping of test routines applied to mainstream business and consumer notebooks products by the most significant notebooks manufacturers by EU market share reveals a similar set of tests related to specific design improvements. Some additional tests related to everyday functionality are also added, such as the durability of the keyboard and screen lid hinge. The tests applied by each manufacturer are summarised in Table 2.3.5. The findings indicate that comprehensive durability testing, including drop, shock and vibration tests, tend to be carried out for selected business models.

It is understood that, in line with the recommendation of Endpoint Technologies, a number of the manufacturers listed have the tests carried out by testing bodies, thereby ensuring that performance is third party verified. TÜV is an example of a test body carrying out durability and so-called HALT (Highly Accelerated Life Tests) tests. For some manufacturers, such as Asus, the tests are carried out in-house.

Table 2.3.5: Indicative sample of manufacturers' notebook durability tests

Manufacturer	Market segment (% models with testing applied)	Models to which testing is applied	Scope of testing
HP	Consumer range (no models)	*No testing claims made for consumer models.*	n/a
	Business range (88% models)	250-i2/3/5, 350-i2/3/5, 350-G1,355-G2 series	Internal test specifications: • Water spill resistant keyboard
		Probook series 455-G1, 640-G1, 645-G1, 840-G1, 430-G2, 450-G2, 455-G2, 470-G2 Elitebook series 820-G1, 840-G1, 1040-G1, 725-G2, 745-G2, Folio 4010-G1, 8470p	Ínternal 'total test process' based on MIL-STD-810G standards: • Drop, shock, vibration, dust, humidity, altitude, temperature range, temperature shock Additional test specifications: • Keyboard strokes (7 year simulation) • Screen/lid open-close (6 year simulation)
Acer	Consumer range (no models)	*No testing claims made for consumer models.*	n/a
	Business range (14% models)	Travelmate P2, P4, B, Aspire S7	Internal test specifications: • Water spill resistant keyboard
		Travelmate P6	Internal test specifications: • Drop, shock, vibration, dust, temperature range • Screen/lid open-close • Dust ingress
Lenovo	Lenovo range (no models)	*No testing claims made for consumer models.*	n/a
	Thinkpad range (56% of models)	11E/T/X/L/W/G series	MIL-STD-810G standards: • Drop, shock, vibration, dust, humidity, altitude, temperature range, temperature shock Additional internal test specifications: • Screen pressure test • Water spill resistant keyboard

Manufacturer	Market segment (% models with testing applied)	Models to which testing is applied	Scope of testing
			• Hinge durability
Dell	Consumer range (32% of models)	XPS	n/a
		Inspiron 3000,5000,7000 models	Internal test specification: • Temperature range • Screen lid open/close (25,000 times) • Keyboard (10 million key strokes) • Trackpad (1 million presses)
	Business range (46% of models)	Latitude series 3000, 5000 models,	MIL-STD-810G standards: • Shock, vibration, temperature range, temperature shock
		Inspiron series 3000,7000 models	Internal test specification: • Temperature range • Screen lid open/close (25,000 times) • Screen lid torsion (25,000 times) • Keyboard (10 million key strokes) • Trackpad (1 million presses)
Asus	All notebooks (100% of models)	All notebook series	Internal test specifications: • Drop, shock and vibration tests • Temperature range • Keyboard strokes simulation • Screen pressure test • Screen lid open/close (20,000 times)
	Business range (100% of models)	ProB and ProP series	Internal test specification with higher performance for: • Drop test (+100% increase in drop height) • Screen pressure test (+20%) • keyboard strokes (+100%)
Toshiba	Consumer range (no models)	*No testing claims made for consumer models.*	n/a
	Business range (58% models)	Tecra series Portege series	Highly Accelerated Lifetime Test simulating 3 years of use:

Manufacturer	Market segment (% models with testing applied)	Models to which testing is applied	Scope of testing
			• Drop, shock and vibration tests • Temperature range • Screen pressure test • Water spill resistant keyboard

Test methods and benchmarks of durability

Stakeholders expressed mixed views on how best to specify the test methods. Some expressed concern that reference should be made to European or International standards such as EN or IEC. Some industry stakeholders are familiar with reference to the US MIL standards and commented that they would prefer that these remained the reference point for verification.

The tests described by MIL 810-G and IP are for the most part reflected by similar test procedures in the IEC 60068 'environmental testing' series and the IEC 60529 'Degrees of protection provided by enclosures' standard. Where possible the proposed test methods have therefore been updated based on an approximation to the equivalent IEC standard. An exact equivalence could not be identified for the water spillage test, so instead reference has been made to the IEC definition of 'acceptable conditions for water ingress'.

The detailed proposed test specifications were determined by cross-referencing test definitions proposed by US market intelligence company Endpoint[81] with test specifications provided in-confidence by Toshiba and Asus, and the published test procedures of HP and Dell. For a number of tests – namely screen resilience, keyboard lifespan and hinge resilience - standardised methods could not be identified:

[81] Endpoint Technologies Associated, *Redefining rugged: Assessing the spectrum of durability in the notebook market*, USA, 2008 and 2011

- Screen resilience, which has been updated to with reference to LCD quality tests for Asus, Toshiba, Apple and LG [82]. The inspection requirements could be further elaborated on in the User Manual based on manufacturer guidelines for LCD units.
- Keyboard lifespan is further specified to ensure that testing is weighted to reflect the most commonly used keys.
- Hinge failure was highlighted by a manufacturer as being a breakage that is particularly costly to repair. A test based on a set number of openings and closures of the screen is therefore proposed, allowing a minimum lifespan for the product to be defined.
- Liquid spillage is generally carried out for hot and cold drinks and either based on an even spillage or a spillage concentrated in specific locations. The lack of standardisation has therefore required some flexibility in how the testing is specified.

Equipment suppliers for such tests can be identified [83], so the verification has been updated to require that the equipment and setup used for the test is reported. In all cases tests must be carried out by a third party.

For tablets a combination of a screen resilience tests with a drop test is proposed, based on the practices of leading manufacturers such as Microsoft and Fujitsu, as well as warranty providers such as Square Trade [84]. This was commented as being important to ensure a durable tablet product. The majority of manufacturers are already understood to use toughened glass such as Corning's Gorilla glass and

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[82] AUO B133EW07 V0 *display specification for LED backlight with high color gamut* (Apple specification) *and* LG Display, *HD TFT specification for approval*, September 2012

[83] *See for example* Design & Assembly Concepts, http://www.dac-us.com/testandreliability.html

[84] Squaretrade, *New Research Rates Google's New Nexus 7 Tablet a "Medium Risk" 5 Breakability Score, Outscoring the iPad Mini*, August 2013 http://www.squaretrade.com/press/new-research-rates-googles-new-nexus-7-tablet-a-medium%20risk-5-breakability-score-outscoring-the-ipad-mini

Schott's Xensation glass, so there would be limited scope for market differentiation by having a specific performance requirement for the screen glass.

2.3.4.3 Final criterion proposal

Core criteria	Comprehensive criteria
AWARD CRITERIA	
	AC8: Notebook durability testing Points shall be awarded for products that have passed durability tests carried out according to IEC 60068, US MIL810G or equivalent. A maximum of x points [*to be specified*] may be awarded: • Accidental drop (x/4 points) • Resistance to shock (x/4 points) • Resistance to vibration (x/4 points) • Screen resilience (x/8 points) • Temperature stress (x/8 points) Functional performance requirements and test specifications are provided in Annex I of the criteria document. In-house tests with a stricter specification shall be accepted without the need to retest. *The tests applicable shall be specified in the ITT in order to reflect the conditions of use defined for the product.* **Verification:** The tenderer shall provide test reports showing that the model has been tested and has met the functional performance requirements. Test results shall be third-party verified. Existing tests for the same model, carried out to the same or a stricter specification, shall be accepted without the need to retest. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

	AC9: Tablet durability testing Points shall be awarded for products that have passed durability tests carried out according to IEC 60068, US MIL 810G or equivalent. A maximum of x points [*to be specified*] may be awarded: • Accidental drop (x/2 points): • Screen resilience (x/2 points): Functional performance requirements and test specifications are provided in Annex I of the criteria document. In-house tests with a stricter specification shall be accepted without the need to retest. **Verification:** The tenderer shall provide test reports showing that the model has been tested and has met the functional performance tests. Test results shall be third-party verified. Existing tests for the same model, carried out to the same or a stricter specification, shall be accepted without the need to retest. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

Final proposed Annex 1: Notebook and Tablet durability test specifications

Test	Test conditions and functional performance requirements	Test method
Accidental drop *(Notebooks and tablets)*	*Minimum specification:* The notebook or tablet shall be dropped from a minimum of 76 cm (30 inches [85]) of height onto a non-yielding surface. A minimum of one drop shall be made on each bottom side and each bottom corner. *Functional requirement:* The notebook or tablet shall be switched off during the test and shall successfully boot up following each drop. The casing shall remain integral and the screen undamaged following each test.	IEC 60068 Part 2-31: Ec (Freefall, procedure 1)
Screen resilience *(Notebooks and tablets)*	*Minimum specification:* With the product placed on a flat surface two loading tests shall be carried out: 1. A minimum load of 50kg shall be evenly applied to the screen lid (for notebooks) or screen (for tablets). 2. A minimum load of 25kg shall be applied to a point at the	The test equipment and setup used shall be confirmed by the tenderer.

[85] US Department of Defence standard MIL-STD-810G Method 516.6 Specification VI 'Transit drop test'

	centre of screen with a diameter of approximately 3cm. *Functional requirement:* The screen surface and pixels shall be inspected for the absence of lines, spots and cracks after application of each loading.	
Resistance to shock	*Minimum specification:* A minimum of a 40G peak half-sine wave pulse shall be applied three times for a duration of a minimum of 6 ms to the top, bottom, right, left, front and rear side of the product. *Functional requirement:* The notebook shall be switched on and running a software application during the test. It shall continue to function following the test.	IEC 60068 Part 2-27: Ea Part 2-47
Resistance to vibration	*Minimum specification:* Randomised sinusoidal vibrations in the frequency range 5Hz up to a minimum of 250Hz shall be applied for a minimum of 1 sweep cycle to the end of each axis of the top, bottom, right, left, front and back of the product. *Functional requirement:* The notebook shall be switched on and running a software application during the test. It shall continue to function following the test.	IEC 60068 Part 2-6: Fc Part 2-47
Temperature stress	*Minimum specification:* The notebook shall be subjected to a minimum of four 24 hour exposure cycles in a test chamber. The notebook shall be operational during a cold cycle at -25^{o}C and a dry heat cycle at +40^{o}C. The notebook shall be non-operational during a cold cycle at -50^{o}C and dry heat cycling between +35^{o}C and +60^{o}C. *Functional requirement:* The notebook shall be checked that it functions following each of the four exposure cycles.	IEC 60068 Part 2-1: Ab/e Part 2-2: B

Summary rationale for the final proposals:

- It is proposed that a basic set of durability tests are specified, reflecting the most common accidents and weak points associated with notebooks, as well as those most commonly applied to business products by the leading manufacturers in the EU market.
- *The requirements requested in the ITT are proposed to be specified depending on the required robustness and the nature of the end-use for the notebooks to be procured.* So, for example, notebooks to be used in the field might be expected to meet all the tests.

- However, given a degree of uncertainty associated with the market availability and additional costs associated with durability tested notebooks it is proposed to specify these tests as award criteria, with points then awarded according to the level of durability offered by the tenderer. A weighting is additionally proposed for the points to be allocated.
- The tests listed for notebooks are proposed to encompass: drop, shock, vibration, screen resilience and temperature stress. For tablets the list is reduced to drop and screen resilience, reflecting the greater inherent robustness of some of the components of a tablet e.g. use of solid state drives.
- To verify the durability tests, reference is proposed to the IEC 60068 standards series. However, it should be recognised that several manufacturers already use the US MIL standards as the basis for testing. In both cases reference to the quoted standards do not provide a clear test routine. The minimum outline test specifications developed for the EU Ecolabel are therefore proposed for inclusion in an Annex.
- The EU Ecolabel test specifications provide a common starting point for testing, describing the basic requirements and setting minimum parameters that are common to the majority of the different test procedures currently applied – i.e. those carried out with reference to IEC, MIL810 and in-house. Manufacturers who apply tests with stricter parameters would therefore also be able to demonstrate compliance.
- Tests specified in the EU Ecolabel for which there was no reference EU or international test method have not been proposed for GPP i.e. screen hinge durability, keyboard lifespan. However, screen resilience is considered sufficiently important to include, with the two test procedures proposed establishing minimum performance thresholds based on current best practice.

- The testing is proposed as having to be verified by a third party in order to provide assurance.

2.5 Criteria area 4 – End-of-life management

2.5.1 Criteria 4.1 – Design for recycling

2.5.1.1 Stakeholder comments received during the revision process

Stakeholder feedback and follow-up evidence

Summary of AHWG, GPP AG and written stakeholder feedback
A manufacturer highlighted that a 25g threshold for plastics marking was the state of the art but that 100g could be acceptable for a Core criterion. Manufacturers proposed that the exemption for "light guides" refer instead to "plastic optical components". Industry stakeholders asked to specify that speakers are exempted and that tape, plastic protective and stretch wraps and labels, or plastic pieces should be excluded when due to shape, the marking of it is not possible. In addition they suggested that the marking should not apply to plastic parts weighing less than 25 g or with surface area less than 50 cm^2 Industry stakeholders asked for exemptions for certain surface coatings and expressed their willingness to provide more data. It was noted that additives in plastics are a key factor in recyclability, but that material declarations would be required to verify this. An industry representative commented that it is possible to verify the presence of a flame retardant in recycled resin if it has received a so-called yellow card (UL746D) for fire protection. A revised proposal on the recyclability of plastic casings, enclosures and bezels required that *paints and coatings* and *flame retardants and their synergists* do not significantly impact upon the recyclability of the plastic when tested according to ISO 180 or equivalent. However, an industry stakeholder asked to delete 'flame retardants and their synergists' and claimed that other equivalent test standards exist and should be included, e.g. ASTM, D256-05. In addition harmonisation with EPEAT was suggested. Industry stakeholder's views on a criterion encouraging a percentage of recycled material were diverse. The precedent set by the legal case European Court of

Justice, Wienstrom ECJ C-448/01 was cited, which raises issues about relating the requirement to the Subject Matter. Another saw the value as being easy to achieve while another saw the limit as very ambitious. Several industry stakeholders felt that recycled content should be measured on average. It does not need to be product specific. This is the standard procedure already with other EU Ecolabelled products, such as with organic cotton.

2.5.1.2 Technical background and rationale for final criteria proposal

Similar to the cluster lifetime extension, the research results of Task 3 and Task 4 revealed that high attention should also be paid to the end-of-life (EoL) management of computers to reduce the overall environmental impacts since secondary resources from recycling can substitute primary production.

The recyclability of plastics and metals

Evidence from pilot studies on recyclability[86], dismantling studies such those carried out by JRC-IES [87] and Fraunhofer IZM (2013)[88], as well as feedback from recyclers, confirmed the importance of considering the recyclability of plastic components.

Metal foils attached to plastic parts reduce the value of the plastics fraction, and may be passed onto an additional shredding process for separation. Coating and plastics parts attached to bulk plastics parts reduce the value of the plastics fractions PC/ABS, white mixed plastics and black mixed plastics from the perspective of the dismantler. Meaning that mono material plastic housing parts without coatings,

[86] Peeters.J.R, Vanegas.P, Tange.L, Van Houwelingen.J and J.R.Duflou, *Closed loop recycling of plastics containing Flame Retardants*, Journal of Resources, Conservation and Recycling, 84 (2014) p-35-43

[87] Ardente, F.; Mathieux, F.: *Integration of resource efficiency and waste management criteria in European product policies – Second phase. Report no 2, Application of the project's method to three product groups*. Joint Research Centre – Institute for Environment and Sustainability, Ispra, 2012

[88] Fraunhofer IZM, *Disassembly analysis of slates: Design for repair and recycling evaluation*, Final report, August 2013.

inserted metal windings, metal shields attached are better to recycle than composite materials.

Manufacturers may alternatively choose a metal casing, for the purposes of ensuring toughness and durability of the product (e.g. cast aluminium, magnesium oxide) as well as avoiding the need for treatments or additives to provide fire protection.

Two potential approaches to defining and verifying the recyclability of plastics were considered for the EU Ecolabel criteria on recyclability. The first based on a 'recyclability rate' calculation as specified in IEC 62635 and reflecting a hypothetical scenario for EU end-of-life WEEE treatment. The second based on consideration of specific technical issues relating to combinations of plastics, metals and additives. Given that the former may change over time and is not comprehensive enough to address specific technical challenges associated with plastic components, it was decided to adopt the second approach.

The potential to verify the recyclability of plastic enclosures was reviewed against the underlying criterion of the successful US eco-label EPEAT - the IEEE 1680.1 standard for the environmental assessment of computer products[89] - and cross referenced with studies on dismantling and plastics recycling. This highlighted the importance of focussing on:

- A requirement relating to the avoidance of paints of coatings that are 'incompatible with recycling';
- An optional criterion that plastic enclosures shall not contain moulded-in or glue-on metal unless the metal inserts can be easily removed;
- Plastic combinations with additives such as flame retardants.

A major concern with regards to verification was raised by stakeholders in relation to what constitutes 'compatibility with recycling'. ‘Compatible’ is defined in EPEAT as being when:

[89] IEEE Computer Society, *Standard for Environmental Assessment of personal computer products*, IEEE Std 1680.1-2009, 5th March 2010.

'Paints and coatings on plastic parts are proven to be compatible with recycling processes if they do not significantly impact the physical/mechanical properties of the recycled resin. Significant impact is defined as >25g reduction in notched Izod impact at room temperature as measured using ASTM D256-05 [ISO 180].'

Notable in this definition is the reference to a specific testing method for the physical/mechanical properties of recycled resin. For metal inserts the verification options include a listing of commonly available tools that can be used to remove a metal insert and a statement from a recycling company with electronics recycling expertise confirming that the product design meets the requirements.

Based on the tests carried out by Peeters et al (2014) to determine the recyclability of plastics incorporating flame retardants could also be verified using the same physical/mechanical test according to ISO 180 that is proposed for paints and coatings.

Stakeholders queried whether flame retardants are actually used in computer casings, whereas for monitors they are a legal requirement to meet fire regulations. Feedback from a major computer OEM confirmed that FRs are incorporated into plastic computer casings, even though this is not a regulatory requirement. Moreover, the ENFIRO FP7 study on flame retardants**Error! Bookmark not defined.** recommended xpanding the recycling of plastics in such a way as to retain the functional value of FR's.

The marking of plastics

Different opinions exist on the industrial value of plastics marked according to ISO 11469 with ISO 1043. Products may be shredded with low grade material recover. According to Köhnlechner (2014)[90], plastic sorting technologies can increasingly cope with black coloured plastics. Amongst others, sorting based on density

[90] Source: Köhnlechner, R.: Erzeugung sauberer PS- und ABS-Fraktionen aus gemischtem Elektronikschrott. In: Thome-Kozmiensky, K.T.; Goldmann, D.: Recycling und Rohstoffe, Volume 7. Munich, 2014.

separation as well as electrostatic properties of different polymer types can achieve high quality output for ABS and HIPS[91] – independent from the plastic colour.

On the other hand, feedback from re-processors and dismantlers carrying out initial separation of plastics suggests that it is of value. The codes in ISO 1043-4 identifying flame retardants were highlighted as being particularly important. But it was noted that they do not identify CAS numbers.

The need for exemptions for cases where technical limitations or restrictions result in marking not being feasible was highlighted by industry stakeholders. For example, transparent plastic parts of display units such as PMMA light guides, which are understood to be easy to identify, and printed circuit boards are therefore proposed exempted from this requirement.

In terms of the weight thresholds it was noted by industry stakeholders that 25g represents 'state of the art' but that 100g could be suitable as a core requirement. The UNSP**Error! Bookmark not defined.** program and the UK Government Buying tandards[92] set 25g as a weight threshold, with the UN criterion awarding extra points. Excluded from these criteria are extruded plastic materials and the light-guide of flat panel displays. The EPEAT Ecolabel sets a minimum weight threshold of 100g and an optional threshold of 25g.

Minimum requirements for plastic recycled content

A number of computer and display manufacturers have sought to increase the recycled content of their products. Evidence from leading notebook manufacturers such as Dell[93], Lenovo[94] and Asus[95] is that high levels of recycled content can be

[91] HIPS: High Impact Polystyrene; ABS: Acrylnitril-Butadien-Styrol

[92] UK Government Buying Standards, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/341537/GBS_spec-monitors.pdf

[93] Dell, *Closed loop recycled content*, http://www.dell.com/learn/us/en/uscorp1/corp-comm/closed-loop-recycled-content

[94] Lenovo, *Post consumer and post industrial recycled content*, http://www.lenovo.com/social_responsibility/us/en/materials.html

achieved in casings. The Label TCO certified edge (version 1.2 for displays) now requires a minimum content for post-consumer plastics of 65 % for larger plastic parts. The TCO database currently contains 89 products with 45 certifications compliant with this specification (date: 27.03.2014).

Specifying plastics with a recycled content is, however, understood from industry stakeholders to pose a specific problem for GPP. This is because there is not an analytical method to verify that the product contains recycled material. The sourcing of recyclate in the required volume and quality is understood to be a challenge for manufacturers because of limited supply, which means that an average recycled content is more feasible, but is more difficult to verify.

2.5.1.3 Final criterion proposal

Core criteria	Comprehensive criteria
TECHNICAL SPECIFICATIONS	
	TS7(a) Recyclability of plastics casings, enclosures and bezels Parts shall not contain moulded-in or glued-on metal inserts unless they can be removed with commonly available tools. Disassembly instructions shall show how to remove them. **Verification:** The tenderer shall detail the tools required to remove any plastic parts containing metal inserts. Visual evidence shall be provided to support compliance. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
	TS7(b) Recyclability of plastic casings, enclosures and bezels The presence of paints and coatings shall not significantly impact upon the resilience of plastic recyclate produced from these components upon recycling and when tested according to ISO 180 [96] or equivalent. **Verification:** The tenderer shall provide valid mechanical/physical

[95] Green Electronics Council, *ASUS: Taiwan's Environmental Pioneer in EPEAT* http://greenelectronicscouncil.org/asus-taiwans-environmental-pioneer-epeat/

[96] For the purposes of this criterion a significant impact is defined as a >25% reduction in the notched izod impact of a recycled resin as measured using ISO 180.

	test reports carried out according to ISO 180 or equivalent. Third party test reports obtained from plastics recyclers, resin manufacturers or independent pilot tests shall be accepted. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.
TS6. Marking of plastic casings, enclosures and bezels External plastic casings, enclosures and bezels with a weight greater than 100 grams and a surface area greater than 50 cm^2 shall be marked in accordance with ISO 11469 and ISO 1043-1. **Verification:** The tenderer shall identify the plastic parts by their weight, their polymer composition, and their ISO 11469 and ISO 1043 markings. The dimension and position of the marking shall be visually illustrated. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.	**TS8. Marking of plastic casings, enclosures and bezels** External plastic casings, enclosures and bezels with a weight greater than 25 grams for tablet and portable all-in-one notebooks and 100 grams for computers and monitors and in all cases a surface area greater than 50 cm^2 shall be marked in accordance with ISO 11469 and ISO 1043, sections 1 and 4. **Verification:** The tenderer shall identify the plastic parts by their weight, their polymer composition, and their ISO 11469 and ISO 1043 markings. The dimension and position of the marking shall be visually illustrated. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

Summary rationale:

- It is proposed to retain criteria on material selection, recyclability and marking in order to recognise that certain combinations of polymers, coatings, metal inlays and alloys may present recycling problems and that the marking will facilitate the sorting activities. Moreover, this overall approach is in line with other GPP schemes and successful electronics eco-labels.
- It is proposed to focus the recyclability requirements on metal insets, coatings and flame retardants, as these were identified as specific barriers to recycling. However, it is proposed to omit flame retardants as this is not within the scope of criteria even in leading ecolabels such as EPEAT and TCO. The verification has been updated to be more specific based on either tooling and dismantling instructions or test results for polymer resins.
- As plastics marking is widely established in practice, it is proposed as a requirement with a focus only on the external casing so as to avoid the need for complex lists of exemptions. In addition, for a comprehensive level, it is proposed that ISO 1043-4 marking is also required in order to identify flame retardants incorporated into the plastics requiring fire protection.

- The weight thresholds for marking have been updated to reflect minimum practice of 100g in the EPEAT Ecolabel (core requirement), which would address the main casing parts of computers and monitors. A 25g threshold is introduced into the comprehensive criterion in order to ensure that the smaller casing parts of products such as tablets and portable all-in-one notebooks are also addressed.
- Due to the difficulties in assurance level of the verification clause for the recycled content it is proposed to omit the requirement on minimum recycled content. Moreover, LCA evidence does not suggest it is a significant environmental hot spot.

2.5.2 Criterion 4.2 – Design for dismantling

2.5.2.1 Stakeholder comments received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
For computers an industry representative questioned whether the criteria were realistic given that notebooks are at the moment not pre-processed by manual dismantling. A Member State voiced concern as to whether the criterion was right for the product group. Although separation can be very manual, the market is driven by the value of the components and materials and industry is developing many different innovative ways of extracting parts that are of value. This is very difficult to reflect in a criterion. For monitors some stakeholders did not see the added value of timed dismantling since there are a lot of facts that will affect the time that are out of the control of the manufacturer. A manufacturer saw the proposal on time threshold as very ambitious and disagreed with third party verification since it will mean to send to destruction a high number of TVs. A Member State saw added value on having the time threshold because it makes a bigger difference than the minimum legal requirements under the WEEE directive. Another stakeholder also supported the added value of having a time threshold.

Industry stakeholders noted that at present there is no standardised method for timed dismantling, making comparison between bids difficult, but that they understood that, following on from the work for Ecodesign, a mandate has been sent to CENELEC.

It was additionally commented that shredding with some selective metal and plastic recovery followed by incineration is currently the most common treatment for handling monitor waste. This position was also supported by a manufacturer.

An industry representative voiced concern that, in general, if manual disassembly was being promoted, this would require cheap labour which could result in greater e-waste exports.

The main concern expressed by industry was the lack of an agreed industry standard for the time measurement. It was claimed that time limits are subjective, i.e., are dependent on the individuals' skills and tools used. In addition they expressed that smaller devices due to size restrictions often are more integrated than larger ones and thus should not be given less time for disassembly.

Manufacturers asked how design for a target 'extraction' time can be requested when neither the process, methodology, tools or skill level of the operative performing the extraction can be predicted.

In addition they questioned the potential environmental benefit of the manual dismantling when in practice WEEE recyclers are likely to shred the whole display and separate PCBs from the outflow using automatic sorting technology.

They asked to define "sub-notebook" as it is not defined in ENERGY STAR and to delete the word "widely" from "widely commercially available" as a tool is either commercially available, or it's not.

In addition they claimed that the dismantling report will be just another administrative task that nobody will use (certainly not the procurer).

With regard to the *Protocol for the dismantling test,* industry stakeholders expressed that the definition of tools is overly prescriptive and that requiring that a tool should be commercially availability can achieve the same purpose and is easier to verify. In

addition they suggested that requiring photos and video to be taken of the disassembly "with a time code displayed" would be an administrative burden. A more efficient alternative would be third party witnessing and/or attestations.

It was asked to clarify if verification is to be carried out for each type of product or each model number or for a representative product from each product family. They mentioned that sometimes there are minor physical differences between products within a product family.

2.5.2.2 Technical background and rationale for the final criteria proposal

Reflecting the approach proposed in the draft revision of the Ecodesign Implementing Measure for Televisions (and Displays) EC/642/2009[97], the potential to time the dismantling and extraction of specific computer and display components of economic and environmental value has been developed into a criteria proposal for the EU Ecolabel for displays. A streamlined version is therefore proposed for GPP in order to promote improved end-of-life management of electrical waste.

The time and complexity of disassembling an IT product at the end of its life is a proxy for the cost effectiveness of extracting components that are valuable from both a life cycle and resource efficiency perspective. It is economically viable to spend tens of minutes to repair a computer, but not more than few minutes for dismantling. It is considered that this will remain the case even if dismantling is, in the future, carried out robotically[98].

Valuable critical metals and raw materials present in IT equipment

[97] European Commission, Integration of resource efficiency and waste management criteria in European product policies: Application of the project's methods to three product groups, JRC-IES, November 2012

[98] R. Knoth, M. Hoffmann, B. Kopacek, P. Kopacek, and C. Lembacher, *Intelligent disassembly of electronic equipment with a flexible semi-automatic disassembly cell*, Austrian Society for Systems Engineering and Automation.

The EU Raw Materials Initiative working group has identified and listed the Critical Raw Materials[99]. Of direct relevance to Green Public Procurement is the recommendation made in the 2010 report that policy actions are undertaken to *'make recycling of raw materials-containing products more efficient'* including *'mobilising end of life products with critical raw materials for proper collection*'. A specific recommendation is also made that:

> *'…overall material efficiency of critical raw materials should be achieved by…minimising raw material losses into residues from where they cannot be economically-recovered.'*

It can be seen from the Bills of Materials for products that CRMs (Critical Raw Materials) are concentrated in a small number of main components, primarily the motherboard, batteries, HDD, optical drives and LED backlights. Sub-components can then be identified that would require extraction in order to recover the CRMs – for example, capacitors containing tantalum, magnets containing neodymium, LED cells containing gallium.

Table 2.5.1: Indicative occurrence of high value metals and CRMs in an indicative notebook computer

Metal	Content per notebook (mg)	LCA hot spot	EU CRM	Occurrence in the notebook
Cobalt	65,000		✓	Lithium ion batteries
Neodymium	2,100		✓	HDD motors and accelerators (70%) Loudspeakers (30%)
Tantalum	1,700		✓	Motherboards capacitors (90%) Other PCB capacitors (10%)
Silver	440	✓		Motherboard (57%) Other PCB's (43%)
Praseodymium	270		✓	HDD accelerators (53%) Loudspeakers (47%)

[99] European Commission, *Critical raw materials for the EU*, Report of the Ad Hoc Working Group on defining critical raw materials, DG Enterprise and Industry, 30th July 2010

Gold	100	✓		Motherboard (54%) Other PCB's (46%)
Dysprosium	60		✓	HDD accelerators
Indium	40		✓	Display and LED Backlights
Palladium	40		✓	Motherboard (64%) Other PCB's (36%)
Platinum	4		✓	HDD platters
Rare Earths [a]	2.48		✓	LED backlights
Gallium	1.6		✓	LED backlights

Notes:

a) Yttrium, gadolinium, cerium, europium

Table 2.5.2: Indicative occurrence of high value metals and CRMs in an indicative desktop computer (without display)

Metal	Content per desktop (mg)	LCA hot spot	EU CRM	Occurrence in the notebook
Steel	6,737.50	✓		Chassis and enclosure
Plastics	1,579.55			Enclosure, cables, peripherals
Aluminium	550.21	✓		Chassis, capacitors, HDD platters
Copper	413.225	✓		Circuitry, cables, capacitors
Zinc	25.94			-
Tin	19.57	✓		Solder
Antimony	18.58		✓	Solder, flame retardants
Nickel	12.70	✓		Metal plating
Neodymium	5.87		✓	HDD motors and accelerators Loudspeakers
Silver	1.70			Motherboard and other PCB's
Gold	0.26	✓		Motherboard and other PCB's
Palladium	0.12		✓	Motherboard and other PCB's
Chromium	0.02			Coatings
Ceramics & others	366.04			Heat sinks, power supply units and capacitors

Table 2.5.3: Indicative occurrence of high value metals and CRMs in electronic displays

Metal	Content per LCD computer display (LED backlit) [mg]	LCA hot spot	EU CRM	Occurrence in the product
Silver	520	✓		PCB and contacts (100%)
Indium	82		✓	Internal coating on display (100%)
Gold	200	✓		PCB and contacts (100%)
Yttrium	3.20		✓	Background illumination (100%)
Palladium	40	✓	✓	PCB and contacts (100%)
Europium	0.06		✓	Background illumination (100%)
Cerium	0.2		✓	Background illumination (100%)
Gallium	3.30		✓	Background illumination (100%)
Gadolinium	1.50		✓	Background illumination (100%)

The market potential for dismantling and CRM recovery

Whilst it is possible to identify components and sub-components for selective extraction, it is not guaranteed that their extraction is currently economically or technically feasible. The collection of WEEE in Europe has grown rapidly since the introduction of the WEEE Directive in 2003, and this is set to increase further as the recast WEEE Directive is transposed at a European level.

Treatment centres tend to be a mixture of large processing centres handling a wide range of different types of WEEE and niche operators concentrating on a few or even single streams. Centres may consist of a combination of manual dismantling and sorting of components with bulk shredding and detoxification (e.g. mercury removal from LCD screens)[100]. Selected components may then be sent to specialist smelters (e.g. PCBs) or be subject to automatic or manual separation (e.g. plastics).

[100] Meskers.C.E.M and C.Hageluken, *The impact of different pre-processing routes on the metal recovery from PC's*, Conference paper *Resource management and technology for material and energy efficiency*, EMPA Materials Science and Technology, September 2009.

The main plastics fraction (e.g. PC/ABS casing), steel and aluminium chassis, alloy casings (painted or unpainted), rechargeable lithium ion batteries, capacitors with a diameter larger than 2.5 cm, external power cables and printed circuit board's larger than 10 cm^2 are generally extracted and passed on to the relevant markets for materials recycling.

From a resource point of view, leading actors in the specialist metals and CRM market claim that some manual pre-treatment, including complete removal of PCBs and other components such as HDDs, followed by subsequent recovery of the precious metals would enable a significantly more efficient recovery of various metals and CRMs, including REEs (Rare Earth Elements)[101]. Taking silver, gold and palladium as examples the recovery rate could be increased in selected scenarios from 12-26% to 90%.

The market position with regards to specific component parts of computers and displays is briefly summarised below:

- Plastic casings: Despite the prevalence of shredding, the recent REWARD/EFRA pilot study highlights the importance of plastics marking and the provision of information about the FRs used as being important to facilitate recovery and recycling[102].
- Printed Circuit Boards (PCBs): The main economic aim of recovering PCBs is to recover the copper, gold, silver and palladium. However, other critical metals such as tantalum in capacitors are lost in this process – so-called 'dissipative losses'.
- LCD/LED display units: Display organic components (liquid crystals, polarisation filters, resins) are generally shredded and may then be incinerated. The indium contained in the displays is generally lost through

[101] C. Hagelüken and C. E. M. Meskers, *Complex life cycles of precious and special metals*, Chapter 10 from *Linkages of Sustainability* (2010) Strüngmann Forum Report, Edited by Thomas E. Graedel and Ester van der Voet.

[102] EFRA (2013) *Recycling of plastics from LCD television sets*

dissipation[103]. Germany is understood to be considering storage of dismantled display units for recycling at a later date. Several mobile pilot plants are being developed to recover metals like copper, manganese, zinc, yttrium, indium from WEEE by hydrometallurgical processes.

- LED backlights: The CRMs rare earth metals used in the manufacture of LED backlight units are related to doping and luminescence. They can include indium, gallium, cerium, europium, yttrium and gadolinium.
- PMMA display light guide: The plastic light guides within an LCD display constitute a large proportion of the plastic used in a TFT display. It is readily identified however, without prior manual separation, it may be dispersed among other shredded fractions.
- Hard Disk Drives (HDDs): HDD contain Rare Earth Metals such as neodymium from magnets. Larger 3.5 inch HDD formats used in desktop computers, servers and datacentres are of interest in terms of the quantity of materials for recovery. Their physical design can, however, hamper recovery. Industry initiatives to recover REEs from HDD's are being developed by Hitachi amongst others.
- Lithium ion batteries: Lithium ion batteries are addressed by the collection requirements under the Batteries Directive 2006/66/EC but it is understood that their recovery rate is currently low, with a recent report claiming as low as 5%[104].

Some industry stakeholders suggested that portable computers are not yet commonly recovered for recycling. The manual dismantling of desktop computers and monitors, with the selective extraction of some key components, is already commonplace. Feedback from the market is that few notebooks are currently reaching recycling facilities. Various possible reasons can be cited - second-hand

[103] See Oeko Institut (2012)

[104] ENDS Europe, *Low recycling rates for lithium batteries criticised*, 14th February 2013

market and repairing, storage at the consumer's home/work, shipment outside EU - and therefore recycling by manual dismantling is not well established yet.

Setting a time threshold for the extraction of key components

A JRC-IES draft report on material efficiency for EU Ecolabel criteria (JRC - IES (2014 draft)) [105] provides an analysis of studies in the literature on the dismantling of electronic displays. Unfortunately, these studies generally refer to the full disassembly of the displays (without a detail of the dismantling of the above mentioned key parts) and results are presented as aggregated average result over a large number of devices.

In order to cope with this data gap, the study performed a survey of recyclers in Europe and visits were made to five facilities (two in Italy, one in UK, one in Belgium and one in Spain). The time for dismantling was found to be one of the most relevant parameter driving the treatments at the recycling facilities. In fact, the recyclers try to get a balance between the costs for disassembly (mainly the labour costs) and the potential revenues from a more accurate separation of components.

A previous JRC-IES report on benefits and impacts/costs of options for different potential material efficiency requirements for Electronic displays[106] provided data collected from the treatment of waste displays and the dismantling of around 70 waste displays in a Italian recycler. Based on this data, they show the percentage of displays of different sizes with a time for dismantling PCB (larger than 10 cm^2), PMMA and TFT panels below certain thresholds. It is observed that around 50% of the displays smaller than 25'' have a time for extraction lower than 250 seconds. It is also observed that around 50% of the displays with a size between 25'' and 40'' have a time for extraction lower than 470 seconds.

[105] JRC - IES (2014 draft). Analysis of material efficiency for EU Ecolabel criteria: the example of two product groups. Environmental Footprint and Material efficiency support for product policy (Not published yet)

[106] JRC-IES (2013). Report on benefits and impacts/costs of options for different potential material efficiency requirements for Electronic displays. Integration of resource efficiency and waste management criteria in European product policies - Second phase, Joint Research Centre - Institute for Environment and Sustainability of the European Commission.

The JRC-IES draft report on material efficiency for EU Ecolabel criteria JRC - IES (2014 draft) gathered additional data about the time for dismantling for electronic displays from two other relevant EU studies. The results from these studies were used to check the robustness of the results obtained by JRC-IES and also to enlarge the experimental sample to aid in the definition of thresholds for the time for dismantling electronic displays. The final results (related to the entire data sample) are subdivided in three size ranges (S < 25''; 25'' ≤ S < 40''; 40'' ≤ S ≤ 55''). The thresholds met by 30% of displays are presented in Table 2.5.4 .

Table 2.5.4:Time for dismantling target components (s). (*Source* JRC-IES (2014 draft) report)

Size	**S < 25''**	**25'' ≤ S < 40''**	**40'' ≤ S ≤ 55''**
Threshold of the time for dismantling [s]	**260**	**340**	**400**

The values represent current recycling activities and practices, which are not expected to change significantly in the near future. Automated systems whilst being a focus of attention have not yet moved out of the pilot phase. Automated dismantling does not exclude the possibility of manual disassembly for some parts (e.g. PCB). This pre-extraction of some key parts from products (e.g. PCB) is an important step that can contribute to higher recycling rates for precious/critical raw materials (Chancerel, Meskers et al. 2009). With technological advancement new parts also raise challenges for depollution and recycling, which would need to be addressed by extraction, for example, cadmium in quantum dots screens and critical raw materials in LED lamps.

With regards to computer products, no similar analysis has yet been undertaken. However, in order to set an award criterion for GPP it is desirable to establish a threshold so that tenders can be clearly differentiated and decisions do not have to be made based on very small time margins, or within the range of uncertainty for comparable extraction sequences. As a starting point a conservative figure has

therefore been selected from a disassembly exercise carried out for a potential EU Ecolabel applicant with support from the Fraunhofer IZM and Tricom[107].

Defining the test method for timed dismantling

Industry stakeholders commented that there is currently no standardised method for timed dismantling. The potential for variability in the results could be significant between, for example, a manufacturer's careful dismantling in a lab and a more destructive dismantling in a recycling plant. It is important to note that the data analysed by JRC-IES relates to destructive dismantling so it is therefore proposed that in all bids, assessment and verification be based on the timing of dismantling in a recycling plant to improve comparability.

A mandate has now been submitted to CENELEC to develop a standard method to support the requirements proposed for inclusion in the revised Ecodesign Regulation for Displays. The timing for this process is likely to extend beyond the programme for adoption of the new EU Ecolabel and GPP criteria for computers. Therefore, an interim method would need to be specified for the GPP criterion. Reference is therefore proposed to an outline developed by JRC-IES[108] of what could be contained within such a standard. Outline steps for the method are for example described in Box 1.

Box 1: Outline steps for the measurement of the time for the extraction of certain target parts in IT products

Terms and definitions

- *Target parts:* Parts and/or components that are targeted for the extraction process.

Operating conditions for the extraction

- *Extraction sequence to be followed:* The extraction sequence to be followed has to be set out prior to the measurement. The sequence shall be documented and provided to the third party carrying out the extraction.
- *Tools for extraction:* The extraction operations should be performed using manual or power-driven standard tools.

Extraction time measurement

- *Measurement sample:* The sample of EEE to be used for the measurement shall be undamaged.

[107] Iameco, *Iameco 2 - Low Carbon, Resource Efficiency and Long Life in PC Design*, http://iameco.com/wp-content/uploads/2013/10/iameco_2_-_Final_Technical_Report_FINAL.pdf

[108] Joint Research Centre – Institute for Environment and Sustainability - "Analysis of dismantleability" - draft 2014

- *Measurement:* The extraction time measurement consists of the measurement with an instrument of the time elapsed between the starting of the first operation listed in the extraction sequence documentation and the end of the last one.

Recording of the test conditions

- *Recording media: Photos shall be taken and a video recorded of the extraction of the components. The video and photos shall include a time code and enable clear identification of the extraction sequence.*

2.5.2.3 Final criterion proposal

Core criteria	Comprehensive criteria
AWARD CRITERIA	
	AC10. Product dismantling potential Points shall be awarded for the time efficient manual dismantling and extraction of the following components from products [109], *excluding tablets, subnotebooks*[110] *and two-in-one notebooks*: All products (i) Printed Circuit Boards relating to computing functions >10 cm² Stationary computer products e.g. desktops (ii) Internal Power Supply Unit (iii) HDD drives Portable computer products e.g. notebooks (iv) Rechargeable battery (v) HDD and optical drives (excluding SSD) Computer monitors (vi) Display panel >100 cm^2 (the Thin Film Transistor unit and film conductors) (vii) LED backlight units Extraction of the relevant components shall be possible using universally available tools [111].The maximum time required to extract them shall not exceed the following thresholds:

[109] Where multiple models with the same product family architecture are to be supplied, only a representative product shall be required to be tested.

[110] A Subnotebook is defined for the purposes of these criteria as a form of notebook that is less than 21mm thick and that weighs less than 1.8kg. Two-in-one notebooks (see the separate definition in Article 2(5)) with a subnotebook form are less than 23mm thick. Subnotebooks incorporate low power processors and solid state drives. Optical disk drives are generally not incorporated. Subnotebooks provide longer rechargeable battery life than notebooks, usually more than 8 hours.

[111] Examples include pliers, nippers, screw-drivers, cutters and hammers as defined by ISO 5742, ISO 1174, ISO 15601, or equivalent).

	Computers: - 600 seconds *Monitors:* - 400 seconds for screen sizes smaller than 25 inches; - 500 seconds for screen sizes greater than or equal to 25 inches and smaller than 40 inches; - 600 seconds for screen sizes greater than or equal to 40 inches and smaller than 55 inches. Points shall be awarded in proportion to reduction in the time required compared to the stated thresholds. A maximum of x points [*to be specified*] shall be awarded: (i) over 60% lower: x points (ii) 31-60% lower: 0.6x points (iii) 10-30% lower: 0.3x points **Verification:** The tenderer shall upon award provide a 'dismantling test report' according to the protocol in Annex II. The dismantling test shall be carried out by a specialised WEEE recycling firm that is a permitted electrical waste treatment operation in accordance with Article 23 of the Waste Framework Directive or that are certified under equivalent national or international WEEE regulations or standards. Third party verification of the timing shall be accepted as an alternative to providing a recording. Equipment holding the EU Ecolabel or another relevant Type I Eco-label fulfilling the specified requirements will be deemed to comply.

Proposed Annex 2: Protocol for the dismantling test

(a) Terms and definitions

(i) Target parts and components: Parts and/or components that are targeted for the extraction process.

(ii) Disassembly step: An operation that finishes with the removal of a component or part and/or with a change of tool.

(b) Operating conditions for the test

(i) Personnel: The test shall be carried out by one person.

(ii) Test sample: The sample product to be used for the test shall be undamaged.

(iii) Tools for extraction: The extraction operations shall be performed using manual or power-driven standard commercially available tools (i.e. pliers, screw-drivers, cutters and hammers as defined by ISO 5742, ISO 1174, ISO 15601).

(iv) Extraction sequence: The extraction sequence shall be documented and, where the test is to be carried out by a third party, this information provided to those carrying out the extraction. The sequence shall be defined as a series of steps that shall be followed by the third party.

(v) Measurement: The extraction time measurement consists of the measurement with an instrument of the time elapsed between the starting of the first step listed in the extraction sequence documentation and

the end of the last one.

(c) Recording of the test conditions and steps

(i) Documentation: The individual steps in the extraction sequence shall be documented and the tools associated with each step shall be specified.
(ii) Recording: Photos shall be taken and a video recorded of the extraction of the components with a time code displayed recording the elapsed time during the recording. The video and photos shall enable clear identification of the steps in the extraction sequence.

Summary rationale for the criteria proposal

- The criterion is proposed to be retained because of its environmental and economic significance for different types of IT equipment.
- The criterion reflects proposals by the Commission for introduction into the Ecodesign implementing measure for Displays requirements to measure and report on product dismantling times from an estimated 2016/17 onwards, being considered based on background studies by JRC-IES an important proxy for economic first stage manual dismantling or in the future automatic dismantling.
- An award criterion is proposed for all products in order to encourage the market to bring forward devices that can be quickly and efficiently dismantled manually.
- Time thresholds are proposed, thereby going further than the declaration that is proposed for Ecodesign. The award status recognises that this is a new request in the market.
- Concerns about the lack of a standardised test method have been responded to by establishing, based on the state-of-the-art developed by JRC-IES, a test protocol that shall be followed by manufacturers in order to produce a 'dismantling test report'. Moreover, the body carrying out the test shall always be a WEEE handler, thereby introducing a degree of comparability with the evidence on which the time thresholds are based.
- The time thresholds suggested for monitors are based on the evidence analysed in order to set a similar criterion for the EU Ecolabel for display products. The values proposed are conservative as JRC-IES studies revealed

that 70% of devices currently being dismantled are compliant with such thresholds.

- For computers there is no similar evidence base to set selective thresholds. The threshold has been set based on analysis by Fraunhofer IZM and Tricom for a potential EU Ecolabel applicant.
- For all products, points would be awarded for improvements on the conservative minimum time threshold proposed.
- Components for extraction have been identified based on LCA hot spots, CRM/REE occurrence and the current/projected market potential for their recycling. Some distinction has been made between components in stationary and portable products, as well as displays.
- The tenderer would need to specify a dismantling sequence for the device and this would then be dismantled and timed by a recycling company, so as to ensure comparability based on more destructive testing. Verification by a 'real-life' option in a WEEE treatment facility mirrors a similar verification option for dismantling criteria 4.1.1.3, 4.3.1.5, 4.3.1.7 and 4.3.2.1 in the EPEAT standard for computers (IEEE 1680.1).

2.5.4 Criterion 4.3 – End of life management

2.5.4.1 Stakeholder comments received during the revision process

Summary of AHWG, GPP AG and written stakeholder feedback
It was queried as to who was the audience for the ITT – a service company, a manufacturer or a third sector/charity organisation. The wording as it is written at the moment could be problematic and verification was seen as being difficult. A clearer distinction should be made between the other criterion and the end of life management criterion, which are primarily targeted at different bidders. An example was given of computers being refurbished/remanufactured for resale by manufacturers. Moreover, a leasing arrangement may be better than purchase as it would create a closed loop. It was commented that, based on evidence from a study in the US [112] there is no general rule that, leasing is always better for the environment, as it depends on the product and the specific conditions. Another manufacturer considered it important that the criterion was flexible, allowing intermediates to bid and leaving it open to the market. A manufacturer highlighted that re-use should be encouraged by the criterion. A Member State asked that it be clarified that computers would be re-used at the end of their service life for the public authority i.e. that they then have the possibility for an extended life. An example was given of a public authority letting a specific contract to a charity to take its computers with an obligation to upgrade and resell a certain percentage and dispose of the rest with a WEEE facility. PAS 141 in the UK should be reviewed as it may provide a model as it provides a protocol for the preparation of electronic products for re-use. It was felt to be important to understand how the ITT would specify the software to be used for sanitisation. Some customers do not support HDD shredding. With regards to verification it was felt by one Member State that it would be difficult for tenderers to bid with a predicted re-use/recycling rate. Moreover, the procurer

[112] Agrawal et al, *Is Leasing Greener than Selling?* Management Science, INFORMS (USA), 28th October 2011, p.523-533

may not be able to monitor performance of such a contract.

It was confirmed by manufacturers that they are able to offer fully tracked systems for taking back equipment for data sanitisation , remanufacturing and certified treatment and recycling/disposal. A number of manufacturers are willing to take back equipment (at the point of supplying new equipment) that they did not manufacture.

2.5.4.2 Technical background and rationale for the final criteria proposals

Second hand usage of IT equipment can prolong the overall lifetime of computers and displays. However, a barrier to IT devices from the public sector being given over for second hand usage is the need for confidential data erasure from computer drives. This issue has been identified by a number of Member States as being a barrier and some have investigated this further in order to identify practical opportunities to work around the problem.

There are a wide variety of methods that allow a user to restore a computer to factory settings. However, in some cases the data can still be recovered. Some Government departments such as Defence have strict technical requirements to ensure that this cannot occur. Advanced software exists which writes random patterns to the HDD but it is costly. These software solutions are used by computer manufacturers and WEEE handlers who offer the service of secure data erasure. The new Solid State Drive (SSD) technology used in products such as tablets is understood to be more difficult to erase data to a high standard.

Authorities in the Netherlands have investigated the issue in order to find ways of maximising the re-use of government IT equipment. They have identified that there tend to be several levels of confidentiality defined by Government Departments. In the example cases investigated, there were four levels and in 95% of these the level of confidentiality required was at the lowest level. At this level the cost of erasing data

becomes cheaper, with approximately €36/computer cited but with the computer then only having a value of €7 [113].

Another option is to remove the HDD for recycling, thus potentially still allowing for the computer to be re-used. However, feedback from social enterprise WEEE recyclers suggests that in most cases adequate data erasure can be achieved using commercial software. Handling of the WEEE needs to be carefully managed from a confidentiality point of view, for example to ensure the same company transports the equipment and carries out data erasure. Exceptions to the need for data erasure tend to be older computers which would be more difficult to resell.

HDD are not understood to command significant price for recycling but in the future, companies such as Rhodia and Hitachi are investigating how to process them in order to extract valuable components such as the magnetic heads which are made from Critical Raw Materials such as neodymium. This requires that HDD or SSD can be easily removed whilst still allowing for re-use of the computer. Such an upgrade is proposed under the Criterion C3 on Upgradeability and Reparability.

Different routes to extend product lifespan

Stakeholders commented that the criterion needs to be clearer in terms of what type of tenderers it would attract and what types of services. In order to do this it is necessary to make a distinction between a contractual arrangement with the original supplier to take back the products at the end of their service life – for example, HP [114] or Dell [115] who remanufacture their own brand products and/or can certify data erasure and proper treatment of collected equipment from any brand - or a contractual arrangement with a third party to re-use or recycle products at the end of their service life – for example, VHS (Austria), AFB (Germany) or Recover-E

[113] Personal communication with Joan Prummel, Category manager waste and resources, Netherlands Enterprise Agency.

[114] Hewlett Packard, *HP's hardware return and recycling programme*, http://www8.hp.com/uk/en/hp-information/environment/hardware.html

[115] Dell, Asset recovery and recycling services, http://www.dell.com/learn/uk/en/ukcorp1/asset-resale-recycling-services

(Netherlands) [116]. Major social enterprises also operate in this sector in France, Spain and United Kingdom.

Products may be resold following basic checks, remanufactured/upgraded for resale or sent for recycling. In the case of resale, data erasure services may need to be provided according to the specifications of the public authority – although as already noted commercial software exists which provides different levels of secure erasure. In some Member States voluntary standards have been established for the quality of product testing to give customers reassurance – for example, the PAS 141 standard in the UK[117].

Feedback from social enterprise recyclers suggests that public authorities do not tend to set re-use targets to meet and in practice it is difficult to predict. Instead service provides report on how much of the equipment collected is prepared for re-use or sent for recycling. Either an inventory is provided in the ITT which might list all the items by serial number, together with age and configuration or a simple identification of broad types of equipment and how many items e.g. notebooks, monitors.

Inventories would tend to be provided where a financial offer is required for the equipment. However, it was noted by one recycler that public authorities tend to use equipment for longer. Consequently equipment may have less re-use potential unless they are exported to less developed countries.

The Netherlands government is aiming at ensuring that products are treated and recycled properly at the end of their life following further re-use cycles[118]. They have been piloting contracts with contractors that maintain ownership of IT equipment during a number of re-use cycles so that they can guarantee that the opportunities for recycling are maximised. These pilots have also highlighted the need to consider the

[116] Recover-E, http://recover-e.nl/

[117] WRAP, Re-use protocols for electrical products, http://www.wrap.org.uk/content/re-use-protocols-electrical-products

[118] Personal communication with Joan Prummel, Category manager waste and resources, Netherlands Enterprise Agency.

energy balance of re-use versus recycling, i.e., does it save more energy to re-use an old product or to recycle it?

WEEE end of life treatment and export

Some of the most significant potential environmental impacts associated with the informal recycling and improper treatment of WEEE exported from the EU were highlighted in section 2.2.4. This is a particular concern for public authorities seeking to ensure that equipment that reaches the end of its service life is disposed of to the standards required under EU legislation.

The European Environment Agency estimates that 16-38% of the EU's WEEE waste (between 550,000 and 1,300,000 tonnes) was exported in 2008[119]. Moreover, whilst illegal WEEE shipments are classified as hazardous waste under the Basel Convention and are the subject of controls under the recast WEEE Directive, the EEA highlight that there are no restrictions on the export of goods for re-use, for which the end of life phase may not comply with expected EU norms for WEEE disposal.

The EU LIFE funded WEEElabex project [120] is an example of a collaboration with industry to create a certification scheme for proper treatment according to WEEE requirements. Projects such as this have now been superseded by the development of the EN 50625 series which, informed by the approach developed by WEEElabex, defines WEEE collection logistics and treatment requirements. Annex A of EN 50625-1 identifies specific components of equipment that shall be removed for the purposes of depollution. Relevant components from Annex A are capacitors, printed circuit boards, backlights containing mercury, batteries and plastics.

Feedback from some recyclers is that their operations are certified under national schemes that implement the WEEE Directive. These certification schemes require reporting on the minimum recovery targets contained within Annex V of the recast

[119] European Environment Agency, *Movements of waste across the EU's internal and external borders*, Report No 7/2012

[120] WEEElabex, http://www.weeelabex.org/

WEEE Directive. It is also the case that some enterprises carry out both preparation for re-use/remarketing and dismantling for recycling, whereas others outsource the dismantling and recycling step. Valid certifications of the facility handling the items are obtained in order to provide assurance to clients.

The tracing of equipment is important for public and private clients. It appears that both manufacturers and social enterprise recyclers operate advanced tracking systems either at the level of individual items of IT equipment or, in the case of some manufacturers, individual parts. The individual ID for an item of equipment may originate from the client's inventory to ensure continuity. Such systems will allow a public authority to identify whether the item has been re-used or recycled, and in some cases where a re-used item is destined for (but not the actual buyer/recipient).

It does not appear to be possible to obtain reporting on what proportion of an individual item or batch of items has been recycled and/or disposed of. Recyclers tend only to report at organisational level on tonnages sent to different streams.

The UK PAS141 standard also makes reference to the certification of legitimate export of WEEE for re-use. It is therefore proposed that guidance is given that when IT equipment reaches its end of life that treatment is, as a minimum, carried out according to the requirements of the EU WEEE Directive Annex VII, but with reference to EN 50625-1 as a standard, or equivalent certification schemes such as WEEElabex, R2 [121] and E-Stewards [122], which may be available at global, national or regional level.

2.5.4.3 Final criterion proposal

For the IT Equipment to be replaced, it is now proposed that public authorities have a separate contractual arrangement that guarantees the collection, testing, upgrading (if necessary) and preparation for resale or donation of the used IT Equipment (or its recycling and safe disposal if it is not reusable).

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[121] Sustainable Electronics Recycling International (SERI), *R2 Standard*, https://sustainableelectronics.org/

[122] E-Stewards, http://e-stewards.org/learn-more/for-enterprises

These services are typically performed by social enterprises or charities, and given the low value of such a contract (with the possible exception of very large public organisations or departments), such an arrangement will likely not fall under the scope of the EU Public Procurement Directives. However, a tendering procedure should be considered to ensure that the contractor fulfils requirements on data protection, extension of the products' life and, when applicable, recycling/proper disposal activities.

Equipment manufacturers can also provide for the remanufacturing of old products to certified quality standards, as well as certification of recycling and/or proper treatment under WEEE legislation, so such a tendering procedure could be run in parallel with a procedure for the purchasing of new equipment in order to encourage potential suppliers of new equipment to also bid.

As was already highlighted, data sanitisation and erasure is likely to be an important consideration. This may be carried out by the contracting authority itself to comply with its own security rules, however, internal reviews by some Member States have highlighted that the same level of security may not always be required across all department. However, such a service is successfully provided by both manufacturers and social enterprise recyclers. As such, for some contracts data sanitisation and erasure may be considered within the scope of such a separate ITT.

Final criteria proposal: End of life management

Core criteria	Comprehensive criteria
SUBJECT MATTER	
Procurement of end-of-life management services for Computers and Monitors	
TECHNICAL SPECIFICATION	
TS1. Secure computer collection, sanitisation, re-use and recycling Tenderers shall provide a re-use and recycling service for a specified inventory of Computers and Monitors that has reached the end of its service life. They shall report on the proportion of equipment re-used or recycled. The tenderer shall demonstrate how they will carry out the following aspects of the overall service: *(according to the type, the state and amount of the equipment, the public authority needs to detail the following points. It may also consider in addition an award criterion rewarding tenderers offering e.g. higher levels of reuse or recycling)* - Collection; - Confidential handling and secure data erasure *(Unless carried out in-house);* - Testing, servicing and upgrading [123]; - Remarketing for re-use in the EU; - Dismantling for recycling and/or disposal. Preparation of items for re-use, as well as recycling and disposal operations shall be carried out in full compliance with the requirements in Article 8 and Annexes VII and VIII of the (recast) WEEE Directive 2012/19/EU [124]. **Verification:** The tenderer shall provide details of the arrangements for collection, data security, testing, remarketing for re-use and recycling/disposal. This shall include, during the contract, valid certifications of compliance for the WEEE handling facilities to be used. According to the location of the handling operations, the following means of proof shall be accepted: – EU operators: A valid permit issued by the	**TS1. Secure computer collection, sanitisation, re-use and recycling** Tenderers shall provide a re-use and recycling service for a specified inventory of Computers and Monitors that has reached the end of its service life. They shall report on the proportion of equipment re-used or recycled. The tenderer shall demonstrate how they will carry out the following aspects of the overall service: *(according to the type, the state and amount of the equipment, the public authority needs to detail the following points. It may also consider in addition an award criterion rewarding tenderers offering e.g. higher levels of reuse or recycling)* - Collection; - Confidential handling and secure data erasure *(Unless carried out in-house);* - Testing, servicing and upgrading [123]; - Remarketing for re-use in the EU; - Dismantling for recycling and/or disposal. Preparation of items for re-use, as well as recycling and disposal operations shall be carried out in full compliance with the requirements in Article 8 and Annexes VII and VIII of the (recast) WEEE Directive 2012/19/EU [124].. **Verification:** The tenderer shall provide details of the arrangements for collection, data security, testing, remarketing for re-use and recycling/disposal. This shall include, during the contract, valid certifications of compliance for the WEEE handling facilities to be used. According to the location of the handling operations, the following means of proof shall be accepted: – EU operators: A valid permit issued by the national competent authority according to

[123] Some Member States have developed standards and/or schemes that public authorities may wish to refer to in order to provide greater detail on how equipment shall be made suitable for reuse and resale.

[124] If the public authority is aware that there are no recycling facilities within a reasonable radius then it may be more appropriate to ask for the equipment to be delivered to an official WEEE collection point.

national competent authority according to Article 23 of the Directive 2008/98/EC or a third party certification of compliance with the technical requirements of EN 50625-1; non-EU operators: A third party certification of compliance with the minimum WEEE requirements laid down in the criterion, the technical requirements of EN 50625-1 or another well-established compliance scheme	Article 23 of the Directive 2008/98/EC or a third party certification of compliance with the technical requirements of EN 50625-1; – non-EU operators: A third party certification of compliance with the minimum WEEE requirements laid down in the criterion, the technical requirements of EN 50625-1 or another well-established compliance scheme [125].
AWARD CRITERIA	
	AC1. Inventory tracking system Points shall be awarded to tenderers operating a tracking system with a unique identifier for each item of equipment in the Contracting Authority's equipment inventory. The system shall enable the proportion of items re-used or recycled, and whether they remained in the EU or were exported. **Verification:** The tenderer shall provide details of the tracking system that they operate.
	AC2. Dismantling to facilitate recycling Points shall be awarded to tenderers that dismantle equipment and extract (before any treatment) relevant components for recycling in accordance with Annexes A2 through to A6 of EN 50625-1 **Verification:** The tenderer shall provide verification of compliance for the dismantling facilities that will be used to fulfil the contract.
CONTRACT PERFORMANCE CLAUSES	
CPC1. Reporting on equipment status The successful tenderer shall provide a report on the status of the equipment in the inventory once all items have been processed for re-use or recycling/disposal. The report shall identify the proportion of items re-used or recycled, whether they remained in the EU or were exported.	**CPC1. Reporting on equipment status** The successful tenderer shall provide a report on the status of the equipment in the inventory once all items have been processed for re-use, recycling or disposal. The report shall identify the proportion of items re-used or recycled.
CPC2. Operation of re-use and recycling facilities The successful tenderer shall provide valid certificates verifying the permitting for the re-use and recycling facilities used to fulfil the contract **Error! Bookmark not defined.**.	**CPC2. Operation of re-use and recycling facilities** The successful tenderer shall provide valid certificates verifying the permitting for the re-use and recycling facilities used to fulfil the contract **Error! Bookmark not defined.**.

[125] The following compliance schemes are considered, at the time of writing, to meet these requirements: WEEELABEX:2011 standard on 'Treatment of WEEE'; 'Responsible Recycling' (R2:2013) standard for electronics recyclers; e-Stewards standard 2.0 for Responsible Recycling and Reuse of Electronic Equipment; Australian/New Zealand standard AS/NZS 5377:2013 on 'Collection, storage, transport and treatment of end-of-life electrical and electronic equipment'

	Valid certification that dismantling has been carried out prior to treatment and in accordance with Annexes A2 through to A6 of EN 50625-1 shall also be provided.

[1] If the public authority is aware that there are no recycling facilities within a reasonable radius then it may be more appropriate to ask for the equipment to be delivered to an official WEEE collection point.

[2] WEEE handlers shall be permitted in compliance with Article 23 of Directive 2008/98/EC and equivalent national or international compliance schemes implementing the Directive.

Summary rationale for the final criteria proposal:

- When purchasing new IT Equipment, the public authority will likely want to dispose of its used equipment. Typically, however, at least a part of this equipment can still be used for an additional period of time by other users.
- From an environmental point of view, and in line with the waste hierarchy, priority should be given to the extension of products' useful life over its recycling and disposal.
- However, it should also be noted that public authorities may tend to make equipment last longer and, in order to avoid improper disposal, require re-use in the EU. Older equipment may not as readily find a market unless it is exported.
- Opportunities to extend IT equipment lifespan through its re-use may be best achieved through the distribution of serviced and upgraded IT equipment by specialist third parties. Therefore, a separate contract is proposed to procure end-of-life management services independent of the contract to supply new equipment, with a requirement to extend the life of the equipment and to guarantee proper treatment upon the end of life.
- Secure data sanitisation and erasure of drives is an important first step in facilitating the re-use of computers. However, this is subject to very specific requirements to be set by the individual contracting authority.
- In terms of core technical specifications, the preparation of equipment for re-use, as well as dismantling for recycling and proper treatment is proposed to

be defined according to Article 8 and Annexes VII and VIII of the WEEE Directive.

- Compliance WEEE handling operations shall be verified by reference to, in the EU, WEEE permits or third party certifications of compliance with the technical requirements of EN 50625-1 and, for outside the EU, with reference to these two previous options or another 'well-established' compliance scheme. The EN standard provides a consistent point of reference because it was developed to provide a harmonised description of compliant handling operations.
- At a comprehensive award level, the use of tracking systems and the dismantling of equipment according to EN 50625-1 are suggested, reflecting best practices amongst IT equipment manufacturers and social enterprise recyclers.
- Dismantling according to Annex A of EN 50625-1 would ensure that key components are extracted in order to minimise environmental pollution and facilitate recycling.
- Extraction of the components listed in Annex A is specified prior to any treatment to ensure they are extracted without shredding. Contract performance clauses should be used in order to monitor execution of contracts, with a specific focus on reporting on re-use/recycling and the provision of valid certifications.

2.7 Criteria area 5 – Further criteria

2.7.1 Criterion 5.1 – Ergonomics

2.7.1.1 Background technical discussion and rationale (04/2014)

Currently, fitness for use is not addressed as a criterion within the GPP criteria set. Ergonomics is an area of potential interest for public procurement because of the need to ensure that working environments are healthy and productive. Workplace claims for problems such as eye and repetitive strain (related to display and keyboards) are also understood to be issues for employers. This could potentially lead to early retirement of displays if they are not suitable for workers.

The well-established electronics label TCO is the main ecolabel addressing ergonomics in its criteria. TCO Certified 2012 for Desktops, Notebooks, All-in-One PCs and Tablet PCs as well as TCO Certified Displays contain criteria regarding both visual ergonomics (image detail, luminance, luminance contrast, reflection and screen colour) and workload ergonomics (inter alia vertical tilt and vertical height for AiO-PCs). These are summarised in Table 2.7.1. The Nordic Swan ecolabel aligns to TCO Displays and Notebooks criteria with regard to ergonomics and includes some own requirements for tablet PCs.

Table 2.7.1: Ergonomic criteria of the TCO ecolabel

Visual ergonomics		**Workload ergonomics**
Image detail characteristics	• Native display resolution requirement	Vertical tilt
Luminance characteristics	• Luminance level • Luminance uniformity • Black level • Luminance uniformity – angular dependence • Greyscale gamma curve	Vertical height
Luminance contrast characters	• Luminance contrast – characters • Luminance contrast – angular dependence	
Reflection characteristics	• Front frame gloss	
Screen colour characteristics	• Correlated colour temperature, CCT, variation • Colour uniformity • RGB settings • Colour uniformity – angular dependence • Colour greyscale linearity	

The German Ecolabel Blue Angel for Computer Monitors (RAL UZ 78c, edition January 2012)[126] includes a criterion based on ISO 9241, a multi-part standard covering ergonomics of human-computer interaction. In particular, DIN EN ISO 9241-307 establishes test methods for the analysis of a variety of visual display technologies, tasks and environments.

2.7.1.2 First proposal (04/2014)

Following stakeholder feedback, for EU Ecolabel it was proposed not to introduce new ergonomics requirements aligned with the label TCO Certified Displays. However, stakeholder feedback was sought on whether a selection of sub-criteria from either the TCO Certified Displays criteria set or EN ISO 9241-307 would be appropriate for GPP.

2.7.1.3 Summary of stakeholder feedback and proposed next steps

The main points arising from the 2nd AHWG meeting was that 1) quality should only be addressed when there is a clear trade-off with environmentally relevant issues and that 2) the cost of proposed test procedure was considered to be too high. Overall, limited additional feedback was received in order to clarify whether there is a clear trade-off with environmentally relevant issues of visual ergonomics. It is therefore proposed not to include a new criterion on the ergonomics of monitors for GPP.

[126] Cf. http://www.blauer-engel.de/en/products_brands/search_products/produkttyp.php?id=619

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