Preparatory study on the Review of Regulation 617/2013 (Lot 3)

Computers and Computer Servers

Task 1 report

Scope

Final version for consultation

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Abbreviations

AC	Alternate Current
AVFS	Adaptive Voltage and Frequency Scaling
B2B	Business to Business
B2C	Business to Consumers
BAT	Best Available Techhnology
BOM	Bill of Materials
CCFL	Cold cathode fluorescent lamp
CPU	Central processing unit
DBEF	Dual Brightness Enhancement Film
DC	Direct Current
dGfx	Discrete Graphic Card
DFS	Dynamic frequency scaling
DIY	Do-it-yourself
DVS	Dynamic voltage scaling
EC	European Commission
EEE	Electrical and electronic equipment
EGA	External graphics adapter
EMEA	Europe, Middle East and Africa
EPA	Environmental Protection Agency (USA)
EPS	External power supply
ESOs	European Standardisation Organisations
EU	European Union
GPU	Graphics processing unit
HDD	Hard disk drives
iGfx	Integrated graphics processing unit
IPS	Internal power supply
JRC	Joint Research Centre
LCD	Liquid crystal display
LED	Light emitting diode
Li-ion	Lithium-ion battery
NiCad	Nickel-Cadmium battery
NiMH	Nickel-metal hydride battery
ODD	Optical disk drive
OS	Operating System
PCB	Printed Circuit Board
PRO	Producer Responsibility Organisation
PSR	Panel self-refresh
PSU	Power Supply Unit
RAM	Random access memory
SME	Small and medium enterprise
SoC	State of charge of a battery
SRAM	Static RAM
SSD	Solid state drives

SSHD	Solid state hybrid drive
VR	Virtual Reality
WEEE	Waste Electrical and Electronic Equipment

Introduction to the task reports

This is the introduction to the interim report of the preparatory study on the Review of Regulation 617/2013 (Lot 3) for Computers and Computer Servers. The interim report has been split into five tasks, following the structure of the MEErP methodology. Each task report has been uploaded individually in the project's website. These task reports present the technical basis to define future ecodesign and/or energy labelling requirements based on the existing Regulation (EU) No 617/2013.

The task reports start with the definition of the scope for this review study (i.e. task 1), which assesses the current scope of the existing regulation in light of recent developments with relevant legislation, standardisation and voluntary agreements in the EU and abroad. The assessment results in a refined scope for this review study.

Following it is task 2, which updates the annual sales and stock of the products in scope according to recent and future market trends and estimates future stocks. Furthermore, it provides an update on these trends as well as on consumer expenditure data, which will be used on the assessment of additional life cycle consumer costs if or when setting new requirements.

Next task is task 3, which presents a detailed overview of use patterns of products in scope according to consumer use and technological developments. It also provides an analysis of other aspects that affect the energy consumption during the use of these products, such as component technologies, power supply load efficiency and user interface in particular power management practices. Furthermore, it also touches on aspects that are important for material and resource efficiency such as repair, maintenance and replacement practices, and it gives an overview of what happens to these products at their end of life. Finally, this task also touches on standardised methods to quantify energy consumption in the different power modes, touching on the active mode, and it presents an overview of the energy consumption of products in scope based on manufacturers and ENERGY STAR database information.

Task 4 presents an analysis of current average technologies at product and component level, and it identifies the Best Available Technologies both at product and component level. An overview of the technical specifications as well as their overall energy consumption is provided when data is available. Finally, the chapter concludes with an overview of the product configurations in terms of components and key materials of current average and Best Available Technologies placed on the European market.

Simplified tasks 5 & 6 report presents the base cases, which will be later used to define the current and future impact of the current computer regulation if no action is taken. The report shows the base cases energy consumption at product category level and their life cycle costs. It also provides a high-level overview of the life cycle global warming potential of desktops and notebooks giving an idea of the contribution of each life cycle stage to the overall environmental impact. Finally, it presents some identified design options which will be used to define reviewed ecodesign requirements.

Task 7.1 report presents the policy options for an amended ecodesign regulation on computers and computer servers. The options have been developed based on the work throughout this review study, dialogue with stakeholders and with the European Commission. The report presents an overview of the barriers and opportunities for the

reviewed energy efficiency policy options, and the rationale for the new material efficiency policy options. This report will be the basis to calculate the estimated energy and material savings potentials by implementing these policy options, in comparison to no action (i.e. Business as Usual – BAU).

The task reports follow the MEErP methodology, with some adaptations which suit the study goals.

1 Introduction to Task 1

Task 1 follows the MEErP methodology and includes the following:

- Product scope: Identification and assessment of relevant categories based on the existing ecodesign regulation, other ecodesign and energy labelling activities such as the draft display regulation, the ongoing Impact Assessment on servers and storage equipment, ENERGY STAR developments, standardisation and measurement method activities and other relevant schemes and activities outside EU. Defining preliminary product scope, definitions and categorisations.
- Test standards: (EU, Member State and third country level). This includes the previous intents by the ENERGY STAR programme to establish an active mode test methodology by using a developed benchmark software.
- Legislation: (EU, Member State and third country level). Including the expected coming display and server regulations.

1.1 Product scope

1.1.1 Existing definitions and categories

1.1.1.1 Ecodesign existing definitions

Commission Regulation (EU) No 617/2013 establishes ecodesign requirements for computers and computer servers. The product definitions employed in the regulation are listed below.

Products and components that are within the scope of the Regulation are defined as:

Computers: Computer means a device, which performs logical operations and processes data, is capable of using input devices and outputting information to a display, and normally includes a central processing unit (CPU) to perform operations. If no CPU is present, then the device must function as a client gateway to a computer server, which acts as a computational processing unit.

Computer servers: Computer server means a computing product that provides services and manages networked resources for client devices, such as desktop computers, notebook computers, desktop thin clients, internet protocol (IP) telephones, or other computer servers. A computer server is typically placed on the market for use in data centres and office/corporate environments. A computer server is primarily accessed via network connections, and not through direct user input devices, such as a keyboard or a mouse. A computer server has the following characteristics:

- (a) is designed to support computer server operating systems (OS) and/or hypervisors, and targeted to run user-installed enterprise applications;
- (b) supports error-correcting code (ECC) and/or buffered memory (including both buffered dual in-line memory modules (DIMMs) and buffered on board (BOB) configurations);
- (c) is placed on the market with one or more AC-DC power supply(ies);
- (d) all processors have access to shared system memory and are independently visible to a single OS or hypervisor.

Desktop computers: Desktop computer means a computer where the main unit is intended to be located in a permanent location and is not designed for portability and which is designed for use with an external display and external peripherals such as a keyboard and mouse.

Integrated desktop computers: Integrated desktop computer means a computer in which the computer and the display function as a single unit, which receives its AC power through a single cable. Integrated desktop computers come in one of two possible forms: (1) a product where the display and the computer are physically combined into a single unit; or (2) a product where the display is separated from the computer but it is connected to the main chassis by a direct current (DC) power cord. An integrated desktop computer is intended to be located in a permanent location and is not designed for portability. Integrated desktop computers are not primarily designed for the display and reception of audio-visual signals.

Notebook computers (including tablet computers, slate computers and mobile thin clients):

Notebook computer means a computer designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an AC power source. Notebook computers utilise an integrated display, with a viewable diagonal screen size of at least 22.86 cm (9 inches), and are capable of operation on an integrated battery or other portable power source.

Tablet computer means a product, which is a type of notebook computer that includes both an attached touch-sensitive display and an attached physical keyboard.

Slate computer means a type of notebook computer that includes an integrated touch-sensitive display but does not have a permanently attached physical keyboard;

Mobile thin client means a type of notebook computer that relies on a connection to remote computing resources (e.g. computer server, remote workstation) to obtain primary functionality and has no rotational storage media integral to the product.

Products that would otherwise meet the definition of notebook computer but have idle state power demand of less than 6 W are not considered to be notebook computers for the purposes of this Regulation.

Desktop thin clients: Desktop thin client means a computer that relies on a connection to remote computing resources (e.g. computer server, remote workstation) to obtain primary functionality and has no rotational storage media integral to the product. The main unit of a desktop thin client must be intended for use in a permanent location (e.g. on a desk) and not for portability. Desktop thin clients can output information to either an external or, where included with the product, an internal display.

Workstations: Workstation means a high-performance, single-user computer primarily used for graphics, Computer Aided Design, software development, financial and scientific applications among other computer intensive tasks, and which has the following characteristics:
   (a) has a mean time between failures (MTBF) of at least 15,000 hours;
   (b) has error-correcting code (ECC) and/or buffered memory;
   (c) meets three of the following five characteristics:

   (1) has supplemental power support for high-end graphics (i.e. peripheral component interconnect (PCI)-E 6-pin 12 V supplemental power feed);

   (2) its system is wired for greater than x4 PCI-E on the motherboard in addition to the graphics slot(s) and/or PCI-X support;

   (3) does not support uniform memory access (UMA) graphics;

   (4) includes five or more PCI, PCI-E or PCI-X slots;

(5) is capable of multi-processor support for two or more CPU (must support physically separate CPU packages/sockets, i.e. not met with support for a single multi core CPU).

Mobile workstation: Mobile workstation means a high-performance, single- user computer primarily used for graphics, Computer Aided Design, software development, financial and scientific applications among other compute intensive tasks, excluding game play, and which is designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an AC power source. Mobile workstations utilise an integrated display and are capable of operation on an integrated battery or other portable power source. Most mobile workstations use an external power supply and most have an integrated keyboard and pointing device.

A mobile workstation has the following characteristics:

(a) has a mean time between failures (MTBF) of at least 13,000 hours;

(b) has at least one discrete graphics card (dGfx) meeting the G3 (with FB Data Width > 128-bit), G4, G5, G6 or G7 classification;

(c) supports the inclusion of three or more internal storage devices;

(d) supports at least 32 GB of system memory.

Small-scale servers: Small-scale server means a type of computer that typically uses desktop computer components in a desktop form factor but is designed primarily to be a storage host for other computers and to perform functions such as providing network infrastructure services and hosting data/ media, and which has the following characteristics:

(a) is designed in a pedestal, tower, or other form factor similar to those of desktop computers such that all data processing, storage, and network interfacing is contained within one box;

(b) is designed to be operational 24 hours per day and 7 days per week;

(c) is primarily designed to operate in a simultaneous multi-user environment serving several users through networked client units;

(d) where placed on the market with an operating system, the operating system is designed for home server or low-end server applications;

(e) is not placed on the market with a discrete graphics card (dGfx) meeting any classification other than G1.

External power supply means a device, which has the following characteristics**:**

(a) is designed to convert alternating current (AC) power input from the mains power source input into lower voltage direct current (DC) or AC output;

(b) is able to convert to only one DC or AC output voltage at a time;

(c) is intended to be used with a separate device that constitutes the primary load;

(d) is contained in a physical enclosure separate from the device that constitutes the primary load;

(e) is connected to the device that constitutes the primary load via a removable or hard-wired male/female electrical connection, cable, cord or other wiring; and

(f) has nameplate output power not exceeding 250 Watts.

Internal power supply means a component designed to convert AC voltage from the mains to DC voltage(s) for the purpose of powering the computer or computer server and has the following characteristics:

> (a) is contained within the computer or computer server casing but is separate from the main computer or computer server board;

> (b) the power supply connects to the mains through a single cable with no intermediate circuitry between the power supply and the mains power; and

> (c) all power connections from the power supply to the computer or computer server components, with the exception of a DC connection to a display in an integrated desktop computer, are internal to the computer casing.

Internal DC-to-DC converters used to convert a single DC voltage from an external power supply into multiple voltages for use by a computer or computer server are not considered internal power supplies.

Discrete Graphics Card (dGfx) means a discrete internal component containing one or more graphics processing units (GPUs) with a local memory controller interface and local graphics-specific memory and falling into one of the following categories:

> (a) G1 (FB_BW ≤ 16);
> (b) G2 (16 < FB_BW ≤ 32);
> (c) G3 (32 <FB_BW ≤ 64);
> (d) G4 (64 <FB_BW ≤ 96);
> (e) G5 (96 <FB_BW ≤ 128);
> (f) G6 (FB_BW > 128 (with FB Data Width < 192-bit));
> (g) G7 (FB_BW > 128 (with FB Data Width ≥ 192-bit)).

Frame buffer bandwidth (FB _BW) means the amount of data that is processed per second by all GPUs on a dGfx, which is calculated using the following formula:

Frame buffer bandwidth = (Data Rate × Data Width)/(8 × 1 000)

Where:

> (a) frame buffer bandwidth is expressed in GigaBytes/ second (GB/s);

> (b) data rate is the effective memory data frequency in MHz;

> (c) data width is the memory frame buffer (FB) data width, expressed in bits (b);

> (d) '8' converts the calculation into Bytes;

> (e) dividing by 1 000 converts Megabytes into Gigabytes.

Internal storage means a component internal to the computer, which provides non-volatile storage of data.

Product type means desktop computer, integrated desktop computer, notebook computer, desktop thin client, workstation, mobile workstation, small-scale server, computer server, blade system and components, multi-node server, server appliance, game console, docking station, internal power supply or external power supply.

Relevant products that are defined in the Regulation, but not within scope include:

Game console means a mains-powered standalone device, which is designed to provide video game playing as its primary function. A game console is typically designed to provide output to an external display as the main game-play display. Game consoles typically include a CPU, system memory and a graphics processing unit(s) (GPU), and may contain hard drives or other internal storage options, and optical drives. Game consoles typically utilise handheld controllers or other interactive controllers as their primary input device rather than an external keyboard or mouse. Game consoles do not

typically include conventional personal computing operating systems but instead utilise console-specific operating systems. Handheld gaming devices, with an integrated display as the primary game-play display, and which primarily operate on an integrated battery or other portable power source rather than via a direct connection to an AC power source, are considered to be a type of game console.

Docking station means a discrete product designed to be connected to a computer in order to perform functions such as expanding connectivity or consolidating connections to peripheral devices. Docking stations may also facilitate charging of internal batteries in the connected computer.

1.1.1.2 Ecodesign categories

Ecodesign computer regulation 617/2013 utilizes a categorization approach for computers in scope as presented in the table below:

Table 1. Products categories in Commission Regulation (EU) No 617/2013.

Product	Product category
Desktop computers	Category A: desktop computer means a desktop computer that does not meet the definition of Category B, Category C or Category D desktop computer; Category B: desktop computer means a desktop computer with: (i) two physical cores within the CPU; and (ii) a minimum of two gigabytes (GB) of system memory; Category C: desktop computer means a desktop computer with: (i) three or more physical cores within the CPU; and (ii) a configuration of a minimum of one of the following two characteristics: — a minimum of two gigabytes (GB) of system memory, and/or — a discrete graphics card (dGfx); Category D: desktop computer means a desktop computer with: (i) a minimum four physical cores in the CPU; and (ii) a configuration of a minimum of one of the following two characteristics: — a minimum of four gigabytes (GB) of system memory, and/or — a discrete graphics card (dGfx) meeting the G3 (with FB Data Width > 128-bit), G4, G5, G6 or G7 classification;
Integrated desktop computers	Category A: integrated desktop computer means an integrated desktop computer that does not meet the definition of Category B, Category C or Category D integrated desktop computer; Category B: integrated desktop computer means an integrated desktop computer with: (i) two physical cores in the CPU; and (ii) a minimum of two gigabytes (GB) of system memory; Category C: integrated desktop computer means an integrated desktop computer with: (i) three or more physical cores in the CPU; and (ii) a configuration of a minimum of one of the following two characteristics: — a minimum of two gigabytes (GB) of system memory, and/or — a discrete graphics card (dGfx); Category D: integrated desktop computer means an integrated desktop computer with: (i) a minimum of four physical cores in the CPU; and (ii) a configuration of a minimum of one of the following two characteristics: — a minimum of four gigabytes (GB) of system memory, and/or — a discrete graphics card (dGfx) meeting the G3 (with FB Data Width > 128-bit), G4, G5, G6 or G7 classification;
Notebook computers	Category A: notebook computer means a notebook computer that does not meet the definition of Category B or Category C notebook computer; Category B: notebook computer means a notebook computer with at least one discrete graphics card (dGfx); Category C: notebook computer means a notebook computer with at least the following characteristics: (a) a minimum two physical cores in the CPU; (b) a minimum two gigabytes (GB) of system memory; and

Product	Product category
	(c) a discrete graphics card (dGfx) meeting the G3 (with FB Data Width > 128-bit), G4, G5, G6 or G7 classification;

Other computers and computer servers in scope than the ones included in the table above are not divided into categories. Only discrete graphics cards are divided into categories, see Section 1.1.1.1 on ecodesign definitions.

1.1.1.3 ENERGY STAR definitions

The ENERGY STAR programme requirements and definitions are significant to this study as Article 9 of Regulation 617/2013 concerning the revision of the regulation explicitly requires the revision to contain a review of the developments in the ENERGY STAR programme. Furthermore, the current regulation was to a large extent based on a previous ENERGY STAR specification, i.e. v5.

The original Lot 3 preparatory study report from August 2007 describes the scope and definitions of ENERGY STAR program requirements version 3.0, which was the effective version at the time of conducting the study, and 4.0, which was awaiting implementation at the time of publishing the study report. The study ended up being based on ENERGY STAR programme requirements version 4.0. Since then versions 5.0 and 6.0 have been published, and the currently (February 2016) valid version is 6.1, adopted in the US on the 10th September 2014 and in the EU on the 7th September 2015. Parallel with the process of this review study, the US EPA has launched work on developing version 7.0 of the ENERGY STAR requirements.

The following describes the definitions of the products in scope, and associated components, of ENERGY STAR requirements version 6.1.

Computer: A device, which performs logical operations and processes data. For the purposes of this specification, computers include both stationary and portable units, including Desktop Computers, Integrated Desktop Computers, Notebook Computers, Small-Scale Servers, Thin Clients, and Workstations. Although computers are capable of using input devices and displays, such devices are not required to be included with the computer upon shipment. Computers are composed of, at a minimum:

> a) A central processing unit (CPU) to perform operations. If no CPU is present, then the device must function as a client gateway to a server, which acts as a computational CPU;
>
> b) User input devices such as a keyboard, mouse, or touchpad; and
>
> c) An Integrated Display screen and/or the ability to support an external display screen to output information.

Desktop Computer and Integrated Desktop Computer: a computer whose main unit is designed to be located in a permanent location, often on a desk or on the floor. Desktop computers are not designed for portability and are designed for use with an external display, keyboard, and mouse. Desktop computers are intended for a broad range of home and office applications, including point of sale applications.

An **integrated Desktop Computer** is a Desktop Computer in which the computing hardware and display are integrated into a single housing, and which is connected to ac mains power through a single cable. Integrated Desktop Computers come in one of two possible forms: (1) a system where the display and computer are physically combined into a single unit; or (2) a system packaged as a single system where the display is

separate but is connected to the main chassis by a dc power cord and both the computer and display are powered from a single power supply. As a subset of Desktop Computers, Integrated Desktop Computers are typically designed to provide similar functionality as Desktop systems.

Notebook Computer: A computer designed specifically for portability and to be operated for extended periods of time both with and without a direct connection to an AC mains power source. Notebook Computers include an Integrated Display, a non-detachable, mechanical keyboard (using physical, moveable keys), and pointing device.

> a) Mobile Thin Client: A computer meeting the definition of a Thin Client, designed specifically for portability, and also meeting the definition of a Notebook Computer. These products are considered to be Notebook Computers for the purposes of this specification.

> b) Two-In-One Notebook: A computer which resembles a traditional Notebook Computer with a clam shell form factor, but has a detachable display which can act as an independent Slate/Tablet when disconnected. The keyboard and display portions of the product must be shipped as an integrated unit. Two-In-One Notebooks are considered Notebooks in the remainder of this specification and are therefore not referenced explicitly.

Slate/Tablet: A computing device designed for portability that meets all of the following criteria:

> a) Includes an integrated display with a diagonal size greater than 6.5 inches and less than 17.4 inches;

> b) Lacking an integrated, physical attached keyboard in its as-shipped configuration;

> c) Includes and primarily relies on touchscreen input; (with optional keyboard);

> d) Includes and primarily relies on a wireless network connection (e.g., Wi-Fi, 3G, etc.); and

> e) Includes and is primarily powered by an internal battery (with connection to the mains for battery charging, not primary powering of the device).

Portable All-In-One Computer: A computing device designed for limited portability that meets all of the following criteria:

> a) Includes an integrated display with a diagonal size greater than or equal to 17.4 inches;

> b) Lacking keyboard integrated into the physical housing of the product in its as-shipped configuration;

> c) Includes and primarily relies on touchscreen input; (with optional keyboard);

> d) Includes wireless network connection (e.g. Wi-Fi, 3G, etc.); and

> e) Includes an internal battery, but is primarily powered by connection to the AC mains.

Workstation: A high-performance, single-user computer typically used for graphics, CAD, software development, financial and scientific applications among other compute intensive tasks. Workstations covered by this specification (a) are marketed as a workstation; (b) provide mean time between failures (MTBF) of at least 15,000 hours (based on either Bellcore TR-NWT000332, issue 6, 12/97 or field collected data); and (c)

support error-correcting code (ECC) and/or buffered memory. In addition, a workstation meets three or more of the following criteria:

   a) Provide supplemental power support for high-end graphics (e.g., PCI-E 6-pin 12V supplemental power feed);

   b) Wired for greater than x4 PCI-E on the motherboard in addition to the graphics slot(s) and/or PCI-X support;

   c) Do not provide support for Uniform Memory Access (UMA) graphics;

   d) Provide 5 or more PCI, PCI-E, or PCI-X slots;

   e) Provide multi-processor support for 2 or more processors (shall support physically separate processor packages/sockets, i.e., requirement cannot be met with support for a single multi-core processor); and/or

   f) Qualification by 2 or more Independent Software Vendor (ISV) product certifications; these certifications can be in process, but shall be completed within 3 months of qualification.

Small-scale Server marketed and sold for non-data centre use: A computer that typically uses desktop components in a desktop form factor, but is designed primarily to be a storage host for other computers. Small-scale Servers are designed to perform functions such as providing network infrastructure services (e.g., archiving) and hosting data/media. These products are not designed to process information for other systems or run web servers as a primary function. A Small-scale Server has the following characteristics:

   a) Designed in a pedestal, tower, or other form factor similar to those of desktop computers such that all data processing, storage, and network interfacing is contained within one box/product;

   b) Designed to operate 24 hours/day, 7 days/week, with minimal unscheduled downtime (on the order of hours/year);

   c) Capable of operating in a simultaneous multi-user environment serving several users through networked client units; and

   d) Designed for an industry accepted operating system for home or low-end server applications (e.g., Windows Home Server, Mac OS X Server, Linux, UNIX, Solaris).

Thin Client: An independently-powered computer that relies on a connection to remote computing resources (e.g., computer server, remote workstation) to obtain primary functionality. Main computing functions (e.g., program execution, data storage, interaction with other Internet resources) are provided by the remote computing resources. Thin Clients covered by this specification are (1) limited to devices with no rotational storage media integral to the computer and (2) designed for use in a permanent location (e.g. on a desk) and not for portability.

   a) Integrated Thin Client: A Thin Client in which computing hardware and display are connected to ac mains power through a single cable. Integrated Thin Client computers come in one of two possible forms: (1) a system where the display and computer are physically combined into a single unit; or (2) a system packaged as a single system where the display is separate but is connected to the main chassis by a DC power cord and both the computer and display are powered from a single power supply. As a subset of Thin Clients, Integrated Thin Clients are typically designed to provide similar functionality as Thin Client systems.

b) Ultra-thin Client: A computer with lesser local resources than a standard Thin Client that sends raw mouse and keyboard input to a remote computing resource and receives back raw video from the remote computing resource. Ultra-thin clients cannot interface with multiple devices simultaneously nor run windowed remote applications due to the lack of a user-discernible client operating system on the device (i.e., beneath firmware, user inaccessible).

External Power Supply (EPS): Also referred to as External Power Adapter. An external power supply circuit that is used to convert household electric current into dc current or lower-voltage ac current to operate a consumer product.

Internal Power Supply (IPS): A component internal to the computer casing and designed to convert ac voltage from the mains to dc voltage(s) for the purpose of powering the computer components. For the purposes of this specification, an internal power supply shall be contained within the computer casing but be separate from the main computer board. The power supply shall connect to the mains through a single cable with no intermediate circuitry between the power supply and the mains power. In addition, all power connections from the power supply to the computer components, with the exception of a DC connection to a display in an Integrated Desktop Computer, shall be internal to the computer casing (i.e., no external cables running from the power supply to the computer or individual components). Internal dc-to-dc converters used to convert a single dc voltage from an external power supply into multiple voltages for use by the computer are not considered internal power supplies.

Graphics Processing Unit (GPU): An integrated circuit, separate from the CPU, designed to accelerate the rendering of either 2D and/or 3D content to displays. A GPU may be mated with a CPU, on the system board of the computer or elsewhere to offload display capabilities from the CPU.

Discrete Graphics (dGfx): A graphics processor (GPU) with a local memory controller interface and local graphics-specific memory.

Integrated Graphics (iGfx): A graphics solution that does not contain Discrete Graphics.

Display: A commercially-available product with a display screen and associated electronics, often encased in a single housing, that as its primary function displays visual information from (1) a computer, workstation or server via one or more inputs (e.g., VGA, DVI, HDMI, DisplayPort, IEEE 1394, USB), (2) external storage (e.g., USB flash drive, memory card), or (3) a network connection.

Enhanced-performance Integrated Display: An integrated Computer Display that has all of the following features and functionalities:

(1) A contrast ratio of at least 60:1 at a horizontal viewing angle of at least 85°, with or without a screen cover glass;

(2) A native resolution greater than or equal to 2.3 megapixels (MP); and

(3) A color gamut of at least sRGB as defined by IEC 61966-2-1. Shifts in color space are allowable as long as 99% or more of defined sRGB colors are supported.

1.1.1.4 Prodcom (Eurostat)

There are a large number of PRODCOM codes that relate to computers and associated products that may be within scope of any potential future update to the ecodesign Regulation on computers. However, PRODCOM includes some overarching categories, which cover a large proportion of computers and associated products. These include NACE 26.11 "Manufacture of electronic components", NACE 26.20 "Manufacture of computers and peripheral equipment", NACE 26.30 "Manufacture of communication equipment", NACE 26.40 "Manufacture of consumer electronics" and NACE 27.20 "Manufacture of batteries and accumulators". The products covered under these categories, as well as other associated manufacturing processes, which are not covered elsewhere, are listed in the table below:

Table 2. Prodcom categories covering products relevant for this study.

PRODCOM code	PRODCOM Nomenclature
26201700	Monitors and projectors, principally used in an automatic data processing system
26202100	Storage units
26202200	Solid-state, non-volatile data storage devices for recording data from an external source (flash memory cards or flash electronic storage cards), unrecorded
26203000	Other units of automatic data processing machines (excluding network communications equipment (e.g. hubs, routers, gateways) for LANs and WANs and sound, video, network and similar cards for automatic data processing machines)
26302320	Machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus
26302370	Other apparatus for the transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network), other than transmission or reception apparatus of HS 8443, 8525, 8527 or 8528
26403460	Flat panel video monitor, LCD or plasma, etc., without tuner (colour video monitors) (excluding with cathode-ray tube)
26406050	Video game consoles (not operated by means of payments)
27115040	Power supply units for telecommunication apparatus, automatic data-processing machines and units thereof
27201100	Primary cells and primary batteries
28992020	Machines and apparatus used solely or principally for the manufacture of semiconductor boules or wafers
28992040	Machines and apparatus for the manufacture of semiconductor devices or of electronic integrated circuits (excluding machine tools for working any material by removal of material operated by ultrasonic processes)
28992060	Machines and apparatus used solely or principally for the manufacture of flat panel displays
28995100	Parts and accessories of machines and apparatus used solely or principally for (a) the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays, (b) the manufacture or repair of masks and reticles, (c) assembling semiconductor devices or electronic integrated circuits, and (d) lifting, handling, loading or unloading of boules, wafers, semiconductor devices, electronic integrated circuits and flat panel displays (excluding tool holders, self-opening dieheads, workholders and parts and accessories for machine-tools operated by ultrasonic processes)

1.1.1.5 Categories according to EN- and ISO standard(s)

Whist there are a large number of EN and ISO standards that, at least in part, address computers, there is only one that currently contains detailed product definitions. Further standards, developed in support on the EC Regulation No 617/2013 on computers may also contain definitions in future but these will be the same as those found in the Regulation itself.

EN 62623:2013 Desktop and notebook computers. Measurement of energy consumption

The EN 62623 standard includes a number of computer product definitions. These are very similar to the product definitions used in the ENERGY STAR v6.1 specification for computers. The EN 62623 definitions are:

- **Desktop computer**
  A desktop computer is a computer where the main unit is intended to be located in a permanent location, often on a desk or on the floor. Desktops are not designed for portability and utilize an external computer display, keyboard, and mouse. Desktops are designed for a broad range of home and office applications.
- **Notebook computer**
  A notebook computer is a computer designed specifically for portability and intended to be operated for extended periods of time either with or without a direct connection to a mains power supply. Notebooks utilize an integrated computer display and are capable of operation from an integrated battery. In addition, most notebooks use an EPS or a.c. brick and have an integrated keyboard and pointing device. Notebook computers are typically designed to provide similar functionality to desktops, including operation of software similar in functionality as that used in desktops. For the purposes of this standard, docking stations are considered accessories and therefore, should not be considered as part of the EUT. Tablet computers, which may use touch-sensitive screens along with, or instead of, other input devices, are considered notebook computers in this standard. Netbook computers which are typically identified by a smaller screen size (constrained) and base memory size are also considered notebook computers in this standard.
- **Integrated desktop computer**
  An integrated desktop computer is a desktop computer where the computer and computer display function as a single unit receiving its a.c. power through a single mains cable. Integrated desktop computers come in one of two possible forms:
  - *a product where the computer display and computer are physically combined into a single unit; or*
  - *a product packaged as a single product, where the display and computer appear as physically separated devices, but cannot be detached to be used separately, and are powered from a single (internal or external) power source.*
  NOTE An integrated desktop computer can also be referred to as an all-in-one computer.

1.1.1.6 Labelling categories (EU Energy Label or Eco-label)

EU Energy Label
As part of the current preparatory study an assessment will be made of the feasibility of establishing and applying Energy Labelling requirements on significant aspects of computers other than energy consumption such as noise, durability, possibilities of dismantling, recyclability as well as information requirements for end of life phase of products. In that regard an assessment will also be made of whether it would be beneficial to possibly replace the EU ENERGY STAR voluntary labelling programme with the a mandatory labelling regulation under Directive 2010/30/EU.

Eco-label

The EU Eco-label has active specifications for desktop ("Personal Computers") and notebook computers (Notebook Computers"). The specifications were published in June 2011 and are currently under review by the Commission. The product categories in the Eco-label specifications are:

- ***Computer***
  'computer' means a device which performs logical operations and processes data, is capable of using input devices and computer displays, and includes a central processing unit (CPU) to perform operations. For the purpose of this Decision, computers shall only include stationary units, including desktop computers, integrated desktop computers and thin clients.

- ***Desktop Computer***
  'desktop computer' means a computer where the main unit is intended to be located in a permanent location, often on a desk or on the floor. Desktops are not designed for portability and utilise an external computer display, keyboard, and mouse. Desktops are designed for a broad range of home and office applications;

- ***Integrated Desktop Computer***
  'integrated desktop computer' means a desktop system in which the computer and computer display function as a single unit which receives its AC power through a single cable. Integrated desktop computers come in one of two possible forms: (1) a system where the computer display and computer are physically combined into a single unit; or (2) a system packaged as a single system where the computer display is separate but is connected to the main chassis by a DC power cord and both the computer and computer display are powered from a single power supply. As a subset of desktop computers, integrated desktop computers are typically designed to provide similar functionality as desktop systems;

- ***Notebook Computers***
  The product group 'notebook computers' shall comprise devices which have the following characteristics: (a) they perform logical operations and process data and are designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an AC power source; (b) they utilise an integrated computer display and are capable of operation off an integrated battery or other portable power source. If a notebook computer is delivered with an external power supply this power supply is considered part of the notebook computer.

  Tablet personal computers, which may use touch-sensitive screens along with or instead of other input devices shall be considered Notebook Computers. However digital picture frames shall not be considered notebook computers.

- ***Thin Client***
  'thin client' means an independently powered computer that relies on a connection to remote computing resources to obtain primary functionality. Main computing (e.g. programme execution, data storage, interaction with other Internet resources, etc.) takes place using the remote computing resources. Thin clients covered by this definition are limited to devices with no rotational

storage media integral to the computer. The main unit of a thin client covered by this definition must be intended for location in a permanent location (e.g. on a desk) and not for portability;

- **Computer Display**
  'computer display' means a display screen and its associated electronics encased in a single housing, or within the computer housing (e.g. integrated desktop computer), that is capable of displaying output information from a computer via one or more inputs, such as a VGA, DVI, display port, and/or IEEE 1394. Examples of computer display technologies are the cathode-ray tube (CRT) and liquid crystal display (LCD);

- **External Power Supply**
  'external power supply' means a component contained in a separate physical enclosure external to the computer casing and designed to convert line voltage AC input from the mains to lower DC voltage(s) for the purpose of powering the computer. An external power supply must connect to the computer via a removable or hard-wired male/female electrical connection, cable, cord or other wiring;

- **Internal Power Supply**
  'internal power supply' means a component internal to the computer casing and designed to convert AC voltage from the mains to DC voltage(s) for the purpose of powering the computer components. For the purposes of this definition, an internal power supply must be contained within the computer casing but shall be separate from the main computer board. The power supply must connect to the mains through a single cable with no intermediate circuitry between the power supply and the mains power. In addition, all power connections from the power supply to the computer components, with the exception of a DC connection to a computer display in an integrated desktop computer, must be internal to the computer casing (i.e. no external cables running from the power supply to the computer or individual components). Internal DC-to-DC converters used to convert a single DC voltage from an external power supply into multiple voltages for use by the computer are not considered internal power supplies;

- **Discrete Graphics Processing Unit (GPU)**
  'discrete graphics processing unit (GPU)' means a graphics processor with a local memory controller interface and a local, graphics-specific memory.

1.1.2 Preliminary product scope

The current EC Computers Regulation No 617/2013 encompasses a wide range of computers and computer servers in its scope. This study will concentrate on the products that fall under the current computer definitions and – given the recent preparatory study conducted on computer servers – will only cover small-scale servers (and not enterprise servers) because, by design, they are desktop computers adapted to provide basic server functions in a small-office/home-office environment. Additional changes to products definitions will also be proposed to better reflect the changing landscape of computer types on the market.

It has been previously stated that the current regulation has kept alignment in definitions with ENERGY STAR. Although coherence and convergence are strongly desirable to facilitate market exchange, because of the different nature of ENERGY STAR and of EU

Regulations, the experience shows that it is not possible to keep product category definitions and specific requirements fully aligned.

Table 3 shows the aspects which are of particular relevance in comparing ENERGY STAR to the ecodesign and/or Energy Labelling regulations:

Table 3. Aspects of comparison between ENERGY STAR and theEcodesign and/or Energy Labelling frameworks.

Aspects of comparison	Energy Star	Ecodesign and/or Energy Labelling regulations
Voluntary/mandatory	**Voluntary** programme where each industry member has some margin of discretion in selecting the most appropriate product category they use to benchmark their product	**Mandatory** requirements where definitions are needed to prevent loopholes, unintentional product coverage and unequivocal future-proof definitions
Setting requirements	Swift consultation process with industry for reviewing specifications every 2 or 3 years (minor revisions can be completed within months)	Participation of different stakeholders, including industry, Member State representatives, environmental NGOs, consumer protection associations and experts from different Commission services, including a political scrutiny process which lasts up to several years
Market share	Only the **most efficient products on the market meet the specifications** (about 25%) at the time they are set, growing up to 80-90% (without direct visibility for the consumer)	Aim at removing the worst performing products from the market (so all products on the market MUST meet the specifications)
Label presence	Labels are only placed on certified products, no indication of the specification version	Labels put on all products and Tiers used to block the bottom class(es) from being placed on the market after a number of years
Relabelling/rescaling	Labels must be "removed" once the specifications are updated if the product does not meet the new specifications (generally every 2-3 years, no grandfathering rule)	Labels are only "rescaled" every 10 years (to avoid overcrowding of top classes)
Boolean vs discrete	No distinction between the very best and those barely fulfilling the minimal requirements	Seven classes (A-G) with the most efficient products being in the top class
Visibility on technology evolution	Improvements are not visible	Improvements are visible along the entire lifespan of the label (e.g. 10 years)

Given the fast moving nature of the Information and Communication Technology (ICT) industry, new types of product categories considered "computers" are regularly brought

into the market. As ecodesign regulations typically have an active lifetime of several years before a review, the market and technology evolution can therefore result in (i) possible loopholes when new products out of scope – but serving the same purpose as products in scope - are sold in high volumes, and, (ii) blocking new products from coming into the EU market.

In order to streamline the current regulation by applying common definitions to mobile and non-mobile products, recognizing their different performance capacities and avoiding potential loopholes for more of these new products into the EU market, computers in scope will be categorized in two main product groups: **Mobile** and **Non-Mobile computers**. These two overarching product groups and their definitions apply separately for all mobile and non-mobile products, with additional product types listed as sub-groups.

Moreover, the split incentives for regulatory measures (particularly ecodesign and Energy Labelling) between consumers and industry are different for mobile and non-mobile products:

- Many mobile products are energy efficient since this results in longer battery life. However, in spite of the lower battery costs because of smaller battery used, efficient mobile technology is more expensive. Mobile products are not necessarily more efficient all the time. For example, they may be efficient when running on battery power but as soon as they are plugged into the mains their efficiency can drop considerably. Consumers need clear, and simple information on energy use of the computer and battery life in order to perform an informed purchase by figures providing a balance of costs and performance, which should constitute a further incentive for industry to produce more and more energy efficient products.
- Non-mobile products are not necessarily energy efficient as only maximum power use is indicated on the product label and the consumer should use external meters to have visibility on energy use, which is paid for by the consumer. There is a clear split incentive between consumer and supplier that may be induced to reduce the product cost by using components, technologies and solutions not necessarily energy efficient. Energy Labelling can mitigate this issue.

Additionally, other aspects not strictly or directly related to the energy use of computers but more broadly related to their life cycle environmental impact, get increasing attention by the public opinion and by the legislator. To this extent the "Circular Economy package[1]" has identified the ecodesign framework as the most appropriate to tackle these aspects. In the particular case of mobile computers, they may need more attention as some aspects, such as the presence of batteries, may influence both durability and recyclability at their end of life. Furthermore, the trend towards smaller and/or thinner mobile computers has resulted in products being more difficult to dismantle and to repair and often hinders the ability for consumers to replace the battery.

Categorizing products into these two overarching categories, consequently, should facilitate specific ecodesign measures.

"Portable all in ones" (PAiO) computers, however, may need specific attention: similar to large tablet computers have components and energy use profiles more akin to Integrated

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[1] http://ec.europa.eu/environment/circular-economy/index_en.htm

Desktop Computers than to tablet computers. "Portable all in ones" are treated as "notebook computers" under the existing ecodesign regulation on computers but as "integrated desktop computers" under ENERGY STAR v6.1. Further work will be conducted during this review to identify the best fitting energy use profiles of PAiOs.

It is also proposed that "external graphics adapters" are included in the scope of this review study. Typically, these devices are used for notebook computers to increase the graphic capability, often for graphic intensive gaming. The main purpose of including the external graphic adapters is to assess the impact on sales and energy consumption and to assess if they should be subject to regulation.

1.1.3 Preliminary product scope criteria

A number of aspects were used in order to support the development of the preliminary product definitions. Each of these assisted in the development of criteria that are relevant to the computers currently on the market but also in determining how product definitions should be structured to account for new types of products coming to the market.

The focus of the product definitions remains on discrete products (and components) rather than on services provided by computer products. This approach was taken because the European Ecodesign Directive (2009/125/EC) addresses products over services. Taking a services approach to the scope would also add considerably more complexity to the study as a computer service generally utilizes many different types of electronic products and may also be a subset of a larger product e.g. a virtual computer "in the cloud".

The product definitions do not take account of the potential different end user environments that the computer products may be sold into. That is, computers are found in many different user environments from homes to businesses. However, in most cases the differences found between products sold into home versus business environments are minimal so no differentiation was required in the product definitions. There are likely to be some differences between the products that are sold into specialist environments such as industrial and medical facilities, however no distinction has been made at this time until further investigatory work is conducted later in the study.

The way in which computers are sold can vary considerably especially for the non-mobile products where computing components are sold separately with end users building the complete computer. An estimated 54 million motherboards were shipped globally in 2015 (compared to a total global sale of slightly below 300 million computers) but it is assumed that most of this market is for smaller companies that place complete systems on the EU market.[2] Whilst the overall market share of self-build computers maybe small, it does still account for a sizable share of high end gaming desktops which on average use considerably more energy than mainstream computers. Recent market estimates suggest that the high-end gaming segments is the fastest growing personal computer segment and that shipment are growing by around 26% per year.[3] Other research

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[2] Digitimes, 2015, "*Global DIY motherboard shipments in 2015 to fall 21.7%, say Taiwan makers*" available from http://www.digitimes.com/news/a20151229PD212.html
[3] IDC 2016 quoted in Computerworld, 2016, "*PC shipments fell by 10.6 percent during the fourth quarter last year, but gaming PCs fought the trend*", available from http://www.computerworld.com/article/3022053/computer-hardware/pricey-gaming-desktops-and-laptops-thrive-in-slumping-pc-market.html

suggests that self-built high end gaming computers will account for almost a quarter of all high end gaming computers by 2017.[4]

The product definitions, listed in Table 4, mostly cover complete products as sold by retailers or manufacturers. It would not be possible to cover self-build computers under any energy efficiency or resource efficiency requirements. However, some components which may be sold separately and which have a strong influence on the energy efficiency of computers have been defined separately in order that further analysis can be conducted during the course of this project.

Technological development in the computer market is fast with minor iterative changes to current types of computers commonplace and new types of computers being launched also not uncommon. After the entry into force of the EU Computer Regulation 617/2013 the market progressively shifted away from desktop devices to mobile devices such as notebook computers, tablets, slates and to some degree smartphones. This shift away from desktops is more prominent in the domestic market than the non-domestic market where desktops still offer some advantages such as better theft protection, enhanced upgradability and lower cost. Although, the influence of these advantages are reducing because mobile computer supported teleworking are becoming more prominent. Even within the notebook computer segment, there have been significant changes since the implementation of the EU Computer Regulation 617/2013. Sales of tablet computers (defined as "slate computers" in the current Regulation) grew rapidly during the development and implementation dates of the current Regulation but have since reduced somewhat in favour of hybrid notebook computers, which have detachable displays. There have also been changes in terms of the way products are used. Recent changes in the gaming computer market place have resulted in more gaming computers being designed to be used with a television rather than a computer monitor resulting in increasingly blurred product differentiation with traditional games consoles. All of these changes in the market place have been considered within the preliminary product definitions.

There is still a significant amount of improvement potential in terms of the energy efficiency of computers above the requirements laid out in the Regulation 617/2013. Of particular interest is the additional improvement potential available in the integrated displays found in integrated desktop computers and most mobile computers. Whilst integrated displays were not called out as a separate component in the preliminary product definitions they are called out within each product type.

The efficiency of internal power supply units (PSUs) can be significantly improved above current ecodesign requirements levels. Additionally, large numbers of motherboard shipments and readily availability in component outlets means that large numbers of PSUs may be sold as discrete products. Therefore, they have been identified as a separate component for further review.

1.1.4 Preliminary scope and product definitions

Table 4 below identifies the preliminary product scope and definitions for products, and associated components that will be considered in further detail during the course of the project.

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[4] Jon Peddie, 2015, The Enthusiast PC Gaming Market Second Half 2014, available from
http://www.jonpeddie.com/download/media/slides/Enthusiast_PC_Gaming_HW_Report_2H14_TOC.pdf

As mentioned in previous sections, the product scope and definitions have been changed from those included in the current computer regulation. Two overarching computer categories have been developed (i.e. "Mobile Personal Computers" and "Non-mobile Personal Computers") to facilitate improved clarity and longevity of the regulation. Lastly, some definitions for computers currently under the scope of the regulation 617/2013 have been amended to better reflect products on the market.

1.1.4.1 Ecodesign definitions

The product categorisation of computers in scope of this review study is shown below, including some high level definitions, which are applicable to all or some of the product categories. More details on categorisation and definitions are shown in Table 4, and the definitions of computers components are shown in
Table *5*.

A '**computer**' is a device, which performs logical operations and processes data, is capable of using input devices and outputting information to other devices. Computers include a central processing unit (CPU) to perform their operations.

A '**personal computer**' is a computer designed to be used by a single user at a time with input devices such as, but not limited to, a keyboard (which can be an on-screen keyboard), a mouse, a trackpad or other pointing device, and with output devices such as, but not limited to, a graphical display or a printer. Other input sources and output destinations are possible either via specific physical ports for specific uses or universal ports like USB 3.1 with type C connector and Thunderbolt 3.0. Personal computers can have internal power supplies or can be designed to use external power supplies for converting AC current into DC current internally used.

Personal computers in scope of this review can be categorised in respect to "mobility":

- A '**non-mobile personal computer**' is designed to be used in a permanent location with constant connection to the electricity mains.
- A '**mobile personal computer**' is a computer designed for portability, which is capable of operating on an integrated source of power, without requiring a permanent connection to an external power source. It generally includes an integrated display, which may be detachable. Mobile computers are typically designed to support home and office computer applications.

Computers with an integrated display with a viewable diagonal screen size below 22.86 cm (9 inches) are outside the scope of this study.

Table 4. Computer products in scope, categorisation and definitions.

Product group	Product category	Definition
Non-mobile personal computers	Desktop computer	A non-mobile personal computer designed to be placed on a desk, on the floor or on a stand. A desktop computer is often shipped with an operating system, which can be replaced or supplemented by the end-user. The category includes integrated desktop computers that have an integrated display as main output media.
	Desktop workstation	a) A 'non-mobile high-performance personal computer for computationally intensive tasks excluding game play. A workstation covered by this regulation: Does not support altering frequency or voltage beyond the CPU and GPU manufacturers' operating specifications, and, b) has system hardware that supports error-correcting code (ECC) that detects and corrects errors with dedicated circuitry on and across the CPU, interconnect, and system memory. In addition, it meets all of the following criteria: I. Provides support for at least 4 processors; II. provides support for one or more graphic or compute accelerators; III. supports connection of at least 4 displays with at least UHD-4k resolution; IV. provides at least 4 slots for fault-tolerant error checking and correcting (ECC) memory and is placed on the market with at least 12 GB ECC memory; V. is wired for > x4 PCI-E on the motherboard in addition to the graphic slot and/or PCIX support; VI. contains five or more logical expansion ports (PCI, PCI-Express, PCI-X, Thunderbolt, > USB3.1, or equivalent); and VII. has received certification for at least three independent software vendor (ISV) products. These certifications can be in process, but shall be completed within 3 months of qualification.
	Desktop thin client	A non-mobile personal computer that relies on a connection to remote computing resources (e.g. computer server, remote workstation, or cloud-based resources) to provide primary functionality and has no rotational storage media integral to the product. The category includes integrated desktop thin clients that have an integrated display as main output media.

Product group	Product category	Definition
Mobile personal computers	Notebook	A mobile personal computer that has an integrated display, and an integrated physical keyboard and a pointing device.
	Tablet /slate	A mobile personal computer that meets the two following criteria: a) Includes an integrated touch-sensitive display as main input and output media and relies on users' activation of the touch-sensitive display for inputs; b) does not have an integrated physical keyboard, although a detached keyboard may be enclosed.
	Portable all in one	A mobile personal computer designed for limited portability that meets all of the following criteria: a) Includes an integrated touch-sensitive display as main input and output media and relies on users' activation of the touch-sensitive display for inputs; b) does not have an integrated physical keyboard, although a detachable keyboard may be enclosed. c) includes an internal battery that allows for limited operation, but is primarily powered by connection to the ac, making it suitable for mobility within the same venue or dwelling.
	Mobile thin client	A mobile personal computer that relies on a connection to remote computing resources (e.g. computer server, remote workstation, or cloud-based resources) to obtain primary functionality and that has no rotational storage media integral to the product.
	Mobile workstation	A 'mobile high-performance personal computer for computationally intensive tasks excluding game play. In addition, it meets all of the following criteria: a) Has a mean time between failures (MTBF) of at least 13,000 hours; b) has at least one discrete graphics card (dGfx) meeting the G3 (with FB Data Width > 128-bit), G4, G5, G6 or G7 classification; c) supports the inclusion of three or more internal storage devices; and d) supports at least 32 GB of system memory.
Computer servers	Small-scale server	Also called small-office/home-office (SOHO) server, is a desktop computer with part of the components adapted or specifically designed to provide network services in a small office environment. A small-scale server has the following characteristics:

Product group	Product category	Definition
		a) It is designed in a desktop form so that all data processing, storage, and network interfacing is contained within one cabinet; b) it is primarily designed to operate in a simultaneous multi-user environment serving several users through networked client units; c) when placed on the market with an operating system, the operating system is designed for home server or low-end server applications; and d) it is not placed on the market with graphics card(s) (dGfx).
Peripheral Products	External graphics adapter	A discrete product designed to be connected to a computer in order to provide additional graphics functionality through the inclusion of one or more dGFxs.
	Computer input device	Any discrete product that provides a means of inputting commands or data, including speech, text or other digital inputs, into a computer. Examples include, but are not limited to, computer keyboards, computer mice, hand-held gaming controllers, cameras, microphones, motion sensors, temperature sensors and orientation sensors.
	Docking station	A discrete product designed to be connected to a computer in order to perform functions such as expanding connectivity or consolidating connections to peripheral devices. A docking station may also facilitate charging of internal batteries in the connected computer. A docking station may contain common or bespoke connection types.

Table 5. Computer components' definitions.

Component	Definition
Internal power supply	A component designed to convert AC voltage from the mains to DC voltage(s) for the purpose of powering a product. An internal power supply unit for computer has the following characteristics: a) It is designed to be contained within a computer casing and is not integrated in the main computer board; b) the power supply connects to the mains through a single cable with no intermediate circuitry between the power supply and the mains power; c) all power connections from the power supply to a computer's or to a computer server's components, with the exception of a DC

Component	Definition
	connection to a display in an integrated desktop computer, are designed to be internal to the computer casing. Internal voltage converters used to convert a single DC voltage from an external power supply into multiple voltages for use by a computer or a computer server are not considered internal power supplies.
External power supply	A device, which has the following characteristics: a) It is designed to convert alternating current (AC) power input from the mains power source input into direct current (DC) or AC output; b) it is able to convert to either one or multiple DC or AC output voltages; c) it is intended to provide power to a separate device that constitutes the primary load; and d) it is contained in a physical enclosure separate from the device that constitutes the primary load.
Central Processing Unit (CPU)	A component in a computer that controls the interpretation and execution of instructions. CPUs may contain one or more physical processors known as 'execution cores'. An execution core means a processor that is physically present. Additional 'virtual' or 'logical' processors derived from one or more than one execution core are not physical cores. More than one execution core may be contained in a processor package occupying a single CPU physical socket. The total number of execution cores in the CPU is the sum of the execution cores provided by the devices connected to all the CPU physical sockets.
Discrete Graphics Card	A discrete internal component containing one or more graphics processing units (GPUs) with a local memory controller interface and local graphics-specific memory. dGfx are not found on the same die as a CPU.
Internal Storage	An internal component of the computer, which provides non-volatile storage of data. Access time is measured in milliseconds.
Main memory	A semiconductor, direct access memory, with very low latency and transfer time (access time), measured in nanoseconds. Connected directly to a computer's motherboard, is used for temporary storage of information.
Cache memory	A semiconductor direct access memory, with extremely low access time that is integrated directly with CPU chip or included on a separate component that has a separate bus interconnect with the CPU. CPUs usually have different independent cache memories, such as instruction and data caches, organized as a hierarchy of cache levels.

1.2 Test standards (EU, Member State and third country level)

There are a number of test standards that have been explicitly developed to measure at least one environmental impact associated with computers or their associated products. In addition, there are a number of other test standards that have not been explicitly developed to measure environmental impacts in computers but can be applied to this product group.

1.2.1 EN or ISO/IEC test standards

There have been a significant number of EN standards either published, or are in the process of being developed, to support European Union environmental legislation, which, to a certain extent, cover computers and associated products. This relevant EU environmental legislation includes:

- Ecodesign Directive [5]
- Waste Electrical and Electronic Equipment Directive (WEEE) [6]
- Restriction of Hazardous Substances Directive (RoHS) [7]
- Electromagnetic Compatibility Directive (EMC) [8]
- Low Voltage Directive (LVD) [9]
- Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation [10]

Whilst EU environmental legislation is a major driver for the development of environmental de jure standards in the EU, environmental de jure standards are developed for a variety of reasons. As a result of all drivers, there are a large number of EN and ISO test standards that have been developed that support the measurement of environmental impacts associated with computers and associated products, including:

EN 62623:2013 Desktop and notebook computers - Measurement of energy consumption
The main international standard addressing the energy efficiency of computers is IEC 62623:2012 from which EN 62623:2013 was derived. The standard was developed using the earlier ECMA 383 standard as a basis. The EN standard applies to desktop and notebook computers. The standard includes a test procedure to enable the measurement of the power and/or energy consumption in different power modes, formulas for calculating typical energy consumptions (TEC) and a categorisation system for computers and selected components. The IEC version of the standard was largely adopted in the latest ENERGY STAR v6.1 specification for computers. As such the standard will be widely used throughout the world.

EN 50564:2011 - Electrical and electronic household and office equipment. Measurement of low power consumption
EN 50564 supports the measurement of low power modes in a wide variety of electrical and electronic equipment, including computers and associated products. EN 50564 is a harmonized test procedure supporting measurement of power demand against the requirements in the Commission Regulation (EU) No 801/2013 (colloquially known as "the Networked Standby Directive").

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[5] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0125
[6] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0019
[7] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0065
[8] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004L0108
[9] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0035
[10] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1907

EN 50563:2011 - External a.c. - d.c. and a.c. - a.c. power supplies. Determination of no-load power and average efficiency of active modes

EN 50563 supports the measurement of energy efficiency in external power supplies. EN 50563 is based on the EPRI test procedure (EPRI Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.4.2) that is used within the ENERGY STAR v6.1 specification for computers. EN 50563:2011 is more detailed than the EPRI protocol and references the more up-to-date EN 50564:2011 for low power measurements.

IEC 62301:2011 - Household electrical appliances - Measurement of standby power
The IEC 62301 standard specifies methods of measuring power demand in standby mode(s) and other low power modes (off mode and network mode). The standard also includes definitions for low power modes. Section 4 of IEC 62301:2011, "General Conditions for Measurements", is referenced in the ENERGY STAR v5.2 and v6.1 specification for computers however the actual measurement of off and sleep modes in ENERGY STAR v6.1 is conducted in line with the test methodology in IEC 62623.

EN ISO 7779:2010 - Acoustics -- Measurement of airborne noise emitted by information technology and telecommunications equipment
EN ISO 7779 provides a methodology for measuring noise from information technology (IT) and telecommunications equipment. The results of measurements made using EN ISO 7779 should be declared using the method laid out in the ISO/DIS 9296.2 standard.

EN 62075:2012 - Audio/video, information and communication technology equipment — Environmentally conscious design
EN 62075 provides design guidance for audio/video, information technology and communication technology to facilitate enhanced management of environmental issues through the design process.

EN 61960:2011 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications - and any other relevant standard
The EN 6190 standard provides a set of criteria to identify the performance of secondary lithium cells and batteries. The standard defines a minimum level of performance, a standardized test methodology and standardised method for reporting results.

EN ISO 11469:2000 - Plastics - Generic identification and marking of plastics products
The EN ISO 11469 standard identifies specifies a system of uniform plastic material marking system. The standard does not cover every aspect of marking (e.g. the marking process, the minimum size of the item to be marked, the size of the lettering or the appropriate location of the marking) but the marking system described is intended to help identify plastics products for subsequent decisions concerning handling, waste recovery or disposal. The standard refers to ISO 1043-1 for generic identification of the plastics.

EN ISO 1043-2:2011 - Plastics - Plastics. Symbols and abbreviated terms. Fillers and reinforcing materials
The EN ISO 1043 standard defines abbreviated terms for the basic polymers used in plastics, symbols for components of these terms, and symbols for special characteristics of plastics.

IEC TR 62635:2012 - Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment
IEC/TR 62635:2012(E) provides a methodology for information exchange involving electronic and electrical equipment manufacturers and recyclers. The standard also provides a methodology enabling calculation of the recyclability and recoverability rates of to facilitate optimized end of life treatment operations.

IEC TR 62921:2015 - Quantification methodology for greenhouse gas emissions for computers and monitors
IEC TR 62921 provides detailed guidance to streamline the quantification of greenhouse gas emissions for computers and monitors thereby reducing costs and resources needed. In addition, the standard includes product category rules (PCR) which highlight a specific process and data assumptions in order to reduce uncertainty when assessing computers and monitors. The technical Report also provides an example of how a greenhouse gas emission calculation could be performed.

ISO 14040:2006 - Environmental management – Life cycle assessment – Principles and framework
The ISO 14040 standard describes the principles and framework for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements. ISO 14040 covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies but does not describe the LCA technique in detail, nor does it specify methodologies for the individual phases of the LCA. The standard is not developed explicitly to support LCA's on computers but can be applied to this product group.

ISO 14044:2006 - Environmental management -- Life cycle assessment -- Requirements and guidelines
The ISO 14044 standard specifies requirements and provides guidelines for life cycle assessment (LCA) including definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements. The standard is not developed explicitly to support LCA's on computers but can be applied to this product group.

ISO/TS 14067:2013 - Greenhouse gases -- Carbon footprint of products -- Requirements and guidelines for quantification and communication
ISO/TS 14067 specifies principles, requirements and guidelines for the quantification and communication of the carbon footprint of a product (CFP). It is based on International Standards on life cycle assessment (ISO 14040 and ISO 14044) for quantification and on environmental labels and declarations (ISO 14020, ISO 14024 and ISO 14025) for communication. Requirements and guidelines for the quantification and communication of a partial carbon footprint of a product (partial CFP) are also provided. The standard is not developed explicitly to support LCA's on computers but can be applied to this product group.

EN 50419:2006 - Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE)

EN 50419 contains the product marking requirements needed to ensure compliance with the WEEE Directive. EN 50419 also contains additional information relating to the marking requirements, including positioning, visibility, dimensions, location and referenced documents. The marking requirements are applicable to all manufacturers and producers of electrical and electronic equipment placing products on the EU market after the 13th August 2005.

EN 50625-1:2014 Collection, logistics & treatment requirements for WEEE - Part 1: General treatment requirements

EN 50625 was prepared as part of a series of standards requested in Commission mandate 518 (detailed in section 3.2) which aim to support implementation and effectiveness of Directive 2012/19/EU (WEEE). The standard contains requirements applicable to the treatment of all types of WEEE and addresses all operators involved in the treatment (including related handling, sorting, and storage) of WEEE. In particular, the standard addresses the following issue areas:

- Management principles
  - o Technical and infrastructural pre-conditions
  - o Training
  - o Monitoring
  - o Shipments
- Technical requirements
  - o General
  - o Receiving of WEEE at treatment facility
  - o Handling of WEEE
  - o Storage of WEEE prior to treatment
  - o De-pollution (including Annex A normative requirements)
  - o De-pollution monitoring (including Annex B normative requirements)
  - o Treatment of non de-polluted WEEE and fractions
  - o Storage of fractions
  - o Recycling and recovery targets (including Annex C & D normative requirements)
  - o Recovery and disposal of fractions
- Documentation

The standard applies to the treatment of WEEE until end-of-waste status is fulfilled, or until the WEEE is prepared for re-use, recycled, recovered, or final disposal. Additional standards in the EN50625 series are designed to cover detailed treatment requirements for specific types of products covered under the WEEE Directive. EN50625 will also be supported by technical reports which will provide more detailed comparison between normative treatment requirements derived directly from the legal text of Directive 2012/19/EC, especially Annex VII, and between informative treatment requirements going beyond the strict requirements of Directive 2012/19/EC.

EN 50625-2-2:2015 - Collection, logistics & Treatment requirements for WEEE - Part 2-2: Treatment requirements for WEEE containing CRTs and flat panel displays

As a part of the EN 50625 series, the EN50625-2-2 standard addresses specific requirements relating to the treatment of WEEE containing CRTs and flat panel displays. The standard applies to the treatment of WEEE containing CRTs and flat panel displays

until end-of-waste status is fulfilled, or fractions are recycled, recovered, or final disposal. This European standard addresses all operators involved in the treatment including related handling, sorting, and storage.

CLC/prTS 50625-3-3 - Collection, logistics & Treatment requirements for WEEE - Part 3-3: Specification for de-pollution - WEEE containing CRTs and flat panel displays
This Technical Specification is intended to be used in conjunction with the WEEE Treatment Standard EN 50625-1 for specific WEEE (i.e. CRTs and flat panel displays) requiring more specialised treatment.

EN 50614 - Requirements for the preparation for re-use of waste electrical and electronic equipment
The ESO, CENELEC, through their technical body CLC/TC 111x 'Environment', is developing the EN 50614 standard which will address some of the aspects detailed in Commission Mandate 518 (detailed in section 3.2). A draft prEN 50614 'Requirements for the preparation for re-use of waste electrical and electronic equipment' standard was circulated to National Standardisation Bodies for a first round of commenting on the 8th February 2016. The CENELEC technical body is currently still working on the standard with an estimated completion date of the 21st September 2016.

EN 62321 series - Determination of certain substances in electrotechnical products
The purpose of the harmonized EN 62321/IEC 62321 series of standards is to provide test methods that will allow determination of the levels of certain substances of concern in electrotechnical products on a consistent global basis.

EN 50581:2012 - Technical documentation for the evaluation of electrical and electronic products with respect to restriction of hazardous substances
The EN 50581 standard specifies the technical documentation a producer of EEE has to collect for applicable substance restrictions in order to demonstrate compliance with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS). The technical documentation required to meet the standard includes:

- A general product description
- Documentation of materials, parts and/or sub-assemblies
- Information showing the relationship between the technical documents and respective materials, parts and/or sub-assemblies
- A list of harmonized standards and/or technical specifications used to prepare the technical documents.

1.2.2 Mandates issued by the EC to the European Standardization Organizations (ESOs)

Three major mandates have been issued by the EC to the European Standardization Organizations (ESOs) which will facilitate improved standardisation of measuring environmental impacts of computers and associated products.

Mandate 545 – Computers and Computer Servers
Mandate 545 to CEN, CENELEC and ETSI for standardisation as regards computers and computer servers, in support of the implementation of Commission Regulation (EU) No 617/2013 of 26 June 2013.

The requested harmonised standards should provide methods for the following parameters and aspects for which requirements are laid down in the Regulation:

All computers:
  i. Power demand for Idle state (W)
  ii. Power demand for Sleep mode (with and without Wake-On-Lan (WOL) enabled (W))
  iii. Power demand for Off mode (with and without Wake-On-Lan (WOL) enabled (W))
  iv. Power demand for Lowest Power State (W)
  v. "Frame buffer bandwidth" (FB _BW) calculation for discrete graphics card (dGfx) categories G1 to G7
  vi. Method to determine whether a reduction in the speed of any active Ethernet network links when transitioning to sleep or off-with-WOL mode occurs.
  vii. Method to determine whether power management capability to enter sleep mode after period of inactivity occurs
  viii. Method to determine time taken for a computer to power down to sleep mode
  ix. Method to determine the time taken for a computer to wake from sleep mode
  x. Method to determine whether the computer can trigger a powerdown timing of the display to sleep mode
  xi. Method to determine whether WOL functionality can be enabled and disabled in sleep mode
  xii. Method to determine whether wireless network connection(s) can be easily activated and deactivated
  xiii. Method to determine whether users are given a clear indication with a symbol, light or equivalent, when wireless network connection(s) have been activated or deactivated.
  xiv. Method to determine noise levels (A-weighted sound power level) of the computer in suitable power modes (e.g. operation/active, idle etc)
  xv. Total content of mercury (as X,X mg) for products with an integrated display containing mercury (in compliance with the RoHs Directive)

Notebook computers only:
  • Minimum number of complete charge/discharge cycles that any main internal batteries must withstand before their capacity falls under a specific ratio, to be set, of their original capacity
  • Method to assess if internal batteries can be "accessed and replaced by a non-professional user"
  • Method to assess if the text on the external packaging of the notebook computer, about replacement of batteries, is clearly visible and legible.

Internal power supply units:
Efficiency measurements at:

  • 100% of rated output power
  • 50% of rated output power
  • 20% of rated output power
  • 10% of rated output power

Power factor measurements at:

  • 100% of rated output power
  • 50% of rated output power
  • 20% of rated output power
  • 10% of rated output power

Requested harmonised standards for computers and computer servers:

1. Measurement of idle state (desktop computers, integrated desktop computers and notebook computers)
   Adaptation of standard EN 62623:2013 - Desktop and notebook computers – Measurement of energy consumption - and any other relevant standard

2. Measurement of sleep mode (desktop computers, integrated desktop computers and notebook computers)
   Adaptation of standard EN 62623:2013 - Desktop and notebook computers – Measurement of energy consumption - and any other relevant standard

3. Measurement of lowest power state (desktop computers, integrated desktop computers and notebook computers)
   Adaptation of standard EN 62623:2013 - Desktop and notebook computers – Measurement of energy consumption - and any other relevant standard

4. Measurement of lowest power state (desktop computers, integrated desktop computers and notebook computers)
   Adaptation of standard EN 50564:2011 - Electrical and electronic household and office equipment - and any other relevant standard

5. Measurement of off mode (desktop computers, integrated desktop computers and notebook computers)
   Adaptation of standard EN 62623:2013 - Desktop and notebook computers – Measurement of energy consumption - and any other relevant standard

6. Method to identify compliance with the requirement to include information, in a "clearly visible and legible" manner, on the external packaging where internal batteries cannot be easily replaced by non-professional users (notebook computers)

7. dGfx category calculation (desktop computers, integrated desktop computers and notebook computers)
   Adaptation of "Categories to be used with ECMA-383 Measuring the Energy Consumption of Personal Computing Products, 3rd edition (December 2010)" and any other relevant standard

8. Measuring internal power supply efficiency (desktop computers, integrated desktop computers, desktop thin clients, workstations, small-scale servers and computer servers)
   Adaptation of "Generalized Test Protocol for Calculating the Energy Efficiency of Internal Ac-Dc and Dc-Dc Power Supplies Revision 6.6 (April, 2012)" and any other relevant standard

9. Measuring internal power supply efficiency (desktop computers, integrated desktop computers, desktop thin clients, workstations, small-scale servers and computer servers)
   Adaptation of EN 50564:2011 Electrical and electronic household and office equipment - Measurement of low power consumption - and any other relevant standard

10. Identifying power management function (desktop computers, integrated desktop computers and notebook computers)
    Adaptation of EN 62623:2013 - Desktop and notebook computers – Measurement of energy consumption - standard and any other relevant standard

11. Measuring minimum number of loading cycles that batteries can withstand (notebook computers)

Adaptation of standard EN 61960:2011 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications - and any other relevant standard

12. Measuring total content of mercury (computers with an integrated display)
Adaptation of one or more of the below standards and any other relevant standard:
IEC 62321-1 ed1.0 - Determination of certain substances in electrotechnical products - Part 1: Introduction and overview
IEC 62321-2 ed1.0 - Determination of certain substances in electrotechnical products - Part 2: Disassembly, disjunction and mechanical sample preparation and any other relevant standard
IEC 62321-3-1 ed1.0 - Determination of certain substances in electrotechnical products - Part 3-1: Screening - Lead, mercury, cadmium, total chromium and total bromine using X-ray fluorescence spectrometry - and any other relevant standard
IEC 62321-4 ed1.0 - Determination of certain substances in electrotechnical products - Part 4: Mercury in polymers, metals and electronics by CV-AAS, CV-AFS, ICP-OES and ICP-MS - and any other relevant standard

13. Measuring noise levels (the declared A-weighted sound power level)
(desktop computer, integrated desktop computer, notebook computer, workstation, mobile workstation, desktop thin client, small-scale server, computer server)
Adaptation of one or more of the below standards and any other relevant standard:
ECMA-109 2nd edition (December 1987) Declared Noise Emission Values of Computer and Business Equipment
ECMA-74 11th edition (December 2010) Measurement of Airborne Noise emitted by Information Technology and Telecommunications Equipment

M544 - Ecodesign requirements for networked standby in support of Regulation (EC) No 1275/2008 and Regulation (EC) No 642/2009
M/ 544 Commission Implementing Decision C(2015) 9468 of 5.1.2016 on a standardisation request to the European standardisation organisations as regards ecodesign requirements for networked standby in support of Regulation (EC) No 1275/2008 and Regulation (EC) No 642/2009.

The objective is to develop harmonised standards on ecodesign for standby, off mode electric power consumption of electrical and electronic household and office equipment. Within the scope of the regulations covered by the mandate are all computers apart from desktop computers, integrated desktop computers and notebook computers. Requested harmonised standards:

The standards shall include:

(a) definitions, where appropriate, of product types, their main characteristics and the parameters to be measured and/or calculated;

(b) the general conditions under which measurements are to be taken and the way the product should be set up, including, where appropriate, the length of wired connections, taking into account the standards referred to in Annex II;

(c) the information the manufacturer is required to provide for the purposes of conformity assessment, pursuant to point 9(b) of Annex II to Regulation (EC) No 1275/2008;

(d) the information the manufacturer is required to provide for the purposes of conformity assessment, pursuant to point 6.1(e) and (f) of Annex I to Regulation (EC) No 642/2009;

(e) the product information the manufacturer is required to provide pursuant to point 7 of Annex II to Regulation (EC) No 1275/2008;

(f) the product information the manufacturer is required to provide pursuant to the second indent of point 6.2 of Annex I to Regulation (EC) No 642/2009;

(g) a method for determining that the product is operating in networked standby, as defined in Regulations (EC) No 1275/2008 and (EC) No 642/2009, and a method for verifying this for network types not defined in the harmonised standards;

(h) a method for determining that the product is capable of being activated by a remotely initiated trigger and a method for verifying this for trigger types not defined in the harmonised standards;

(i) a method for determining that the product falls within the scope of point 3(a) of Annex II to Regulation (EC) No 1275/2008 and, where applicable, allows the user to deactivate the wireless network connection(s); and

(j) the procedure for measuring the power consumption of a product in networked standby mode.

M543 – Material Efficiency
In December 2015, the EC published a standardisation request to the European standardisation organisations (ESO's) covering ecodesign requirements on material efficiency aspects for energy-related products in support of the implementation of Directive 2009/125/EC.[11] It was noted in the mandate, that the absence of adequate metrics is one of the reasons for the relative lack of ecodesign requirements related to material efficiency in previous ecodesign implementing measures. The mandate therefore requests that the ESOs draft new European standards and European standardisation deliverables on material efficiency aspects for energy-related products in support of the ecodesign Directive 2009/125/EC. This standardisation request clarifies that the following material efficiency aspects should be covered:

- Extending product lifetime.
- Ability to re-use components or recycle materials from products at end-of-life.
- Use of re-used components and/or recycled materials in products

M518 - STANDARDISATION IN THE FIELD OF WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT
In January 2013, the EC published a standardisation request for the ESO's to develop

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[11] European Commission Mandate 543 on Material Efficiency, available from http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=564#

European standards for the treatment, including recovery, recycling and preparing for reuse, of WEEE.[12] The product scope within the standards includes all products within the extended scope of the new WEEE Directive as well as any batteries that are frequently disposed of with WEEE.

This standardisation request clarifies that the following WEEE aspects should be covered:
- Data protection
- Collection of WEEE to ensure that collection activities do not inhibit proper treatment or reuse
- Distinguish between normative treatment requirements (listed in Directive 2012/19/EC) and informative treatment requirements that go beyond those in Directive 2012/19/EC

The standardisation request also includes options WEEE aspects that could be included in the standards:
- Detailed process management requirements for the treatment of WEEE (including preparation for reuse as defined in Article 3 of Directive 2008/98/EC).

There is also a clear remit within the standardisation request that unnecessary administrative burdens are not placed on any organisations, irrespective of size, as a result of any requirements listed in the standards.

A number of EN standards have been developed, with more currently under development, in line with the requirements listed in Commission Mandate 518. These standards were described in section 3.1 of this report.

1.2.3 Test standards in individual Member States

Given the international nature of the computer hardware business most test standards are either developed in major markets (e.g. the USA or EU) or are developed at the international level. There are some examples of test standards being developed at the individual member state level however.

British Standards Institute ZZ/1 Publicly Available Specification (PAS) 141:2011 [13]

PAS 141 is a process management specification dealing with the re-use of used and waste electrical and electronic equipment (UEEE and WEEE). The main aims of PAS 141 are to improve the standards for the re-use and refurbishment of electrical and electronic equipment that has reached the end of its first useful life. In addition, the standard aims to ensure that used electrical products are electrically safe and functionally fit for purpose. PAS 2011 also provides a method of differentiating legitimate exports from illegal exports of WEEE under the guise of being sent abroad for re-use.

There are other initiatives at the EU member state level which aim to reduce the environmental impacts of computers and associated products. Whilst these initiatives cannot be classified as a formal test standard they do contain formalised methods for meeting a wide range of environmental criteria. These initiatives include:

Blue Angel [14]

Blauer Engel, or The Blue Angel in English, is a German ecolabel (but used in other EU countries) that includes environmental criteria to address multiple environmental impacts

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[12] European Commission Mandate 518 on Standardisation in the field of Waste Electrical and Electronic Equipment, available at http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=526

[13] http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030245346

[14] https://www.blauer-engel.de/en/products/office/computers

associated with computers and associated products. The Blue Angel uses references to established EN standards to support measurement of many criteria and the ENERGY STAR test procedures for some types of computers. However, it also includes bespoke methods for verifying compliance to other criteria where no suitable EN standard is available for support.

The Nordic Swan [15]
The Nordic Swan is an EU based ecolabel, which originates from the Nordic countries but is also used in other EU member states. The Nordic Swan also includes multiple environmental criteria which address some of the major environmental impacts categories found in computers and associated products. Like the Blue Angel ecolabel, the Nordic Swan also references established EN standards to support measurement of criteria and also a dynamic link to the latest ENERGY STAR test procedure. It too includes bespoke methods for verifying compliance to other criteria where no suitable EN standard is available for support.

TCO Development [16]
TCO Development is the Sweden based organization behind the multi-environmental attribute TCO Certified eco-label. The TCO Certified eco-label covers a number of different product types that are likely to be within scope of this review project including; notebooks, tablets, smartphones, desktops, all-in-one PCs and headsets. Various external sources for measurement of criteria are included within the TCO certified eco-label including reference to ENERGY STAR and established standards but the eco-label also includes initiative specific procedures for verifying compliance to criteria where no established standard is available.

1.2.4 Third country test standards
There are a number of initiatives in countries outside of the EU that include bespoke test standards for measuring environmental impacts related to computers and associated products. The most widely known of these initiatives are discussed below.

Australia - AS/NZS 5813.1 - Information technology equipment –Energy performance of computers Part 1: Methods of measurement of energy performance.
The AS/NZS 5813.1 standard is used to support Australian mandatory energy efficiency requirements. The standard is largely technically equivalent to the ENERGY STAR v5.2 test procedure.

Australia - AS/NZS 5814.1 - Information technology equipment –Energy performance of internal power supplies Part 1: Methods of measurement of energy performance.
The AS/NZS 5814.1 standard is used to support Australian mandatory energy efficiency requirements. The standard is technically equivalent to the Generalised Internal Power Supply Efficiency Test Protocol Version 6.5.

Japan - Top Runner Programme [17]
Japan's Top Runner Programme includes mandatory energy efficiency standards for a range of energy intensive products, including computers. Manufacturers are given a set number of years to achieve the energy efficiency targets, which are based on the most efficient model on the market (i.e. the 'Top Runner') at the time the targets are

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[15] http://www.nordic-ecolabel.org/criteria/product-groups/
[16] http://tcodevelopment.com/
[17] http://www.eccj.or.jp/top_runner/pdf/tr_computers_magneticdiscunits_dec2009.pdf

developed. The Top Runner Programme uses a bespoke test procedure for measuring the energy efficiency of computers.

Korea – e-standby Programme [18]
Korea requires mandatory reporting of standby power demand requirements for a range of electrical products including computers. It was not possible during the course of this research project to identify if the Korean e-standby programme included a bespoke test procedure or references one of the established standardised test procedures.

EPEAT/IEEE 1680.1 [19, 20]
EPEAT is a green procurement scheme aimed at promoting the development and dissemination of multi-criteria specifications for a range of ICT products. The programme is managed by the Green Electronics Council and supported by the US EPA and US DoE. The programme is based in the US but is active internationally with manufacturers able to register products separately in 42 countries around the world. The IEEE series of standards (apart from IEEE 1680.4) are used to inform the development of EPEAT specifications. The IEEE 1680 series are a USA based series of standards which focus on IT products and which include environmental performance criteria across multiple environmental impact categories. The IEEE 1680.1 standard defines environmental performance criteria for computers relating to reduction or elimination of environmentally sensitive materials, materials selection, design for end of life, lifecycle extension, energy conservation, end of life management, corporate performance, and packaging. Many of the IEEE criteria reference established ISO standards to support measurement of criteria and also the ENERGY STAR test procedure. Alternative verification methods are included for criteria verification that cannot be supported by a formal test procedure.

80 PLUS certification [21]
The 80 Plus initiative is a voluntary certification program, launched and operated by Ecova US-based company, which includes energy efficiency criteria, and an associated test procedure, for computer internal power supply units (PSUs). The energy efficiency criteria are separated into six increasing stringent specifications ranging from the basic 80 Plus to 80 Plus Bronze, Silver, Gold, Platinum and Titanium. The 80Plus specifications and test procedure are further subdivided to account for different voltages and frequencies in the end user markets. The associated test procedure is used in other major environmental initiatives including ENERGY STAR and within the transitional methods for EC Regulation 617/2013.

The Greenhouse Gas (GHG) Protocol: Product Life Cycle Accounting and Reporting Standard [22]
The Greenhouse Gas (GHG) Protocol, developed by World Resources Institute (WRI) and World Business Council on Sustainable Development (WBCSD) via through a multi-stakeholder process over a three-year period, includes a methodology that can be used to understand the full life cycle emissions of a product and focus efforts on the greatest GHG reduction opportunities. The Greenhouse Gas (GHG) Protocol Product Life Cycle Accounting and Reporting Standard is referenced in other major environmental initiatives such as the IEEE 1680 standards.

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[18] http://www.kemco.or.kr/new_eng/pg02/pg02100300.asp
[19] http://www.epeat.net/
[20] http://grouper.ieee.org/groups/1680/
[21] http://www.plugloadsolutions.com/80PlusPowerSupplies.aspx
[22] http://www.ghgprotocol.org/standards/product-standard

GreenScreen for Safer Chemicals [23]

GreenScreen, developed by Clean Production Action in the USA, is a method of comparative Chemical Hazard Assessment (CHA) that can be used for identifying chemicals of high concern and safer alternatives. The advantage of the methods is that it allows for the selection of chemical alternatives that are less likely to be restricted in future regulations. The method is widely used by at least one major manufacturer of computer products.

1.2.5 Industry-based specifications and test standards

There is a wide range of industry based specifications that cover the environmental impacts of computers. The main initiatives that are used by more than one organisation are discussed below.

ECMA 383 - Measuring the Energy Consumption of Personal Computing Products [24]

The Ecma 383 standard, developed in December 2010, provides a methodology for measuring the in use energy of desktop, integrated desktop and notebook computers. The standard was the forerunner to the ISO 62623:2012 standard (which in turn was later developed into EN 62623:2013). Given the development of the standards through official standards bodies the current version of Ecma 383 is of less importance now.

ECMA-328 - Determination of Chemical Emission Rates from Electronic Equipment [25]

ECMA-328 includes a methodology to allow the determination of chemical emission rates from a range of technology products including computers and associated products. The methods comprise preparation, sampling (or monitoring) in a controlled ETC, storage and analysis, calculation and reporting of emission rates.

ECMA-370 - TED – The Eco Declaration [26]

The 5th addition of the Ecma 370, specifies environmental attributes and measurement methods for ICT and CE products according to regulations, standards, guidelines and currently accepted practices. The standard, which merged with the Nordic Eco declaration, was one of the first initiatives designed to communicate environmental information about IT products and had a strong influence on the original IEEE 1680.1 standard that was later adopted by EPEAT. The Ecma 370 standard is still used in the IT industry, primarily in Europe but also more widely, to communicate multi-attribute environmental information about IT products.

ECMA-341 - Environmental Design Considerations for ICT & CE Products [27]

The Ecma 341 standard, which aims to align with the IEC 62075 standard, specifies requirements and recommendations for the design of environmentally sound products. The standard addresses life cycle thinking aspects, material efficiency, energy efficiency, consumables and batteries, chemical and noise emissions, extension of product lifetime, end of life, hazardous substances/preparations, and product packaging.

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[23] http://www.greenscreenchemicals.org/
[24] http://www.ecma-international.org/publications/standards/Ecma-383.htm
[25] http://www.ecma-international.org/publications/standards/Ecma-328.htm
[26] http://www.ecma-international.org/publications/standards/Ecma-370.htm
[27] http://www.ecma-international.org/publications/standards/Ecma-341.htm

Benchmark test standards

There are also a wide range on industry-based test standards that aim to quantify the overall computing performance of computers. These are known as "benchmarks" and could be investigated for use in supporting ecodesign and in particular Energy Labelling measures that consider the performance of a computer in respect to the energy used. The ENERGY STAR programme already makes use of benchmarks for a number of product types including workstation computers and servers. An intent of using a benchmark programme for ENERGY STAR computer specification was quite advanced during development of ENERGY STAR computer specification v.5.0. An overview of some of the more popular benchmarks is shown in Table 6.

Table 6. Computer Benchmark Software Overview.

Benchmark	Common Operating Systems Supported	Overall System Score	Performance of Components Tested/Reported			
			CPU	GPU	Memory	Storage
Linpack	OS X, Windows and Linux	No	Yes	No	No	No
SPECviewperf	Windows	No	No	Yes	No	No
PCMark8	Windows and Android	Yes	Yes	Yes	Yes	Yes
Novabench	Windows and OS X	Yes	Yes	Yes	Yes	Yes
PassMark PerformanceTest	Windows	Yes	Yes	Yes	Yes	Yes
SiSoftware Sandra 2016	Windows	Yes	Yes	Yes	Yes	Yes
Cinebench R15	Windows and OS X	No	Yes	Yes	No	No
Geekbench 3	OS X, Windows, Linux, Android, BlackBerry, and iOS	No	Yes	No	No	No

These benchmarks, and any other suitable benchmarks, will be investigated in more detail during the project to identify if they could be used within a potential ecodesign or, more likely, Energy Labelling Regulation on computers.

An ideal test procedure does not require the test of specific components, part of the computer, but just the overall "system" performance/energy-use ratio in a number of typical usage scenarios, such as word processing (all except thin clients), Internet browsing including standard format video playing (e.g. HTML5, all computer classes). For workstations a number-crunching calculation, such as transposition of a complex matrix and a graphic operation (rendering of a vector complex image or graphical filtering of a picture) would be a more adequate test. Conversely a SOHO server should be tested with a simultaneous access by 3 clients for a read/write operation and print service.

1.2.6 Comparative analysis of test standards

There is a considerable amount of harmonization amongst the existing standards that support measurement of environmental impacts associated with computers.

The ENERGY STAR test procedures are widely used throughout most major markets either directly through the ENERGY STAR programme or via adoption into other environmental initiatives. This includes adoption into most of the mandatory measures placed on computers in different areas of the world. As such there is little overlap between the ENERGY STAR test procedures and any other (i.e. most initiatives have harmonized with the ENERGY STAR test procedures). There is some overlap on low

power mode measurement between ENERGY STAR, which currently references IEC 62301, and approaches within the EU which tend to use the EN 50564 standard. However, these two standards are largely harmonized.

There is less formal harmonization of other non-energy in use test standards as the tests for many of these impacts have not yet been formalised within national or international standards. Criteria, and associated verification methods, are often shared across initiatives in an informal manner often in an iterative fashion as initiatives update their specifications.

There is unlikely to be any issues with accuracy (tolerances) or reproducibility of power demand test procedures given that they are well established and formalised in international or national standards. There is some concern that established energy use test procedures do not accurately reflect the actual usage of computers.

There are more likely to be issues with the accuracy (tolerances) or reproducibility of measuring non-energy in use impacts given the relatively new focus on these impact areas and the fact that many of the background test approaches have not been formalised in international or national standards.

1.2.7 New test standards

New test standards are being developed to help accurately measure the environmental impacts of computers on a regular basis. There are currently new test procedures being developed for the following impact areas:

- Energy "in use" mode (the current regulation 617/2013 only estimates energy "in idle" mode and in standby mode.
- Measurable battery life (supported full cycles before efficiency degradation below a specific level)
- Recyclability, reusability and recoverability

Further insights into these new test standards will be reported during the course of the preparatory study.

1.3 Legislation

Computers and their associated products are currently covered by a number of pieces of legislation, both in the EU and wider afield, which attempt to address the environmental impacts of these products through mandatory measures.

1.3.1 EU legislation

There are several pieces of environmental legislation which either directly or indirectly address products within the scope of this review project.

EU Directive 2009/125/EC - Ecodesign for Energy-Related Products [28]
The Ecodesign Directive provides consistent EU-wide rules for improving the environmental performance of products placed on the EU market. This EU wide approach ensures that Member States' national regulations are aligned so that potential barriers to intra-EU trade are removed.

The Directive's main aim is to provide a framework for reducing the environmental impacts of products throughout their entire life cycle. As many of the environmental

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[28] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0125&from=EN

impacts associated with products are determined during the design phase, the ecodesign Directive aims to bring about improvements in environmental performance through mandating changes at the product design stage.

The Ecodesign Directive is a framework directive, meaning that it does not directly set minimum requirements rather the aims of the Directive are implemented through product-specific Regulations, which are directly applicable in all EU member states. For a product to be covered by under the Ecodesign Directive it needs to meet the following criteria:

- have a volume of sales that exceeds 200,000 units per year throughout the internal European market
- have a significant environmental impact within the internal market
- present significant potential for improvement in environmental impact without incurring excessive costs

EU Regulation 617/2013/EU - Ecodesign Requirements for Computers and Computer Servers[29]

The European Commission published Commission Regulation (EU) No 617/2013 implementing ecodesign requirement measures for computers and computer servers on the 27th June 2013. The Regulation includes requirements on annual typical energy consumption (TEC), operational modes and power management enabling as well as energy efficiency requirements on internal power supply units. The Regulation applies to a range of computers including:

- desktop computers;
- integrated desktop computers;
- notebook computers (including tablet computers, slate computers and mobile thin clients);
- desktop thin clients;
- workstations;
- mobile workstations;
- small-scale servers;
- computer servers.

The ecodesign Regulation on computers entered into force on 17th July 2013 with some requirements applying from that date whilst other requirements were phased in over the following 18-months.

The ecodesign requirements for desktop, integrated desktop and notebook computers are largely based on the ENERGY STAR v5.2 specifications. The requirements allow for higher specification computers that were not expected to be covered under the voluntary ENERGY STAR v5.2 specification. That is, ENERGY STAR as a voluntary initiative can presume that some higher specification products will not be able to meet the energy efficiency requirements (e.g. high specification gaming desktops) and so are not considered in detail when the requirements are developed. Given the voluntary nature of ENERGY STAR manufacturers can therefore choose whether or not to register their products under the programme. Mandatory measures such as the EU ecodesign regulations need to consider all products on the market as all computers in scope must

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[29] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:175:0013:0033:EN:PDF

comply with the requirements. Furthermore, the classification of discrete graphic cards was changed in order to follow the most recent industry classification of these cards.

Other requirements were made more stringent than those found in the ENERGY STAR v5.2 specification to account for improvements in energy efficiency since the development of the ENERGY STAR specification. In addition, some types of computers, including workstation computers, very high specification desktop and notebook PCs and thin clients were exempted from most energy efficiency measures (apart from requirements placed on the efficiency of the power supply units). The exemptions were included as very high specification computers would not have been able to meet the prescribed TEC levels. The Regulation also includes requirements on the internal power supply, which are based on the 80 Plus specification and associated test procedure, with most types of computers needing to meet these requirements.

EU Regulation 1275/2008/EC - Ecodesign requirements for Standby and off mode [30]
The Standby and Off Mode Regulation, an implementing Regulation under the Ecodesign Directive (2009/125/EC), sets mandatory power demand limits on low power modes (e.g. networked standby, sleep and off mode) and power management requirements for household and office electrical and electronic equipment. Commission Regulation (EU) No 801/2013 of 22nd August 2013 amended requirements in the Standby Regulation (1275/2008/EC) by introducing requirements for networked standby as well as updating the scope of the Regulation. [31]

The EU Computer Regulation (617/2013/EU) for Computers and Computer Servers explicitly pulls desktops, integrated desktops and some notebooks out of scope of the Standby Directive as the ecodesign regulation on computers includes more appropriate requirements on power management, sleep mode, off mode and lowest power state. Any notebook computer that use less than 6W in idle or have displays with a diagonal length less than 22.86 cm (9 inches) remain within scope of the Standby Regulation as they are not considered to be notebook computers under the EU Regulation on computers.

EU Regulation 278/2009/EC - Ecodesign requirements for External power supplies [32]
The ecodesign Regulation on external power supplies (EPS), an implementing Regulation under the ecodesign Directive (2009/125/EC), incudes no-load condition electric power demand and average active efficiency for all external power supplies (EPS) with an output of less than 250 W and supplying only one output voltage at a time. The EPS Regulation only applies to EPS that are intended to be used to power household and office electrical and electronic equipment.

The EU Ecodesign Regulation (617/2013/EU) for Computers and Computer Servers explicitly states that any EPS that are placed on the EU market with computers are covered by Commission Regulation (EC) No 278/2009.

EU Directive 2012/19/EU - WEEE Directive [33]
The Waste Electrical and Electronic Equipment (WEEE) Directive implements the principle of "extended producer responsibility" where producers of EEE are expected to take

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[30] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:339:0045:0052:en:PDF
[31] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:225:0001:0012:en:PDF
[32] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:093:0003:0010:EN:PDF
[33] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0019&from=EN

responsibility for the environmental impact of their products at the end of life. As such, the WEEE Directive aims to reduce environmental impacts through setting targets for the separate collection, reuse, recovery, recycling and environmentally sound disposal of WEEE.

As EEE, computers and many associated products fall under the scope of the WEEE Directive. Ecodesign requirements for computers could therefore be used to assist the WEEE Directive aims via the introduction of product design requirements that enhance reuse, material recovery and effective recycling.

EU Regulation 1907/2006/EC - REACH Regulation [34]

The Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) addresses chemicals, and their safe use, and aims to improve the protection of human health and the environment through a system of Registration, Evaluation, Authorisation and Restriction of Chemicals. The REACH Regulation places greater responsibility on industry to manage the risks from the chemicals they manufacture, import and market in the EU. Companies are required to demonstrate how substances can be used safely and risk management measures must be reported to users. The REACH Regulation also establishes procedures for collecting and assessing information on the properties and hazards of substances and requires that companies register their substances in a central database. The entries in the database are then assessed to determine whether the risks of the substances can be managed. The REACH Regulation allows for some chemicals to be determined "substances of very high concern (SVHC)" due to their large potential negative impacts on human health or the environment. The European Chemicals Agency must be notified of the presence of SVHCs in certain products and the use of SVHCs may then be subject to prior authorisation. Substances can also be banned were risks are deemed to be unmanageable. As such, REACH encourages substitution of the most dangerous chemicals when suitable alternatives have been identified.

As REACH applies to all chemical substances, in theory, it also covers the chemicals that are used in computers and associated products that are within scope of this review project.

EU Directive 2011/65/EU - RoHS Directive [35]

The Restriction of Hazardous Substances (RoHS) Directive aims to reduce hazardous substances from electrical and electronic equipment (EEE) that is placed on the EU market. A number of hazardous substances are listed in the Directive along with maximum concentration values that must be met. The RoHS Directive does contain some exemptions where it has been decided that it may not be possible to manufacture some products without the use of one or more of the banned substances.

The RoHS Directive explicitly states that "IT and telecommunications equipment" are within scope and so the computers and associated products that are within scope of this review project are also within scope of the RoHS Directive.

Ecodesign requirements for computers could therefore be used to assist the RoHS Directive aims via the introduction of product design requirements that contribute to the

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[34] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006R1907-20140410&from=EN
[35] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0065&from=EN

reduction of the use of hazardous substances. This could include requirements such as labelling of hazardous materials that are subject to exemptions under the RoHS Directive.

EU Directive 2004/108/EC - Electromagnetic Compatibility Directive [36]
The Electromagnetic Compatibility Directive (EMC) Directive has the primary aim of protecting the electromagnetic spectrum. The Directive requires that products must not emit unwanted electromagnetic interference and must be protected against a normal level of interference. The vast majority of complete electrical products must comply independent of whether they are mains or battery powered. The EMC Directive does contain exemptions for a range of components with no intrinsic function and some products that already covered by other directives such as medical, military and communications equipment.

The new EMC directive (2014/30/EU) has been published and will come into force on the 20th April 2016.[37]

Most home and office computers are likely to be covered by the EMC Directive.

EU Directive 2006/95/EC - Low Voltage Directive [38]
The Low Voltage Directive (LVD) ensures that electrical equipment that operates within certain voltage limits, provides a high level of protection. The LVD Directive covers all health and safety risks of electrical equipment operating with a voltage of between 50 and 1000 volts for alternating current and between 75 and 1500 volts for direct current. Consumer goods with a voltage below 50 for alternating current or 75 for direct current are covered by the General Product Safety Directive (GPSD) (2001/95/EC).

The new Low Voltage Directive (2014/35/EU) will come into force on the 20th April 2016.[39]

Most computers and some associated products that are within scope of this review project would fall under the scope of the LVD Directive.

EU Council Decision 2013/107/EU - ENERGY STAR [40]
The ENERGY STAR programme is a joint U.S. Environmental Protection Agency and the U.S. Department of Energy voluntary labelling programme which focusses on the energy efficiency of a variety of products including many types of computers. The programme has also been adopted in several other countries including Australia, Canada and Japan. At the EU level ENERGY STAR is implemented via the EU Council Decision (2013/107/EU) and subsequent Commission Decision (2014/202/EU)[41] but only covers IT and office equipment.

ENERGY STAR has a significant influence in the market place. One of the reasons for this influence is that the specifications behind the programme are de-facto mandatory considerations in both US and EU central government procurement contracts. Article 6 of the EU Directive (2012/27/EU) on energy efficiency requires that central government

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[36] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:390:0024:0037:en:PDF
[37] http://ec.europa.eu/growth/sectors/electrical-engineering/directives/index_en.htm
[38] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:374:0010:0019:en:PDF
[39] http://ec.europa.eu/growth/sectors/electrical-engineering/directives/index_en.htm
[40] http://eur-lex.europa.eu/resource.html?uri=cellar:d895abc3-8588-11e2-89d6-01aa75ed71a1.0006.01/DOC_1&format=PDF
[41] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0202&from=EN

bodies purchase products that are at least as energy efficient as dictated by the latest ENERGY STAR specifications levels covered under the US-EU agreement.[42]

There have been a number of ENERGY STAR specifications developed for computer since the beginning of the programme in 1992 with the latest specification (version 6.1) having been adopted in the EU in September 2014. The US and EU are due to start the development of a new ENERGY STAR specification (version 7.0) for computers in 2016. In general, the ENERGY STAR specification development process initiates when it is clear that a significant number of products on the market already meet existing specifications or where it is deemed suitable to develop a new specification for products not already covered under the programme. The guiding principle is that ENERGY STAR specifications should be met by around 25% of the most efficient products on the market at the time of setting the requirements.

There is normally a delay of between 9 months to a year after finalisation of a new ENERGY STAR specification before it is implemented. This delay is designed to provide manufacturers with the opportunity to make changes to their products so that they can meet the new ENERGY STAR specification. Due to complexities in the process, there are often further delays in adopting new ENERGY STAR specifications in the EU although these processes are under review.

When applying for to label products with the ENERGY STAR label, manufacturers must submit data about the product's functional characteristics and power demands into an ENERGY STAR database (i.e. either the US or EU controlled databases or both). These databases provide a significant amount of information about the performances of products on the market.

Given its large influence in the marketplace, the corresponding databases and use of established test procedures, ENERGY STAR is often used as the basis for regulatory measures on computer energy efficiency.

EU Regulation 66/2010/EC - EU Ecolabel [43, 44]
The EU Ecolabel is a voluntary labelling scheme, enforced in EU Regulation (66/2010/EC), that includes a large number of criteria, which aim to identify products which have low environmental impacts across many impact categories. Manufacturers can apply the logo to products, which meet all of the EU Ecolabel criteria.

The EU Ecolabel covers a range of different types of computer including desktop, integrated desktop, thin clients, notebook and tablet/slate computers.[45, 46] The specifications were published in June 2011 and are currently under review by the Commission. The EU Ecolabel requires certification by a third-party body. A number of requirements can be the starting point for requirements in the ecodesign and or the Labelling regulation on aspects related to durability, reparability and recyclability.

1.3.2 Member State legislation
No member state legislation could be found which covers the environmental impacts of computers or associated products that are within scope of this review project.

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[42] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:en:PDF
[43] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:027:0001:0019:en:PDF
[44] http://ec.europa.eu/environment/ecolabel/index_en.htm
[45] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011D0337&from=EN
[46] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011D0330&from=EN

1.3.3 Third country legislation

There are a number of pieces of legislation that have already been developed, or are in the process of being developed, which address the energy efficiency of computers and associated products.

China Mandatory Measures [47]

On the 14th November, 2012, in accordance with the regulations of the Management of Energy Efficiency Label, the Chinese Government released the "Implementation Rules of Energy Efficiency Label of Microcomputers". The rules require that desktop, integrated desktop and notebook computers placed on the Chinese market meet mandatory energy efficiency limits and are labelled according to three energy classes by the 1st February 2013. The mandatory requirements included in the Chinese initiative are significantly less stringent than the ENERGY STAR v5.2 specification limits and do not address power supply efficiency.

Australian MEPS [48]

The Greenhouse and Energy Minimum Standards Act 2012 (Act) establishes a national framework for regulating the energy efficiency of products supplied or used within Australia including through the introduction of mandatory energy efficiency requirements. The Australian Government have developed a set of these mandatory energy efficiency requirements for a range of products including computers. From 1 October 2013, all computers manufactured in, or imported into, Australia (and New Zealand) are subject to Minimum Energy Performance Standards (MEPS). These MEPS cover a wide range of computing products with the specifications based on the largely ENERGY STAR v5.2 requirements. The Australian MEPS diverge from the ENERGY STAR requirements in that they do not include any requirements on power supply efficiencies (unless products are sold in quantities of less than 200 units per year) and they also include additional allowances to account for higher specification products. The Australian MEPS includes a "Deemed-to-Comply" option for single models where the manufacturing quantity does not exceed 200 units in a year. In this case ETEC requirements do not apply but external power supplies must be performance mark V and internal power supplies 80Plus silver when tested using AS/NZS 5814.1.

The Australian MEPS and test procedures are detailed in the following Australian standards:

- **AS/NZS 5813.2**– Information technology equipment –Energy performance of computers Part 2: Minimum energy performance standards (MEPS) for computers.
- **AS/NZS 5813.1** - Information technology equipment –Energy performance of computers Part 1: Methods of measurement of energy performance.
- **AS/NZS 5814.1** - Information technology equipment –Energy performance of internal power supplies Part 1: Methods of measurement of energy performance.

Californian Rule Making Process [49]

In 2012 the California Energy Commission (CEC) instigated a rulemaking proceeding to consider amendments to the Commission's Appliance Efficiency Regulations (Title 20, Cal. Code Regs., §§ 1601 - 1608). The Commission is currently considering establishing

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[47] http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards/RelatedResearchonStandard/detail/673.html
[48] https://www.legislation.gov.au/Details/F2013L00726/Download
[49] http://www.energy.ca.gov/appliances/2014-AAER-2/prerulemaking/

efficiency standards, test procedures, marking and labelling requirements, and other regulations for a number of appliances including computers.

In March 2015, the CEC published a pre-rulemaking document on computers, computer monitors, and signage displays. The document included a set of proposed product definitions, energy efficiency specifications and associated test procedures. After considerable stakeholder engagement, the CEC published their second version of the draft rulemaking in March 2016 with some major changes to the requirements and product scope. At the time of writing it is understood that the CEC are considering further stakeholder input into the second draft rulemaking document ahead of a formal adoption procedure.

Further insights into the Californian rule making process will be reported during the course of the preparatory study.

US Department of Energy (DoE) Rule Making [50]

The U.S. Department of Energy (DOE) has issued a proposed determination that, if finalized, would give DOE authority to issue mandatory energy efficiency requirements on computers. This decision has been taken as the DOE identified that computers may qualify as a covered product under Part A of Title III of the Energy Policy and Conservation Act (EPCA) because the average U.S. household energy use for computers is likely to exceed the 100 kilowatt-hours (kWh) per year limit laid out in the EPCA.

At the time of writing the DOE had not issued any draft determinations and so no further information can be provided. Again, updates on the DOE process will be reported during the course of the preparatory study.

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[50] http://energy.gov/eere/buildings/rulemakings-and-notices