

ELFORSK

Development of Test Definition and Energy Labelling Criteria for Electricity Consumption of Computers in all Modes

Annexes

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ENERGY STAR® Program Requirements for Computers

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ENERGY STAR® Program Requirements for Computers

Partner Commitments

Commitments

The following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacturing of ENERGY STAR qualified computers. The ENERGY STAR Partner must adhere to the following program requirements:

- comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be met for use of the ENERGY STAR certification mark on computers and specifying the testing criteria for computers. EPA may, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at EPA's request;
- comply with current ENERGY STAR Identity Guidelines, describing how the ENERGY STAR marks and name may be used. Partner is responsible for adhering to these guidelines and for ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance;
- work with resellers of Partner's products to help ensure that these products remain in compliance with ENERGY STAR requirements. Any party within the distribution channel of an ENERGY STAR qualified computer product that alters the power profile of a product after its date of manufacture through hardware or software modifications must ensure that the product continues to meet the ENERGY STAR requirements before delivering this product to the end customer. If the product no longer meets the requirements, it may not bear the ENERGY STAR mark;
- qualify at least one ENERGY STAR computer model within one year of activating the computers portion of the agreement. When Partner qualifies the product, it must meet the specification (e.g., Tier 1 or 2) in effect at that time;
- provide clear and consistent labeling of ENERGY STAR qualified computers. The ENERGY STAR mark must be clearly displayed:

1. On the top or front of the product. Labeling on the top or front of the product may be permanent or temporary. All temporary labeling must be affixed to the top or front of the product with an adhesive or cling-type application;

Electronic Labeling Option: Manufacturers have the option of using an alternative electronic labeling approach in place of this product labeling requirement, as long it meets the following requirements:

- The ENERGY STAR mark in cyan, black, or white (as described in "The ENERGY STAR Identity Guidelines" available at www.energystar.gov/logos) appears at system start-up. The electronic mark must display for a minimum of 5 seconds;
- The ENERGY STAR mark must be at least 10% of the screen by area, may not be smaller than 76 pixels x 78 pixels, and must be legible.

EPA will consider alternative proposals regarding approach, duration, or size for electronic labeling on a case-by-case basis.

2. In product literature (i.e., user manuals, spec sheets, etc.);
 3. On product packaging for products sold at retail; and
 4. On the manufacturer's Internet site where information about ENERGY STAR qualified models is displayed:
 - If information concerning ENERGY STAR is provided on the Partner Web site, as specified by the ENERGY STAR Web Linking Policy (this document can be found in the Partner Resources section on the ENERGY STAR Web site at www.energystar.gov), EPA may provide links where appropriate to the Partner Web site;
- agree to complete steps to educate users of their products about the benefits of power management by including the following information, in addition to that described in the User Information Requirements found in the ENERGY STAR Eligibility Criteria (Section 3.A.3), with each computer (i.e., in the user manual or on a box insert):
 1. Energy saving potential;
 2. Financial saving potential;
 3. Environmental benefits
 4. Information on ENERGY STAR and a link to www.energystar.gov; and
 5. ENERGY STAR logo (used in accordance with "The ENERGY STAR Identity Guidelines" available at www.energystar.gov/logos).

In addition to the information contained with the product, the manufacturer will have similar information with a link to www.energystar.gov/powermanagement on the company Web site, readily accessible from computer product pages, product specifications, and related content pages.

At the manufacturer's request, EPA will supply suggested facts and figures related to the above criteria, template elements, or a complete template suitable for use in user guides or box inserts.

EPA's goal is to achieve a 40% power management enabling rate nationally by 2010; 60% by 2012; and \geq 80% by 2014. EPA recognizes the importance of documenting enabling rates and encourages industry to develop a collective strategy for securing and funding this research, and sharing findings with EPA and the public.

- provide to EPA, on an annual basis, an updated list of ENERGY STAR qualified computer models. Once the Partner submits its first list of ENERGY STAR qualified computer models, the Partner will be listed as an ENERGY STAR Partner. Partner must provide annual updates in order to remain on the list of participating product manufacturers;
- provide to EPA, on an annual basis, unit shipment data or other market indicators to assist in determining the market penetration of ENERGY STAR. Specifically, Partner must submit the total number of ENERGY STAR qualified computers shipped (in units by model) or an equivalent measurement as agreed to in advance by EPA and Partner. Partner is also encouraged to provide ENERGY STAR qualified unit shipment data segmented by meaningful product characteristics (e.g., capacity, size, speed, or other as relevant), total unit shipments for each model in its product line, and percent of total unit shipments that qualify as ENERGY STAR. The data for each calendar year should be submitted to EPA, preferably in electronic format, no later than the following March and may be provided directly from the Partner or through a third party. The data will be used by EPA only for program evaluation purposes and will be closely controlled. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;
- notify EPA of a change in the designated responsible party or contacts for computers within 30 days.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures and should keep EPA informed on the progress of these efforts:

- consider energy efficiency improvements in company facilities and pursue the ENERGY STAR mark for buildings;
- purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes;
- ensure the power management feature is enabled on all ENERGY STAR qualified monitors and computers in use in company facilities, particularly upon installation and after service is performed;
- provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified product models;
- provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, communicate, and/or promote Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR Web pages, etc. The plan may be as simple as providing a list of planned activities or planned milestones that Partner would like EPA to be aware of. For example, activities may include: (1) increase the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrate the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) provide information to users (via the Web site and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4) build awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event;
- provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.



ENERGY STAR® Program Requirements for Computers

Eligibility Criteria

Below is the Version 4.0 product specification for ENERGY STAR qualified computers. A product must meet all of the identified criteria to earn the ENERGY STAR.

1) **Definitions:** Below are the definitions of the relevant terms in this document.

- A. **Computer:** A device which performs logical operations and processes data. Computers are composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; (2) user input devices such as a keyboard, mouse, digitizer or game controller; and (3) a display screen to output information. For the purposes of this specification, computers include both stationary and portable units, including desktop computers, gaming consoles, integrated computers, notebook computers, tablet PCs, desktop-derived servers and workstations. Although computers must be capable of using input devices and displays, as noted in numbers 2 and 3 above, computer systems do not need to include these devices on shipment to meet this definition.

Components

- B. **Display:** A commercially-available, electronic product with a display screen and its associated electronics encased in a single housing, or within the computer housing (e.g., notebook or integrated computer), that is capable of displaying output information from a computer via one or more inputs, such as a VGA, DVI, and/or IEEE 1394. Examples of display technologies are the cathode-ray tube (CRT) and liquid crystal display (LCD).
- C. **External Power Supply:** 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.
- D. **Internal Power Supply:** 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 must be contained within the computer casing but 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 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.

Computer Types

- E. **Desktop Computer:** 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 monitor, keyboard, and mouse. Desktops are designed for a broad range of home and office applications including, email, web browsing, word processing, standard graphics applications, gaming, etc.

F. Desktop-Derived Server: A desktop-derived server is a computer that typically uses desktop components in a tower form factor, but is designed explicitly to be a host for other computers or applications. For the purposes of this specification, a computer must be marketed as a server and have the following characteristics to be considered a desktop-derived server:

- Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and has no more than single processor capability (1 socket on board);
- 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;
- Designed to operate in a high-reliability, high-availability application environment where the computer must be operational 24 hours/day and 7 days/week, and unscheduled downtime is extremely low (on the order of hours/year);
- Capable of operating in a simultaneous multi-user environment serving several users through networked client units; and
- Shipped with an industry accepted operating system for standard server applications (e.g., Windows NT, Windows 2003 Server, Mac OS X Server, OS/400, OS/390, Linux, Unix and Solaris).

Desktop-derived servers are designed to perform functions such as processing information for other systems, providing network infrastructure services (e.g., archiving), data hosting and running web servers.

This specification does not cover mid-range or large servers, defined for purposes of this specification as:

- Designed and placed on the market as a Class A product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a single or dual processor capability (1 or greater sockets on board);
- Placed on the market as a Class B product, but hardware upgraded from a Class A product, per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed capable of having a single or dual processor capability (1 or greater sockets on board); and
- Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a *minimum* dual processor capability (2 sockets on board).

G. Game Consoles: Stand alone computers whose primary use is to play video games. For the purposes of this specification, game consoles must use a hardware architecture based on typical computer components (e.g., processors, system memory, video architecture, optical and/or hard drives, etc.). The primary input for game consoles are special hand held controllers rather than the mouse and keyboard used by more conventional computer types. Game consoles are also equipped with audio visual outputs for use with televisions as the primary display, rather than an external monitor or integrated display. These devices do not typically use a conventional operating system, but often perform a variety of multimedia functions such as: DVD/CD playback, digital picture viewing, and digital music playback.

H. Integrated Computer: A desktop system in which the computer and display function as a single unit which receives its ac power through a single cable. Integrated 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 computers are typically designed to provide similar functionality as desktop systems.

- I. Notebook and Tablet Computers: A computer designed specifically for portability and to be operated for extended periods of time without a direct connection to an ac power source. Notebooks and tablets must utilize an integrated monitor and be capable of operation off an integrated battery or other portable power source. In addition, most notebooks and tablets use an external power supply and have an integrated keyboard and pointing device, though tablets use touch-sensitive screens. Notebook and tablet computers are typically designed to provide similar functionality to desktops except within a portable device. For the purposes of this specification, docking stations are considered accessories and therefore, the performance levels associated with notebooks presented in Table 1 of Section 3, below, do not include them.
- J. Workstation: For the purposes of this specification, to qualify as a workstation, a computer must:
- Be marketed as a workstation;
 - Have a mean time between failures (MTBF) of at least 15,000 hours based on either Bellcore TR-NWT-000332, issue 6, 12/97 or field collected data; and
 - Support error-correcting code (ECC) and/or buffered memory.

In addition, a workstation must meet three of the following six optional characteristics:

- Have supplemental power support for high-end graphics (i.e., PCI-E 6-pin 12V supplemental power feed);
- System is wired for greater than x4 PCI-E on the motherboard in addition to the graphics slot(s) and/or PCI-X support;
- Does not support Uniform Memory Access (UMA) graphics;
- Includes 5 or more PCI, PCIe or PCI-X slots;
- Capable of multi-processor support for two or more processors (must support physically separate processor packages/sockets, i.e., not met with support for a single multi core processor); and/or
- Be qualified by at least 2 Independent Software Vendor (ISV) product certifications; these certifications can be in process, but must be completed within 3 months of qualification.

Operational Modes

- K. Idle State: For purposes of testing and qualifying computers under this specification, this is the state in which the operating system and other software have completed loading, the machine is not asleep, and activity is limited to those basic applications that the system starts by default.
- L. Sleep Mode: A low power state that the computer is capable of entering automatically after a period of inactivity or by manual selection. A computer with sleep capability can quickly “wake” in response to network connections or user interface devices. For the purposes of this specification, Sleep mode correlates to ACPI System Level S3 (suspend to RAM) state, where applicable.
- M. Standby Level (Off Mode): The power consumption level in the lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the appliance is connected to the main electricity supply and used in accordance with the manufacturer’s instructions. For purposes of this specification, Standby correlates to ACPI

System Level S4 or S5 states, where applicable.

Networking and Power Management

- N. Network Interface: The components (hardware and software) whose primary function is to make the computer capable of communicating over one or more network technologies. For purposes of testing to this specification, Network Interface refers to the IEEE 802.3 wired Ethernet interface.
- O. Wake Event: A user, programmed, or external event or stimulus that causes the computer to transition from Sleep or Standby to active mode of operation. Examples of wake events include, but are not limited to: movement of the mouse, keyboard activity, or a button press on the chassis, and in the case of external events, stimulus conveyed via a remote control, network, modem, etc.
- P. Wake On LAN (WOL): Functionality which allows a computer to wake from Sleep or Standby when directed by a network request.

- 2) **Qualifying Products**: Computers must meet the computer definition as well as one of the product type definitions provided in Section 1, above, to qualify as ENERGY STAR. **Please note that EPA will explore additional computer types, such as thin clients, for potential Tier 2 requirements.** The following table provides a list of the types of computers that are (and are not) eligible for ENERGY STAR.

Products Covered by Version 4.0 Specification	Products Not Covered by Version 4.0 Specification
a. Desktop Computers	g. Mid-Range and Large Servers (as defined in Section 1F)
b. Game Consoles	h. Thin Clients/Blade PCs
c. Integrated Computer Systems	i. Handhelds and PDAs
d. Notebook Computers/Tablet PCs	
e. Desktop-Derived Servers	
f. Workstations	

- 3) **Energy Efficiency and Power Management Criteria**: Computers must meet the requirements below to qualify as ENERGY STAR. Effective dates for Tier 1 and Tier 2 are covered in Section 5 of this specification.

A) Tier 1 Requirements - Effective July 20, 2007

(1) Power Supply Efficiency Requirements

Computers Using an Internal Power Supply: 80% minimum efficiency at 20%, 50%, and 100% of rated output and Power Factor ≥ 0.9 at 100% of rated output.

Computers Using an External Power Supply: Must be ENERGY STAR qualified or meet the no-load and active mode efficiency levels provided in the ENERGY STAR Program Requirements for Single Voltage Ac-Ac and Ac-Dc External Power Supplies. The ENERGY STAR specification and qualified product list can be found at www.energystar.gov/powersupplies. Note: This performance requirement also applies to multiple voltage output external power supplies as tested in accordance to the Internal Power Supply test method referenced in Section 4, below.

(2) Operational Mode Efficiency Requirements

Desktop Categories for Idle Criteria: For the purposes of determining Idle state levels, desktops (including integrated computers, desktop-derived servers and game consoles) must qualify under Categories A, B, or C as defined below:

Category A: All desktop computers that do not meet the definition of either Category B or Category C below will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B desktops must have:

- Multi-core processor(s) or greater than 1 discrete processor; and
- Minimum of 1 gigabyte of system memory.

Category C: To qualify under Category C desktops must have:

- Multi-core processor(s) or greater than 1 discrete processor; and
- A GPU with greater than 128 megabytes of dedicated, non-shared memory.

In addition to the requirements above, models qualifying under Category C must be configured with a minimum of 2 of the following 3 characteristics:

- Minimum of 2 gigabytes of system memory;
- TV tuner and/or video capture capability with high definition support; and/or
- Minimum of 2 hard disk drives.

Notebook Categories for Idle Criteria: For the purposes of determining Idle state levels, notebooks and tablets must qualify under Categories A or B as defined below:

Category A: All notebook computers that do not meet the definition of Category B below will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B notebooks must have:

- A GPU with a minimum of 128 megabytes of dedicated, non-shared memory.

Workstation Levels: Workstation levels will be determined using a simplified Typical Electricity Consumption (TEC) approach to allow manufacturers energy trade offs between different operating modes, based on a given weighting factor for each mode. The final level will be based on the TEC power level (P_{TEC}) which will be determined by the following formula:

$$P_{TEC} = 0.1 * P_{Standby} + 0.2 * P_{Sleep} + 0.7 * P_{Idle}$$

where, $P_{Standby}$ is the power measured in Standby, P_{Sleep} is the power measured in Sleep, and in P_{Idle} is the power measured in Idle. This P_{TEC} value will then be compared to the TEC budget which is determined by a fixed percentage of the maximum power of the system, including an adder for installed hard drives as indicated in the equation in Table 1. The test procedure for determining the maximum power of workstations can be found in Section 4 of Appendix A.

Power Level Requirements: The following tables indicate the required power allowances for the Tier 1 specification. Table 1 gives the baseline requirements, while Table 2 gives additional power allowances for WOL. For those products that meet the WOL enabling requirement for either Sleep or Standby, a model must meet the energy level provided in Table 1 summed with the appropriate allowances from Table 2. **Note: Products whose Sleep levels meet the Standby power requirements do not need to have a distinct Standby (Off mode), and may qualify for this specification using only Sleep mode.**

Table 1: Tier 1 Energy Efficiency Requirements

Product Type	Tier 1 Requirements
Desktops, Integrated Computers, Desktop-Derived Servers and Gaming Consoles	<p>Standby (Off Mode): ≤ 2.0 W</p> <p>Sleep Mode: ≤ 4.0 W</p> <p>Idle State: Category A: ≤ 50.0 W Category B: ≤ 65.0 W Category C: ≤ 95.0 W</p> <p><i>Note: Desktop-derived servers (as defined in section 1. F) are exempt from the Sleep level above.</i></p>
Notebooks and Tablets	<p>Standby (Off Mode): ≤ 1.0 W</p> <p>Sleep Mode: ≤ 1.7 W</p> <p>Idle State: Category A: ≤ 14.0 W Category B: ≤ 22.0 W</p>
Workstations	<p>TEC Power (P_{TEC}): $\leq 0.35 * [P_{Max} + (\# HDDs * 5)]$ W</p> <p><i>Note: Where P_{max} is the maximum power drawn by the system as tested per the test procedure in Section 4 of Appendix A, and #HDD is the number of installed hard drives in the system.</i></p>

Table 2: Tier 1 Capability Adder for Sleep and Standby

Capability	Additional Power Allowance
Wake On LAN (WOL)	+ 0.7 W for Sleep + 0.7 W for Standby

Qualifying Computers with Power Management Capabilities: The following requirements should be followed when determining whether models should be qualified with or without WOL:

Standby: Computers should be tested and reported as shipped for Standby. Models that will be shipped with WOL enabled for Standby should be tested with WOL enabled and will qualify using the extra allowance for Standby found in Table 2 above. Likewise, products shipped with WOL disabled for Standby must be tested with WOL disabled and must meet the baseline requirement for Standby found in Table 1.

Sleep: Computers should be tested and reported as shipped for Sleep. Models sold through enterprise channels, as defined in the Tier 1 Power Management Requirements (Section 3.A.3), shall be tested, qualified, and shipped WOL enabled. Products going directly to consumers through normal retail channels are not required to be shipped with WOL enabled from Sleep, and may be tested, qualified, and shipped with WOL either enabled or disabled. Those models sold

both through enterprise channels and directly to consumers must test and meet both the levels with and without WOL.

Systems where any additional management services are, at the customer's request, pre-provisioned by the manufacturer, do not need to test the systems with these functions in an active state providing the function is not actually activated until there is specific action by the end user (i.e., manufacturer should test in pre-provisioned state and does not have to consider the power use after full provisioning occurs on site).

(3) Power Management Requirements

Shipment Requirement: Products must be shipped with the display's Sleep mode set to activate within 15 minutes of user inactivity. All products, except for desktop-derived servers which are exempt from this requirement, must be shipped with a Sleep mode which is set to activate within 30 minutes of user inactivity. Products may have more than one low power mode but these proposed criteria address Sleep mode as defined in this specification. Computers shall reduce the speed of any active 1 Gb/s Ethernet network links when transitioning to Sleep or Standby.

All computers, regardless of distribution channel, shall have the ability to enable and disable WOL for Sleep mode. Systems shipped through enterprise channels must have Wake On LAN (WOL) enabled from the Sleep mode when operating on ac power (i.e. notebooks may automatically disable WOL when operating on their portable power sources). For the purpose of this specification, "enterprise channels" are defined as sales channels normally used by large and medium-sized business, government organizations, and educational institutions, with the intent of identifying machines that will be used in managed client/server environments. For all computers with WOL enabled any directed packet filters shall be enabled and set to an industry standard default configuration. Until one (or more) standards are agreed upon, partners are asked to provide their direct packet filter configurations to EPA for publication on the Website to stimulate discussion and development of standard configurations. Systems in which the Sleep mode maintains full network connectivity, providing the same fully connected network state found in Idle, can be considered to meet the WOL enabling requirement and may qualify using the corresponding WOL capability adder.

All machines shipped to enterprise customers shall be capable of both remote and scheduled wake events from Sleep mode. Manufacturers shall ensure, where the manufacturer has control (i.e., configured through hardware settings rather than software settings), that these settings can be managed centrally, as the client wishes, with tools provided by the manufacturer.

User Information Requirement: In order to ensure that purchasers/users are properly informed on the benefits of power management, the manufacturer will include with each computer, one of the following:

- Information on ENERGY STAR and the benefits of power management in either a hard copy or electronic copy of the user manual. This information should be near the front of the user guide; or
- A package or box insert on ENERGY STAR and the benefits of power management.

Either option must at least include the following information:

- Notice that the computer has been shipped enabled for power management and what the time settings are; and
- How to properly wake the computer from Sleep mode;

(B) Tier 2 Requirements - Effective January 1, 2009

(1a) Tier 2 Energy Efficiency Performance Metric. All computers will be required to meet the

following minimum performance per unit energy metric:

Energy Efficiency Performance Software and Associated Levels: **TBD**

- OR -

(1b) Provisional Tier 2 Idle State Requirements. If an energy efficiency performance metric and associated performance levels are not ready to go into effect **by January 1, 2009**, a provisional Tier 2 specification will automatically go into effect and will remain in effect until such a benchmark is established. This provisional Tier 2 will include revised Idle state levels for all computer types (those included in Tier 1 as well as others as appropriate [e.g., thin clients]) with the intention of capturing the top 25% performers in energy efficiency.

Additional topics, including the following, will also be re-examined under a provisional Tier 2:

- Idle levels for notebooks and integrated computers that incorporate the energy use of the displays;
- Quantitative distinctions between desktop categories (e.g., megabytes of video memory, number of processor cores, megabytes of system memory) to ensure that these distinctions remain current;
- Sleep levels for desktop-derived servers; and
- Allowances for additional management tools, such as service processors in Sleep and Standby, which may aid in the adoption of computer power management.

In the case of the implementation of a provisional Tier 2, EPA and the European Commission will re-examine these new topics and finalize new levels at least six months prior to the effective date for Tier 2.

(2) Power Management Requirements: In addition to the requirements provided under Tier 1, above, ENERGY STAR qualified computers must maintain full network connectivity while in Sleep mode, according to a platform-independent industry standard. All computers shall reduce their network link speeds during times of low data traffic levels in accordance with any industry standards that provide for quick transitions among link rates.

C) Voluntary Requirements

User Interface: Although not mandatory, manufacturers are strongly recommended to design products in accordance with the Power Control User Interface Standard — IEEE 1621 (formally known as “Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments”). Compliance with IEEE 1621 will make power controls more consistent and intuitive across all electronic devices. For more information on the standard see <http://eetd.LBL.gov/Controls>.

4) Test Procedures: Manufacturers are required to perform tests and self-certify those models that meet the ENERGY STAR guidelines.

- In performing these tests, partner agrees to use the test procedures provided in Table 3, below.
- The test results must be reported to EPA or the European Commission, as appropriate.

Additional testing and reporting requirements are provided below.

A. Number of Units Required for Idle Testing: Manufacturers may initially test a single unit for

qualification. If the initial unit tested meets the maximum power level for Idle but falls within 10% of that level, one additional unit of the same model with an identical configuration must also be tested. Manufacturers shall report Idle values for both units. To qualify as ENERGY STAR, both units must meet the maximum Idle level for that product category. **Note:** This additional testing is only required for Idle qualification – only one unit is required to be tested for Sleep and Standby. The following example further illustrates this approach:

Category A desktops must meet an Idle level of 50 watts or less, making 45 Watts the 10% threshold for additional testing. The following scenarios could then occur when testing a model for qualification:

- If the first unit is measured at 44 watts, no more testing is needed and the model qualifies (44 watts is 12% more efficient than the specification and is therefore “outside” the 10% threshold).
- If the first unit is measured at 45 watts, no more testing is needed and the model qualifies (45 watts is exactly 10% more efficient than the specification).
- If the first unit is measured at 47 watts, then an additional unit must be tested to determine qualification (47 Watts is only 6% more efficient than the specification and is “within” the 10% threshold).
- If the two units are then tested at 47 and 51 watts, the model does not qualify as ENERGY STAR—even though the average is 49 watts— because one of the values (51) exceeds the ENERGY STAR specification.
- If the two units are then tested at 47 and 49 watts, the model does qualify as ENERGY STAR because both values meet the ENERGY STAR specification of 50 watts.

B. Models Capable of Operating at Multiple Voltage/Frequency Combinations: Manufacturers shall test their products based on the market(s) in which the models will be sold and promoted as ENERGY STAR qualified. EPA and its ENERGY STAR Country Partners have agreed upon a table with three voltage/frequency combinations for testing purposes. Please refer to the Test Conditions in the Test Procedure (Appendix A) for details regarding international voltage/frequency combinations for each market.

For products that are sold as ENERGY STAR in multiple international markets and, therefore, rated at multiple input voltages, the manufacturer must test at and report the required power consumption or efficiency values at all relevant voltage/frequency combinations. For example, a manufacturer that is shipping the same model to the United States and Europe must measure, meet the specification, and report test values at both 115 Volts/60 Hz and 230 Volts/50 Hz in order to qualify the model as ENERGY STAR in both markets. If a model qualifies as ENERGY STAR at only one voltage/frequency combination (e.g., 115 Volts/60 Hz), then it may only be qualified and promoted as ENERGY STAR in those regions that support the tested voltage/frequency combination (e.g., North America and Taiwan).

Table 3: Test Procedures for Measuring Operational Modes

Specification Requirement	Test Protocol	Source
Standby (Off Mode), Sleep Mode, Idle State and Maximum Power	ENERGY STAR Computer Test Method (Version 4.0)	Appendix A

Power Supply Efficiency	IPS: Internal Power Supply Efficiency Protocol EPS: ENERGY STAR Test Method for External Power Supplies	IPS: www.efficientpowersupplies.org EPS: www.energystar.gov/powersupplies
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C. Qualifying Families of Products: Models that are unchanged or that differ only in finish from those sold in a previous year may remain qualified without the submission of new test data assuming the specification remains unchanged. If a product model is offered in the market in multiple configurations or styles, as a product “family” or series, the partner may report and qualify the product under a single model number, as long as all of the models within that family or series meet either of the following requirements:

- Computers that are built on the same platform and are identical in every respect except for housing and color may be qualified through submission of test data for a single, representative model.
- If a product model is offered in the market in multiple configurations, the partner may report and qualify the product under a single model number that represents the highest power configuration available in the family, rather than reporting each and every individual model in the family. In this case, the highest configuration would consist of: the highest power processor, the maximum memory configuration, the highest power GPU, etc. For desktop systems which meet the definition for multiple desktop categories (as defined in section 3.A.2) depending on the specific configuration, manufacturers will have to submit the highest power configuration for each category under which they would like the system to qualify. For example, a system that could be configured either as a Category A or a Category B desktop would require a submittal of the highest power configuration for both categories in order to qualify as ENERGY STAR. If a product could be configured to meet all three categories, it would then have to submit data for the highest power configuration in all categories. Manufacturers will be held accountable for any efficiency claims made about all other models in the family, including those not tested or for which data was not reported.

5) Effective Date: The date that manufacturers may begin to qualify products as ENERGY STAR, under this Version 4.0 specification, will be defined as the *effective date* of the agreement. Any previously executed agreement on the subject of ENERGY STAR qualified computers shall be terminated effective July 19, 2007.

1. Qualifying Products Under Tier 1 of the Version 4.0 Specification: The first phase of this specification will commence on **July 20, 2007**. All products, including models originally qualified under Version 3.0, with a **date of manufacture** on or after **July 20, 2007**, must meet the new (Version 4.0) requirements in order to qualify for ENERGY STAR. The **date of manufacture** is specific to each unit and is the date (e.g., month and year) of which a unit is considered to be completely assembled.
2. Qualifying Products Under Tier 2 of the Version 4.0 Specification: The second phase of this specification, Tier 2, will commence on **January 1, 2009**. All products, including models originally qualified under Tier 1, with a **date of manufacture** on or after **January 1, 2009**, must meet the Tier 2 requirements in order to qualify for ENERGY STAR.
3. Elimination of Grandfathering: EPA will not allow grandfathering under this Version 4.0 ENERGY STAR specification. **ENERGY STAR qualification under previous versions is not automatically granted for the life of the product model.** Therefore, any product sold,

marketed, or identified by the manufacturing partner as ENERGY STAR must meet the current specification in effect at the time of manufacture of the product.

- 6) Future Specification Revisions:** EPA reserves the right to revise the specification should technological and/or market changes affect its usefulness to consumers or industry or its impact on the environment. In keeping with current policy, revisions to the specification will be discussed with stakeholders. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model. To qualify as ENERGY STAR, a product model must meet the ENERGY STAR specification in effect on the model's date of manufacture.

APPENDIX A

ENERGY STAR Test Procedure for Determining the Power Use of Computers in Standby, Sleep, Idle and Maximum Power

The following protocol should be followed when measuring power consumption levels of computers for compliance with the Standby, Sleep, and Idle levels provided in the ENERGY STAR Version 4.0 Computer Specification. Partners must measure a representative sample of the configuration as shipped to the customer. However, the Partner does not need to consider power consumption changes that may result from component additions, BIOS and/or software settings made by the computer user after sale of product. *This procedure is intended to be followed in order and the mode being tested is labeled where appropriate.*

I. Definitions

Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the Version 4.0 ENERGY STAR Eligibility Criteria for Computers.

UUT

UUT is an acronym for “unit under test,” which in this case refers to the computer being tested.

UPS

UPS is an acronym for “Uninterruptible Power Supply,” which refers to a combination of converters, switches and energy storage means, for example batteries, constituting a power supply for maintaining continuity of load power in case of input power failure.

II. Testing Requirements

Approved Meter

Approved meters will include the following attributes¹:

- Power resolution of 1 mW or better;
- An available current crest factor of 3 or more at its rated range value; and
- Lower bound on the current range of 10mA or less.

The following attributes in addition to those above are suggested:

- Frequency response of at least 3 kHz; and
- Calibration with a standard that is traceable to the U.S. National Institute of Standards and Technology (NIST).

It is also desirable for measurement instruments to be able to average power accurately over any user selected time interval (this is usually done with an internal math’s calculation dividing accumulated energy by time within the meter, which is the most accurate approach). As an alternative, the measurement instrument would have to be capable of integrating energy over any user selected time interval with an energy resolution of less than or equal to 0.1 mWh and integrating time displayed with a resolution of 1 second or less.

Accuracy

Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level. Measurements of power of less than 0.5 W shall be made with an

¹ *Characteristics of approved meters taken from IEC 62301 Ed 1.0: Measurement of Standby Power*

uncertainty of less than or equal to 0.01 W at the 95% confidence level. The power measurement instrument shall have a resolution of:

- 0.01 W or better for power measurements of 10 W or less;
- 0.1 W or better for power measurements of greater than 10 W up to 100 W; and
- 1 W or better for power measurements of greater than 100 W.

All power figures should be in watts and rounded to the second decimal place. For loads greater than or equal to 10 W, three significant figures shall be reported.

Test Conditions

Supply Voltage:	North America/Taiwan:	115 (± 1%) Volts AC, 60 Hz (± 1%)
	Europe/Australia/New Zealand:	230 (± 1%) Volts AC, 50 Hz (± 1%)
	Japan:	100 (± 1%) Volts AC, 50 Hz (± 1%)/60 Hz (± 1%)
		<i>Note: For products rated for > 1.5 kW maximum power, the voltage range is ± 4%</i>
Total Harmonic Distortion (THD) (Voltage):	< 2% THD (< 5% for products which are rated for > 1.5 kW maximum power)	
Ambient Temperature:	23°C ± 5°C	
Relative Humidity:	10 – 80 %	

(Reference IEC 62301: Household Electrical Appliances – Measurement of Standby Power, Sections 3.2, 3.3)

Test Configuration

Power consumption of a computer shall be measured and tested from an ac source to the UUT.

The UUT must be connected to an Ethernet network switch capable of the UUT’s highest and lowest network speeds. The network connection must be live during all tests.

III. Test Procedure for Standby, Sleep and Idle for All Products

Measurement of ac power consumption of a computer should be conducted as follows:

UUT Preparation

1. Record the manufacturer and model name of the UUT.
2. Ensure that the UUT is connected to a live Ethernet (IEEE 802.3) network switch as specified in Section II., “Test Configuration,” above, and that the connection is live. The computer must maintain this live connection to the switch for the duration of testing, disregarding brief lapses when transitioning between link speeds.
3. Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test.
4. Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT. For a valid test to take place the meter should remain in place until all Standby, Sleep, and Idle power data is recorded.
5. Record the ac voltage.
6. Boot computer and wait until the operating system has fully loaded.
7. If necessary, run the initial operating system setup and allow all preliminary file indexing and other one-time/periodic processes to complete.

8. Record basic information about the computer's configuration – computer type, operating system name and version, processor type and speed, and total and available physical memory, etc.²
9. Record basic information about the video card - video card name, resolution, amount of onboard memory, and bits per pixel.³
10. Ensure that the UUT is configured as shipped including all accessories, power management settings, WOL enabling and software shipped by default. UUT should also be configured using the following requirements for all tests:
 - a. Desktop systems (including workstations and desktop-derived servers) shipped without accessories should be configured with a standard mouse, keyboard and external monitor.
 - b. Notebooks and tablets should include all accessories shipped with the system, and need not include a separate keyboard or mouse when equipped with an integrated pointing device or digitizer.
 - c. Notebooks and tablets should have the battery pack(s) removed for all tests. For systems where operation without a battery pack is not a supported configuration, the test may be performed with fully charged battery pack(s) installed, making sure to report this configuration in the test results.
 - d. Power to wireless radios should be turned off for all tests. This applies to wireless network adapters (e.g., 802.11) or device-to-device wireless protocols.
11. The following guidelines should be followed to configure power settings for displays (adjusting no other power management settings):
 - a. For computers with external displays (most desktops): use the monitor power management settings to prevent the monitor from powering down to ensure it stays on for the full length of the Idle test as described below.
 - b. For computers with integrated monitors (notebooks, tablets and integrated systems): use the power management settings to set the monitor to power down after 1 minute.
12. Shut down the computer.

Standby (Off Mode) Testing

13. With the UUT shut down and in Standby, set the meter to begin accumulating true power values at an interval of 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.⁴

Idle Mode Testing

14. Switch on the computer and begin recording elapsed time, starting either when the computer is initially switched on, or immediately after completing any log in activity necessary to fully boot the system. Once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed. Exactly 15 minutes after the initial boot or log in, set the meter to begin accumulating true power values at an interval of 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.

Sleep Mode Testing

15. After completing the Idle measurements, place the computer in Sleep mode. Reset the meter (if necessary) and begin accumulating true power values at an interval of 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.

² On Windows-based machines, much of this information can be found by selecting the following window: Start / Programs / Accessories / System Tools / System Information.

³ On Windows-based machines, this can be found by selecting the following window: Start / Programs / Accessories / System Tools / Components / Display.

⁴ Laboratory-grade, full-function meters can integrate values over time and report the average value automatically. Other meters would require the user to capture a series of changing values every 5 seconds for a five minute period and then compute the average manually.

16. If testing both WOL enabled and WOL disabled for Sleep, wake the computer and change the WOL from Sleep setting through the operating system settings or by other means. Place the computer back in Sleep mode and repeat step 14, recording Sleep power necessary for this alternate configuration.

Reporting Test Results

17. The test results must be reported to EPA or the European Commission, as appropriate, taking care to ensure that all required information has been included.

IV. Maximum Power Test for Workstations

The maximum power for workstations is found by the simultaneous operation of two industry standard benchmarks: Linpack to stress the core system (e.g., processor, memory, etc.) and SPECviewperf[®] (version 9.x or higher) to stress the system's GPU. Additional information on these benchmarks, including free downloads, can be found at the URLs found below:

Linpack <http://www.netlib.org/linpack/>
SPECviewperf[®] <http://www.spec.org/benchmarks.html#gpc>

This test must be repeated three times on the same UUT, and all three measurements must fall within a $\pm 2\%$ tolerance relative to the average of the three measured maximum power values.

Measurement of the maximum ac power consumption of a workstation should be conducted as follows:

UUT Preparation

1. Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test. The meter should be able to store and output the maximum power measurement reached during the test or be capable of another method of determining maximum power.
2. Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT.
3. Record the ac voltage.
4. Boot the computer and, if not already installed, install Linpack and SPECviewperf as indicated on the above Websites.
5. Set Linpack with all the defaults for the given architecture of the UUT and set the appropriate array size "n" for maximizing power draw during the test.
6. Ensure all guidelines set by the SPEC organization for running SPECviewperf are being met.

Maximum Power Testing

7. Set the meter to begin accumulating true power values at an interval of 1 reading per second, and begin taking measurements. Run SPECviewperf and as many simultaneous instances of Linpack as needed to fully stress the system.
8. Accumulate power values until SPECviewperf and all instances have completed running. Record the maximum power value attained during the test.

Reporting Test Results

9. The test results must be reported to EPA or the European Commission, taking care to ensure that all required information has been included.
10. Upon submittal of data, manufacturers must also include the following data:
 - a. Value of the n (the array size) used for Linpack,
 - b. Number of simultaneous copies of Linpack run during the test,
 - c. Version of SPECviewperf run for test,
 - d. All compiler optimizations used in compiling Linpack and SPECviewperf, and

- e. A precompiled binary for end users to download and run of both SPECviewperf and Linpack. These can be distributed either through a centralized standards body such as SPEC, by the OEM or by a related third party.

V. Continuing Verification

This testing procedure describes the method by which a single unit may be tested for compliance. An ongoing testing process is highly recommended to ensure that products from different production runs are in compliance with ENERGY STAR.

Annex B: ENERGY STAR Program Requirements for Computers: Version 5.0



ENERGY STAR[®] Program Requirements for Computers

Version 5.0

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ENERGY STAR[®] Program Requirements for Computers

Partner Commitments Version 5.0

Commitments

The following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacturing of ENERGY STAR qualified computers. The ENERGY STAR Partner must adhere to the following program requirements:

- comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be met for use of the ENERGY STAR certification mark on computers and specifying the testing criteria for computers. EPA may, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at EPA's request;
- comply with current ENERGY STAR Identity Guidelines, describing how the ENERGY STAR marks and name may be used. Partner is responsible for adhering to these guidelines and for ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance;
- work with resellers of Partner's products to help ensure that these products remain in compliance with ENERGY STAR requirements. Any party within the distribution channel of an ENERGY STAR qualified computer product that alters the power profile of a product after its date of manufacture through hardware or software modifications must ensure that the product continues to meet the ENERGY STAR requirements before delivering this product to the end customer. If the product no longer meets the requirements, it may not bear the ENERGY STAR mark;
- qualify at least one ENERGY STAR computer model within one year of activating the computers portion of the agreement. When Partner qualifies the product, it must meet the specification (e.g., Tier 1 or 2) in effect at that time;
- provide clear and consistent labeling of ENERGY STAR qualified computers. The ENERGY STAR mark must be clearly displayed:

1. On the top or front of the product. Labeling on the top or front of the product may be permanent or temporary. All temporary labeling must be affixed to the top or front of the product with an adhesive or cling-type application;

Electronic Labeling Option: Manufacturers have the option of using an alternative electronic labeling approach in place of this product labeling requirement, as long it meets the following requirements:

- The ENERGY STAR mark in cyan, black, or white (as described in "The ENERGY STAR Identity Guidelines" available at www.energystar.gov/logos) appears at system start-up. The electronic mark must display for a minimum of 5 seconds;
- The ENERGY STAR mark must be at least 10% of the screen by area, may not be smaller than 76 pixels x 78 pixels, and must be legible.

EPA will consider alternative proposals regarding approach, duration, or size for electronic labeling on a case-by-case basis.

2. In product literature (i.e., user manuals, spec sheets, etc.);
 3. On product packaging for products sold at retail; and
 4. On the manufacturer's Internet site where information about ENERGY STAR qualified models is displayed:
 - If information concerning ENERGY STAR is provided on the Partner Web site, as specified by the ENERGY STAR Web Linking Policy (this document can be found in the Partner Resources section on the ENERGY STAR Web site at www.energystar.gov), EPA may provide links where appropriate to the Partner Web site;
- agree to complete steps to educate users of their products about the benefits of power management by including the following information, in addition to that described in the User Information Requirements found in the ENERGY STAR Eligibility Criteria (Section 3.C), with each computer (i.e., in the user manual or on a box insert):
 1. Energy saving potential;
 2. Financial saving potential;
 3. Environmental benefits;
 4. Information on ENERGY STAR and a link to www.energystar.gov; and
 5. ENERGY STAR logo (used in accordance with "The ENERGY STAR Identity Guidelines" available at www.energystar.gov/logos).

In addition, a link should be made available to www.energystar.gov/powermanagement from computer product pages, product specifications, and related content pages.

At the manufacturer's request, EPA will supply suggested facts and figures related to the above criteria, template elements, or a complete template suitable for use in user guides or box inserts.

- provide to EPA, on at least an annual basis, an updated list of ENERGY STAR qualified computer models. Once the Partner submits its first list of ENERGY STAR qualified computer models, the Partner will be listed as an ENERGY STAR Partner. Partner must provide at least an annual update in order to remain on the list of participating product manufacturers;
- provide to EPA, on an annual basis, unit shipment data or other market indicators to assist in determining the market penetration of ENERGY STAR. Specifically, Partner must submit the total number of ENERGY STAR qualified computers shipped (in units by model) or an equivalent measurement as agreed to in advance by EPA and Partner. Partner is also encouraged to provide ENERGY STAR qualified unit shipment data segmented by meaningful product characteristics (e.g., capacity, size, speed, or other as relevant), total unit shipments for each model in its product line, and percent of total unit shipments that qualify as ENERGY STAR. The data for each calendar year should be submitted to EPA, preferably in electronic format, no later than the following March and may be provided directly from the Partner or through a third party. The data will be used by EPA only for program evaluation purposes and will be closely controlled. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;
- notify EPA of a change in the designated responsible party or contacts for computers within 30 days;
- participate in the ENERGY STAR Verification Testing Program. EPA will select computers each year for verification testing. The manufacturer of each selected product will be required to conduct testing of the specified products as outlined in the Verification Testing Guidelines and Procedures Manual. These requirements will be effective with Version 5.0, and may be modified and updated outside the official specification revision process. The manual for this program will be available on the ENERGY STAR Office Equipment Partner Resources page on the ENERGY STAR website. If the sample fails to meet the performance requirements of the ENERGY STAR specification, the failure will be

addressed under EPA's product failure and dispute protocol and if applicable, the procedure for delisting products.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures and should keep EPA informed on the progress of these efforts:

- consider energy efficiency improvements in company facilities and pursue the ENERGY STAR mark for buildings;
- purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes;
- ensure the power management feature is enabled on all ENERGY STAR qualified displays and computers in use in company facilities, particularly upon installation and after service is performed;
- provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified product models;
- provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, communicate, and/or promote Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR Web pages, etc. The plan may be as simple as providing a list of planned activities or planned milestones that Partner would like EPA to be aware of. For example, activities may include: (1) increase the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrate the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) provide information to users (via the Web site and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4) build awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event;
- provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message;
- join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. SmartWay Transport works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit www.epa.gov/smartway;
- join EPA's Climate Leaders Partnership to inventory and reduce greenhouse gas emissions. Through participation, companies create a credible record of their accomplishments and receive EPA recognition as corporate environmental leaders. For more information on Climate Leaders, visit www.epa.gov/climateleaders;
- join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities, visit <http://www.epa.gov/grnpower>.



ENERGY STAR® Program Requirements for Computers

Eligibility Criteria (Version 5.0)

Below is the Version 5.0 product specification for ENERGY STAR qualified computers. A product must meet all of the identified criteria to earn the ENERGY STAR.

1) Definitions: Below are the definitions of the relevant terms in this document.

- A. Computer: A device which performs logical operations and processes data. Computers are composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; (2) user input devices such as a keyboard, mouse, digitizer or game controller; and (3) a computer display screen to output information. For the purposes of this specification, computers include both stationary and portable units, including desktop computers, gaming consoles, integrated desktop computers, notebook computers, small-scale servers, thin clients, and workstations. Although computers must be capable of using input devices and computer displays, as noted in numbers 2 and 3 above, computer systems do not need to include these devices on shipment to meet this definition.

Components

- B. Computer Display: A display screen and its associated electronics encased in a single housing, or within the computer housing (e.g., notebook or 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).
- C. Discrete Graphics Processing Unit (GPU): A graphics processor with a local memory controller interface and a local, graphics-specific memory.
- D. External Power Supply: 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.
- E. Internal Power Supply: 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 must be contained within the computer casing but 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.

Computer Types

- F. Desktop Computer: 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.
- G. Small-Scale Server: A computer that typically uses desktop components in a desktop form factor, but is designed primarily to be a storage host for other computers. A computer must have the following characteristics to be considered a Small-Scale Server:
- 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;
 - Intended to be operational 24 hours/day and 7 days/week, and unscheduled downtime is extremely low (on the order of hours/year);
 - Capable of operating in a simultaneous multi-user environment serving several users through networked client units; and
 - 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).

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.

This specification does not cover Computer Servers as defined in the ENERGY STAR Version 1.0 Computer Server specification. Small-Scale Servers covered by this specification are limited to computers marketed for non-datacenter operation (e.g. homes, small offices).

- H. Game Console: A standalone computer-like device whose primary use is to play video games. Game consoles use a hardware architecture based in part on typical computer components (e.g., processors, system memory, video architecture, optical and/or hard drives, etc.). The primary input for game consoles are special hand held controllers rather than the mouse and keyboard used by more conventional computer types. Game consoles are also equipped with audio visual outputs for use with televisions as the primary display, rather than (or in addition to) an external or integrated display. These devices do not typically use a conventional PC operating system, but often perform a variety of multimedia functions such as: DVD/CD playback, digital picture viewing, and digital music playback. Handheld gaming devices, typically battery powered and intended for use with an integral display as the primary display, are not covered by this specification.
- I. Integrated Desktop Computer: 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.
- J. Thin Client: An independently-powered computer that relies on a connection to remote computing resources to obtain primary functionality. Main computing (e.g., program execution, data storage, interaction with other Internet resources, etc.) takes place using the remote computing resources. Thin Clients covered by this specification are limited to devices with no rotational storage media integral to the computer. The main unit of a Thin Client covered by this specification must be intended for location in a permanent location (e.g. on a desk) and not for portability.

- K. **Notebook Computer:** 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. Notebooks must utilize an integrated computer display and be capable of operation off of an integrated battery or other portable power source. In addition, most notebooks use an external power supply 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 specification, docking stations are considered accessories and therefore, the performance levels associated with notebooks presented in Section 3, below, do not include them. Tablet PCs, which may use touch-sensitive screens along with or instead of other input devices, are considered Notebook Computers in this specification.
- L. **Workstation:** A high-performance, single-user computer typically used for graphics, CAD, software development, financial and scientific applications among other compute intensive tasks. To qualify as a workstation, a computer must:

- Be marketed as a workstation;
- Have a mean time between failures (MTBF) of at least 15,000 hours based on either Bellcore TR-NWT-000332, issue 6, 12/97 or field collected data; and
- Support error-correcting code (ECC) and/or buffered memory.

In addition, a workstation must meet three of the following six optional characteristics:

- Have supplemental power support for high-end graphics (i.e., PCI-E 6-pin 12V supplemental power feed);
- System is wired for greater than x4 PCI-E on the motherboard in addition to the graphics slot(s) and/or PCI-X support;
- Does not support Uniform Memory Access (UMA) graphics;
- Includes 5 or more PCI, PCIe or PCI-X slots;
- Capable of multi-processor support for two or more processors (must support physically separate processor packages/sockets, i.e., not met with support for a single multi core processor); and/or
- Be qualified by at least 2 Independent Software Vendor (ISV) product certifications; these certifications can be in process, but must be completed within 3 months of qualification.

Operational Modes

- M. **Off Mode:** The power consumption level in the lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. For systems where ACPI standards are applicable, Off Mode correlates to ACPI System Level S5 state.
- N. **Sleep Mode:** A low power state that the computer is capable of entering automatically after a period of inactivity or by manual selection. A computer with sleep capability can quickly "wake" in response to network connections or user interface devices with a latency of ≤ 5 seconds from initiation of wake event to system becoming fully usable including rendering of display. For systems where ACPI standards are applicable, Sleep mode most commonly correlates to ACPI System Level S3 (suspend to RAM) state.
- O. **Idle State:** The state in which the operating system and other software have completed loading, a user profile has been created, the machine is not asleep, and activity is limited to those basic

applications that the system starts by default.

- P. Active State: The state in which the computer is carrying out useful work in response to a) prior or concurrent user input or b) prior or concurrent instruction over the network. This state includes active processing, seeking data from storage, memory, or cache, including idle state time while awaiting further user input and before entering low power modes.
- Q. Typical Energy Consumption (TEC): A method of testing and comparing the energy performance of computers, which focuses on the typical electricity consumed by a product while in normal operation during a representative period of time. For Desktops and Notebooks, the key criterion of the TEC approach is a value for typical annual electricity use, measured in kilowatt-hours (kWh), using measurements of average operational mode power levels scaled by an assumed typical usage model (duty cycle). For Workstations, requirements are based on a TEC power value calculated from operational mode power levels, maximum power, and an assumed duty cycle.

Networking and Power Management

- R. Network Interface: The components (hardware and software) whose primary function is to make the computer capable of communicating over one or more network technologies. Examples of Network Interfaces are IEEE 802.3 (Ethernet) and IEEE 802.11 (Wi-Fi).
- S. Wake Event: A user, scheduled, or external event or stimulus that causes the computer to transition from Sleep or Off to active mode of operation. Examples of wake events include, but are not limited to: movement of the mouse, keyboard activity, controller input, real-time clock event, or a button press on the chassis, and in the case of external events, stimulus conveyed via a remote control, network, modem, etc.
- T. Wake On LAN (WOL): Functionality which allows a computer to wake from Sleep or Off when directed by a network request via Ethernet.
- U. Full Network Connectivity: The ability of the computer to maintain network presence while in sleep and intelligently wake when further processing is required (including occasional processing required to maintain network presence). Maintaining network presence may include obtaining and/or defending an assigned interface or network address, responding to requests from other nodes on the network, or maintaining existing network connections, all while in the sleep state. In this fashion, presence of the computer, its network services and applications, is maintained even though the computer is in sleep. From the vantage point of the network, a sleeping computer with full network connectivity is functionally equivalent to an idle computer with respect to common applications and usage models. Full network connectivity in sleep is not limited to a specific set of protocols but can cover applications installed after initial installation.

Marketing and Shipment Channels

- V. Enterprise Channels: Sales channels normally used by large and medium-sized business, government organizations, educational institutions, or other organizations purchasing computers used in managed client/server environments.
- W. Model Number: A unique marketing name that applies to a specific hardware/software configuration (i.e. operating system, types or processors, memory, GPU, etc.) that is either pre-defined, or a configuration that is selected by the customer.
- X. Model Name: A marketing name that includes reference to both the PC model family number, a short description of the product, or branding references.

Y. **Product Family:** A high-level description referring to a group of computers typically sharing one chassis/motherboard combination that often contains hundreds of possible hardware and software configurations.

2) Qualifying Products: Computers must meet the computer definition as well as one of the product type definitions provided in Section 1, above, to qualify as ENERGY STAR. The following table provides a list of the types of computers that are (and are not) eligible for ENERGY STAR.

Products Covered by Version 5.0 Specification	Products Not Covered by Version 5.0 Specification
<ul style="list-style-type: none"> • Desktop Computers • Integrated Desktop Computers • Notebook Computers • Workstations • Game Consoles • Small-Scale Servers • Thin Clients 	<ul style="list-style-type: none"> • Computer Servers (as defined in Version 1.0 Computer Server specification) • Handhelds, PDAs, and Smartphones

3) Energy Efficiency and Power Management Criteria: Computers must meet the requirements below to qualify as ENERGY STAR. The Version 5.0 effective date is covered in Section 5 of this specification.

(A) Power Supply Efficiency Requirements - Requirements are applicable to all product categories covered by the ENERGY STAR Computer Specification:

Computers Using an Internal Power Supply: 85% minimum efficiency at 50% of rated output and 82% minimum efficiency at 20% and 100% of rated output, with Power Factor \geq 0.9 at 100% of rated output.

Computers Using an External Power Supply: External Power Supplies sold with ENERGY STAR computers must be ENERGY STAR qualified or meet the no-load and active mode efficiency levels provided in the ENERGY STAR Program Requirements for Single Voltage External Ac-Ac and Ac-Dc Power Supplies, Version 2.0. The ENERGY STAR specification and qualified product list can be found at www.energystar.gov/powersupplies. Note: This performance requirement also applies to multiple voltage output external power supplies as tested in accordance to the Internal Power Supply test method referenced in Section 4, below.

(B) Efficiency and Performance Requirements:

1) Desktop, Integrated Desktop, and Notebook Levels:

Desktop Categories for TEC Criteria: For the purposes of determining TEC levels, desktops and integrated desktops must qualify under Categories A, B, C, or D as defined below:

Category A: All desktop computers that do not meet the definition of Category B, Category C, or Category D below will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B, desktops must have:

- Equal to 2 Physical Cores; and
- Greater than or equal to 2 gigabytes (GB) of System Memory.

Category C: To qualify under Category C, desktops must have:

- Greater than 2 Physical Cores.

In addition to the requirement above, models qualifying under Category C must be configured with a minimum of 1 of the following 2 characteristics:

- Greater than or equal to 2 gigabytes (GB) of System Memory; and/or
- A Discrete GPU.

Category D: To qualify under Category D, desktops must have:

- Greater than or equal to 4 Physical Cores.

In addition to the requirement above, models qualifying under Category D must be configured with a minimum of 1 of the following 2 characteristics:

- Greater than or equal to 4 gigabytes (GB) of System Memory; and/or
- A Discrete GPU with a Frame Buffer Width greater than 128-bit.

Notebook Categories for TEC Criteria: For the purposes of determining TEC levels, notebooks must qualify under Categories A, B, or C as defined below:

Category A: All notebook computers that do not meet the definition of Category B or Category C below will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B, notebooks must have:

- A Discrete GPU.

Category C: To qualify under Category C, notebooks must have:

- Greater than or equal to 2 Physical Cores;
- Greater than or equal to 2 gigabytes (GB) of System Memory; and
- A Discrete GPU with a Frame Buffer Width greater than 128-bit.

TEC (Desktop and Notebook product categories): The following tables indicate the required TEC levels for the 5.0 Specification. Table 1 below lists TEC requirements for Version 5.0, while Table 2 gives weightings for each operational mode by product type. TEC will be determined using the formula below:

$$E_{TEC} = (8760/1000) * (P_{off} * T_{off} + P_{sleep} * T_{sleep} + P_{idle} * T_{idle})$$

where all P_x are power values in watts, all T_x are Time values in % of year, and the TEC E_{TEC} is in units of kWh and represents annual energy consumption based on mode weightings in Table 2.

Table 1: E_{TEC} Requirement – Desktops and Notebooks

	Desktops and Integrated Computers (kWh)	Notebook Computers (kWh)
TEC (kWh)	Category A: ≤ 148.0 Category B: ≤ 175.0 Category C: ≤ 209.0 Category D: ≤ 234.0	Category A: ≤ 40.0 Category B: ≤ 53.0 Category C: ≤ 88.5
Capability Adjustments		
Memory	1 kWh (per GB over base) <i>Base Memory:</i> Categories A, B and C: 2 GB Category D: 4 GB	0.4 kWh (per GB over 4)
Premium Graphics (for Discrete GPUs with specified Frame Buffer Widths)	Cat. A, B: 35 kWh (FB Width ≤ 128-bit) 50 kWh (FB Width > 128-bit) Cat. C, D: 50 kWh (FB Width > 128-bit)	Cat. B: 3 kWh (FB Width > 64-bit)
Additional Internal Storage	25 kWh	3 kWh

Table 2: Operational Mode Weighting – Desktops and Notebooks

	Desktop		Notebook	
	Conventional	Proxying*	Conventional	Proxying*
Toff	55%	40%	60%	45%
Tsleep	5%	30%	10%	30%
Tidle	40%	30%	30%	25%

Note: Proxying refers to a computer that maintains Full Network Connectivity as defined in Section 1 of this specification. For a system to qualify under the proxying weightings above, it must meet a non-proprietary proxying standard that has been approved by the EPA and the European Union as meeting the goals of ENERGY STAR. Such approval must be in place prior to submittal of product data for qualification. See Section 3.C, Qualifying Computers with Power Management Capabilities, for further information and testing requirements.

2) Workstation Levels:

P_{TEC} (Workstation product category): The following tables indicate the required P_{TEC} levels for the 5.0 Specification. Table 3 below lists P_{TEC} requirements for Version 5.0, while Table 4 gives weightings for each operational mode. P_{TEC} will be determined using the formula below:

$$P_{TEC} = 0.35 * P_{off} + 0.10 * P_{sleep} + 0.55 * P_{idle}$$

where all P_x are power values in watts.

Table 3: P_{TEC} Requirement - Workstations

$P_{TEC} \leq 0.28 * [P_{max} + (\# \text{ HDD} * 5)]$
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Table 4: Operational Mode Weighting - Workstations

Toff	35%
Tsleep	10%
Tidle	55%
<i>Note: Weightings are included in the P_{TEC} formula, above.</i>	

Multiple Graphics Devices (Workstations): Workstations that meet ENERGY STAR requirements with a single graphics device may also qualify a configuration with more than one graphics device, provided the additional hardware configuration is identical with the exception of the additional graphics device(s). The use of multiple graphics includes, but is not limited to, driving multiple displays and ganging for high-performance, multi-GPU configurations (e.g. ATI Crossfire, NVIDIA SLI). In such cases, and until such time as SPECviewperf® supports multiple graphics threads, manufacturers may submit the test data for the workstation with the single graphics device for both configurations without retesting the system.

3) Game Console Levels:

Table 5: Game Console Requirements (TBD) – Effective July 1, 2010

Note: To allow for time to further refine requirements and commence efforts to engage game publishers in the ENERGY STAR process, development of game console requirements will continue through the close of the calendar year, 2008. This effort will continue building on the concepts and requirements present in previous drafts of the Computer specification, and EPA will release a next draft of Game Console requirements shortly. The continued work on game consoles will not impact the effective date for the remainder of the computer specification.

Once development of these game console requirements is completed, the final requirements will be wrapped into the Final Version 5.0 Specification. No changes to the 5.0 requirements for other product types will be made.

4) Small-Scale Server Levels:

For the purposes of determining Idle state levels, Small-Scale Servers must qualify under Categories A or B, as defined below:

Category A: All Small-Scale Servers that do not meet the definition of Category B will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B Small-Scale Servers must have:

- Processor(s) with greater than 1 physical core or greater than 1 discrete processor; and
- Minimum of 1 gigabyte of system memory.

**Table 6: Small-Scale Server Efficiency Requirements
Small-Scale Server Operational Mode Power Requirements**

Off Mode:	≤ 2.0 W	
Idle State:		
Category A:	≤ 50.0 W	
Category B:	≤ 65.0 W	
Capability		Additional Power Allowance
Wake On LAN (WOL) (Applies only if computer is shipped with WOL enabled)		+ 0.7 W for Off

5) Thin Client Levels

Thin Client Categories for Idle Criteria: For the purposes of determining Idle levels, Thin Clients must qualify under Categories A or B as defined below:

Category A: All Thin Clients that do not meet the definition of Category B, below, will be considered under Category A for ENERGY STAR qualification.

Category B: To qualify under Category B, Thin Clients must:

- Support local multimedia encode/decode.

Table 7 : Thin Client Efficiency Requirements

Thin Client Operational Mode Power Requirements	
Off Mode:	≤ 2 W
Sleep Mode (if applicable):	≤ 2 W
Idle State:	
Category A:	≤ 12.0 W
Category B:	≤ 15.0 W
Capability	Additional Power Allowance
Wake On LAN (WOL) (Applies only if computer is shipped with WOL enabled)	+ 0.7 W for Sleep + 0.7 W for Off

(C) Power Management Requirements: Products must meet the power management requirements detailed in Table 8, below, and be tested as shipped.

Table 8: Power Management Requirements

Specification Requirement		Applicable to	
Shipment Requirements			
Sleep Mode	Shipped with a Sleep mode which is set to activate within 30 minutes (1 hr for Game Consoles) of user inactivity. Computers shall reduce the speed of any active 1 Gb/s Ethernet network links when transitioning to Sleep or Off. (Note: Game Consoles may transition to a full off mode within the timeframe above in lieu of sleep.)	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	√
		Small-Scale Servers	
		Thin Clients	
Display Sleep Mode	Shipped with the display's Sleep mode set to activate within 15 minutes of user inactivity.	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	√
		Small-Scale Servers (if computer display is present)	√
		Thin Clients	√

Network Requirements for Power Management			
Wake on LAN (WOL)	Computers with Ethernet capability shall have the ability to enable and disable WOL for Sleep mode.	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	
		Small-Scale Servers	√
		Thin Clients (<i>Only applies if software updates from the centrally managed network are conducted while the unit is in sleep or off mode. Thin Clients whose standard framework for upgrading client software does not require off-hours scheduling are exempt from the requirement.</i>)	√
	<i>Applies to computers shipped through Enterprise Channels, only:</i> Computers with Ethernet capability must meet one of the following requirements: <ul style="list-style-type: none"> ▪ be shipped with Wake On LAN (WOL) enabled from the Sleep mode when operating on ac power (i.e. notebooks may automatically disable WOL when disconnected from the mains); or ▪ provide control to enable WOL that is sufficiently-accessible from both the client operating system user interface and over the network if computer is shipped to enterprise without WOL enabled. 	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	
		Small-Scale Servers	√
		Thin Clients (<i>Only applies if software updates from the centrally managed network are conducted while the unit is in sleep or off mode. Thin Clients whose standard framework for upgrading client software does not require off-hours scheduling are exempt from the requirement.</i>)	√
Wake Management	<i>Applies to computers shipped through Enterprise Channels, only:</i> Computers with Ethernet capability shall be capable of both remote (via network) and scheduled wake events from Sleep mode (e.g. Real Time Clock). Manufacturers shall ensure, where the manufacturer has control (i.e., configured through hardware settings rather than software settings), that these settings can be managed centrally, as the client wishes, with tools provided by the manufacturer.	Desktop Computers	√
		Integrated Desktop Computers	√
		Notebook Computers	√
		Workstations	√
		Game Consoles	
		Small-Scale Servers	√
		Thin Clients	√

For all computers with WOL enabled, any directed packet filters shall be enabled and set to an industry standard default configuration. Until one (or more) standards are agreed upon, partners are asked to provide their direct packet filter configurations to EPA for publication on the Website to stimulate discussion and development of standard configurations.

Qualifying Computers with Power Management Capabilities: The following requirements should be followed when determining whether models should be qualified with or without WOL:

Off: Computers shall be tested and reported as shipped for Off. Models that will be shipped with WOL enabled for Off shall be tested with WOL enabled. Likewise, products shipped with WOL disabled for Off shall be tested with WOL disabled.

Sleep: Computers shall be tested and reported as shipped for Sleep. Models sold through enterprise channels, as defined in Section 1, definition V, shall be tested, qualified, and shipped with WOL enabled/disabled based on the requirements in Table 8. Products going directly to consumers through normal retail channels only are not required to be shipped with WOL enabled from Sleep, and may be tested, qualified, and shipped with WOL either enabled or disabled.

Proxying: Desktop, Integrated Desktop, and Notebook Computers shall be tested and reported for Idle, Sleep, and Off with proxying features enabled or disabled as shipped. For a system to qualify using TEC weightings for proxying, it must meet a proxying standard that has been approved by the EPA and European Union as meeting the goals of ENERGY STAR. Such approval must be in place prior to submittal of product data for qualification.

Customer Software and Management Service Pre-Provisioning:

The Partner will remain responsible for testing products and qualifying them as they ship them. If the product meets and is qualified as ENERGY STAR at this point, it can be labeled as such.

If the Partner is hired by a customer to load a custom image, the Partner must take the following steps:

- The Partner must let the customer know that their product may not meet ENERGY STAR with the custom image loaded (*a sample letter is available for use from the ENERGY STAR website that can be shared with customers*).
- The Partner must encourage their customer to test the product for ENERGY STAR compliance.
- The Partner must encourage their customer, should the product no longer meet ENERGY STAR, to make use of EPA's free technical assistance that can assist with Power Management performance. Please see tools as well as contact information at: www.energystar.gov/fedofficeenergy.

Although EPA believes that Partners in partnership with EPA can help ensure their products continue to be leadership products when it comes to efficiency once deployed, EPA is committed to helping to reduce the likelihood that custom images will disrupt a product's ability to meet ENERGY STAR requirements. For example, EPA is engaging in federal desktop core configuration discussions with the intention of facilitating the development of a core configuration for Federal Agencies that supports energy efficiency. In April 2008, EPA also launched the ENERGY STAR Low Carbon IT Campaign in an effort to get more businesses and organizations to implement power management. More information on the campaign can be found at: www.energystar.gov/lowcarbonit.

User Information Requirement: In order to ensure that purchasers/users are properly informed on the benefits of power management, the manufacturer will include with each computer, one of the following:

- Information on ENERGY STAR and the benefits of power management in either a hard copy or electronic copy of the user manual. This information should be near the front of the user guide; or
- A package or box insert on ENERGY STAR and the benefits of power management.

Either option must at least include the following information:

- Notice that the computer has been shipped enabled for power management and what the time settings are (either the default settings for the system or a note stating that the default settings for

the computer comply with the ENERGY STAR requirements of less than 15 min of user inactivity for the display and less than 30 min of inactivity for the computer, recommended by the ENERGY STAR program for optimal energy savings); and

- How to properly wake the computer from Sleep mode.

(D) Voluntary Requirements

User Interface: Although not mandatory, manufacturers are strongly recommended to design products in accordance with the Power Control User Interface Standard — IEEE 1621 (formally known as “Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments”). Compliance with IEEE 1621 will make power controls more consistent and intuitive across all electronic devices. For more information on the standard see <http://eetd.LBL.gov/Controls>.

4) Test Procedures: Manufacturers are required to perform tests and self-certify those models that meet the ENERGY STAR guidelines.

- In performing these tests, partner agrees to use the test procedures provided in Table 9, below.
- The test results must be reported to EPA or the European Commission, as appropriate.

Additional testing and reporting requirements are provided below.

- A. Number of Units Required for TEC or Idle Testing: Manufacturers may initially test a single unit for qualification. If the initial unit tested is less than or equal to the applicable requirement for TEC or Idle but falls within 10% of that level, one additional unit of the same model with an identical configuration must also be tested. Manufacturers shall report test values for both units. To qualify as ENERGY STAR, both units must meet the maximum TEC or Idle level for that product and that product category.

Note: This additional testing is only required for TEC qualification (*Desktops, Integrated Desktops, Notebooks, Workstations*) and Idle qualification (*Small-Scale Servers, Thin Clients*) – only one unit is required to be tested for Sleep and Off if such requirements apply. The following examples further illustrate this approach:

1. A *Category A Desktop* must meet a TEC level of 148.0 kWh or less, making 133.2 kWh the 10% threshold for additional testing.
 - If the first unit is measured at 130 kWh, no more testing is needed and the model qualifies (130 kWh is 12% more efficient than the specification and is therefore “outside” the 10% threshold).
 - If the first unit is measured at 133.2 kWh, no more testing is needed and the model qualifies (133.2 kWh is exactly 10% more efficient than the specification).
 - If the first unit is measured at 135 kWh, then an additional unit must be tested to determine qualification (135 kWh is only 9% more efficient than the specification and is “within” the 10% threshold).
 - If the two units are then tested at 135 and 151 kWh, the model does not qualify as ENERGY STAR—even though the average is 143 kWh — because one of the values exceeds the ENERGY STAR specification.
 - If the two units are then tested at 135 and 147 kWh, the model does qualify as ENERGY STAR because both values meet the ENERGY STAR specification of 148.0 kWh.
2. A *Category A Small-Scale Server* must meet an Idle level of 50 watts or less, making 45 Watts the 10% threshold for additional testing. The following scenarios could then occur when testing a model for qualification:

- If the first unit is measured at 44 watts, no more testing is needed and the model qualifies (44 watts is 12% more efficient than the specification and is therefore “outside” the 10% threshold).
- If the first unit is measured at 45 watts, no more testing is needed and the model qualifies (45 watts is exactly 10% more efficient than the specification).
- If the first unit is measured at 47 watts, then an additional unit must be tested to determine qualification (47 Watts is only 6% more efficient than the specification and is “within” the 10% threshold).
- If the two units are then tested at 47 and 51 watts, the model does not qualify as ENERGY STAR—even though the average is 49 watts— because one of the values (51) exceeds the ENERGY STAR specification.
- If the two units are then tested at 47 and 49 watts, the model does qualify as ENERGY STAR because both values meet the ENERGY STAR specification of 50 watts.

B. Models Capable of Operating at Multiple Voltage/Frequency Combinations: Manufacturers shall test their products based on the market(s) in which the models will be sold and promoted as ENERGY STAR qualified.

For products that are sold as ENERGY STAR in multiple international markets and, therefore, rated at multiple input voltages, the manufacturer must test at and report the required measured power consumption and efficiency values at all relevant voltage/frequency combinations. For example, a manufacturer that is shipping the same model to the United States and Europe must measure, meet the specification, and report test values at both 115 Volts/60 Hz and 230 Volts/50 Hz in order to qualify the model as ENERGY STAR in both markets. If a model qualifies as ENERGY STAR at only one voltage/frequency combination (e.g., 115 Volts/60 Hz), then it may only be qualified and promoted as ENERGY STAR in those regions that support the tested voltage/frequency combination (e.g., North America and Taiwan).

Table 9: Test Procedures

Product Category	Specification Requirement	Test Protocol	Source
All Computers	Power Supply Efficiency	<p>IPS: <i>Generalized Internal Power Supply Efficiency Test Protocol Rev. 6.4.2</i></p> <p>EPS: <i>ENERGY STAR Test Method for External Power Supplies</i></p> <p><i>Note: Should any information/procedures in addition to those described by the Internal Power Supply Efficiency Protocol be required in order to test an Internal Power Supply, partners must make available to EPA upon request the test setup used to acquire IPS data used in a product submittal.</i></p>	<p>IPS: www.efficientpowersupplies.org</p> <p>EPS: www.energystar.gov/powersupplies</p>
Desktop, Integrated, and Notebook Computers	E_{TEC} (from measurements of Off Mode, Sleep Mode, and Idle State)	ENERGY STAR Computer Test Method (Version 5.0), Section III	Appendix A
Workstations	P_{TEC} (from measurements of Off Mode, Sleep Mode, Idle State, and Maximum Power)	ENERGY STAR Computer Test Method (Version 5.0), Section III-IV	
Game Consoles	Off Mode, and Sleep/Auto-Off	ENERGY STAR Computer Test Method (Version 5.0), Section V	
Small-Scale Servers	Off Mode and Idle State	ENERGY STAR Computer Test Method (Version 5.0), Section III	
Thin Clients	Off Mode, Sleep Mode, and Idle State	ENERGY STAR Computer Test Method (Version 5.0), Section III	

- C. Qualifying Families of Products: Models that are unchanged or that differ only in finish from those sold in a previous year may remain qualified without the submission of new test data assuming the specification remains unchanged. If a product model is offered in the market in multiple configurations or styles, as a product “family” or series, the partner may report and qualify the product under a single model number, as long as all of the models within that family or series meet

meet either of the following requirements:

- Computers that are built on the same platform and are identical in every respect except for housing and color may be qualified through submission of test data for a single, representative model.
- If a product model is offered in the market in multiple configurations, the partner may report and qualify the product under a single unique model identifier number that represents the highest power configuration available in the family, rather than reporting each and every individual model in the family; there must not be higher consuming configurations of the same product model than the representative configuration. In this case, the highest configuration would consist of: the highest power processor, the maximum memory configuration, the highest power GPU, etc. For systems which meet the definition for multiple categories (as defined in section 3.B) depending on the specific configuration, manufacturers will have to submit the highest power configuration for each category under which they would like the system to qualify. For example, a system that could be configured either as a Category A or a Category B desktop would require a submittal of the highest power configuration for both categories in order to qualify as ENERGY STAR. If a product could be configured to meet all three categories, it would then have to submit data for the highest power configuration in all categories. Manufacturers will be held accountable for any efficiency claims made about all other models in the family, including those not tested or for which data was not reported.

All units/configurations associated with a product model designation, for which a Partner is seeking ENERGY STAR qualification, must meet the ENERGY STAR requirements. If a Partner wishes to qualify configurations of a model for which non-qualifying alternative configurations exist, the Partner must assign the qualifying configurations an identifier in the model name/number that is unique to ENERGY STAR Qualified configurations. This identifier must be used consistently in association with the qualifying configurations in marketing/sales materials and on the ENERGY STAR list of qualified products (e.g. model A1234 for baseline configurations and A1234-ES for ENERGY STAR qualifying configurations).

5) Effective Date: The date that manufacturers may begin to qualify products as ENERGY STAR will be defined as the *effective date* of the agreement. The ENERGY STAR Version 5.0 Computers Specification effective date is July 1, 2009. All products (except for Game Consoles), including models originally qualified under Version 4.0, with a **date of manufacture** on or after **July 1, 2009** must meet the Version 5.0 requirements in order to qualify for ENERGY STAR. Game Consoles with a **date of manufacture** on or after **July 1, 2010** must meet the Version 5.0 requirements in order to qualify for ENERGY STAR. Any previously executed agreement on the subject of ENERGY STAR qualified computers shall be terminated effective June 30, 2009.

6) Future Specification Revisions: EPA reserves the right to revise the specification should technological and/or market changes affect its usefulness to consumers or industry or its impact on the environment. In keeping with current policy, revisions to the specification will be discussed with stakeholders. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model. To qualify as ENERGY STAR, a product model must meet the ENERGY STAR specification in effect on the model's date of manufacture.

APPENDIX A: ENERGY STAR Test Procedure for Determining the Power Use of Computers/Game Consoles in Off, Sleep, and Idle

The following protocol should be followed when measuring power consumption levels of computers/game consoles for compliance with the Off, Sleep, and Idle levels provided in the ENERGY STAR Version 5.0 Computer Specification. Partners must measure a representative sample of the configuration as shipped to the customer. However, the Partner does not need to consider power consumption changes that may result from component additions, BIOS and/or software settings made by the computer user after sale of product. *This procedure is intended to be followed in order and the mode being tested is labeled where appropriate.*

Computers must be tested with configuration and settings as shipped, unless otherwise specified in the test procedure in this Appendix A. Steps requiring alternative setup are marked with an asterisk (“ ”).*

I. Definitions

Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the Version 5.0 ENERGY STAR Eligibility Criteria for Computers.

UUT

UUT is an acronym for “unit under test,” which in this case refers to the computer being tested.

UPS

UPS is an acronym for “Uninterruptible Power Supply,” which refers to a combination of converters, switches and energy storage means, for example batteries, constituting a power supply for maintaining continuity of load power in case of input power failure.

II. Testing Requirements

Approved Meter

Approved meters will include the following attributes¹:

- Power resolution of 1 mW or better;
- An available current crest factor of 3 or more at its rated range value; and
- Lower bound on the current range of 10mA or less.

The following attributes in addition to those above are suggested:

- Frequency response of at least 3 kHz; and
- Calibration with a standard that is traceable to the U.S. National Institute of Standards and Technology (NIST).

It is also desirable for measurement instruments to be able to average power accurately over any user selected time interval (this is usually done with an internal math’s calculation dividing accumulated energy by time within the meter, which is the most accurate approach). As an alternative, the measurement instrument would have to be capable of integrating energy over any user selected time interval with an energy resolution of less than or equal to 0.1 mWh and integrating time displayed with a resolution of 1 second or less.

¹ *Characteristics of approved meters taken from IEC 62301 Ed 1.0: Measurement of Standby Power*

Accuracy

Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level. Measurements of power of less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level. The power measurement instrument shall have a resolution of:

- 0.01 W or better for power measurements of 10 W or less;
- 0.1 W or better for power measurements of greater than 10 W up to 100 W; and
- 1 W or better for power measurements of greater than 100 W.

All power figures should be in watts and rounded to the second decimal place. For loads greater than or equal to 10 W, three significant figures shall be reported.

Test Conditions

Supply Voltage:	North America/Taiwan:	115 (± 1%) Volts AC, 60 Hz (± 1%)
	Europe/Australia/New Zealand:	230 (± 1%) Volts AC, 50 Hz (± 1%)
	Japan:	100 (± 1%) Volts AC, 50 Hz (± 1%)/60 Hz (± 1%)
		<i>Note:</i> For products rated for > 1.5 kW maximum power, the voltage range is ± 4%
Total Harmonic Distortion (THD) (Voltage):	< 2% THD (< 5% for products which are rated for > 1.5 kW maximum power)	
Ambient Temperature:	23°C ± 5°C	
Relative Humidity:	10 – 80 %	

(Reference IEC 62301: Household Electrical Appliances – Measurement of Standby Power, Sections 4.2, 4.3, 4.4)

Test Configuration

Power consumption of a computer shall be measured and tested from an ac source to the UUT.

If the UUT supports Ethernet, it must be connected to an Ethernet network switch capable of the UUT's highest and lowest network speeds. The network connection must be live during all tests.

III. Test Procedure for Off, Sleep and Idle for All Computer Products

Measurement of ac power consumption of a computer should be conducted as follows:

UUT Preparation

1. Record the manufacturer and model name of the UUT.
2. Ensure that the UUT is connected to network resources as detailed below, and that the UUT maintains this live connection for the duration of testing, disregarding brief lapses when transitioning between link speeds.
 - a. *Desktops, Integrated Desktops, and Notebooks* shall be connected to a live Ethernet (IEEE 802.3) network switch as specified in Section II., "Test Configuration," above. The computer must maintain this live connection to the switch for the duration of testing, disregarding brief lapses when transitioning between link speeds. Computers without Ethernet capability must maintain a live wireless connection to a wireless router or network access point for the duration of testing.
 - b. *Small-Scale Servers* shall be connected to a live Ethernet (IEEE 802.3) network switch as specified in Section II., "Test Configuration," above, and that the connection is live.

- c. *Thin Clients* shall be connected to a live server via a live Ethernet (IEEE 802.3) network switch and shall run intended terminal/remote connection software.
3. Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test.
4. Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT. For a valid test to take place the meter should remain in place until all Off, Sleep, and Idle power data is recorded.
5. Record the ac voltage and frequency.
6. Boot computer and wait until the operating system has fully loaded. If necessary, run the initial operating system setup and allow all preliminary file indexing and other one-time/periodic processes to complete.
7. Record basic information about the computer's configuration – computer type, operating system name and version, processor type and speed, and total and available physical memory, etc.
8. Record basic information about the video card or graphics chipset (if applicable) - video card/chipset name, frame buffer width, resolution, amount of onboard memory, and bits per pixel.
9. * Ensure that the UUT is configured as shipped including all accessories, WOL enabling, and software shipped by default. UUT should also be configured using the following requirements for all tests:
 - a. *Desktop* systems shipped without accessories should be configured with a standard mouse, keyboard and external computer display.
 - b. *Notebooks* should include all accessories shipped with the system, and need not include a separate keyboard or mouse when equipped with an integrated pointing device or digitizer.
 - c. *Notebooks* should have the battery pack(s) removed for all tests. For systems where operation without a battery pack is not a supported configuration, the test may be performed with fully charged battery pack(s) installed, making sure to report this configuration in the test results.
 - d. *Small-Scale Servers* and *Thin Clients* shipped without accessories should be configured with a standard mouse, keyboard and external computer display (if server has display output functionality).
 - e. For Computers with Ethernet capability, power to wireless radios should be turned off for all tests. This applies to wireless network adapters (e.g., 802.11) or device-to-device wireless protocols. For Computers without Ethernet capability, power to a wireless LAN radio (e.g. IEEE 802.11) should remain on during testing and must maintain a live wireless connection to a wireless router or network access point, which supports the highest and lowest data speeds of the client radio, for the duration of testing.
 - f. Primary hard drives may not be power managed ("spun-down") during Idle testing unless containing non-volatile cache integral to the drive (e.g. "hybrid" hard drives). If more than one internal hard drive is installed as shipped, the non-primary, internal hard drive(s) may be tested with hard drive power management enabled as shipped. If these additional drives are not power managed when shipped to customers, they must be tested without such features implemented.
10. * The following guidelines should be followed to configure power settings for computer displays (adjusting no other power management settings):
 - a. For computers with external computer displays (most desktops): use the computer display power management settings to prevent the display from powering down to ensure it stays on for the full length of the Idle test as described below.
 - b. For computers with integrated computer displays (notebooks and integrated systems): use the power management settings to set the display to power down after 1 minute.
11. Shut down the UUT.

Off Mode Testing

12. With the UUT shut down and in Off, set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.²

Idle Mode Testing

13. Switch on the computer and begin recording elapsed time, starting either when the computer is initially switched on, or immediately after completing any log in activity necessary to fully boot the system. Once logged in with the operating system fully loaded and ready, close any open windows so that the standard operational desktop screen or equivalent ready screen is displayed. Between 5 and 15 minutes after the initial boot or log in, set the meter to begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.

Sleep Mode Testing

14. After completing the Idle measurements, place the computer in Sleep mode. Reset the meter (if necessary) and begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.
15. If testing both WOL enabled and WOL disabled for Sleep, wake the computer and change the WOL from Sleep setting through the operating system settings or by other means. Place the computer back in Sleep mode and repeat step 14, recording Sleep power necessary for this alternate configuration.

Reporting Test Results

16. The test results must be reported to EPA or the European Commission, as appropriate, taking care to ensure that all required information has been included, including modal power values and eligible capability adjustments for Desktops, Integrated Desktops, and Notebooks.

IV. Maximum Power Test for Workstations

The maximum power for workstations is found by the simultaneous operation of two industry standard benchmarks: Linpack to stress the core system (e.g., processor, memory, etc.) and SPECviewperf[®] (latest available version for the UUT) to stress the system's GPU. Additional information on these benchmarks, including free downloads, can be found at the URLs found below:

Linpack <http://www.netlib.org/linpack/>

SPECviewperf[®] <http://www.spec.org/benchmarks.html#gpc>

This test must be repeated three times on the same UUT, and all three measurements must fall within a $\pm 2\%$ tolerance relative to the average of the three measured maximum power values.

Measurement of the maximum ac power consumption of a workstation should be conducted as follows:

UUT Preparation

1. Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test. The meter should be able to store and

² Laboratory-grade, full-function meters can integrate values over time and report the average value automatically. Other meters would require the user to capture a series of changing values every 5 seconds for a five minute period and then compute the average manually.

output the maximum power measurement reached during the test or be capable of another method of determining maximum power.

2. Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT.
3. Record the ac voltage.
4. * Boot the computer and, if not already installed, install Linpack and SPECviewperf as indicated on the above Websites.
5. Set Linpack with all the defaults for the given architecture of the UUT and set the appropriate array size “n” for maximizing power draw during the test.
6. Ensure all guidelines set by the SPEC organization for running SPECviewperf are being met.

Maximum Power Testing

7. Set the meter to begin accumulating true power values at an interval of less than or equal to 1 reading per second, and begin taking measurements. Run SPECviewperf and as many simultaneous instances of Linpack as needed to fully stress the system.
8. Accumulate power values until SPECviewperf and all instances have completed running. Record the maximum power value attained during the test.

Reporting Test Results

9. The test results must be reported to EPA or the European Commission, taking care to ensure that all required information has been included.
10. Upon submittal of data, manufacturers must also include the following data:
 - a. Value of the n (the array size) used for Linpack,
 - b. Number of simultaneous copies of Linpack run during the test,
 - c. Version of SPECviewperf run for test,
 - d. All compiler optimizations used in compiling Linpack and SPECviewperf, and
 - e. A precompiled binary for end users to download and run of both SPECviewperf and Linpack. These can be distributed either through a centralized standards body such as SPEC, by the OEM or by a related third party.

V. Test Procedure for All Modes for Game Consoles

Measurement of ac power consumption of a computer should be conducted as follows:

UUT Preparation

1. Record the manufacturer and model name of the UUT.
2. Record basic information about the computer’s configuration – computer type, operating system name and version, processor type and speed, total and available physical memory, etc.
3. Ensure that the UUT is connected to a TV(s) which support all of the output types supported by the UUT.
 - a. *For each output that supports APD, repeat step 10 of this procedure.*
4. Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test.
5. Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT. For a valid test to take place the meter should remain in place until all power data is recorded.
6. Record the ac voltage and frequency.
7. Turn on the console and wait until the operating system has fully loaded.
8. If necessary, run the initial system setup and allow all preliminary tasks and other one-time/periodic processes to complete.
9. Ensure that the UUT is configured as shipped including all accessories, power management settings and software shipped by default.
10. For each applicable output, wait for 15 minutes and ensure the output drops after the prescribed time.
11. Place the system in a state without the game loaded.

12. Wait one hour and verify the system goes into a low power state.
13. Bring the console back into its OS loaded state.
14. Load a game and bring it to the games menu.
15. Begin game play and pause the game.
16. Wait one hour and verify the system goes into a low power state. (Applicable after Version 5.0)
17. Shut down the UUT.

Off Mode Testing

18. With the UUT shut down and in Off, set the meter to begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.³

Sleep/APD Mode Testing

19. After completing the Off mode measurements, place the computer in it's Sleep/APD mode. Reset the meter (if necessary) and begin accumulating true power values at an interval of greater than or equal to 1 reading per second. Accumulate power values for 5 additional minutes and record the average (arithmetic mean) value observed during that 5 minute period.

VI. Continuing Verification

This testing procedure describes the method by which a single unit may be tested for compliance. An ongoing testing process is highly recommended to ensure that products from different production runs are in compliance with ENERGY STAR.

³ *Laboratory-grade, full-function meters can integrate values over time and report the average value automatically. Other meters would require the user to capture a series of changing values every 5 seconds for a five minute period and then compute the average manually.*

APPENDIX B: Sample Calculations

- I. **Desktop, Integrated Desktop, Notebook Computers:** Below is a sample TEC calculation intended to show how levels for compliance are determined based on functional adders and operational mode measurements.

Example: Below is a sample E_{TEC} evaluation for a Category A Notebook Computer (integrated GPU, 8 GB Memory Installed, 1 HDD)

1. Measure values using the Appendix A test procedure.
 $Off = 1W$
 $Sleep = 1.7W$
 $Idle = 10W$
2. Determine which Capability Adjustments apply.
Integrated Graphics? Does not apply for Premium Graphics.
*8GB Memory installed. Does meet memory adjustment level: 8 yields a 1.6kWh adjustment (4 * 0.4kWh).*
3. Apply Weightings based on Table 2 to calculate TEC:

Table 2 (for conventional notebook):

Toff	60%
Tsleep	10%
Tidle	30%

$$\begin{aligned}
 E_{TEC} &= (8760/1000) * (P_{off} * T_{off} + P_{sleep} * T_{sleep} + P_{idle} * T_{idle}) \\
 &= (8760/1000) * (P_{off} * .60 + P_{sleep} * .10 + P_{idle} * .30) \\
 &= (8760/1000) * (1 * .60 + 1.7 * .10 + 10 * .30) \\
 &= \mathbf{33.03 kWh}
 \end{aligned}$$

4. Determine TEC Requirement for the computer by adding any capability adjustments (step 2) to the Base TEC requirement (Table1).

Table 1 (for notebooks):

Notebook Computers (kWh)	
Category A	40
Category B	53
Category C	88.5

$$\text{ENERGY STAR TEC Requirement} = 40 kWh + 1.6kW = 41.6 kWh$$

5. Compare E_{TEC} to the ENERGY STAR TEC Requirement (step 4) to determine if the model qualifies.

Category A TEC requirement: 41.6 kWh
 E_{TEC} : 33.03 kWh
 $33.03 kWh < 41.6 kWh$
Notebook meets ENERGY STAR requirements.

II. **Workstations:** Below is a sample P_{TEC} calculation for a Workstation with 2 hard drives.

1. Measure values using the Appendix A test procedure.

$Off = 2\ W$
 $Sleep = 4W$
 $Idle = 80W$
 $Max\ Power = 180W$

2. Note number of Hard Drives installed.
Two hard drives installed during test.

3. Apply Weightings based on Table 4 to calculate P_{TEC} :

Table 4:

Toff	35%
Tsleep	10%
Tidle	55%

$$\begin{aligned} P_{TEC} &= (.35 * P_{off} + .10 * P_{sleep} + .55 * P_{idle}) \\ &= (.35 * 2 + .10 * 4 + .55 * 80) \\ &= \mathbf{45.10\ W} \end{aligned}$$

4. Calculate the P_{TEC} requirement using the formula in Table 3.

$$\begin{aligned} P_{TEC} &= 0.28 * [P_{max} + (\# \text{ HDD} * 5)] \\ P_{TEC} &= 0.28 * [180 + 2 * 5] \\ P_{TEC} &= 53.2 \end{aligned}$$

5. Compare the adjusted P_{TEC} to the ENERGY STAR levels to determine if the model qualifies.

$$45.10 < 53.2$$

Workstation meets ENERGY STAR requirements.

Annex C: ECMA Energy Efficiency Assessment Criteria Proposal

Ecma Energy Efficiency Assessment Criteria Proposal

AMD, Dell, Ecos, HP, IBM, ICF, Intel, ITI, LBNL,
Terra Novum

Ecma TC38-TG2

17 May 2006

Save energy by developing a metric framework that enables an apples to apples comparison of the energy efficiency at system level of a given comparable solution, taking into account:

- *System performance and capability/utility*
- *Use scenarios*
- *User experience criteria*

Create a framework that will enable worldwide regulators to harmonise energy requirements

Enable regulations or public policy to move toward system level energy efficiency criteria

Be OS and platform agnostic

Long-term the standard or technical report should have relevance to all Information Communication Technology and Consumer Electronics products.

Initial focus will be at a system level for computers, specifically: notebooks, desktops and servers.

- *Phase 1 will be desktop computers (while keeping notebooks in mind to ensure scalability)*
- *Servers: Coordinate with the SPEC committee*
- *Workstations TBD*

System definition

- *The desktop product (inclusive of OS, system drivers and utilities (application software TBD) as required)*
- *Note: Video devices are outside scope (unless integrated)*

The assessment criteria must have practical relevance to the target audience

There should be minimal duplication of existing work.

The framework will seek to be scalable from laptops through servers and single unit systems through to enterprise level applications.

- *While ensuring a scalable metric, measurement criteria across product segments may well vary.*

Should not impede businesses such as “build to order”

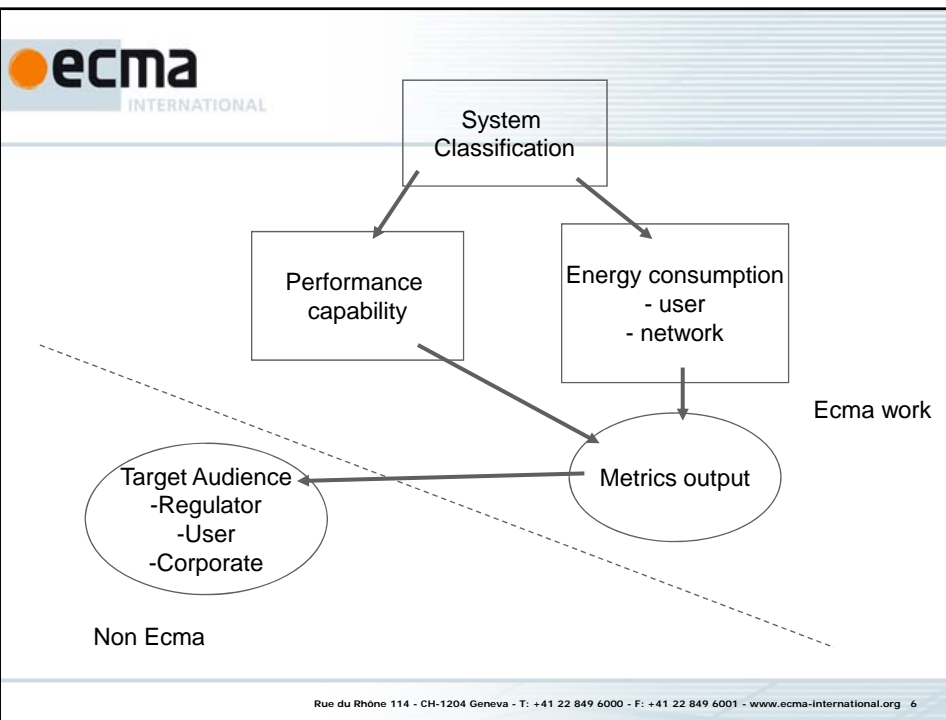
Ecma, as a standards body, will deliver the definitions and measurement/test procedures. Ecma will not set limits or targets

Qualified estimates

Three components of the framework

- *System classification*
 - **Classifications are defined based on being fundamental because it changes how next two components are run (motorbike vs pickup)**
- *Measure the compute performance and capability*
- *Measure the energy consumed for a typical defined workload/duty cycle*

Output is a set of metrics



Classifications are defined based on variation that has large impact on next two steps in framework

Which ones are important - TBC?

- *Corporate examples*
 - **Entry level**
- *Consumer examples*
 - **Gaming PC**
 - **Entertainment PC**
 - **Home office**

Challenges

- *Agreement on classifications*
- *Note: Minimum number of classifications is desirable*
- *Defining dominant representative workloads*
- *Defining duty cycles to represent this*
- *How do we prioritise?*

Capability: What could it do

- *Enumerate the system – Hardware and software features and capabilities (Include power management capabilities)*
- *Capabilities listed here would only be those that affect energy consumption (trackball vs mouse for example)*

Performance: what did it do

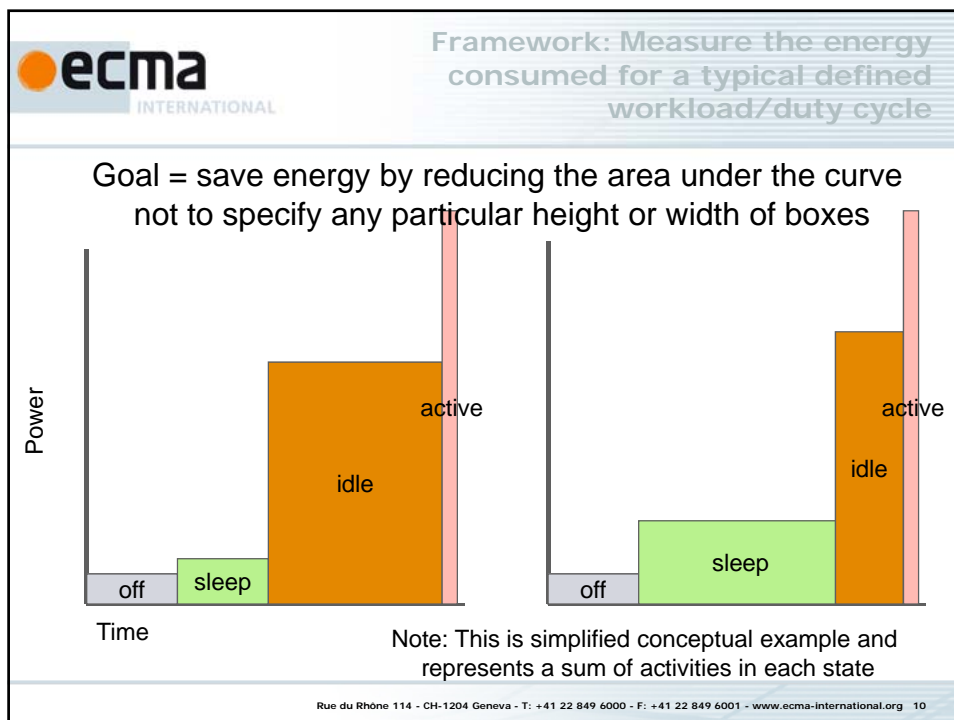
- *Goal is to measure a base system configuration as set up to enable the benchmarks to be run with power management “as shipped”*

Challenges

- *Capability – automated or manual? How to standardise?*
- *Benchmarks required: Open source? Create an RFI? Who to?*
- *How accurate? Eg ensure OS patch or small hardware change does not have major impact on end result*
- *Repeatability*
- *OS/architecture/application agnostic*
- *As shipped*
- *Background tasks*

Benchmark	Platform & OS	Costs # zero's	Synthetic or application	Type	Quality control	Comments
SPEC – PP	Server based, platform and OS agnostic	3	Application	Throughput	Yes – review process	Industry accepted. Open membership, international body.
SPEC – OSG (inc CPU)	Server centric (except CPU) / OS agnostic	3	Application	Variable	Yes	As above
SPEC – GPC	Workstation / OS agnostic	2	Application	Time	Yes	As above
SPEC – HPG	High performance platform / OS agnostic	3	Application	?	Yes	As above
BAPCO – SYSMARK	Client / Windows	3	Application	Response based system	Yes	As above
BAPCO – MobileMark	Mobile / Windows	3	Application	Battery life	Yes	As above
TPC	Server / OS agnostic	5	Application	Throughput	Yes + Audits	As above
SAP	Server / OS agnostic	5	Application	Throughout	Yes	Proprietary
FutureMark 3DMark PCMark	Client / Windows	0 - 2	Synthetic	Variable	No	For profit, commercial product.

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Energy measurement

- *Identify an agreed duty cycle*
- *Measure the energy used over a period of time (using duty cycle) that enables extrapolation to an annual period*
- *Workload includes simulated user and network activity*

Challenges

- *How to ensure all available power states are utilised*
- *Development of the measurement protocol*
 - **Technician issues**
 - **Computer issues**
- *Extrapolation rules*
- *What is the granularity – at what level of variability in parts will require additional testing (what level of sigma?)*

Annual energy consumption calculated and reported

Performance and capability reported

Metric must be relevant to the target audience

Challenges

- *How to define duty cycle*
- *Developing something that is meaningful and simple but not simplistic!*

Need a base line config – adjust based on options (allocate as needed across power states)

- *Set threshold whereby any add on can be ignored for purposes of this calculation*

How to communicate data to users?

- *Will it still be Energy Star? Should not do after config decisions otherwise cannot be used to influence buying decisions.*

Major task just to get base level done: Build to order solutions as next stage.

Scalability across platforms

- *OS, software*
- *Architecture*
- *ACPI maturity*
- *AC vs DC (power consumed while charging battery)*
- *Tablet PC has no keyboard*
- *Servers*

As shipped concerns

- *Google desktop example*

Threadedness

Timescales

- *Will work on agreeing milestones to help EPA implement meeting Tier II spec by Jan 2009*
- *Ecma to define milestones*

What is the right way to involve EPA and EU Commission in this work in order to meet timeframes?

Three components of the framework agreed

- *System classification*
- *Measure the compute performance and capability*
- *Measure the energy consumed for a typical defined workload/duty cycle*

Many challenges remain!

This Task Group committed to meet the challenge

We are committed to work with the EPA on their Tier II challenge

We believe this work holds the promise of saving more energy than other approaches

Annex D: Standard ECMA-383 - Measuring Energy Consumption, Performance and Capabilities of ICT and CE Products

Free download: www.ecma-international.org/publications/standards/Ecma-383.htm

Standard ECMA-383

1st Edition / June 2008

**Measuring Energy
Consumption,
Performance and
Capabilities of ICT and
CE Products**

Standard

Standard
ECMA-383
1st Edition / June 2008

**Measuring Energy
Consumption, Performance
and Capabilities of ICT and
CE Products**

Introduction

Ecma developed and published the world's first environmentally conscious design standard (ECD) for the ICT & CE industries in 2003 as ECMA-341. This Standard is aimed at the designer and provides pragmatic advice on how to reduce the environmental footprint of a product at the design stage.

ECMA-341 was offered to the IEC (International Electro-technical Committee) for conversion into an IEC standard. IEC TC108 set up a Project Team (PT62075) to complete this work. This Standard is now available as IEC 62075.

Whilst ECMA-341 includes the definitions of low power modes and generic energy saving guidance for designers of ICT & CE products, this Standard complements that guidance by defining a methodology on how to measure the energy efficiency of a product whilst taking into account its performance and capabilities.

Although this Standard's title allows covering all ICT and CE products this initial edition covers desktop and notebook computers only with a media rich and office productivity workload.

Future editions may take into account additional operating systems and workloads for computers and also to broaden in scope to other ICT and CE products.

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1 Scope

Although the title is broader in scope, this edition of the Standard applies to:

- desktop computers
- notebook computers

that are marketed as final products and are hereafter referred to as the Unit Under Test (UUT).

Additionally, this edition of the Standard applies to the following list of workloads

- office productivity
- media rich

defined in [5.2](#) and running under an Operating System that is either principally designed for, or at least configured for, desktop or notebook use.

This Standard defines how to evaluate and report energy consumption, performance and capabilities being the vital factors for the energy efficient performance (EEP) of the UUT. Additionally it provides a standardised results reporting format.

This Standard requires the user to measure and record a set of energy, power, time, and capability results (using a Benchmark), not a single metric of energy efficiency. This Standard does not set any pass/fail criteria for the UUT. Users of the reported results (regulators, customers etc) may define such criteria.

This standard does not provide specifications for a Benchmark.

2 Conformance

The user of this Standard shall meet all “shall” requirements in Clause [6](#).

3 Normative references

None.

4 Definitions

4.1 Benchmark

software that exercises the UUT with a Workload to measure energy consumption and performance and that enumerates and reports UUT capabilities

4.2 Duty cycle

4.2.1 Benchmark duty cycle

time a UUT spends in each of its [activity modes](#) as measured by the Benchmark

4.2.2 User defined duty cycle

time a UUT spends in each of its [activity modes](#) as defined by the user

4.3 Energy use

amount of energy *used by a UUT measured* from the mains power source over a given period of time and measured in kWh

4.4 Performance

the speed a UUT can complete a Workload when compared to the Benchmark reference unit

4.5 Workload
defined set of activities

4.6 UUT (Product)
unit under test (also referred to as product)

5 Specifications for the UUT

5.1 Computer classifications

5.1.1 Desktop computer

A personal computer where the main unit is intended to be located in a fixed location, often on a desk or on the floor. Desktops are not designed for portability and utilize an integrated or external monitor, keyboard, and mouse.

5.1.2 Notebook computer

A personal computer designed specifically for portability and to be operated for extended periods of time without a direct connection to an ac power source. Notebook computers must utilize an integrated monitor (may be touch sensitive) and be capable of operation off an integrated battery or other notebook power source. In addition, most notebook computers use an external power supply and have an integrated keyboard and pointing device.

5.2 Activity Modes

Off Mode: The power consumption level in the lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the UUT is connected to the main electricity supply and used in accordance with the manufacturer's instructions. Off mode is similar to "ACPI state S5".

Sleep Mode: The mode that the UUT is capable of entering automatically after a period of inactivity or by manual selection. A UUT with sleep capability can "wake" in response to network connections or user interface devices or an internally generated condition. Sleep mode is similar to "ACPI state S3".

Idle Mode: The mode in which the operating system and other software have completed loading, and activity is limited to those basic applications that the system starts by default.

Active mode: The mode in which the UUT is executing a workload.

5.3 Computer workloads

5.3.1 Office productivity workload

A Workload designed primarily for office (home or business) applications such as word processing, email, web browsing, accounting, etc.

5.3.2 Media rich workload

A Workload designed primarily for entertainment purposes such as listening to music, watching videos, editing audio, pictures, video, etc.

NOTE

Although the Media rich workload could be used on products designed for gaming applications, this workload is not intended to exercise many of the special capabilities of this category of personal computers.

5.4 Core components

The UUT shall at least contain the following components:

- Central Processing Unit (CPU)
- Graphics Processing Unit (GPU)
- Memory (volatile)

- Non-volatile bulk storage (e.g. hard disk)
- Operating System
- Audio
- Primary Network Connection
- Input Devices

6 Procedure

6.1 Workflow

The user shall follow this workflow:

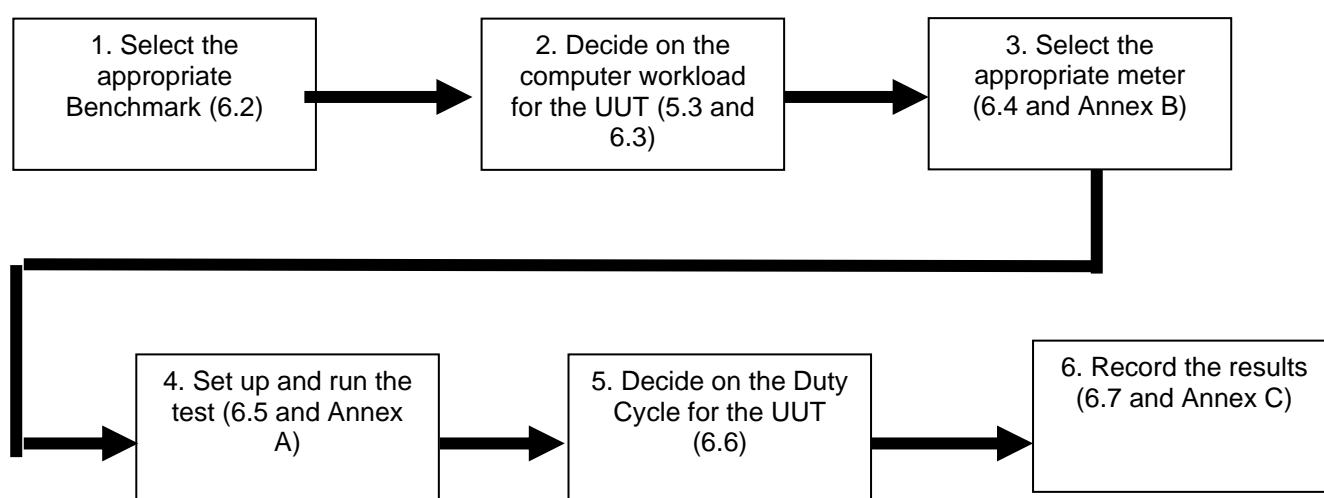


Figure – 6.1: Workflow

6.2 Selecting a Benchmark

The User shall select a Benchmark registered at: <http://www.ecma-international.org/publications/standards/Benchmark.htm> suited for intended use of the UUT as specified at: <http://www.ecma-international.org/publications/Standards/Criteria.htm>. The User shall record the name of the selected benchmark per Annex C.

6.3 Decide on the UUT Workload

The User shall decide whether the primary use of the UUT is an

- Office productivity workload
- Media rich workload.

6.4 Meter requirements

For energy and power measurements, a meter that meets the requirements in Annex B shall be used.

6.5 Test system set up

The user shall follow the requirements as detailed in Annex A.

6.6 Decide on the Duty Cycle

The User shall determine whether a user defined duty cycle is to be used. He shall report the benchmark duty cycle in a format as described in Annex C together with the user defined duty cycle as appropriate.

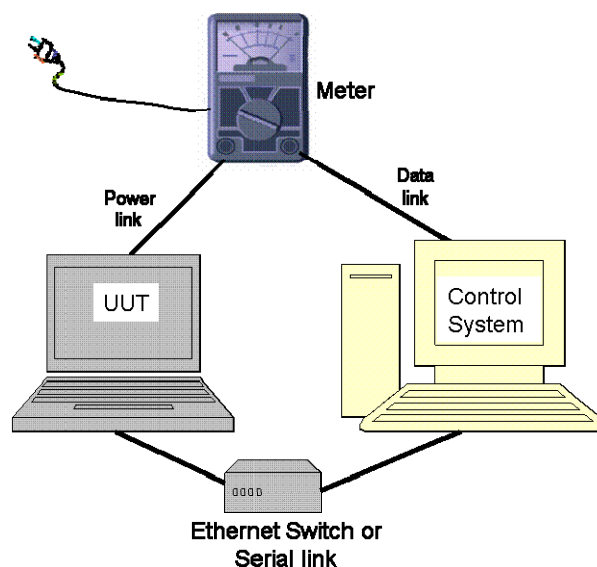
6.7 Recording and presenting the results

All results shall be presented in a manner clearly showing the workload used and in a format as indicated in Annex C.

Annex A (normative)

Test set up

The test shall be set up per the example below.



1. The UUT shall be configured in its "as shipped" default state and at a minimum contain all core components as defined in [5.4](#).
2. For notebook computers, the battery shall be either removed or charged to 100 % before test starts.
3. Whether the monitor is switched on or off shall be determined by the user. It is recommended that this decision is carried out in conjunction with an assessment of intended use of the test results.

Testing conditions

Supply Voltage:	North America/Taiwan: Europe/Australia/New Zealand: Japan:	115 (± 1 %) Volts AC, 60 Hz (± 1 %) 230 (± 1 %) Volts AC, 50 Hz (± 1 %) 100 (± 1 %) Volts AC, 50 Hz (± 1 %)/60 Hz (± 1 %) <i>NOTE</i> <i>For products rated for > 1.5 kW maximum power, the voltage range is ± 4 %</i>
Total Harmonic Distortion (THD) (Voltage):	< 2 % THD (< 5 % for products which are rated for > 1.5 kW maximum power)	
Ambient Temperature:	23°C ± 5°C	
Relative Humidity:	10 – 80 %	

Annex B (normative)

Meter specifications

The power meter used in conjunction with this Standard shall include the following attributes:

- Power resolution of 1 mW or better
- An available current crest factor of 3 or more at its rated range value; and
- Lower bound on the current range of 10 mA or less.
- Have a frequency response of at least 3 kHz; and
- Be calibrated with a standard that is traceable internationally.
- Be able to average power accurately over any user selected time interval (this is usually done with an internal math's calculation dividing accumulated energy by time within the meter, which is the most accurate approach). Or, alternatively, the meter shall be capable of integrating energy over any user selected time interval with an energy resolution of less than or equal to 0.1 mWh and integrating time displayed with a resolution of 1 second or less.
- Provide a control and logging interface that the Benchmark uses to allow logging of the data onto a control system.

Accuracy of power measurement

Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2 % at the 95 % confidence level. Measurements of power of less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95 % confidence level. The power measurement instrument shall have a resolution of:

0.01 W or better for power measurements of 10 W or less;

0.1 W or better for power measurements of greater than 10 W up to 100 W; and

1 W or better for power measurements of greater than 100 W.

All power measurements shall be in watts and rounded to the second decimal place. For power measurements greater than or equal to 10 W, three significant figures shall be reported.

Annex C (normative)

Results reporting format

Results from this test methodology shall be presented in the following order:

1. Product description
2. Benchmark details
3. Results
 - A. Energy consumption
 - B. Performance score
 - C. Capabilities
4. Test conditions
5. Declaration

Under each of the headings noted above the following minimum set of information shall be reported. The format listed below is an example format only; the user should use the format of his choice.

1. Product description

Manufacturer _____

UUT Code / Model Number _____

UUT Workload: Productivity workload Media rich workload

UUT Type: notebook computer Desktop Computer

Operating System: Windows Mac OS

Operating system version details _____

Display: Off On

If display on: Size _____ Brightness ___ cd/m² ___ Resolution _____

Vendor _____ HD Ready (Yes/No) _____ Refresh rate _____

Interface type: VGA HDMI DVI Other

Operating System Power policy applied during test (e.g. power save, balanced, performance etc) _____

BIOS (or equivalent) vendor and version number _____

Motherboard model and version number _____

2. Benchmark details

Benchmark name _____

Benchmark version _____

3. Results

3A Energy consumption

Benchmark duty cycle reported results

	Active	Idle	Sleep	Off
Power (W) – Average	n/a			
Energy (Wh)		n/a	n/a	n/a
Measurement Time (s)				

User defined duty cycle calculated results

	Active	Idle	Sleep	Off
Energy (Wh)				
Extrapolated time (h)				

Note: Extrapolated time is Measured time multiplied by a factor defined by the user.

Power supply efficiency levels:

Load (%)	Efficiency (%)

3B Performance score results

Performance Score	
-------------------	--

3C Capabilities

CPU		Video/Graphics	
Vendor		Vendor	
Name		Model Number / Name	
Model Number		Memory Size	
Number of Cores		Resolution	
Core Frequency		Bus Type	
Bus Frequency		Driver revision number	
L1 Cache			
L2 Cache			
L3 Cache			
Volatile Memory (e.g. DRAM)		Audio	
Size (Mb)			
Array Capacity		Vendor	
Speed		Model	
Family (E.G. DDR2, 3 etc)		Definition	
Number devices			

Quantity input devices _____

	Mouse	Keyboard	Other
Model Number / Name			
Interface type (USB, PS2, Wireless etc)			

Storage

Quantity Hard Drives _____

	Drive #1	Drive #2	Drive #3	Drive #4
Vendor & Version				
Model				
Capacity				
Speed				
Link Power management supported? If yes, note type				

Quantity Optical Drives _____

	Drive #1	Drive #2	Drive #3	Drive #4
Vendor & version				
Model				
Capacity				
Speed				
Link Power management supported? If yes, note type				

Quantity other storage devices _____

Device type				
Vendor & Version				
Model				
Capacity				
Speed				

Quantity Network (wired and wireless) devices _____

Network type				
Vendor & Version				
Model				
Bus Interface				
Capable speed				
Tested speed				

Other system capabilities

4. Test Conditions

Sample size tested: _____

Name of meter used: _____



Test Conditions	
Supply Voltage:	
Total Harmonic Distortion (THD) (Voltage):	
Ambient Temperature:	
Relative Humidity:	

5. Declaration

Signed _____

Date _____

Annex D (informative)

Bibliography

IEEE 1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments

IEC 62075: Audio/Video, Information and Communication Technology Equipment - Environmentally Conscious Design

Energy Star V5.0, Draft 1 (February 22, 2008)

ACPI (Advanced Configuration and Power Interface) specification

IEC 62301 Ed 1.0: Measurement of Standby Power

ISO 554-1976: Standard atmospheres for conditioning and/or testing specifications.