BEFORE THE CALIFORNIA ENERGY COMMISSION

Docket #12-AAER-2A – Consumer Electronics
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May 9, 2013

**Response of the Information Technology Industry Council and the Technology Network to the Invitation to Participate in the Development of Appliance Efficiency Measures – Consumer Electronics**

The Information Technology Industry Council ("ITI"; http://www.itic.org/) and the Technology Network ("TechNet"; http://www.technet.org/) respectfully submit this response to the CEC's Invitation to Participate (ITP) as regards computers, computer monitors, and networking equipment. Our members represent the leading global innovators of information and communications technology (ICT), an industry committed to developing energy-efficient solutions demanded by our customers and to helping drive sustainable economic growth and energy independence across our nation's economy.

## I. Context.

Over the past 40 years, the ICT industry has achieved unprecedented improvements in energy efficiency without the impetus of government regulation. Indeed, analysis by the American Council for an Energy-Efficient Economy (ACEEE) found that ICT's return on energy investments has significantly outpaced other industry sectors:

| | 1960 | 2010 | Improvement |
|---|---|---|---|
| Electricity Generation | 10,780 Btus per kWh of electricity | 9,980 Btus per kWh of electricity | 8 percent |
| Automobiles | 14.3 miles per gallon of gas | 22.6 miles per gallon of gas | 58 percent |
| Labor Output | 20.6 dollars per working hour | 59.4 dollars per working hour | 188 percent |
| Passenger Airlines | 8,836 Btus per passenger mile | 2,917 Btus per passenger mile | 196 percent |
| Lighting | Incandescent light bulb at 13 lumens per watt | Compact fluorescent lamp at 57 lumens/watt | 339 percent |
| Computer Systems | 0.015 instructions per second per watt | 40,000,000 Instructions per second per watt | 266,666,666,600% |

Source: Skip Laitner, ACEEE, various calculations, January 2011

In a 2008 report, the ACEEE looked at the impact of ICT on the energy efficiency of the U.S. economy. The report highlighted the nexus between ICT and energy intensiveness of the U.S. economy:

*"Information and communication technologies (ICT) have transformed our economy and our lives, but they also have revolutionized the relationship between economic production and energy consumption."*[1]

The ACEEE report, authored by economist Skip Laitner, took a top-down, econometric approach to evaluating the energy and climate impact of ICT. Examining the trends of ICT proliferation and the energy-intensity of the U.S. economy, the report concluded: *"For every extra kilowatt-hour of electricity that has been demanded by ICT, the U.S. economy increased its overall energy savings by a factor of about 10… The extraordinary implication of this finding is that ICT provide a net savings of energy across our economy."*[2]

A subsequent U.S. assessment of the climate change mitigation potential of ICT, undertaken by The Boston Consulting Group and based on cost-curve analysis done by McKinsey, estimated that ICT-enabled solutions could reduce overall national annual CO2 emissions up to 22 percent as compared to business-as-usual projections for 2020.[3] Even at the low end, this estimate underscores that ICT solutions can play a huge role in addressing climate change, relative to other solutions sets that are available.

In 2008, The Climate Group and the Global e-Sustainability Initiative (GeSI) produced a report entitled, "*Smart 2020: Enabling the Low-Carbon Economy in the Information Age,"* that found that ICT strategies could reduce global carbon emissions by up to 15 percent in 2020 against a business-as-usual baseline projection.[4]

In December 2012, GeSI released an update of that report, the "*SMARTer 2020"* Report,[5] taking into account new innovations in mobile communications, especially machines talking to machines, cloud computing, and in smarter devices and applications. The new report finds that:

1. ICT-enabled solutions offer the potential to reduce global 2020 GHG emissions by 16.5%;
2. The GHG reduction potential of ICT is over 7 times its own emissions, saving up to $1.9 trillion annually; and,

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1 Laitner, Skip, *ICT: The Power of Productivity,* American Council for an Energy-Efficient Economy, February, 2008.
2 IBID.
3 The Global e-Sustainability Initiative and The Boston Consulting Group, *Smart 2020: Enabling the Low-Carbon Economy in the Information Age, US Report Addendum*, 2008.
4 The Global e-Sustainability Initiative and The Climate Group, *Smart 2020: Enabling the Low Carbon Economy in the Information Age,* 2008.
5 The Global e-Sustainability Initiative and The Boston Consulting Group, *Smarter 2020:*

3. An enabling policy environment is required to realize the potential of ICT to reduce global GHG emissions.

ACEEE last year also released a new and relevant report, entitled "*A Defining Framework for Intelligent Efficiency,*"[6] that includes the following observation,

*"System efficiency opportunities produce energy savings that dwarf component-based efficiency improvements by an order of magnitude. System efficiency is performance-based, optimizing the performance of the system overall—its components, their relationships to one another, and their relationships to human operators. One of the cornerstones of systems-based efficiency is information and communication technologies (ICT), such as the internet, affordable sensors and computing capacity that are the foundation upon which systems efficiency are built. We can make great strides using these readily available technologies. If homeowners and businesses were to take advantage of currently available information and communications technologies that enable system efficiencies, the United States could reduce its energy use by about 12-22% and realize tens or hundreds of billions of dollars in energy savings and productivity gains. In addition, there are technologies that are just beginning to be implemented that promise even greater savings."*

Further on in the Report, ACEEE adds to this observation by noting,

*"There is a growing awareness among the energy efficiency research and policy communities that the larger opportunity for energy efficiency lies in full system optimization. A great deal of the efficiency of a system lies not in the efficiency of the individual component devices, but rather arises from how devices interact and how the user interacts with the system overall."*

Recognizing the unique nature of ICT products -- their complexity, their rapid evolution, their global nature, and their interplay with many other product types in intelligent efficiency solutions -- EPA and ITI have hosted an informal brainstorming dialog among stakeholders regarding the near term future of ENERGY STAR for ICT products and ICT-enabled solutions. The question of how to adapt to the expanding world of networked systems has been one of the key issues considered, and is discussed in the "Informing Documents" that were issued in February 2013. [7] Included in those Informing Documents is the observation that it is vital,

*"to understand and design-in intelligent efficiency or systems efficiency whereby use of energy is reduced based on how components are connected and work together, rather than based solely on the efficiency of the components themselves. The key is to better understand, beyond the traditional products approach, whether the components could*

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6 Neal Elliott, Maggie Molina, Dan Trombley, American Council for an Energy-Efficient Economy, *A Defining Framework for Intelligent Efficiency, 2012.*

7 ENERGY STAR ICT Product Road-Mapping Informing Document, *Track 1: ENERGY STAR Product Specifications*, 2013. http://www.energystar.gov/index.cfm?c=prod_development.prod_development_workshop

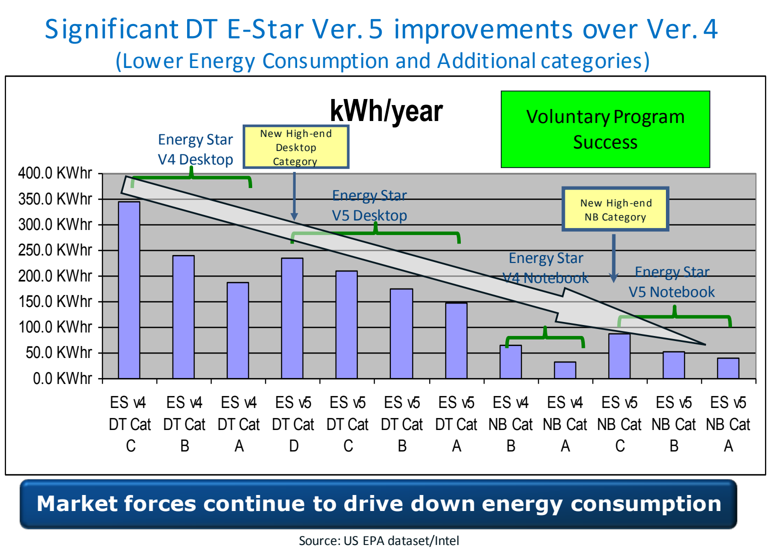
*be designed in a way to achieve further gains in intelligent system efficiency without other unintended consequences."*

### Client Computers and Displays Energy Efficiency Improvements:

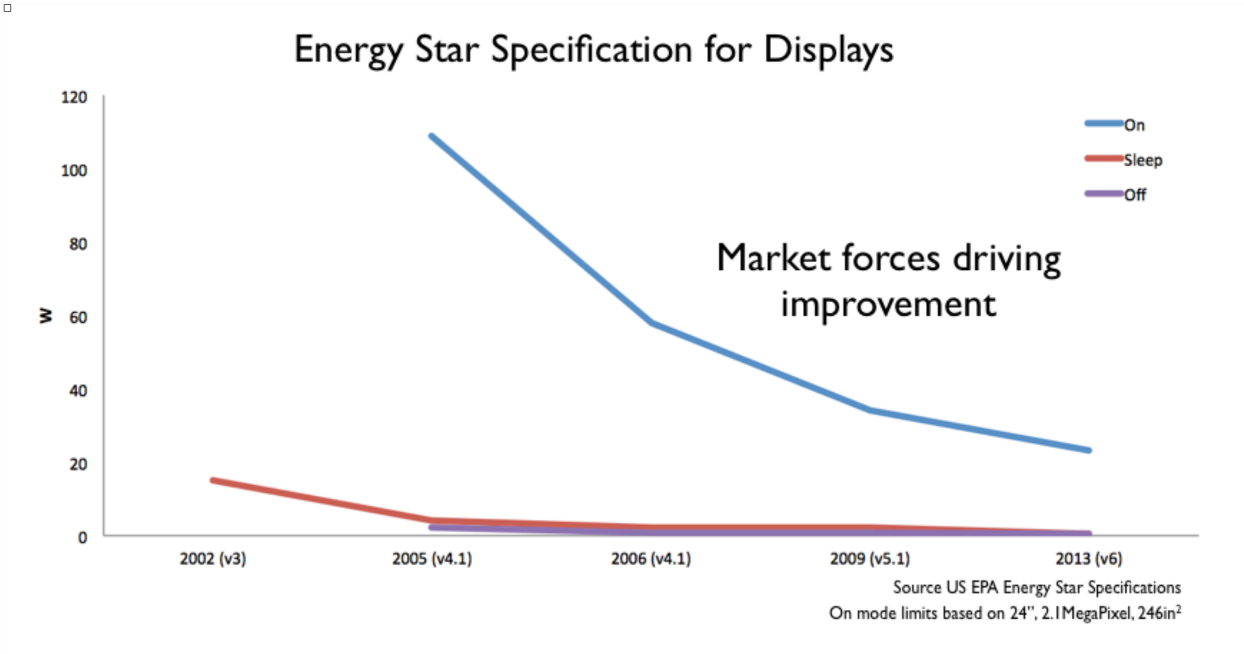
Client computer systems are already enabled to advance energy efficiency, driven by usage model and advances in technologies such as battery, displays, communication, and human interfaces. Overall, there have been higher levels of integration, replacing single function tools with more integrated and mobile units. The usage model is also evolving pushing increased personal productivity and efficiency. The industry has worked with various agencies to develop standards for efficiency while still encouraging the holistic efficiency approach.

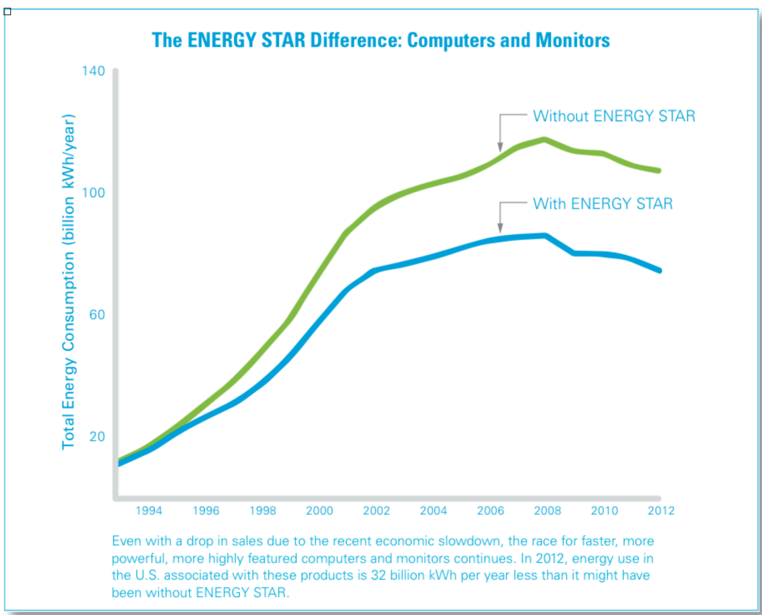
The industry's approach is in 3 areas:

1. Energy efficiency gains while continuing to drive innovation (fig. below). Industry factors:
   - Market segment/consumer demand
   - Competition
   - Caring for the planet – product energy footprint reduction through technology innovation[8]
2. Support for voluntary programs to incentivize product energy efficiency in specific product categories. These programs continue to show a strong record of success in driving down overall product energy (TEC) footprint, not only on the targeted products, but also on products that reuse similar components.




[8] As one example of the carbon footprint reductions occurring in the latest technology from ITI member companies, AMD reported up to a 40% carbon footprint reduction with their current generation processing technology, when compared to their previous generation technology.
http://www.amd.com/us/press-releases/Pages/apu-carbon-footprint-2011jan27.aspx




3. Global effort: Industry is driving Global Energy Efficiency Convergence of product energy efficiency regulations and standards, with applicability for voluntary and mandatory programs. This will enable energy-efficient ICT products to be cost-effectively deployed to both save energy and promote economic growth.

All of the above is relevant context to both the ITP, and to the clean energy and GHG emissions goals that have been established by the state of California. Continued ICT-enabled sustainability solutions innovation will be critical to achieving these aggressive goals. Such innovation will involve harnessing the controls and data made available through the state's investment in smart meters and related improvements to the grid, but it will also be important across the entirety of the California economy.

As expressed in our July 24, 2012 meeting with Commissioner McAllister, we have been and will continue to take a constructive approach to working with the Commission on this current potential rulemaking as regards computers and computer monitors. As an example, industry seized the opportunity to partner with CEC and UC Irvine on launching a PC behavioral survey to understand consumer behavior pertaining to PC power management enabling. The responses that follow are all made in that spirit, within the context of the data and observations above, and also within the context of the eight principles for government regulation of energy efficiency for ICT products that we presented to Commissioner McAllister at our July 24th meeting. Those principles are:

- Ensure programs facilitate product innovation;
- Ensure programs are based on sound data collection and analysis;
- Seek to adopt international standards and metrics;
- Enact voluntary programs to achieve product energy efficiency gains;
- Avoid using voluntary program metrics as market access requirements;
- Harmonize with the international product category system;
- Ensure transparency and stakeholder participation in the regulatory process;
- Adopt minimally trade-restrictive conformity assessment requirements; and,
- Maintain flexible, consumer-friendly labeling requirements.

While the industry advocates a voluntary approach for ICT energy efficiency improvements, should there be a regulatory (MEPs) approach, industry's approach is that regulations should be based on removing least efficient products from the market, i.e., target the bottom 25% least energy efficient mainstream products (shipped in large volumes). In addition, if they are to be cost effective, MEPs cannot penalize high performance, specialized, low shipment volume products that certain customers (including California customers) require to perform specialized tasks. As is true in other MEPs-based regulations, these products should not be in scope.

## <u>II. Detailed Responses</u>.

### A. Computers.

#### 1. Basic Information Requested:

- Product Definition and Scope
    - Desktops, notebooks, tablets, thin clients, work stations?
        - ICT industry position is the CEC should target mainstream HVM products and provide exclusion for high performance, specialized, low volume products, low TEC products. Specifically, only mainstream high volume Desktop, Integrated Desktop and Notebook PCs (consumer/enterprise) should be in scope.

- Out of scope/Exclusion:
  - Very high-end, specialized, and low volume Desktop, Integrated Desktop and Notebooks
  - Workstations and Thin Clients: Workstations are generally designed to provide higher performance, and are much lower volume; Thin Clients use EPS (already regulated)—enterprise model/remotely managed; fairly new with evolving design and no mainstream definition.
  - Tablets/Slate: Primarily DC operation; very low TEC; EPS/BCS already regulated by CEC; ENERGY STAR moved away from TEC approach for ENERGY STAR Version 6.0. Tablet/slate focus is extended battery life (market forces driving it – no need to regulate).

- Performance categories (similar to ENERGY STAR)?
  - While industry advocates that any MEPs target setting (with the goal to remove bottom 25% of least energy efficient products) be based on California shipping data, industry is cognizant of CEC resource challenges with such data collection effort. Similar data collection challenges exist in other global jurisdictions. Specific for computers, industry has been advocating use of ENERGY STAR TEC framework and category systems, with certain product exemptions for MEPs programs to avoid their excluding products from the market. This is needed since the voluntary programs like ENERGY STAR only define mainstream products categories, to reduce the number of system categories and program complexity. High-end and specialized products are not designed to comply with ENERGY STAR category TEC targets. Such products are low-volume, specialized, with wide TEC variability (Example: Mobile workstations, high-end desktops) and do not justify creating new product categories.
  - ENERGY STAR V5.2 categories is the convergence point for MEPs and voluntary based programs worldwide (see table below with key examples); ENERGY STAR V6 categories are still evolving, and are not appropriate for MEPs programs.

| Global PC Energy Programs | Desktops/Integrated Desktops | Notebooks | Status/Est. Effective data |
|---|---|---|---|
| *ENERGY STAR V5.2 Categories* | *CAT A*<br>*CAT B*<br>*CAT C*<br>*CAT D* | *CAT A*<br>*CAT B*<br>*CAT C* | |
| EU (ErP Lot 3) | ✓ | ✓ | Voted; July |

| | | | |
|---|---|---|---|
| | | | 2014 |
| China | ✓ | ✓ | Multi-grade/ 2012 |
| South Korea | ✓ | ✓ | Effective July 2012 |
| Australia | ✓ | ✓ | Effective Oct. 2013 |
| India | ✓ | ✓ | Awaiting DT implementation |

- Focus should be on systems energy efficiency approach, not modal power or component level specification
- Power Supplies: Industry supports complying with existing CEC Mark IV external power supply requirements (no change). Industry is opposed to a mandate for complying with IPS 80Plus requirements. Focus should be rather on complying with system level TEC targets in AC mode as a measure of true AC energy consumption reduction.

- Existing Test Procedures
    - Existing Test Procedures [ENERGY STAR, Benchmarks, Industry standards, Ecma-383/IEC 62623 (as applicable to V5.2), No Int'l standard exists for WS/TC]
- Sources of Test Data
    - Manufactures/suppliers test data and Declaration of Conformity from a competent lab in any jurisdiction should be acceptable for demonstrating compliance
- Existing Standards and Standards under Development
    - IEC-62623; ENERGY STAR; EPRI Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.4.2; Test Method for calculating the Energy Efficiency of single-voltage, Ac-Dc and Ac-Ac external power supplies. August 11, 2004; ISO-17025 for test lab qualification
- Product Lifetime
    - While product lifetime varies, typical lifetime for Enterprise model is 3-5 years driven by IT policy which varies by a given enterprise; consumers PC replacement is more aligned with product warranty approach 1-3 or 3-5 years. The time period varies widely based on manufacturer incentives and the length of time an individual desires to keep their PC.
- Product Development Trends

    Voluntary programs like ENERGY STAR have helped drive energy efficiency improvements – year over year driven by market forces. ICT efficiency has advanced through other innovations, spurred by self-driven technological improvements as:

    - the rapid decrease in the energy consumed per transistor
    - standardized compute states
    - power management modes (system and sub-system)

- battery technologies and capacity
- efficient AC/DC conversion
- adaptive intelligent system management
- thermal management
- DC distribution, virtualization
- de-duplication
- network resiliency
- equipment security
- LCD/LED display (enhancements) - more energy efficient backlight technologies Improvements in panel transmissivity

There has been continuous improvement in energy efficiency on computers covering software, hardware, and integration with data center operations. Some examples include:

- Software:
  - Operating systems optimized for power management
  - Application software
- Hardware:
  - Form factor minimization
  - Platform optimizations
  - Proxy technologies
  - Intelligent network devices
  - Dynamic power savings technologies
  - Multi-core processors
  - Enhanced low power silicon process technologies
    - Integrated product designs
    - Specialized function hardware
    - Remote system management
- Emerging PC Usages:
  - New PC usages are emerging (example: Always-on, Always-connected; Connected Standby) the systems will transition to power management similar to what is found in smart phones and tablets. Such systems are extremely responsive, to allow user to be in always connected state with much faster resume time latency.
  - These new PC usages are defining power modes different from traditional ACPI states. Example Win8 Connected standby systems lack the traditional S3 and S4 modes. Similarly these systems will power manage to low power, long idle-active mode (display off, HDD not spinning) with some application activity running in the background to keep the system in always connected state.
  - At the same time, manufacturing and other constraints create challenges for producing technology that can lower power consumption, as well as the pace with which technological improvements are rolled out. For example, the production of smaller and smaller transistors, containing atomic-level features are becoming increasingly difficult and costly to

manufacture causing a deceleration of manufacturing transitions. As a result, graphics processors built with the next generation of 20 nm manufacturing technology are expected to roll-out, at the earliest, in mid-late 2015, and in low volumes. In addition, the first products built with 20 nm technology will be high-end graphics processors, with a gradual introduction of this manufacturing technology occurring over time to entry level and mainstream products.

- In addition to the feasibility constraints just cited, the production of lower power technology is also associated with development costs that can impact the overall cost effectiveness of products utilizing that technology, over their lifetime.

## 2. Operations, Functions and Modes:

- What are defined modes of operation for computers
    - Industry advocates harmonizing to ENERGY STAR Version 5.2 TEC/adder, and power management approach. This includes use of idle (S0), sleep (S3), and off (S5) modes for TEC calculations.
    - Adder approach needs to focus on memory, hard drives, and discrete GPU based on Ecma-383 methodology. In addition for MEPs based approach Industry advocates providing allowances for discrete audio and TV tuner where applicable. While less critical for voluntary programs, MEPs approach on adders/allowance needs to be comprehensive, to lower the risk of excluding systems from California market.

- What power management features do computers have at both the system and subsystem levels?

Current power management technology is defined by the ACPI[9] (Advanced Configuration and Power Interface) specification. Operating system, system firmware and hardware work in unison to power manage the computer.

- S states – Explained above. Computers can be programmed to automatically enter S3 and S4 after a period of user inactivity.
- C states – CPU states. Power managed states for the CPU that range from stopping the CPU clock to dropping CPU voltage, turn off memory caches and putting memory into self-refresh.
- P states – Performance states for dynamic processor throttling. The processor can lower its frequencies and voltages to operating system application/task demand.
- D states – Device power states for PCI and PCIe components. Individual devices can be put in lower power states, including turned off, based on need.

[9] www.**acpi**.info

- Graphics processing units employ many of these same techniques internally. For some examples, see attached whitepaper[10].
- Computer screens are turned off after a period of mouse/keyboard, and or system inactivity

- What are common settings for these features as shipped and in preset energy saving or performance modes?
  All major computer companies ship PCs with all of these power savings featured enabled by default. Screen power down and Sleep (S3) engagement due to inactivity is set per ENEGY STAR requirement even on systems that don't carry the ENERGY STAR label. Industry position is that PC energy efficiency program should focus on system level requirements, providing system makers flexibility on designing, sourcing, and power management of components to best meet the requirements at the system level. Hence, beyond the system level power management there are no common settings at the feature/component level, since each implementation will be different.

  Note: There has been a lot of interest within CEC on understanding the effectiveness of PC power management enabling features especially on consumer PCs. Two areas of interest are a) PC power management enabling as shipped b) Consumer behavior on use of PC power management features. As mentioned earlier, Industry is working with CEC and UC Irvine on launching a PC behavioral survey to understand consumer behavior pertaining to PC power management enabling.

- What are the power use of computers and their subsystems (such as a graphics card) in the various modes of operation for existing and the next generation computers?
- See below example of an integrated graphics Desktop PC system power analysis[11]. Since PCs are highly configurable, this example by no means represents a broad spectrum of integrated graphics systems on the market. PCs with discrete GPU cards have additional energy allowance (adder) commensurate with discrete graphics class (G1-G7).

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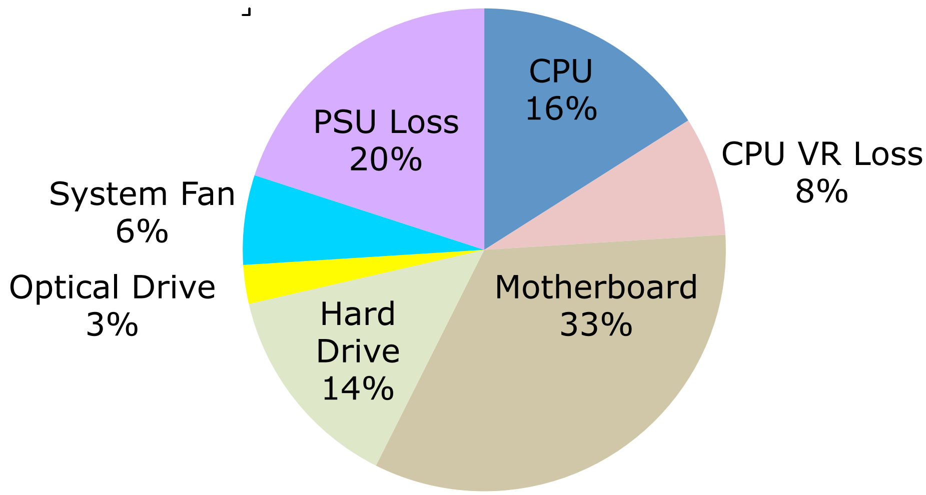
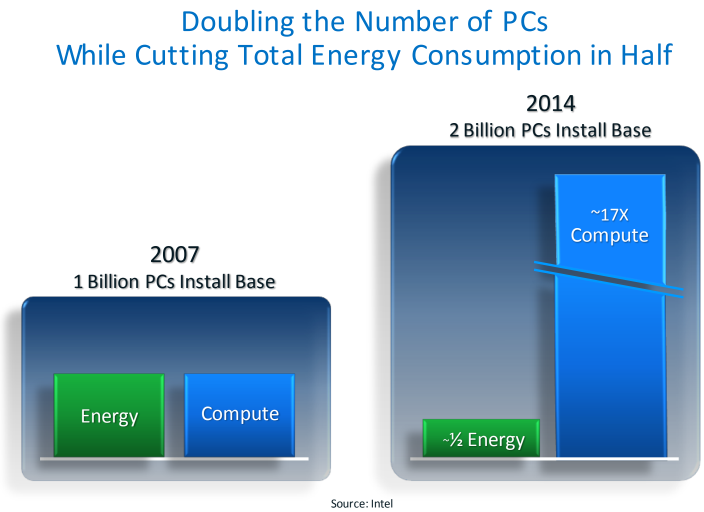
[10] http://www.amd.com/us/Documents/amd_powertune_whitepaper.pdf

[11] Source: Intel Corp.




- PC configurability complexity, Power supplies, MB design, etc. are key part of PC design. While all these factors have an impact on system power, it is important not to mandate any component requirements and provide flexibility to the system maker to meet TEC requirements at the system level.
- Trend is on the rise for mainly DC devices that utilize low power, lower processing capability – for example ARM-based tablets/slates computing products. Such devices mainly impact AC plug loads during battery charging operation, and are addressed under CEC Battery Charger Systems and External Power Supplies requirements.
- Always-on, always-connected and Connected Standby usages are also on the rise

- How does power use scale with the utilization of hardware such as processors, graphics cards, wireless networking etc.?
  - Public/Private programs like ENERGY STAR have helped encourage the ICT industry to develop new approaches to advance energy efficiency, driven by power management adoption as well as usage model and advances in technologies such as battery, displays, communication and human interfaces. Overall, there have been higher levels of integration, replacing single function tools with more integrated and mobile units. The usage model is also evolving, pushing increased personal productivity and efficiency by enabling a shift to lower power devices that better match their computing capacity needs. The results have been impressive:




- Computer energy efficiency has doubled every 1.57 years and is projected to continue at this pace for the foreseeable future.[12] As a consequence, the energy consumption of desktop computers been reduced from an average of 350kWhr per device to under 100kWhr, while increasing compute capacity nearly 10x.
- Wireless networking – The power consumption of wireless networking varies based on data that is being transferred, use environment (network environment). The number of spatial streams/radios supported in a device/client contributes to the power draw. More spatial streams supported the more power the device needs to support that chipset.
- Refer to Wi-Fi alliance website on the number of spatial streams supported for each device http://certifications.wi-fi.org/search_products.php?search=1&lang=en&filter_category_id=20&listmode=1

- What components and functions represent a fixed power use while the computer is on or in a sleep state?
  - Typical power states sequence for a PC is active mode, idle modes (short idle/long idle), system sleep and Off states. Based on Ecma-383 3rd Edition[13], enterprise profile study, and later adopted by IEC 62623, active power (workload) contribution is very small (<2%) and hence ignored for enterprise duty cycle study and TEC equation. Systems are shipped with power management enabled as a factory default. Industry follows the

[12] Koomey, Jonathan G., Stephen Berard, Marla Sanchez, and Henry Wong. 2011. *Implications of Historical Trends in The Electrical Efficiency of Computing*. IEEE Annals of the History of Computing. vol. 33, no. 3. July-September. pp. 46-54

[13] www.ecma-international.org/publications/standards/Ecma-383.htm

ENERGY STAR power management enabling guideline for System and Display sleep, Wake on LAN(WOL), and Wake Management

  - Nothing is fixed when is PC is 'on' or power managed; when in sleep – most subsystems are fixed or not drawing much power (power gated); memory refresh (dependent on memory capacity). However, the new Connected Standby sleep mode is different from the traditional sleep mode as mentioned, and may require subsystems to draw slightly more power.

- How much time computers spend in their various modes both in commercial and residential applications? How frequently are various functions of a computer in utilization such as "wake on LAN?"
  - This is based on duty cycles in ENERGY STAR Version 5– based on comprehensive Enterprise PC studies
  - Proxying provides the capability for PC to sleep longer (different duty cycles in ENERGY STAR)

3. **Energy Saving Technologies, Components, and Features** How long does it take a computer to wake from various sleep modes? What contributes to this wake time?
    - S3: from wake event to getting the computer ready for activity (< 1.7 sec WHQL requirements; ENERGY STAR < 5 sec)
    - S4: Varies with non-volatile technologies; resume time varies with amount of memory we have.

      While hibernate mode is generally enabled for Notebook PCs in DC mode to save data, when the battery capacity reaches a pre-defined critical level, the mode is not enabled as shipped, in AC mode for NB PCs (when battery depletion is not an issue). However, any system/platform meeting Microsoft Connected Standby requirements must disable hibernate in order to meet WHQL requirements.

      Hibernate mode is almost never enabled for desktop and integrated desktop systems as shipped, as these systems do not operate in DC mode. The other key reason is S4/hibernation has significant impact on the user experience, while having minimal or even negative impact on energy consumption reduction. Here are some examples:
        - Remote communication applications like SKYPE and IT management consoles break because of the long S4 resume latency.
        - The transition from S3 to S4 requires the system to revert to the Active Mode (ACPI S0) first, prior to entering another power management mode. The Active Mode (ACPI S0) consumes significantly more power than in Sleep Mode since hard drives spin up, all clocks go to full speed and all CPU cores may go online initially. For a period of time, the power demand actually increases!
        - Systems have to go into Sleep Mode (ACPI S3) first to satisfy ENERGY STAR power management requirements. Should PCs be required to add yet another lower power mode such as ACPI S4 Hibernate, the PC Operating System would be required to Wake

the PC up to Idle Mode and the system waits for at least a minute before it attempts the S4 transition. Industry has determined that on the average system, a PC would have to stay in an S4 hibernate mode for at least 2 – 3 hours to make up for the extra power consumed while the PC was in the S0 Idle Mode.

- To what extent is the efficiency developed for mobile computing incorporated in desktop computers?

  In terms of x86 technology, desktops employ virtually all of the power saving techniques used by notebooks. A non-exhaustive list would include:

  - Sleep (S3) and hibernation (S4) (Hibernation is rarely used on desktops.)
  - CPU processor management that stops CPU clocks, powers down CPU core caches and drops voltage when the CPU is idle.
  - Runtime power management that lowers CPU frequency and drops CPU voltage depending on the intensity of the operating system workload.
  - The same chip sets that are deployed on laptops. (Intel and AMD converged desktop and laptop chip sets years ago.)
  - Latest generation power managed GPUs (Most desktops ship with integrated graphics.)

  At the same time, desktop customers require a lower cost/higher performance paradigm as compared to laptops. Because of this need, desktops tend to not use laptop components (SODIMMs, laptop storage solutions etc.) that force desktop designers to use more expensive board designs and compromise performance. Due to the same cost/performance expectations for desktops, certain power management technologies such as switchable graphics are also typically not available on desktop systems. It should also be noted that the lower power CPU and graphics solutions used in laptops are bin selected out of a manufacturing yield. The more we use these components on desktops, the fewer are available for laptops.

- To what extent is the efficiency developed for slate devices incorporated in notebook computers?
  - Slates and Notebook computers are of different product categories and power management architectures
  - Differences
    - Software (Android, iOS, Windows CE)
      - Slates software are highly optimized for mobility, connectivity and experiencing media, not meant primarily for multitasking
      - Notebook software offers the full suite of applications for content generation and multitasking
    - Input/output devices and connectivity
      - Slates – limited I/O options (USB, HDMI, wireless)
      - Notebook – full suite of I/O options (Ethernet, USB, Firewire, HDMI etc.)

            - Storage capacity
                - Slates – using SSD which is faster, have lower power consumption, and higher cost but limited storage capacity (16GB-128GB)
                - Notebook – using HDD >128GB up to 1TB
            - Graphics solutions
                - Slates – typically do not include discrete GPUs due to power and physical limitations
                - Notebooks – can include discrete GPUs, especially in the performance and enthusiast segments

    - The differences stated above would result in differences in energy efficiency and power penalties associated to having those features and capabilities.
    - Another simple justification of differences is battery capacity, Notebooks have battery capacities from 20-200Wh (depending on the performance), Slates have battery capacity typically <20Wh. (refer to CEC website for battery information).
    - The battery capacity also translates to size/ form factor, Slates are meant for mobility and connectivity
    - Basically, it is inappropriate to compare Notebooks and Tablets in the same category and it needs to be properly addressed.
    - With that said, battery optimization is prevalent in both product categories without regulations driving improvement. Market forces are the main drivers of battery optimization, which leads to energy efficiency improvements.
- What are the design practices and technologies incorporated into the most efficient computers?
    - PCs are highly configurable and serve many segments. Power consumption varies within each product category based on customer requirements, market segments, and price points (average selling price)
    - All system boards, VR regulation are designed the same way
    - Designed to ACPI specs; common design practices, configurability and component manufacturer's 3 sigma statistical distributions
- What are the incremental costs associated with more efficient hardware?
    - Power supplies, VR, lacking deep c states (lower cost), PCB
    - Research and development of new products, subsystem and transistor design, manufacturing processes and power management technologies
- How well are hardware efficiency features utilized by computer system software?
    - OS, BIOS, FW.  ACPI compliant HW, FW system all designed to optimize energy efficiency. X86 based systems --- iOS, Linux ACPI compliant systems, variability among vendors
- To what extent are hardware efficiency features dependent on proper enabling by users? Which features are enabled by default?
    - Most PCs are shipped with power management functions enabled for display and system sleep (factory default). The Government agencies like

CEC, industry, utility companies and other stakeholders have a role to educate consumers on the value of power management enabled systems, so that they don't accidentally disable power management functions. Industry is partnering with CEC and UC Irvine on launching a PC behavioral survey to understand consumer behavior pertaining to PC power management enabling. The CEC should not mandate any new functions for power management beyond the ENERGY STAR program

- What are the power management settings in California's current stock of computers? What are the settings in new computers being offered for sale?
    - Same as other Geo's (all power managed – factory default)

4. **Market Characteristics:**
    - How many computers are sold each year in California? How many are currently in use? Form factor? Performance category? Commercial or residential? How are these expected to grow?
        - Industry relies on 3rd party analyst data (IDC, Gartner, etc.) for Market Characteristics and Market Share analysis. Such data are publicly available at least at the national level. Where California data are not available, CEC could make estimates or sanction California level study if warranted.
        - As such CEC should understand the installed base, stock aging, new shipments, and form factor changes to fully understand the market characteristics. Needless to say that new shipments of computers and displays will be more energy efficient than the previous generation of similar products.
        - In regards to form factor, CEA's recent study of US consumers[14] provides important data; we understand CEA will be making that data available.
    - To what extent is the computer market uniform or different within the state, country, continent, and world?
        - Not much different – products are designed and built for global markets
    - Is there a particular time of the year when new models are released?
        - Varies by a given manufacturer and launch cycles; consumer vs. enterprise cycles are different
    - What is the range of efficiency in the market for computers with similar performance? How much variance is there?
        - PC configuration differences are a key source of variability. The other key factor is the statistical (3 sigma) manufacturing variations inherent at each process step, and during manufacture of hundreds of components sourced in manufacturing of a PC.
    - How frequently are computers updated after initial release (firmware and hardware)?
        - No fixed frequency, however there is occasional OS/FW refresh (enterprise); consumers (OS). As SW/OS/Apps play a more critical role in

[14] CEA, 15th Annual CE Ownership and Market Potential Study, April 2013

new PC usages, more frequent revisions from software suppliers will become likely

5. **Market Competition for Efficiency Products:**

- How many small businesses are involved in the manufacture, sale, or installation of these products?
    - Industry relies on 3rd party analyst data (IDC, Gartner, etc.) for Market Characteristics and Market Share analysis. Such data are publicly available at least at the national level. Where California data are not available, CEC could make estimates or sanction California level study if warranted. Industry relies on its own sources for system energy consumption models.
- What are the current market drivers towards improving computer efficiency?
    - Design & Sales Cycles -- Moore's Law and end-of-life of product models
    - Market Competition for Efficient Products
    - Customers, battery life, new usages
- What markets currently place requirements on the efficiency of computers through regulations or procurement requirements?
    - Slightly varies by geography. Most global jurisdictions implementing a MEPs based regulation are converging to ENERGY STAR Version 5.2 framework and in some cases with limits and adders.
    - See industry position on energy efficiency regulations in the context section
- How are consumers able to identify the most efficient products on the market? The least efficient?
    - ENERGY STAR label; Notebooks-- Battery life
    - Other key factors: Brand, functionality, price
- What is the current market share of computers that meet ENERGY STAR's computer specifications 4, 5.2, and current draft 6.
    - ITI can help based on ENERGY STAR penetration data (Most meet TEC level but not power supply requirements for Version 4; ~40-50% (version 5.2 TEC); current draft 6 (<20%, TBD)

6. **Other:**

- What types of operations prevent a computer from automatically entering sleep mode?
    - No application will force disabling power mgmt. (violates WHQL); user activity (productivity software, playing movie; games), or user disabled power mgt.
- To what degree do background programs and services affect energy consumption?
    - Could be significant depending on the application (virus check, WinZip, others, etc.)

- What product development trends in the computer market may have an impact on power consumption or proper categorization of devices?
    - Connected standby; Always-on, Always-connected usages
    - High-resolution panels, such as Ultra-HD/4K displays, touch panels, enhanced performance displays, etc.
    - Introduction of new capabilities, e.g. biometric recognition, increased use of sensors, 3D modeling, voice and gesture control, multi-display technology such as using multi-stream support capability of DisplayPort 1.2 to have one DisplayPort drive multiple daisy-chained monitors.
- What are the incremental costs between the different levels of 80 plus compliant power supplies and power supplies that do not meet the 80 plus specifications? What are the main drivers of these costs?

Table below shows just the power supply cost delta from going to 80+ Silver from 80+ Bronze. Note this data is based on cost and markup[10] information from a sample of key IPS suppliers and other sources. Power supply ratings are consistent with those commonly shipped in the latest form factors.

| Multi-output IPSU rating in Watts | Incremental IPSU Cost, 80+Bronze -> 80+ Silver |
|---|---|
| 270 | $2.55- 2.95 |
| 300 | $2.35-2.70 |
| 460 | $3.65-4.20 |
| Market Weighted Average | $2.50-2.90 |

| Average Incremental Cost | PSU Markup | Annual Energy Savings (kWh) | Product Life (years) | Breakeven Life (years) |
|---|---|---|---|---|
| $2.50 | 1.625 | $0.87 | 3.5 – 4.0* | 4.67 |

*Enterprise customers normally cycle their desktops every 3 years.

| Efficiency Baseline APFC 68% Efficient | 300 Watts OEM Cost/Consumer Cost | 460 Watts OEM Cost/Consumer Cost | 270 Watts OEM Cost/Consumer Cost |
|---|---|---|---|
| 80+ Bronze | $2.35-2.70 /$3.80-4.40 | $3.65-4.20 /$5.95-6.85 | $2.55-2.95/$4.15-4.75 |
| 80+ Silver | $5.00-5.75 /$8.15-9.40 | $7.10-8.20 /$11.55-13.30 | $4.85-5.57/$7.90-9.10 |
| 80+ Gold | $9.15-10.50 /14.90-17.15 | $13.65-15.70 /$22.20-25.50 | $8.60-9.90 /$14.00-16.10 |
| 80+ Platinum | Not available in multi output format | Not available in multi output format | Not available in multi output format |

[10] **NRDC Comments on** ENERGY STAR Computers Version 6, March 10 2011 Kickoff Meeting

# Computer Monitors.

## Basic Information Requested

1. Product Definition and Scope
    - Comments are based only on ICT display products (excludes Electronic billboards)

**a. Product definition recommendations**

Definitions below references currently available definitions in established energy efficiency programs.

- **Electronic Display** (reference ENERGY STAR): A commercially-available product with a display screen and associated electronics, often encased in a single housing, that as its primary function displays visual information from (1) a computer, workstation or server via one or more inputs (e.g., VGA, DVI, HDMI, IEEE 1394), (2) a USB flash drive, (3) a memory card, or (4) a wireless Internet connection.

- **Computer Monitor** (reference ENERGY STAR): An electronic device, typically with a diagonal screen size greater than 12 inches and a pixel density greater than 5,000 pixels per square inch (pixels/in2), that displays a computer's user interface and open programs, allowing the user to interact with the computer, typically using a keyboard and mouse.

- **Enhanced-Performance Display** (reference ENERGY STAR and AS NZS 5815.2:2013): A computer monitor that has all of the following features and functionalities:

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

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

  (c) A color gamut size of at least sRGB as defined by IEC619662-1.Shifts in color space are allowable as long as 99% or more of defined sRGB colors are supported.

- **Digital Picture Frame** (reference ENERGY STAR)**:** An electronic device, typically with a diagonal screen size less than 12 inches, whose primary function is to display digital images. It may also feature a programmable timer, occupancy sensor, audio, video, or Bluetooth or wireless connectivity.

- **Signage Display** (reference ENERGY STAR): An electronic device typically with a diagonal screen size greater than 12 inches and a pixel density less than or equal to 5,000 pixels/in2. It is typically marketed as commercial signage for use in areas where it is intended to be viewed by multiple people in non-desk based environments, such as retail or department stores, restaurants, museums, hotels, outdoor venues, airports, conference rooms or classrooms.

- **Specialized electronic displays** (reference AS NZS 5815.2:2013): Intended for use primarily in commercial, professional fields, engineering, medicine, graphic arts, etc., and not intended for sale to the general public. Examples include the following:

    (i) Those defined as professional products that are in the scope of EN 55103.

    (ii) Medical products as set out in the IEC 60601 series.

    (iii) Those that comply with the Digital Imaging and Communications in Medicine (DICOM) standard (for medical electronic displays). Products used in diagnostic medical applications that do not have a power state meeting the definition of Standby Active (Sleep) Mode, (e.g. FDA's specifications for medical devices that require luminance to be maintained over the lifetime of the electronic displays among other requirements that prevent such electronic displays from implementing power management capabilities).

    (iv) Products that can display content through installed serial digital interface (SDI) signal path/s including medical electronic displays intended by manufacturers to be used in the diagnosis, treatment, or monitoring of a patient.

- **Public displays** (reference AS NZS 5815.2:2013)**:** Products intended for electronically displaying content to multiple users such as in public settings, conference rooms, etc., with one or more of the following characteristics:

    (i) Product has a screen size of 81 cm (32 inches) or above.

    (ii) The product is marketed as a product that is intended to be viewed by more than one user at a time.

    (iii) The product is not intended for desktop use.

    (iv) The product is not supplied with a means of allowing it to be freestanding.

    (v) The product requires installation on a permanent basis (it cannot be easily moved without tools being used).

- **Large displays** (reference AS NZS 5815.2:2013)**:** Devices with a display size greater than 152cm (60inches) diagonally.

**b. Scope recommendations:**

Industry recommends including only mainstream high volume ICT display consumer/enterprise products in the scope of the regulation in the specifications.

The product categories below should be excluded from the scope of the regulation. This is aligned with the Australian MEPS program (AS NZS 5815.2:2013)

i) High performance displays – These displays lead in productivity and efficiency gains for users. Key California industries including aerospace/defense, high tech (R&D, computing, biotech), and entertainment (film, TV, music) utilize this technology. These displays are often used in the CAD/Cam, photography, stocks and securities analysis and trading industries where a higher performance is required for productivity. These panels provide a higher pixel density and wider viewing angles compared to normal TN displays. These displays require more backlighting which means more power to achieve the same luminance as a similar TN display. This is a tradeoff between higher performance requiring more power. They are sold in smaller volumes and not targeting the mainstream consumer market.

ii) Specialized Electronic Displays/Signage Displays – These displays are not sold to the general public and are highly specialized. There are no established standards or benchmarks for these specialized displays.

iii) Public Displays – These displays are for public viewing (more than one user at a time), they are highly customizable, they require special installation. They are not mainstream displays. There are no established standards or benchmarks for these public displays.

## 2. Existing Test Procedures

| Test Procedures | Link |
|---|---|
| ENERGY STAR v5.1 | https://www.energystar.gov/index.cfm?fuseaction=products_for_partners.showMonitors |
| ENERGY STAR v6.0 | https://www.energystar.gov/index.cfm?fuseaction=products_for_partners.showMonitors |
| Australia MEPS for Computer Monitors (AS NZS 5815.1:2012) | http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Computers_and_Peripherals/201011b-supp-info-consult-ris-computers.pdf |
| IEC 62301- Household electrical appliances- Measurement of standby power | http://webstore.iec.ch/webstore/webstore.nsf/Artnum_PK/44782 |
| IEC 62087 – edition 3 Methods of | http://webstore.iec.ch/webstore/webstore.nsf/Artnum_P |

| | |
|---|---|
| measurement for the power consumption of audio, video and related equipment | K/45001 |
| EPRI: Generalized Internal Power Supply Efficiency Test Protocol | http://www.efficientpowersupplies.org/methods.asp |
| EPRI: Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies, Aug. 11, 2004. | http://www.efficientpowersupplies.org/methods.asp |

## 3. Sources of Test Data

Industry promotes and recommends the use of manufactures/suppliers test data together with a declaration of conformity from a competent lab in any jurisdiction. This should be acceptable for demonstrating compliance for a mandatory minimum energy performance standard (MEPS) program.

## 4. Existing Standards and Standards under Development

| **Mandatory Minimum Energy Performance Standards (MEPS) Programs for Displays** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Ctry** | **Prog** | **Scope** | **Date** | **Off** | **Sleep** | **Active/On** | **Power Management** |
| EU | ErP Lot 5 EC 642/2009 (revision) | Electronic displays-including TV (Computer monitors recently included) | Not published | 0.3W | 0.5W/1 W | Energy Efficiency Index (EEI) Metric: screen size and resolution | APD to sleep/off |
| EU | Standby/Off EC1275/2008 | All IT products | 2013 | 0.5W | - | - | APD to off |
| China | China Energy Label<br><br>GB 21520-2008 | Displays (LCD and CRTs) **Does not take into account resolution or quality of displays** | 2008 | 0.5W -2W | - | Energy efficiency (Cd/W) Metric: screen size and intensity | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Korea | eStandby<br><br>**Aligned to ENERGY STAR v5.1** | Displays | 2012 | 0.5 | 2W | Metric based on resolution and screen size | APD to sleep |
| Aus/NZ | Aus/NZ MEPS<br><br>(AS NZS 5815.1:2012)<br><br>**Aligned to ENERGY STAR v5.1** | Computer Monitors **(exempts high performance displays, specialized electronic signage displays and public displays)** | 2013 | 1W | 2W | Metric based on resolution and screen size<br><br>Projected annual energy consumption labeling + star rating | APD to sleep |

| **Voluntary Energy Efficiency Programs for Displays** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Ctry** | **Prog** | **Scope** | **Date** | **Off** | **Sleep** | **Active/On** | **Power Management** |
| USA | ENERGY STAR v5.1 | Computer monitors, digital picture frames, signage displays | 2009 | 1W | 2W | Metric based on resolution and screen size | APD to sleep |
| USA | ENERGY STAR v6.0 | Computer monitors, digital picture frames, signage displays | 2013 | 1W | 0.5W ++ | Metric based on resolution and screen size | APD to sleep |
| Global | TCO label **(based on latest ENERGY STAR version)** | Displays | 2012 | 1W | 0.5W++ | Metric based on resolution and screen size | APD to sleep |

++ Need to include additional power allowance to the base values which is dependent on the functionality available on the product (e.g. WIFI gives an additional 2W)

5. Product Lifetime

   There is no available industry estimate of the lifetime of a product. Computer monitors for consumers are designed to be reliable and free from defect for 1 to 3 years or 3 to 5 years. This is the warranty provided by manufacturers. Some manufacturers offer warranty through the number of usage hours (e.g. <30,000hours.) These are the typical minimum design targets.

   For enterprise models, their typical replacement cycle is 3-5 years

   Warranty life is not an indication of lifetime of the product. It is an indication of the quality of the product that the manufacturers guarantee and provide service for. They are often used as design targets to minimize warranty costs.

   It is very difficult to predict consumer usage patterns or estimate how long before they dispose products.

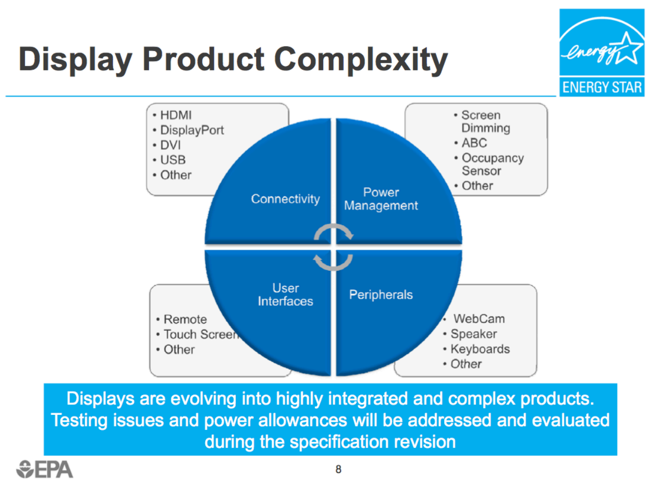
6. Product Development Trends

For a comprehensive understanding and breakdown of product development trends refer to industry market intelligence research companies like International Data Corporation (IDC), Gartner or DisplaySearch. E.g. DisplaySearch has reports that try to answer questions on migration trends by regions and growth patterns.

http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/reports_monitors.asp

- Energy Efficiency: Voluntary programs like ENERGY STAR help drive energy efficiency improvements. Refer to the Context section on the energy efficiency trends of the ENERGY STAR program.

- Complexity of displays have increased, they have evolved from being a single function display only device to a device with various capabilities to complement the host product (PC, Laptop). These capabilities include enhanced graphics and input output options (e.g. DVI, HDMI, Thunderbolt, USB hubs, Webcams, speakers, networking etc.). Some displays offer a touch screen option as well. The chart below from EPA recognizes this shift in technology trend.




- Size: Desktop Monitor displays range from 15"-30". A recent analysis from DisplaySearch on the average display size from 2010-2013 is only one inch. This shows that the desktop monitor sizes are relatively stable. Industry does not expect desktop monitor sizes to increase to that of TVs.

**Table 1: Average Diagonal Size of Key FPD Applications**

| Key Applications | 2010 | 2011 | 2012 | 2013 | Average Size Difference (2010-2013) | |
|---|---|---|---|---|---|---|
| Desktop Monitor | 19.9" | 20.3" | 20.7" | 20.9" | 1.0" | 5% |
| LCD TV | 33.2" | 34.5" | 35.9" | 36.1" | 2.9" | 9% |
| Mobile PC | 13.6" | 12.8" | 12.1" | 12.2" | -1.4" | -10% |
| Mobile Phone | 2.4" | 2.6" | 3" | 3.3" | 0.9" | 38% |
| OLED TV | 15" | | 55" | 55" | 40.0" | 267% |
| Plasma TV | 46.3" | 47" | 48.1" | 50" | 3.7" | 8% |
| Portable Media Player | 2.8" | 3.1" | 3.1" | 3.6" | 0.8" | 29% |
| Portable Navigation Device | 4.3" | 4.5" | 4.5" | 4.6" | 0.3" | 7% |
| Public Display | 41.7" | 41.3" | 44.9" | 46.5" | 4.8" | 12% |

Source: NPD DisplaySearch *Quarterly Worldwide FPD Shipment and Forecast Report*

**Desktop Monitor**

NPD DisplaySearch anticipates challenges in desktop monitor panel demand especially in 2012 and 2013. That challenge is a result of the maturity of desktop PC bundles and stagnant replacement in the stand-alone PCs. However, consumers are buying larger-sized LCD monitors such as 23", 24", and 27", so average monitor diagonal size is increasing from 19.9" in 2010 to 20.9" in 2013.

- Display panel developments – moving from CRTs → LCD
    - LCD Technology
    a. Twisted Nematic (TN) –narrow viewing angles, poor color gamut, low brightness
    b. Vertical alignment (VA) – wide viewing angles, wider color gamut, deep contrast, higher brightness
    c. In plane switching (IPS) – wide viewing angles, wider color gamut, deep contrast, higher brightness
    d. Plane line switching (PLS) – wide viewing angles, wider color gamut, deep contrast, higher brightness

- Backlight technologies
  - CCFL – 1 backlight and generates heat (always on),
    - LCD blocks the light
    - Uses a diffuser for even brightness
    - longer warm up times
  - LED backlight
    - energy efficient and less heat
    - not perfect blacks
    - more expensive
    - slimmer designs
    - shorter warm up times

- Power management (save energy, improve user experience, extend monitor life)
  - Auto brightness controls
  - Automatic sleep modes

- Higher resolution
  - Higher resolution tablet and smartphone devices likely to stimulate higher resolution notebook panels

## Operations

7. How should the energy efficiency of standalone display devices be measured or bench marked (e.g., energy/area, energy/pixel, etc.)? Why?

Industry recommends and proposes that energy efficiency be measured and bench marked as per Energy star v5.1. It is a mature and well-recognized specification that is referenced in other jurisdictions.

There is also a need to have provisions for additional features and peripherals due to shifts in display functionalities.

Power modes:

- Off
- Sleep
- Active/On (scalable metric taking into account the display resolution and area)

Active mode– dependent on performance, quality, technology and usage scenarios

**a. How does display resolution impact power draw?**

- LCD-The higher the resolution the higher the power drawn. LCD's with higher resolution need to have a stronger backlight to accommodate these additional pixels.
- GPUs – The higher the resolution the higher the power drain. More pixels

require more processing from the GPU as well as more frame buffer traffic.

**b. How does display brightness impact power draw?**
Refer to ENERGY STAR link below. There have been good discussions on this topic, which CEC could refer to. Industry does not have trend data that correlates power to brightness.
https://energystar.gov/products/specs/node/145

8. For each display category:
    a. What are the modes of operation?

1) On Mode: The operational mode of a display that (1) is connected to a power source, (2) has all mechanical (hard) power switches turned on, and (3) is producing an image.

2) Sleep Mode: The operational mode of a display that (1) is connected to a power source, (2) has all mechanical (hard) power switches turned on, and (3) is in a reduced-power state after receiving a signal from a connected device (e.g., computer, game console, set-top box) or by cause of an internal function (e.g., sleep timer, occupancy sensor). Sleep Mode is considered a “soft” low- power condition, in that the product may exit Sleep Mode upon receiving a signal from a connected device or by cause of an internal function.

3) Off Mode: The operational mode of a display that (1) is connected to a power source, (2) has one or more manual power switches turned off, and (3) is not providing any function. The product may only exit Off Mode by cause of direct user actuation of a manual power switch.

b. What is the typical usage profile (duty cycle)?

There are currently no standards or good benchmarks to demonstrate typical usage profiles or duty cycles. Usage patterns of consumers vary by market segments and even within the same segments.

If a standard use profile is ever determined to be required for Displays, it will need to be agreed to by industry and specified in a standard. The generation of this standard needs to have the involvement of Display manufacturers.

c. What are the typical factory default settings (e.g. power management, brightness, refresh rate, etc.)?

Displays (devices) have power management capabilities and are managed by the PCs/Host. Displays are dependent on the host pc for power management.

d. What is the maximum and minimum power draw during active mode across various display sizes?

It varies, highly dependent on customer use patterns and technology.

e. What is the maximum and minimum sleep/standby mode power draw?

Based on existing regulations ERP Lot 6, most displays need to meet Standby/Off <=0.5W. Off mode is defined as the lowest power mode of the product, in products with a mechanical switch this is the mode when the switch is off.
As specified in ENERGY STAR v5.1 Sleep mode ≤ 2W

f. What is the maximum and minimum power draw with no input data signal (i.e., when the computer is off but the monitor is on)?

If there are no input data signals, displays should default to a sleep mode of ≤ 2W (Computer off and monitor is in sleep). The minimum power draw for standby/off would be ≤ 0.5W as per ErP Lot 6 (computer is off, monitor off). Displays are slave devices, which responds according to the PCs/hosts that they are connected to.

g. Do power management (e.g. auto power down) operations change depending on connection type (e.g. DVI, HDMI, etc.)? If so, how?

Yes. I/O ports consume power due to the additional circuitry in the product that is typically different for each type of bridge provided.

Refer existing specifications of ENERGY STAR Displays v6, Computer and Imaging equipment v2.0- that recognizes the need for adders that accommodates I/O ports

### Energy Consuming Feature

9. What built-in energy consuming features are typically included in displays (e.g. cameras, USB charging ports, speakers, etc.)?

    a. How much energy does each feature use?

Backlight consumes approximately 2/3 of the power of a display, remaining is panel electronics and additional features
In Active mode the main power draw of a display is the backlight
In Sleep mode the main power draw is to support the components that need

to be ready to respond to external inputs/interactions e.g. USB, Thunderbolt ports, Ethernet ports, touch screen etc.

b. How much does each cost the manufacturer to include on a per-unit basis?

Industry recommends CEC to refer to 3rd party analyst data (IDC, Gartner, DisplaySearch etc.) for information on the different cost of subsystems

c. How common are they?

The display market is trending towards integrated devices, consumers look to displays as docks for the devices. For the consumer market, there is a demand for integrated cameras and speakers. For the commercial market, the demand is to enhance productivity, which would mean additional connectivity ports (e.g. USB, Ethernet).

## Energy Saving Features & Technologies

10. What energy saving technologies or features are currently included in displays?

- Sleep
- Off
- Back light control technologies (BLC)

For examples of some of these technologies are highlighted in the whitepaper[15]

a. How much energy does each save?

   This is highly dependent on the usage models of the user and is very hard to predict.

b. How much does each cost the manufacturer to implement on a per-product basis?

   See below.

c. How common are they?

   Industry recommends CEC to refer to 3rd party analyst data (IDC, Gartner, DisplaySearch etc.) for information on the different cost. DisplaySearch offers reports on supply chain and cost breakdown.

11. Which energy saving technologies or features could potentially be incorporated in

[15] http://www.intel.com/content/dam/doc/white-paper/power-management-technologies-for-processor-graphics-display-and-memory-paper.pdf

displays?

a. How much energy does each save?

   Manufacturers are always looking to improve and optimize energy efficiency driven by market forces. New technology information is highly confidential.

b. How much does each cost the manufacturer to implement on a per-product basis?

   - See above on confidentiality.

## Control Features

12. What features can improve overall display efficiency by changing the duty cycle or lowering the power draw of the equipment (e.g., activity sensor, power management, automatic brightness control)?

    a. Please explain how these features save energy.

    - Activity sensors – detects presence and brings the display to a lower power state faster. More relevant to TVs? Monitors are slave devices and depend on the host device (PCs) or external stimulus to enter a low power state.

    - Power management – employed in displays to enter/exit Sleep or Off/standby state depending on PC activity. Displays are slave devices that respond to the host PC.

    - Automatic brightness control – is intended for user comfort and ergonomics. It comes with a cost penalty and power penalty of additional electronics (sensors, components). There are power savings when displays are in low ambient lighting conditions where the displays are dimmed. These savings are similar to products without Automatic brightness control should they adjust the brightness manually. It is more relevant to mobile devices where the product is used in different environments and for battery conservation. For displays, which are often in a fixed location, it is a choice point for customers. Also computer displays are often at arm’s length of the user so it could be easily adjusted to the brightness levels for the user and his environment.

    b. How much do they cost to implement into a display on a per product basis?

       Industry recommends CEC to refer to 3rd party analyst data (IDC, Gartner, DisplaySearch etc.) for information on the different costs.

    c. What impact would proper implementation of these efficiency features have on the energy consumption of displays?

- Power management - if employed correctly would have a significant impact to displays. Displays would only be in Active state when it's needed and transition into a lower power state when it's not in use.
- See above on Automatic brightness control.

d. Are consumers receptive to these control features?

- Consumers are receptive to power management features
- Other regulations and eco labels have placed limits for low power modes.
- As for the Activity sensors and Automatic brightness controls, there is no clear evidence to show that consumers are receptive, refer to IDC, Gartner or Display Search.

## Market Characteristics

13. What are the annual California shipments for 2009 to 2012 as well as projected for 2013 to 2015 by display category?

a. What are the typical sizes in the market for each display category?

See below on a recent analysis by market research group DisplaySearch on the typical sizes of displays.

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b. What percent of shipments in each display category has automatic brightness adjustment controls?

Industry relies on 3rd party analyst data (IDC, Gartner, etc.) for Market Characteristics and Market Share analysis. Where California data are not available, CEC could make estimates or sanction California level study if warranted.

c. What percent of shipments in each category has an easily accessible off switch that reduces power draw to zero?

Same as above

d. What is the percent of shipments in the market across the typical sizes and resolutions for each display category?

Same as above

e. What is the percent of shipments by backlight technology (e.g. CCFL, LED [edge & array], OLED or other)?

Same as above

f. How many small businesses are involved in the manufacture, sale, or installation of these products?

Same as above

### Installed Base Characteristics

14. What is the current California installed base for displays by category?

Industry recommends CEC to coordinate with CalRecycle to review the annual SB20/50.
The annual reports are broken out into the following categories:

- TV (CRT)
- Monitors (CRT)
- Flat Panel (LCD) Monitors
- Laptop Computers (LCD)
- Flat Panel (LCD) Televisions
- Flat Panel (Plasma) Televisions
- Portable DVD Player (with LCD screen)

http://www.calrecycle.ca.gov/electronics/act2003/
Contact: EWaste@calrecycle.ca.gov (916) 341-6269

a. What are the typical sizes in the installed base for each display category?
b. What percentage of the installed base do these typical sizes account for by display category?
Industry relies on 3rd party analyst data (IDC, Gartner, etc.) for Market Characteristics and Market Share analysis.

### Market Competition for Efficient Products

15. What are the current market drivers initiating the improvement of display efficiency?
    - Commercial customers are interested in energy efficient product and manufacturers respond to that market demand through voluntary programs like ENERGY STAR.

16. How are consumers identifying the most efficient products on the market?
    - Commercial customers- ENERGY STAR
    - Consumer – Some consumer may look for ENERGY STAR, but most consumers are more concerned about price and performance.

17. What is the market share of displays that meet ENERGY STAR 5.1 and 6.0 criteria?
    - Refer to ENERGY STAR program annual shipment reporting.

**Independent Market Research and Intelligence Companies**

IDC -- http://www.idc.com

Gartner -- http://www.gartner.com/technology/home.jsp

DisplaySearch --
http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/index.asp

## C. Networking Equipment

Following publication of the Invitation to Participate, the Commission on April 4 hosted workshops on "Set-top boxes, *including Networking Equipment*" (italics added). ITI and TechNet are in general support of the comments submitted by the Telecommunications Industry Association, that (a) networking equipment should be excluded from the scope of the products under consideration by the Commission, and (b) the Commission should also make clear that commercial network infrastructure equipment is excluded from the scope of the potential rulemaking.

The Commission's March 14, 2012 Order Instituting Rulemaking on Appliance Efficiency Regulations did not propose to include networking equipment in any of the three proposed regulatory phases. TechNet and ITI have concentrated our efforts over the past year and a half working with our members and the Commission on issues related to computers and displays, which are to be considered in Phase 1.

Networking equipment products and markets are evolving rapidly. Products are diverse, complicating easy categorization. In such an environment, the potential costs of regulatory action are likely to be especially high relative to the benefits that could be obtained through regulation. Through initiatives such as the Obama Administration's Green Button Initiative, which would allow consumers to use energy data to better manage household energy use, networking equipment has the potential to play a key role in helping households achieve significant overall reductions in energy use.

Our organizations are interested in working with the Commission to scale the deployment of home energy networking functionality, perhaps through the use of incentives. But we believe that the Commission should refrain at this time from expanding the product scope in the OIR, so as not to inhibit device and network functionality or lose potential efficiency gains made possible by home or business area networking equipment.

## III. Concluding Remarks

A great deal of information has been supplied within these 35 pages. We welcome the opportunity to discuss this information further, and we will of course participate in the May 29th Workshop.

Please direct any inquiries concerning the information in this submission to Chris Hankin of ITI (chankin@itic.org) and Jim Hawley of TechNet (jhawley@technet.org).