Proposal for Standards – Consumer Electronics (Docket #12-AAER-2A) -- Computers

Appliance Efficiency Standards and Measures

For California Energy Commission's Invitation to Submit Proposals

Authors.

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1 Executive summary

The Information Technology Industry Council and TechNet appreciate the opportunity to submit the enclosed computers proposal. For decades, California has been a leader in achieving significant improvements in energy efficiency, often made possible by technologies the state's information and communication technologies (ICT) industry has pioneered. In recent decades, the ICT industry has achieved unrivaled improvements in energy efficiency, significantly reducing the power consumption of computer systems while concurrently increasing their performance. According to the American Council for an Energy Efficient Economy (ACEEE), ICT has "revolutionized the relationship between economic production and energy consumption".

The tremendous efficiency gains have resulted not from mandatory government requirements but as a result of market and consumer demand, vigorous innovation and competition and voluntary initiatives such as Energy Star, and these gains will continue in the future. New, more efficient products are displacing old technologies at a rapid rate. The realization of the State's energy goals pursuant to the Warren-Alquist State Energy Resources Conservation and Development Act and other laws, and the health of the state's economy, will depend upon continuing a vibrant, innovative ICT sector and the state's continuing technology leadership.

Our industry's approach to continued improvements in energy efficiency is through three areas:

1. Energy efficiency gains while continuing to drive innovation. Industry factors:
   - Market segment/consumer demand
   - Competition
   - Caring for the planet – product energy footprint reduction through technology innovation

2. Support for voluntary programs, to incentivize product energy efficiency in specific product categories. These programs continue to show strong record of success in driving down overall product energy (TEC) footprint. Not only on the targeted products but products which reuse similar components.

3. Global regulatory convergence, with industry driving global convergence of product energy efficiency regulations and standards, with applicability for both voluntary and mandatory programs. This will enable energy-efficient ICT products to be cost-effectively deployed to both save energy and promote economic growth.

The market for computers is complex, dynamic and not well suited to regulatory approaches applied to more static sectors. Should the CEC conclude that regulations on computers are nonetheless unavoidable, in order to prevent disruption to key California industries, research, technology development, and consumers, regulations must focus on the cost-effective removal of the least efficient, high-volume products, while providing exemptions for high performance, specialized low shipping volume products. Regulations must not impede innovation. Appropriate specification limits can target the least energy efficient products where it is cost effective, and where based on sound data collection and analysis. Any energy efficiency regulations adopted should also enable manufacturer self-testing, declaration of compliance by manufacturers, and provide an online registration process (if registration is needed).

Therefore, ITI and TechNet propose the following:

Focus	Approach	Comments
Framework	Energy Star Version 5.2	Definitions, TEC equation, Duty Cycles, etc. Test methodology based on IEC 62623 (Version 5.2)
Product Scope	**In Scope:** Mainstream NB; DT;AIO **Out of Scope:** Workstations; Thin Clients; Small-scale servers; Tablets/slates **Exemption:** PCs< 40kWh; High-end DT/NB; Mobile Workstations	Exemption definitions and criteria provided in earlier sections
Category System	ENERGY STAR Version 5.2	ENERGY STAR Version 6 category system is new and needs to be exercised first
dGfx and other adder approach	dGfx: Ecma-383 (G1-G7 GPU classes); Other adders based on ENERGY STAR and Global MEPs programs	Discrete audio/TV tuner are not part on ENERGY STAR for Computers
Power supplies	EPS (Mark IV) IPS: No IPS requirements	See IPS analysis in the appendix for justification
TEC/Adder Target setting	-Based on California Data, or -Align with ENERGY STAR V5.2 targets and adders (dGfx, audio, TV tuner adders aligned to global MEPs programs) - No modal power limits	Data collection (75 percentile approach)
Power Management	Energy Star V5.2 Power Mgmt (exemption for FreeDOS; Linux, etc.)	Awaiting outcome of UC Irvine study

Labeling	No product or retail package labeling	
Certification	Manufacturer self-declaration; Test conducted in competent test facility	

2 Product Description and Proposal Scope

2.1 Technical Description

[Provide technical description of the product, its components, software, power supplies, controls, or any other components that control device functionality and consume energy or water.]

A. **Product Description**: ENERGY STAR product Specification for Computers[1] describes Computers as devices which perform logical operation and processes data. For the purpose of CEC RFP these include Desktop Computers, Integrated Desktop Computers, and Notebooks Computers. These devices are at a minimum composed of:

- A central processing unit (CPU) to perform operations
- User input devices such as a keyboard, mouse, touchpad, etc.
- An integrated display screen and/or the ability to support an external display

B. Computer Components and key sub-systems:

  - Motherboard
  - Graphics Processing Unit (GPU): Use Energy Star description for this and below
  - Discrete Graphics (dGfx)
  - Integrated Graphics (iGfx)
  - Display
  - Power Supplies (IPS/EPS)
  - Storage (hard disk drive[HDD]; solid state drive[SSD])
  - System Memory
  - SW/OS
  - Other components (Chassis, fans, optical drives, peripherals).

C. Functionality and power consumption:

  - Figure 1 example of an integrated graphics Desktop PC system power analysis[2] . Since PCs are highly configurable, this example by no means represents a broad

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[1] ENERGY STAR product Specification for Computers (Final Draft Version 6.0)

[2] Source: Intel Corp.

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).

- 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.
- New PC usages such as always-on, always-connected and Connected Standby are emerging.

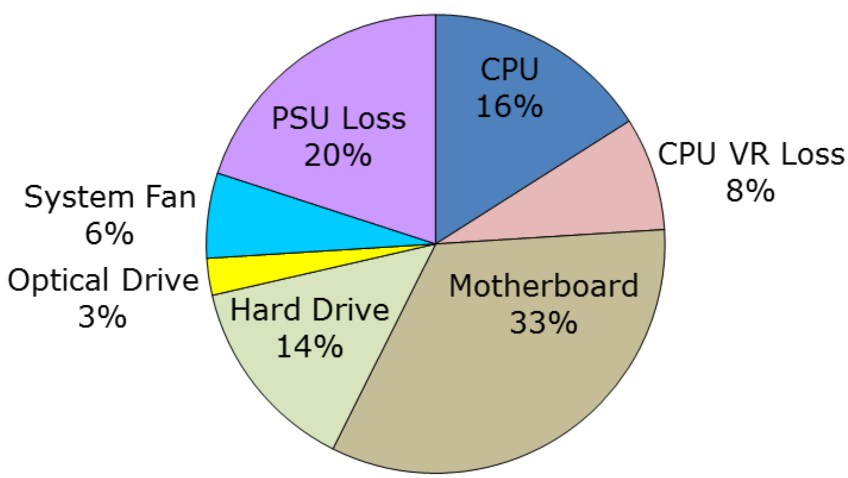

Figure 1

2.2 Technologies and Best Practices for Energy/Water Efficiency

[Discuss the best design practices for energy/water efficiency, energy/water reducing features in products available today and in the near future, and technology improvements that will improve efficiency. If possible, contrast these improvements with generic or lower efficiency design approaches and technologies.]

A. Best Practices and Key Drivers:

- 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 (Figure 2) :

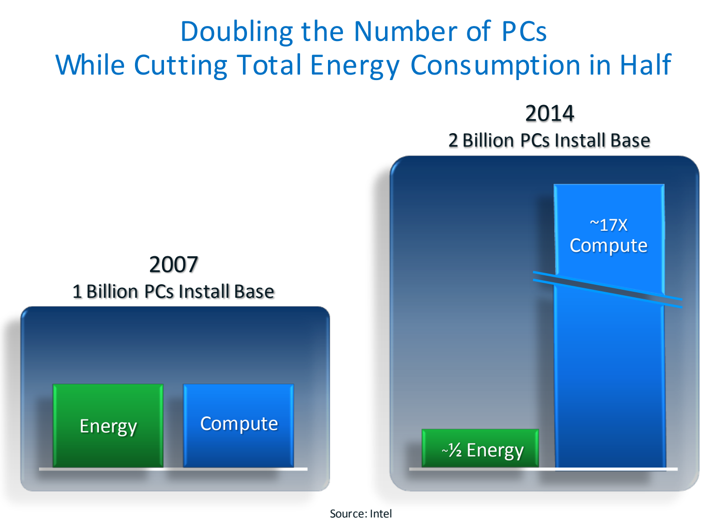

Figure 2

- Computer energy efficiency has doubled every 1.57 years and is projected to continue at this pace for the foreseeable future.
- Wireless networking – The power consumption of wireless networking varies based on data that is being transferred, and use environment (network environment). The number of spatial streams/radios supported in a device/client contributes to the power draw. The more the spatial streams, 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

B. Technology Improvements 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 such 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

C. Emerging 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.
- While gains continue to be made in computer energy efficiency, manufacturing and other constraints create challenges for 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. Also, with ongoing reductions in transistor dimensions, manufacturing process variations that result in die-to-die and intra die variations affecting device power and performance, have become increasingly difficult to control. As a result, while the energy efficiency of discrete graphics has continued to improve over time, graphics processors built with the next generation, i.e. 20 nm manufacturing technology, are expected to roll-out, at the earliest, in mid-late 2015, and in low volumes.
- 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.

D. SW and power management:

- Current power management technology is defined by the ACPI (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.
- Graphics processing units employ many of these same techniques internally. For some examples, see www.**amd**.com/us/Documents/**amd_powertune_whitepaper**.pdf
- Computer screens are turned off after a period of mouse/keyboard, and or system inactivity

E. **System Design Considerations**:

- 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

F. **Architecture and system design trade-offs:** Several questions were raised at the CEC ITP workshop as to why more energy efficient components and power management employed by tablet-like devices can't be used for Notebook PC design and similarly why Notebook components and power management is not used for Desktops and Integrated Desktop computers. The simple answer is a one-size-fits-all power and performance approach is not workable across the computer segments, from components selection to system design. Here are specific examples to compare tablet/slate, Notebook, and Desktop PC differences:

- Slates and Notebook computers are of different product categories and power management architectures
- Differences
  i. Software (Android, iOS, Windows CE)
     1. Slates software are highly optimized for mobility, connectivity and experiencing media, not meant primarily for multitasking. It's suited for light task based applications.
     2. Notebook software offers the full suite of applications for content generation and multitasking
  ii. Input/output devices and connectivity
     1. Slates – limited I/O options (USB, HDMI, wireless)
     2. Notebook – full suite of I/O options (Ethernet, USB, Firewire, HDMI etc.)
  iii. DDR Memory
     1. Slates used relatively little DDR memory. 1GB or less is common.
     2. Notebooks use more DDR memory to minimize fetches from storage that reduce overall performance. 4GB or more is common.
  iv. Storage capacity
     1. Slates – using SSD which is faster, have lower power consumption, and higher cost but limited storage capacity (16GB-128GB)
     2. Notebook – using HDD >128GB up to 1TB

Note: SSDs are more costly (estimated $0.6/GB for a 1TB SSD drive) and have limited capacity but are more reliable and consume less power than a HDD. This helps improve battery life in notebook computers.
Though SSDs are more energy efficient they are limited in capacity and cost prohibitive, as it's a relatively new technology. On the other hand HDD is more mature, available in larger capacities and less costly (estimated $0.1/GB for 1TB HDD)
http://ocz.com/consumer/ssd-guide/ssd-vs-hdd

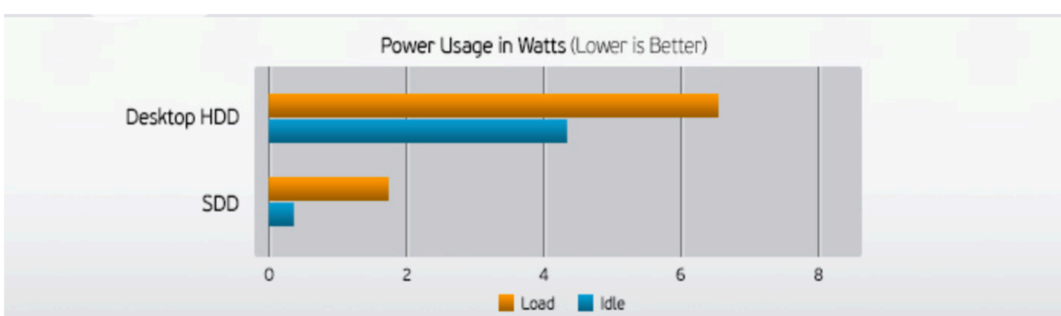

Figure 3

v. Graphics solutions
   1. Slates – typically do not include discrete GPUs due to power and physical limitations
   2. Notebooks – can include discrete GPUs, especially in the performance and enthusiast segments

vi. Usability
   1. Slates – not designed for long periods of data input and manipulation
   2. Notebooks – design, including keyboards, screen size and internal components intended to enable prolonged periods of data processing and analysis by users

vii. Usage model
   1. Slates – Optimized for a low performance usage model.
   2. Notebooks – Higher performance while using sophisticated runtime power management and sleep to keep power footprint low.

- The differences stated above result in differences in energy efficiency and power penalties associated with 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. Slates tend to weigh less.
- 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.
- Desktop computers employ all of the power management techniques used by notebooks. These techniques are listed above in section 2.2.D. Higher performance at a lower price point relative to notebooks is a key selling point for desktops. Desktops support higher voltage levels to power the fastest CPUs and DDR memory. Note that higher performance yields a thermal penalty. Desktops will employ both larger and more fans compared to notebooks.

2.3 Design Life

[How long will the product be in use after it is purchased? This information can be presented as a single estimate, or a distribution of estimates to show a range of product lifetimes.]

- 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.
- Anecdotal evidence shows that for cell phones, the replacement cycle is driven by contract period (1-2 years). For devices that are not subsidized (no contracts) other factors come into play. New form factors with rapid usage experience changes like tablets/slates, PC/Tablet convertibles the replacement cycle is shorter than mature desktop form factors where major drivers may be new OS/ HW for higher performance, faster response and connectivity, need for large storage, lower ASP, etc.

2.4 Manufacturing Cycle

[How often are new models of a product introduced into the market? How long do individual product models typically remain on store shelves? How frequently are modest design modifications made within a model? For electronic devices, how frequently are software updates sent to units in operation? How often are product packages changed, printed, or updated?]

- Consumers model introductions normally driven by: Public holidays, back to school shopping, new usages, etc.
- Commercial model introductions are normally driven by: Corporate IT replacement cycles, budgets, new OS, etc.

2.5 Product Classes

[Provide information and details of product classes intended to be covered by the proposals as well as those that should be excluded (be specific). Generally, products are classified based on features, functionality, or other unique market characteristics.]

A. In Scope:

- Should CEC decide that it must regulate, the CEC should target mainstream high volume Desktop, Integrated Desktop and Notebook PCs (consumer/enterprise), using the ENERGY STAR 5.2 definitions.

- ENERGY STAR V5.2 categories are the convergence point for MEPs and voluntary based programs worldwide (see table below with key examples); ENERGY STAR V6 categories are new and need to be exercised under a voluntary program before adoption for mandatory programs.

Table 1

Global PC Energy Programs	Desktops/Integrated Desktops	Notebooks	Status/Est. Effective data
ENERGY STAR V5.2 Categories	*CAT A* *CAT B* *CAT C* *CAT D*	*CAT A* *CAT B* *CAT C*	
EU (ErP Lot 3)	✓	✓	Done/Effective 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

B. Out of Scope (To be excluded):

- < 40 kWh systems (Example: Tablets/slates, Notebook PCs, low power Desktop/Integrated Desktops PCs, etc.)
- Mobile Workstations, per definition below
  - Be marketed as a (mobile) workstation
  - Be qualified by at least 2 Independent Software Vendors (ISV) product certifications; these certifications can be in process, but must be completed within 3 months of qualification
  - Open GL Certified
  - ≥G3 Discrete GPU
  - Integrated Docking Station Design

- High-end NB products meeting the following criteria (currently part of CAT C)

Notebook	CAT C High-end Exemption
CPU	≥ 4 Cores
GPU	GPU ≥ G3 and ≥192-bit (FBW) (any additional GPU allowed)
Memory size	≥ 16 GB

- High-end DT products meeting the following criteria (currently part of CAT D)

Desktop	CAT D High-end Exemption
CPU	≥ 6 Cores
GPU	GPU ≥ G3 and ≥192-bit (FBW) (any additional GPU allowed)
Memory size	≥ 16 GB
PSU Rating	≥ 500W

- Workstations (Per ENERGY STAR definition)
- Thin Clients
- Small-scale Servers
- 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).
- Power Supplies: While Industry supports complying with existing CEC Mark IV external powers 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. (see Appendix A for detailed IPS analysis)

Note: Focus should be on systems energy efficiency approach, not modal power or component level specification

C. Rationale for exclusion:

- Specialized, high performance, low unit shipment volume, computing products like: Workstations, Thin Clients (and Enhanced Performance Displays / Digital Signage for Displays response) are not in scope. Should be clearly exempted from scope due to the fact that these products offer specialized/high performance to customers who need this level of performance (such as science, engineering, medicine, graphics design, animation, multiple users (digital signage)), and the unit shipping volumes for these products are significantly less when compared with mainstream products. This fact can be clearly seen when viewing IDC shipment data.
- Mobile "slates" that are designed to run primarily or solely on battery power. And it should be noted that the External Power Supplies and Battery Chargers for these and many other products are already regulated in CA. There is absolutely no need to regulate Slates in CA.

- It should also be noted that within the IT Industry where manufactures develop and sell products worldwide, there is an almost absolute need to design products to meet the most stringent requirements in the world, given that it is simply too costly to design products for specific countries or regions.
- The ICT Industry has been very competitive and responsive in developing energy efficient products for customers in response to market forces. For example, many Government and commercial customers are required or want to buy ENERGY STAR® qualified products.

3 Unit Energy/Water Usage

[Provide as much detail as possible about unit energy/water usage by product class, efficiency level, capacity or any other characteristic that drives energy/water use.]

3.1 Duty Cycle

[Describe the different states, modes, or uses of a product that impact its energy or water consumption (e.g., on, off, and standby modes). Estimate the number of hours the product is used in its various states. Please include an annual estimate of hours of use if the usage is described in some other way. If the product includes automated controls that may alter the duty cycle, please discuss the usage changes caused by these controls.]

- **Computers power modes**:
  - 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[3], 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 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.

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

- 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 (kWh/yr.) calculations.
- NRDC's "anecdotal testing" described in their May 9th response to CEC is of concern. The recommendation that CEC use an active mode correction factor when estimating computer energy use was based on loading of one laptop PC with accessories, and an application that appears to have been selected to support a desired conclusion. Computing continues to involve long periods of user interaction with information/data on the computer's screen without any active input occurring, i.e. the computer is in an "idle" mode; this occurs while reading emails, looking at internet search results, reviewing data/documents, etc. In addition, active mode power consumption continues to decrease compared to previous generation computing platforms. Industry has seen no valid information supporting the recommendation that NRDC provided to CEC.

o **Duty Cycles**: The following table shows the duty cycles (mode weighting) used for Desktops, Integrated Desktops, and Notebook Computers based on ENERGY STAR Computers V5.2. These mode weightings are used for annualized energy consumption (aka TEC) calculations.

Table 2: Mode Weightings for Desktop and Integrated Desktop Computers

Mode Weighting	Conventional	Full Network Connectivity			
		Base Capability	Remote Wake	Service Discovery/Name Services	Full Proxying
T_{off}	55%	**50%**	**47%**	**43%**	40%
T_{sleep}	5%	**14%**	**20%**	**25%**	30%
T_{idle}	40%	**36%**	**33%**	**32%**	30%

Table 3: Mode Weightings for Notebook Computers

Mode Weighting	Conventional	Full Network Connectivity			
		Base Capability	Remote Wake	Service Discovery / Name Services	Full Proxying
T_{off}	60%	**54%**	**49%**	**48%**	45%
T_{sleep}	10%	**18%**	**24%**	**26%**	30%
T_{idle}	30%	**28%**	**27%**	**26%**	25%

- The duty cycles in ENERGY STAR Version 5/5.2– based on comprehensive duty cycle study conducted by Microsoft[4] on over 75,000 computers. http://www.energystar.gov/index.cfm?c=archives.computer_spec_version_5_0 Participate in
- Proxying provides the capability for PC to sleep longer (different duty cycles in ENERGY STAR)
- Mode weightings are used in the following ENERGY STAR TEC equation

$$E_{TEC} = (8760 / 1000) * \{(P_{OFF} * T_{OFF}) + (P_{SLEEP} * T_{SLEEP}) + (P_{IDLE} * T_{IDLE})\}$$

Where:

- P_{OFF} = *Measured power consumption in Off Mode (W)*
- P_{SLEEP} = *Measured power consumption in Sleep Mode (W)*
- P_{IDLE} = *Measured power consumption in Idle Mode (W)*
- T_{OFF}, T_{SLEEP}, *and* T_{IDLE} *are mode weightings as specified in Table*

:

[4] http://www.energystar.gov/index.cfm?c=archives.computer_spec_version_5_0

3.2 Efficiency Levels

[Provide at least two levels of efficiency—a minimum baseline case and an improved case—for each state/mode/use. Provide the average power, energy, and/or water consumption for each level.]

- **Minimum baseline case**: This is based on current stock energy estimates of Desktop and Notebook computers in California (See Section 5 Tables 6-9 for details). Industry estimates of average energy consumption (kWh/year) is further split by consumer and commercial computer systems. The numbers are being reported with and without power management enabling, with an assumption that certain percentage of PC stock in CA. lacks power management enabling. Actual level of baseline energy efficiency is somewhere between the two cases reported below.

Average UEC (kWh/yr) - With power management

	DT	NB
Residential	187.3	58.3
Commercial	159.2	50.2

Average UEC (kWh/yr) - Without power management

	DT	NB
Residential	296.4	144.7
Commercial	280.8	136.6

- **Improved Case**: This is based on the following scenarios
  - **Existing Stock:** Average UEC (kWh/yr.) improvement on existing stock is based on actions taken in response to CEC/UCI survey to understand power management enabling gaps. The improvement level will be hard to predict at this stage without fully understanding the outcome of the survey. Should the power management enabling gaps deemed significant, the follow-up actions taken to incentivize consumers to enable power management will determine the real UEC improvements.
  - **New Shipments:** Should there be a need for regulation after closing power management enabling gaps, Industry proposes two approaches for establishing mainstream Desktops, Integrated Desktops, and Notebook computers energy efficiency levels:

1. CA. based data collection on mainstream desktops, integrated desktops and Notebooks computers, to derive targets based on top 75-90 percentile methodology.
2. Should the data collection effort is not feasible, Industry would advocate aligning with ENERGY STAR V5.2 base TEC targets, while allowances for dGfx, audio, TV tuner are aligned to global MEPs programs
   - Focus on system level TEC -- no modal power limits
   - Power management enabled by default on 100% of systems; and program in place to educate users of energy cost savings impact of power management.
   - Year over year PC energy efficiency improvements driven by market forces.

To reiterate, Industry believes that power management is still the lowest hanging fruit that will yield the greatest energy savings without adding additional cost for customers and withholding performance. California regulators and utility providers should evaluate the results of the UC CA Irvine study to identify opportunities for improving use of power management capabilities already being provided by IT product manufacturers. And work closely with ENERGY STAR Low Carbon IT Campaign that provides support for consumer and corporate customers to enable power management on existing stock of both PC's and Displays. Additional information is available:

http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_users

http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join

http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_manage_reps

3.3 Energy and/or Water Consumption

[Provide estimated energy/water consumed based on the above information on duty cycle (3.1) efficiency levels (3.2). The energy/water consumption of a state is equal to the average rate of consumption in the state multiplied by the average hours per year a product is in that state. The unit energy/water consumption of a product is the sum of the energy/water consumption in all of its states.]

- Industry approach and data is provided in subsequent sections below

4 Market Saturation and Sales

4.1 California Stock and Sales

[Provide an estimate of existing and projected stock and sales of the product in California. Provide a projected California Annual Growth Rate (CAGR) and any other pertinent information that will affect stock or sales over time.]

Industry used NRDC/IOUs data based on IDC and other sources with additional assumptions. California's stock is affected by current buying trends in the market. As noted recently by IDC and other industry studies, consumers are increasingly using tablets and smart phone to perform more of their computing needs, resulting in recent declines in PC sales http://www.idc.com/getdoc.jsp?containerId=prUS24129913

Key Assumptions:

- **Existing stock**: Residential vs. Commercial stock numbers (Mu) and splits based on NRDC reported data during ITP phase.

Table 4:

Source: NRDC [Stock and Energy Use Estimates from KEMA Numbers]				
Stock (million units)				
	DT	**NB**	**Total**	
Residential	9.6	8.6	**18.2**	KEMA 2010
Commercial	13.8	12.4	**26.2**	
Total	**23.4**	**21.0**	**44.4**	
Res	41%			Hamm and Green 2008
Com	59%			

- **New Shipments**: These are based on IOUs sources from ITP citing IDC data for the US PC shipments. CA. shipments are based on GDP ratio. Future PC shipment volumes are extrapolated based on IDC CAGR, as reported by IOUs.

Table 5:

Source: IOUs Data		**IDC**	**EPA**	**IDC**	**Estimates based on IDC CAGR (2013-2017)**				
Million units		**2011**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
US	Desktop PC	25.0	34.9	24.6	23.3	23.1	22.9	22.7	**22.58**
	Notebook/Mini	46.3	53.2	41.9	40.6	40.5	40.3	40.2	**40.03**
	Workstations		0.7						
	Total PC	**71.3**	**88.8**	**66.5**	**63.8**	**63.5**	**63.2**	**62.9**	**62.6**
CA	Desktop PC	3.2	4.54	3.2	3.0	3.0	3.0	3.0	2.9
	Notebook PC	6.0	6.91	5.4	5.3	5.3	5.2	5.2	5.2
	Workstations		0.09						
	Total PC	**9.3**	**11.5**	**8.6**	**8.3**	**8.3**	**8.2**	**8.2**	**8.1**

- Industry wants to take a cautious approach on further analysis without agreement on current CA stock, consumer vs. corporate split within PC ENERGY STAR V5.2 categories, new shipment rate and assumptions on replacement cycle. It may be noted that a percentage of new shipments will apply toward retiring existing stock (with known stock age and energy), and the remainder as new PC shipments in the market place. Such an analysis could be complex and may in fact be misleading, without agreement on a set of assumptions and shipment estimates Industry will work with CEC and other stakeholders to agree on dataset for California during the process.

4.2 Efficiency Options: Current Market and Future Market Adoption

[Provide an estimate of the number of models, and the number of units or market share per model or class, with high efficiency features integrated in them that are currently sold in the market. Describe the high efficiency options and their impact on the operation of the device. Provide detailed information on high efficiency products' market share, and whether any voluntary measures are in place to accelerate market transformation. What are the impacts of voluntary measures currently in effect on the market penetration of high efficiency options? How many products in the market already incorporate the concepts expressed in the proposal?]

The IT Industry (including PCs, Displays, and Servers) recognizes the importance of considering energy efficiency in the design of products. Many customers require energy efficient products and energy efficiency is a key criterion in bids and tenders involving the Public and Enterprise sectors. To the extent technically and economically possible, IT product manufacturers implement design changes reducing energy consumption as part of the normal design and development process. Throughout the evolution of the IT industry, product and component manufacturers have been able to reduce the power consumption of these products, while concurrently increasing performance. We have for years considered the needs of customers in developing energy efficient products; we were leaders in working with the US EPA to develop and continue to support the US EPA's Energy Star program that identifies the most efficient products on the market. And product energy efficiency will continue to remain a key input to the design and development of our IT products independent of any regulatory requirements involving energy efficiency.

5 Statewide Energy Usage

[Provide an estimate of current statewide energy/water usage of products within the proposal's scope by multiplying unit energy/water consumption by market saturation and sales figures from Section 4. Describe how this energy usage is expected to change in the future without implementing the proposal.]

Key Assumptions:

- PC stock Aging: Oldest PCs are 5 year old. 20% of stock is 1 year old; 20% 2 year old; 20% 3 year old, 20% 4 year old and 20% 5 year old
- Consumer Notebook used ~ 17.5% increase in power/cost associated with panels and losses in DC conversions as compared to Corporate NB
- Consumer Desktop used Corporate Desktop values w/ standard efficiency PSU
- Unit Energy Consumption (kWh/year) represents system base TEC (without adders)
- External Monitor power not included

Table: 6

Average UEC (kWh/yr) - With power management

	DT	NB
Residential	187.3	58.3
Commercial	159.2	50.2

Table: 7

Average UEC (kWh/yr) - Without power management

	DT	NB
Residential	296.4	144.7
Commercial	280.8	136.6

Table: 8

Stock Energy Use (TWh/yr.) - With Power Management

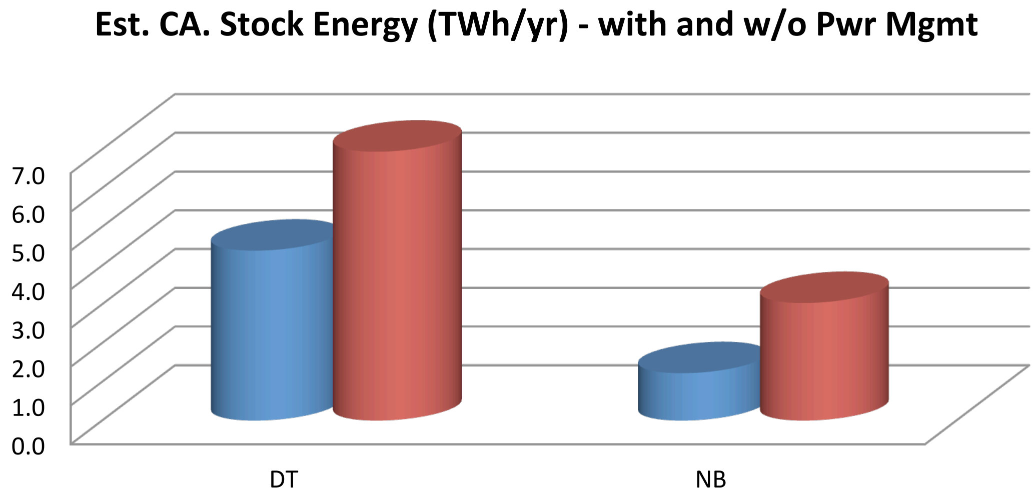
	DT	NB	Total
Residential	1.8	0.5	**2.3**
Commercial	2.2	0.6	**2.8**
Total	**4.4**	**1.2**	**5.6**

Table: 9

Stock Energy Use (TWh/yr.) - Without Power Management

	DT	NB	Total
Residential	2.8	1.2	**4.1**
Commercial	3.9	1.7	**5.6**
Total	**6.9**	**3.0**	**10.0**

Figure: 3



Summary/Analysis: While no one may know the exact magnitude of CA. existing PC stock energy, industry based its analysis on two extreme cases a) stock energy with power management enabled on 100% of systems and b) stock energy with power management disabled on 100% of systems. Since power management enabling has been a key discussion point, it is important to demonstrate the point that power management enabling is critical to PC energy savings in California. We expect CA PC stock energy is somewhere between two cases here.

Power management is still the lowest hanging fruit that will yield the greatest energy savings without adding additional cost for California customers without penalizing performance. Industry cannot do this alone –without help from regulators and utilities to help change consumer behavior such as user education, incentives etc. (if studies like the UC Irvine study in work, indicate the need).

California regulators and utility providers should evaluate
http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_users
http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join
http://www.energystar.gov/index.cfm?c=power_mgt.pr_power_manage_reps

6 Proposal

6.1 Summary of proposal

[Describe the framework of the proposal, its goals, and the expected market transformation. Also discuss alternate approaches to achieving energy/water savings, and why the proposed approach is superior.]

Focus	Approach	Comments
Framework	Energy Star Version 5.2	Definitions, TEC equation, Duty Cycles, etc. Test methodology based on IEC 62623 (Version 5.2)
Product Scope	**In Scope:** Mainstream NB; DT;AIO **Out of Scope:** Workstations; Thin Clients; Small-scale servers; Tablets/slates **Exemption:** PCs< 40kWh; High-end DT/NB; Mobile Workstations	Exemption definitions and criteria provided in earlier sections
Category System	ENERGY STAR Version 5.2	ENERGY STAR Version 6 category system is new and needs to be exercised first
dGfx and other adder approach	dGfx: Ecma-383 (G1-G7 GPU classes); Other adders based on ENERGY STAR and Global MEPs programs	Discrete audio/TV tuner are not part on ENERGY STAR for Computers
Power supplies	EPS (Mark IV) IPS: No IPS requirements	See IPS analysis in the appendix for justification
TEC/Adder Target setting	-Based on California Data, or -Align with ENERGY STAR V5.2 targets and adders (dGfx, audio, TV tuner adders aligned to global MEPs programs) - No modal power limits	Data collection (75 percentile approach)
Power Management	Energy Star V5.2 Power Mgmt (exemption for FreeDOS; Linux, etc.)	Awaiting outcome of UC Irvine study
Labeling	No product or retail package labeling	
Certification	Manufacturer self-declaration; Test conducted in competent test facility	

Methodology/Approach discussion:

- Industry completed risk assessment in 2009 and determined that for mandatory programs, 75-90% percentile methodology provides a good trade-off point between:
  - Shipping majority of the configurations and ensuring the worst 10- 25% EE products are removed from the market.
- As stated in our ITP response, 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 V5.2 TEC framework and category systems, when data collection was not possible.
- The caveat to above approach is that in addition to be cost effective, MEPs approach 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.
- ENERGY STAR program metric is based on 25 percentile methodology and is not designed for mandatory regulations
  - The 3 sigma distribution shows a large number of system components would not comply with Energy Star limits, if used on mandatory regulation without product exemptions.
- In summary industry supports Energy Star framework, but with less stringent requirements and appropriate exemptions for mandatory programs

6.2 Implementation Plan

[What entities would be responsible for what actions and when? Describe how the proposal would be implemented.]

- It is premature to develop an implementation plan for the regulation development process. Should there be a need for regulation; Industry would work with CEC to recommend one.
- In general, related to manufacturers implementing new energy regulations, the following standard recommendations hold:
  - Manufacturer self-certification or testing (at accredited labs) should be accepted as means of declaring compliance.
  - Registration of products by brand holders or their suppliers. Registration process should be available online and should accommodate registration by brand holders' suppliers (one time authorization from brand holder accepted)
  - Effective Date: At least 2 years from final publication. (This will allow manufacturer's sufficient time to manage any redesign efforts required to meet with the regulation, communicate requirements, and prepare for full implementation by the compliance date)

6.3 Proposed Test Procedure(s)

[If the proposal includes the measurement of product performance or market transformation, describe how these would be measured. Describe why the methodology is the best available, necessary, and the least-cost approach that produces the necessary information.]

Industry proposed to harmonize test procedures for Desktops, Integrated Desktops, and Notebook computers with IEC 62623 (using V5.2 test procedures)

6.4 Proposed Regulatory Language

[Please include draft proposed language if the proposal would require a new regulation, memorandum of understanding, or legislation. To enhance the clarity of such a proposal, define both the scope of what products or entities would be covered and provide definitions for any terms that differ from the dictionary definition or are critical to the proposal. For proposed appliance efficiency standards, also include which types of data the Commission should require for certification.]

Industry will defer the proposed regulatory language to the future stages of the proposed rulemaking process

7 Technological Feasibility

[Discuss the feasibility of improving products that are currently not as efficient as those that would result from the proposed measures. Which technologies are available for manufacturers to improve existing products? Which technologies are proprietary and which are not? How would the improvements impact other aspects of product quality and performance? How long would it take manufacturers to implement these improvements across their affected product line?]

Attached are 3 cost effectiveness scenarios using Desktop Systems standard BOM components and replacing these with more energy efficient components, with potential impact on system performance, Energy savings (kWh/Yr.), NPV if energy cost savings based on 3 and 5 year product life cycle, BOM cost adder with alternative components and number of years to recuperate BOM cost adder. Following assumptions were provided by CEC for NPV calculations:

- The cost of electricity: $0.15 per kWh
- Discount rate: 3%

Table 10: Desktops Computers: Cost Effectiveness Energy Efficiency (Impact of Desktops using more energy efficient components)

			Impact						
Orignal BOM	Standard DT BOM	Alternate BOM (More Energy Efficient)	Performance	Energy Saving (TEC) kWh	Energy Saving/yr ($)	Energy Savings NPV 3 years	Energy Savings NPV 5 years	BOM Cost Adder ($)	Break even in 5 years?
Scenario 1									
AS Rock H77 PRO4 MVP	MB	Intel DH77EB	Similar	28.49	$4.3	$12.09	$19.57	$35.0	No
Western Digital WD10EZEX Blue	HDD/SSD	Western Digital WD1002E/	Same	2.98	$0.4	$1.26	$2.05	$9.0	No
Radeon HD6770	Graphics	Radeon HD 7750	Similar	49.44	$7.4	$20.98	$33.96	$0.0	Yes
InWin IP-300EF7-2	PSU Eff.	FSP AU-400 GOLD	Similar	5.78	$0.9	$2.45	$3.97	$20.0	No
Scenario 2									
Biostar TZ77B	MB	MSI Z77A-G41	Similar	12.89	$1.9	$5.47	$8.86	($10.0)	Yes
Western Digital WD1002FAEX Black	HDD/SSD	Western Digital WD1002E/	Lower	7.71	$1.2	$3.27	$5.30	($11.0)	cheaper
GeForce GTX580	Graphics	GeForce GTX 680	Similar	47.83	$7.2	$20.29	$32.86	$70.0	No
InWin IP-300EF7-2	PSU Eff.	Antec EA-650 Platinum	Similar	-1.68	($0.3)	($0.71)	($1.16)	$70.0	more power
Scenario 3									
Jetway NAF93-Q77	MB	Intel DQ77MK	Slighly up	21.97	$3.3	$9.32	$15.09	$2.8	Yes
Western Digital WD1002EARX Green	HDD/SSD	Intel SSDSA2M160G2GC	Smaller size, faster	11.42	$1.7	$4.85	$7.85	$121.0	No
Radeon HD5870	Graphics	Radeon HD 7850	Similar	29.96	$4.5	$12.71	$20.58	$14.0	Between3-5
InWin IP-300EF7-2	PSU Eff.	Antec EA-550 Platinum	Similar	5.54	$0.8	$2.35	$3.80	$40.0	No

Table 11: Desktop Computers Scenario Summary

Desktop Systems	Energy Saving (TEC) kWh	Energy Saving/yr ($)	Energy Savings NPV 3 years	Energy Savings NPV 5 years	BOM Cost Adder ($)	Years to break-even
Scenario 1	86.69	$ 13.00	$36.78	$59.55	63.99	More than 5
Scenario 2	66.75	$ 10.01	$28.32	$45.86	118.99	Much more than 5
Scenario 3	68.89	$ 10.33	$29.23	$47.32	177.81	Much more than 5

Summary/Analysis: In all 3 scenarios BOM cost adder far outweigh potential savings in energy cost over product lifecycle. While this exercise appears to be the logical approach for balancing energy savings and system cost and performance, the system makers indeed undertake similar analysis and trade-offs during system design for each market segment. This includes evaluating alternative components and their contribution at system level, where energy savings easily make up the BOM cost adder (as seen in scenarios above). There are other factors to consider. Example in the scenario 2 above, while the choice of platinum power supply should lead to lower power, that was not the case here, PSU difference in power is more about sizing the PSU right, instead of picking a higher efficiency PSU (80plus Bronze 300 PSU is more efficient than a 650 Platinum rated). PCs are highly configurable as marketed, and at the end lot of such choices are made by the end-user before buying the equipment. User behavior and education are other important factors.

Economic Analysis

[Provide the lifecycle cost and cost-to-benefit ratio of the proposed recommendation as it relates to the consumer. If possible, please also include wider societal lifecycle cost and benefit. In addition, discuss whether the proposed change is likely to impact the California economy, tax revenue, and jobs.]

As Industry stated in ITP response, Client computing products 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 like DOE, EPA, and other global regulatory agencies, to develop standards for efficiency while still encouraging the holistic efficiency approach. Industry continues to drive improvements driven by market forces.

Industry would like to note that there are a number of problems associated with the information provided to CEC to date by the IOUs, including the IOU's *Response to California Energy Commission 2013 Pre-Rulemaking Appliance Efficiency (May 9, 2013).* These problems result from the limited dataset, selective data reporting, use of incorrect or untested assumptions, lack of transparency around some reporting, and failure to seek any industry review before publication; some examples include:

- IOU testing of 2012 graphics cards utilized "trend line" assumptions rather than any actual testing of cards in the G1, G3 or G5 graphics categories; as a result no 2012 test data exists for these categories to support the recommended power limits;
- The IOU information on "baseline and achievable cost-effective desktop energy consumption" in their May 9th response to CEC, excluded some data that was collected in the IOU's own previous studies. While the data for a "typical" D2 computer was included in this analysis, the data for a high performance "enthusiast" D2 desktop (cost-effective system TEC of 278 KWh was reported) was excluded. High performance computing platforms should not be excluded from the California market.
- IOU recommended TEC values for graphics cards[5], based on their 2012 test data, and fails to allow for the wide range in performance that is found in some categories of discrete graphics. For example, the G7 graphics category contains cards with a frame buffer bandwidth ranging from ~130 GB/s - 400 GB/s. While the IOUs acknowledge that increasing frame buffer bandwidth reflects increasing graphics performance, they fail to report that the one 2012 G7 card tested with a frame buffer bandwidth > 350 GB/s would not qualify with their recommended TEC allowance for G7 cards. In fact, four out of the seven G7 cards included in the 2012 testing would not meet the IOU recommended TEC value. Proposing power caps that are based on cards with lower frame buffer bandwidth in the G7 category would restrict the future availability of higher performance graphics for end-users in California.
- In general, IOU recommended TEC allowances for graphics cards; do not appear to be based on representative samples of graphics cards that exist in the various categories.

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[5] [PG&E] Pacific Gas and Electric Company. Updated Discrete Graphics Processing Unit Testing Results. Prepared by Ecova. https://www.energystar.gov/products/specs/sites/products/files/California%20IOU%20%20NEEA%20Comments_Public.pdf; (referenced in IOU's May response to CEC.)

- The IOU's cost effectiveness analysis is specific to an analysis of a few components that were introduced to the market in 2011-2012, and that were discounted in value for 2015, the anticipated date of a regulation. If newer or different technology, introduced in 2013 or later is required to meet limits established by a regulation in 2015, the IOU's analysis and their application of discounting would no longer apply.
- Some information necessary for transparency is missing from the IOU's report, e.g. component pricing information which was used as the basis for the cost effectiveness calculations.
- Some of the IOU's cost effectiveness results could not be repeated, e.g. for the systems where discrete graphics components were changed in cost effective efficient build systems compared to baseline systems.

  - Using a CAGR %/year of -14.5% for graphics, the same as the IOUs, and the average selling prices of the cards on July 17, 2013 based on retail pricing points from several online computer parts retailers, the following cost effectiveness results were obtained:

Table 12

Card:	**Radeon HD 6850**	**Radeon HD 6870**	**NVidia GTX 660**
Platform	DT3-1, high performance baseline	DT 3-2, very high performance baseline	DT 3-1 high performance, and DT 3-2 very high performance cost effective efficient build
Selling price, July 17, 2013 (based on on-line retailers)	$107-159, average $135	~$125, average $125	$199-284, average $243
Estimated value July 2017 applying CAGR -14.5%/year	$91.50	$98.00	$178
Cost differential between baseline and cost effective build	$86.50	$80	----
IOUs' calculated lifetime net energy savings based on efficient build	$25.63 for DT 3-1	$17.86 for DT 3-2	----
Based on graphics cost alone, is efficient build cost effective?	No	No	____

- Costs associated with replacing standard efficiency power supplies with more efficient units were greatly underestimated. The most expensive cost, the increase in the cost to the manufacturer of the more efficient power supply, was omitted. Below is a table listing cost increases to both the manufacturer and customers for more efficient power supplies. Note these cost quotes are averaged taking into account varying vendors, OEMs, volumes, times of the year and vendor quote strategies. The customer markup is 50%.

Table 13

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	$3.45/$5.18	$2.65/$3.98	$3.25/$4.88
80+ Silver	$6.90/$10.35	$8.22/$12.33	$6.00/$9.00
80+ Gold	$8.10/$12.15	$10.95/$16.43	$7.95/$11.93
80+ Platinum	$11.25/$16.88	$14.35/$21.53	$11.45/$17.18

7.1 Incremental First Costs

[Please provide the estimated incremental cost to improve the product's efficiency to meet the proposal. Explain in detail how that incremental cost figure was developed and which specific products or product baselines were used to compare cost. Please disaggregate incremental costs associated with non-efficiency improvements. Incremental first costs should be focused on the price to the final purchaser (e.g., the change in retail price for the product).]

Industry is not proposing further product energy efficiency improvements other than to ensure that current PC programs like power management enabling are being implemented.

7.2 Incremental Operating Costs and Savings

[Please provide the estimated incremental operating costs or savings of products with improved efficiency. Incremental operating costs or savings should be focused on the costs or savings to the consumer. These costs or savings may include costs or savings associated with maintenance (if maintenance will change due to the proposed standard), or costs or savings from reduced or increased energy/water consumption. Include any costs or savings from reduced or improved product efficacy resulting from the proposal. Please disaggregate incremental costs associated with non-efficiency improvements.]

The question to address later in the process is what costs, if any, the CEC and other CA state agencies would incur in addressing any gaps in Power Management enabling behavior (based on survey output). The cost may be in the form of incentives, and energy savings will be based on how big the potential gap is.

7.3 Infrastructure Costs and Savings

[Please provide the estimated incremental infrastructure savings or costs of market transformation that are necessary for or will result from implementing the proposal. This refers to the incremental savings or costs caused by a change in the installed base towards higher efficiency products. A broad array of costs should be considered, from power plants and energy infrastructure to network and plumbing infrastructure. Please also include any impact on housing costs.]

Industry does not expect any infrastructure level changes at this point, subject to changes based on the proposed CEC rulemaking on appliance energy efficiency

7.4 State or Local Government Costs and Savings

[Estimate the resources necessary for the Energy Commission or any other named state or local agency to implement the proposal as described in 6.2. These costs could include contracts, staff, and necessary expenditures/purchases. Estimate the costs and savings to state and local governments if these entities purchase products with improved efficiencies as a result of the proposal.]

Lacking complete picture, it is premature to quantify resources at this point. Any proposed incentives to motivate users to enable power management (if that turns out to be a gap) will need to be assessed. This will have to wait until the survey results.

7.5 Business Impacts

[Estimate how the proposal would: create or eliminate jobs in the state, create or eliminate businesses in the state, provide competitive advantages or cause competitive disadvantages for businesses currently doing business in the state, increase or decrease investments in the state, and/or provide incentives for innovation in products, materials, or processes.]

No significant business impact based on Industry proposal. Industry will need to evaluate business impact based on the proposed CEC rulemaking. Removal of high performance products from the market would result in disadvantage to California businesses, research & development, academic institutions and consumers.

7.6 Lifecycle Cost and Net Benefit

[Provide an estimate of lifecycle cost for both the products that the market will be transformed towards as well as transformed away from as discussed in 6.1. Lifecycle cost is the sum of operating costs and first costs over the useful lifespan of the product. This cost must be calculated from the perspective of the consumer. A second societal or broader lifecycle cost is also welcome.]

Cost versus benefit modeling is not the only criteria that should be considered when assessing the need to regulate computing products, nor is it a straight-forward analysis. While it may be possible to estimate and analyze the relative costs versus benefit of changes made on non-complex products, this becomes substantially more difficult with computing products. Computers by design are highly configurable to enable meeting a very broad range of customer's computing needs. The range of computing capability is addressed in two fundamental ways. First, there are different classes of computing products such as Desktop PCs, Notebooks, and Workstations to name a few. Second, within each computer product family (typically one chassis / motherboard), the design of computers enables customers to select from among a number of configurable components to meet the customer's individual computing needs. Configurable components include the Central Processor (chipset), memory, Hard Disk Drive, Solid State Memory, graphics solutions (cards/on board), etc. to name a few of the most common configurable components. Many of these configurable components within the PC Model family alter the amount of power the computer uses when in an Idle / Operation mode.

This unique situation with computing products was recognized by the US EPA where they worked with industry to create a framework for categorizing Personal Computers, and various performance tolerances (adders) to account for the power consumption consumed by components providing customers with different levels of performance. Attempting to apply simple cost versus benefit analysis to regulatory proposals involving energy efficiency becomes almost impossible given the wide array of computing product categories, each of which is designed to be configured to meet individual or group of customer's needs.

9 Savings Potential

[Restate the estimated per unit energy/water lifecycle savings to the consumer. Estimate the California energy/water savings and peak demand reduction that would result by implementing the proposal. Please be clear on the time-period methodology (e.g., savings for first-year sales, after entire stock turnover, savings in 2014, etc.)]

Industry will further evaluate this based on power management enabling gap

10 Acceptance Issues

[Provide information related to consumer acceptance of high efficiency products in the market or products that would result from the proposal. Provide solutions to issues and problems identified. Discuss issues that were raised in the Energy Commission's workshops or comments, and how the proposal would address these issues.]

Industry is not proposing significant changes to impact user acceptance at this point. Industry will need to evaluate acceptance impact based on the proposed CEC rule making

11 Environmental and Societal Impacts

[Describe any potential beneficial or adverse environmental impacts from implementing the proposal? Does the proposal impact indoor-outdoor air quality or otherwise affect indoor-outdoor environmental quality? Does the proposal affect atmospheric emissions (including greenhouse gas emissions and ozone-depleting gases), and if so, by how much (million metric tons of CO_2 equivalents)? Are there environmental impacts associated with material extraction, manufacturing, and packaging, shipping to the point-of-sale or other activities associated with implementing the measure? What are the impacts to the health and welfare of California residents, worker safety, and the state's environment?

Power Management enabling gap, if any, will highlight any potential opportunity to reduce carbon footprint.

12 Federal Preemption or Other Regulatory or Legislative Considerations

[Does the proposal duplicate or conflict with federal regulations contained in the Code of Federal Regulations that address the same products or issues as the proposal? If so, why is the proposal justified? Are there any existing federal or state test procedures or standards in effect? Please discuss any potential duplication or conflict with those procedures or standards, and why the proposal is necessary in light of those issues. In addition, please discuss how the proposal affects or complements existing federal, state, or local statutes, ordinances, or regulations.]

CEC should review the recently published DOE Proposed Determination of Coverage for computers, and the comments soon to be submitted in response, in considering the potential for federal preemption.

13 Methodology for Calculating Cost and Savings

[Describe the methodology and approach used in the development of the proposed measures. Typically, this section will contain the assumptions used for the analysis of the proposal, a description of the base case (current Standards or current practice) and the proposed measure. The proposal should also exhibit the methodology used to calculate the savings and incremental cost of efficiency improvement.]

The Base Case is based Current ENERGY STAR V5.2 and Non-ENERGY STAR systems; while the proposal will align mainstream PC shipments in California with ENERGY STAR V5.2 framework and TEC limits – should there be a need for regulation (Except for proposed exemptions).

14 Bibliography and Other Research

[List the research and analysis, studies, reports, experts, industry standards, and personal communications that were consulted to develop the proposal. Include research that is underway that is related to an aspect of the proposal. Indicate if data or information will be produced in time to be used in an update of the standards.]

- AMD. 2012. AMD Powertune Technology. White Paper. http://www.amd.com/la/Documents/amd_powertune_whitepaper.pdf

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- CLASP, NRDC The Impact of Graphics Cards on Desktop Computer Energy Consumption, September 2012. http://www.clasponline.org/Resources/Resources/StandardsLabelingResourceLibrary/2012/Impact-of-Graphics-Cards-on-Desktop-Computer-Energy-Consumption

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- [EPA] U.S. Environmental Protection Agency. ENERGY STAR Program Requirements. Product Specification for Computers. Version 6.0 final draft.
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- Jon Peddie Research, Tech Watch Quarterly (Graphics), Q1, 2013.

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- Microsoft, Power Transition Report for Energy Star, 2008

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APPENDIX A: Internal Power Supply Analysis

Industry Design of PC Platforms:

- For energy regulations, Industry designs platforms to meet energy regulations
  - For mandatory regulations - must guarantee that all shipping systems pass
  - Design is done to guarantee that 3 sigma (99.73% of systems will meet the requirement)

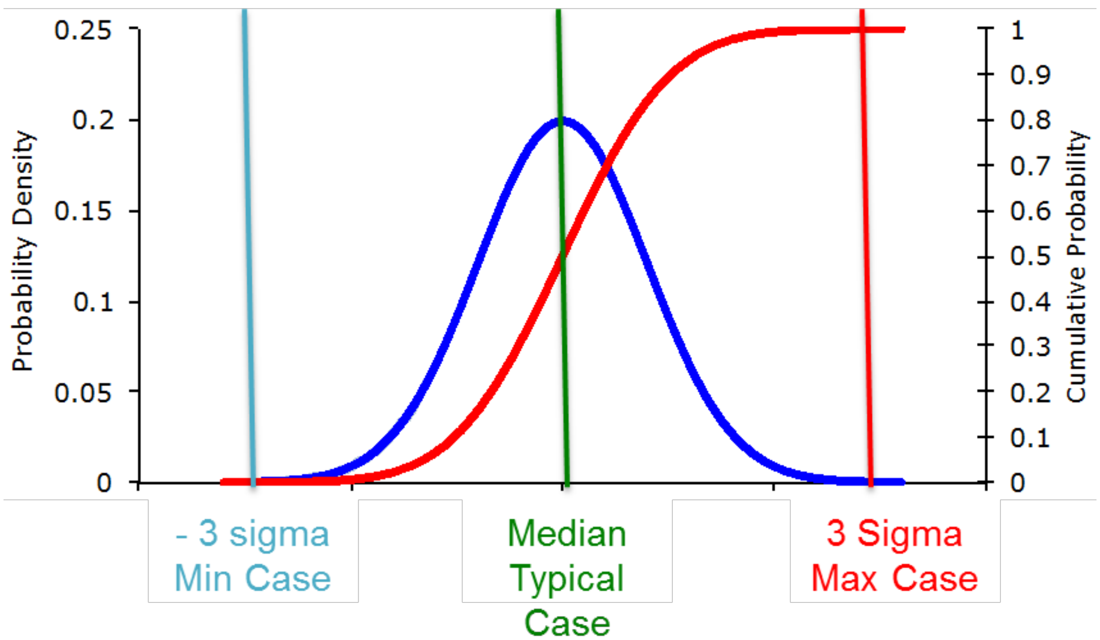


Figure 5

- Component Datasheet
  - Idle Max, represents 3 sigma
  - Idle Typical, represents Median
  - Idle Min, represents -3 sigma
- For each mandatory regulation, the system is designed to meet that regulation through a "worst case" (3 sigma) design.

How ENERGY STAR targets are picked:

- A system is picked at random (Statistically, a typical system)
  - We are talking a about a single system design and how its power will vary based on manufacturing distributions of all of the components.
  - 50% of the systems will have lower power than that system
  - 50% of the system will have higher power than that system
- ENERGY STAR picks the 25th quartile and sets this as its limit
  - The 25th quartile of a system with is most likely done to a typical design

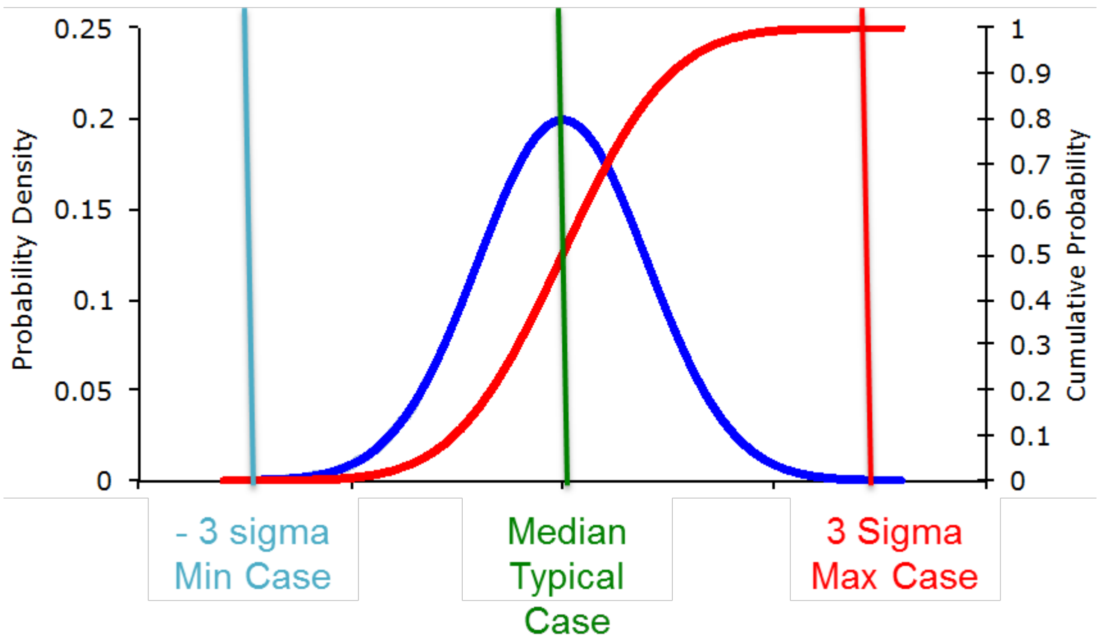


Figure 5

- Industry response to ENERGY STAR is to do a 3 sigma, worst case design for every system (within target product family) system maker plans to qualify as ENERGY STAR
  - Only way to guarantee every system within product model will comply
  - This results in much lower energy for the typical system a consumer would see

ENERGY STAR Version 5 Distributions (2012 analysis):

Figure 6

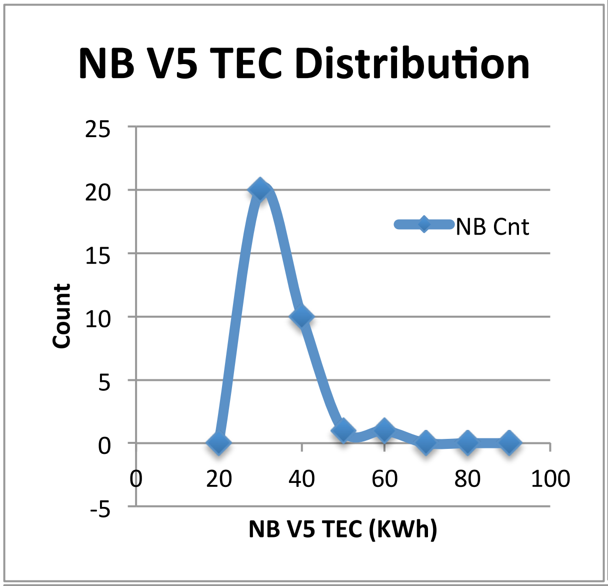
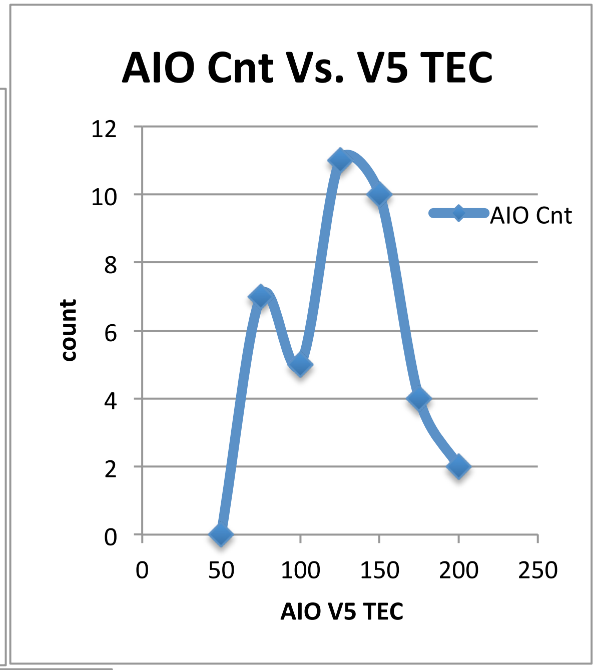


Figure 7



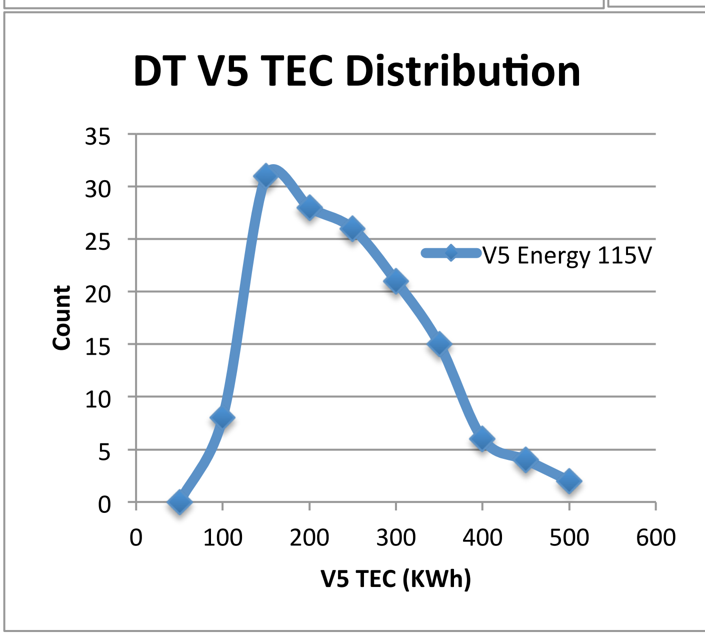


Figure 8

- Looking at all systems:
  - Includes 80Plus and non-80Plus PSUs
- ITI Dataset shows: (from Oct 2011)
  - NB ~ 30 KWh, DT ~ 180 KWh, AIO ~150 KWh
- NRDC NB/DT TEC data not realistic (need to validate assumptions)
  - NB = 80KWh, DT=300KWh

PSU Efficiency (Myths and Facts) --- 80Plus IPS/EPS - Mark V

Table 14

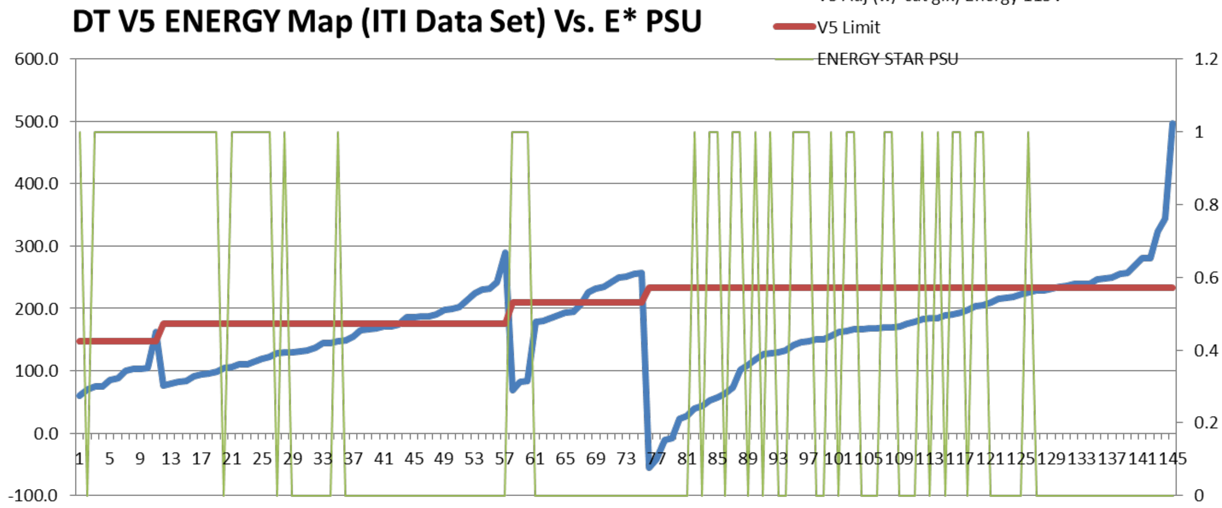
80 PLUS Test Type	115V Internal Non-Redundant				230V Internal Redundant			
Fraction of Rated Load	**10%**	**20%**	**50%**	**100%**	**10%**	**20%**	**50%**	**100%**
80 PLUS		80%	80%	80%				
80 PLUS Bronze		82%	85%	82%		81%	85%	81%
80 PLUS Silver		85%	88%	85%		85%	89%	85%
80 PLUS Gold		87%	90%	87%		88%	92%	88%
80 PLUS Platinum		90%	92%	89%		90%	94%	91%
80 PLUS Titanium					90%	94%	96%	91%

Mark	Performance Requirements				
	Nameplate Power Output (P_{no})[1]	No- Load Power[2]	Nameplate Power Output (P_{no})	Average Active Efficiency[3]	Power Factor
I	Used if none of the other criteria are met.				
II	0 to ≤ 10 watts	≤ 0.75	0 to < 1 watt	$\geq 0.39 \times P_{no}$	Not applicable
	> 10 to 250 watts	≤ 1.0	1 to < 49 watts	$\geq 0.107 \times Ln(P_{no}) + 0.39$	
			> 49 watts	≥ 0.82	
III	0 to < 10 watts	≤ 0.5	0 to 1 watt	$\geq 0.49 \times P_{no}$	Not applicable
	10 to 250 watts	≤ 0.75	> 1 to 49 watts	$\geq 0.09 \times Ln(P_{no})+0.49$	
			> 49 to 250 watts	≥ 0.84	
IV	0 to 250 watts	≤ 0.5	0 to < 1 watt	$\geq 0.5 \times P_{no}$	Not applicable
			1 to 51 watts	$\geq 0.09 \times Ln(P_{no})+0.5$	
			> 51 to 250 watts	≥ 0.85	
V	0 to < 50 watts	≤ 0.5 for ac-ac; ≤ 0.3 for ac-dc	0 to ≤ 1 watt	Standard: $\geq 0.480 * P_{no} + 0.140$ Low Voltage[4]: $\geq 0.497 * P_{no} + 0.067$	Power supplies with greater than or equal to 100 watts **input** power must have a true power factor of 0.9 or greater at 100% of rated load when tested at 115 volts @ 60Hz.
	≥ 50 to ≤ 250 watts	≤ 0.5	> 1 to ≤ 49 watts	Standard: $\geq [0.0626 * Ln (P_{no})] + 0.622$ Low Voltage: $\geq [0.0750 * Ln (P_{no})] + 0.561$	
			> 49 to 250 watts	Standard: ≥ 0.870 Low Voltage: ≥ 0.860	
VI and higher	Reserved for future use.				

- 80plus IPS and mark "V" EPS are more efficient?
    - True if your device operates in the load ranges these PSUs have optimized.
    - BUT, TEC is more driven by Off, Sleep and Idle power levels, which are below the optimized levels and vary by PC design!
    - It's like buying a car which requires a special "***energy efficient carburetor***"
        - Sounds great, but turns out it gets 100 mpg at 100 mph or higher
        - But everyone drives 65 mph (not at 100 mph)
- **While in theory it is more efficient; in practice it optimizes UNUSED loads**
- **Loads point vary by PC design (why focus on a moving target?)**
- **It saves no ENERGY, Increases platform cost, and prevents innovation. It takes time away from attacking real energy problems**
- **Computer design is complicated, let the designer figure out how best to optimize the platform for meeting TEC goals (don't regulate system design)**

Impact of ENERGY STAR required IPS (80Plus)

Figure 9



<u>All non-ENERGY STAR PSU systems pass limits</u>

- Why exclude these systems from the market?
  - Most of the passing systems are with non-ENERGY STAR PSUs
  - All comply with V5 TEC Limits
  - IPS efficiency load points are not reflective of important ENERGY Load levels (THIS IS THE PROBLEM)

80Plus is one of the tools for system designer – it should not be a requirement!

<u>SUMMARY:</u>

- Current PSU Regulations are good enough
  - Address Power Factor Correction
    - Deals with impact on power distribution
  - Address No-Load Power
    - Deals with off-mode losses
- Let the industry design systems to meet energy requirements
  - Designer of the system knows best what load levels need efficiencies
    - Important ones identified by active, idle, sleep and off power
    - These loads vary dramatically based off the Pmax of the PSU
    - Only the designer of the platform knows this; 3rd party is not in a position to prescribe what's best for the design