

12 September 2013

Ms. Brenda Edwards
U.S. Department of Energy
Building Technologies Program
Mailstop EE-2J
Proposed Determination for Computers
EERE-2013-BT-DET-0035
1000 Independence Avenue SW
Washington, DC 20585-0121

California Energy Commission

DOCKETED
12-AAER-2A

TN 72026

OCT. 02 2013

Re: Notice of Proposed Determination of Computers as a Covered Consumer Product, Docket # EERE-2013-BT-DET-0035

Dear Ms. Edwards,

The Information Technology Industry Council (ITI; <http://www.itic.org/>) appreciates the opportunity to submit comments on the Proposed Determination of Computers as a Covered Consumer Product, as published by the Department of Energy (DOE or Department) on July 12, 2013; docket number EERE-2013-BT-DET-0035, RIN 1904-AD04.

ITI represents 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.

Following are our responses to the issues highlighted in the July 12th notice.

Definition of Computers

We urge the DOE to leverage work already done for the ENERGY STAR® program, including the definition of a "computer". Per Version 6 of the ENERGY STAR specification for computers;

- 1) *Computer: A device which performs logical operations and processes data. For the purposes of this specification, computers include both stationary and portable units, including Desktop Computers, Integrated Desktop Computers, Notebook Computers, Small-Scale Servers, Thin Clients, and Workstations. Although computers are capable of using input devices and displays, such devices are not required to be included with the computer upon shipment. Computers are composed of, at a minimum:*
 - a) *A central processing unit (CPU) to perform operations. If no CPU is present, then the device must function as a client gateway to a server which acts as a computational CPU;*
 - b) *User input devices such as a keyboard, mouse, or touchpad; and*

- c) *An Integrated Display screen and/or the ability to support an external display screen to output information.*

Further, definitions and scope should focus on mainstream high volume products, specifically desktop computers, integrated desktops, and notebook personal computers (PCs). Exclusions should be provided for high performance, specialized, low volume products and low Typical Electrical Consumption (TEC) products, specifically;

- Very high-end, specialized and low volume desktops, integrated desktops and notebooks
- Workstations; generally designed to provide higher performance, and are much lower volume
- Thin Clients; use external power supplies which are relatively new with evolving design and no widely accepted definition
- Tablets or Slates; Primarily DC operation; very low TEC; ENERGY STAR moved away from TEC approach for ENERGY STAR Version 6.0; focus is extended battery life

EPCA and Calculations for Average Household Energy Consumption

The DOE has determined tentatively that computers qualify as a covered product under Part A of Title III of the Energy Policy and Conservation Act (EPCA), as amended. We appreciate the opportunity to present a case as to why classifying computers as covered products is not necessary to carry out the purposes of the EPCA, and that average U.S. household energy use is not likely to exceed 100 kilowatt-hours (kWh) per year, particularly by the time a Rule would enter into force.

Summary - ITI Recommendation

ITI recommends that the DOE not classify computers as covered devices under Part A of the EPCA, and instead partner with the US EPA to promote the ENERGY STAR program domestically and internationally.

In summary:

1. US PCs installed base is changing rapidly driven by:
 - a. Computer form factor evolution - with higher adoption of lower power laptop and tablet devices over consumer desktop PCs, the result is a net reduction in installed base energy consumption.
 - b. Consumer Desktop PC volumes as a percentage of consumer PC installed base is dropping significantly, while the overall traditional PC installed base is shrinking.
2. Consumer Desktop PC with higher unit energy continues to be the smallest of the consumer and commercial notebook and desktop PC segments with 12.7% of 2012 PC shipments¹; overall PC energy consumption in the consumer segment is decreasing.
3. Some of the data cited by DOE appears to overstate consumer installed volume as compared to other 3rd party sources.

¹ Derived from Q2 2013 IDC US Quarterly PC Tracker Historical and Forecast Analysis

- a. Even using DOE data sources as the baseline, the weighted average unit energy consumption (UEC) is 104 kWh, based on 2012 Industry energy models.
 - b. Using alternative 3rd party sources as the baseline, the weighted average UEC is 76 kWh, based on Industry 2012 energy models.
4. Using either of the baselines above, the weighted average UEC for the consumer segment is expected to significantly drop as:
- a. Desktop and Notebook PC energy efficiency continues to improve driven by innovation, market forces, and voluntary programs like ENERGY STAR (Figure 4).
 - b. Desktop PCs are likely to lose a significant % of its installed base units to mobile PCs and tablets over the next 5-7 years, based on analyst projections.
 - c. Industry/market driven energy efficiency improvements in battery chargers and battery technology are expected to continue lowering power consumption of Notebooks, Tablets, and other mobile PC devices.

Supporting Details

1. PC Installed base Analysis: DOE cited data from Fraunhofer study² circa 2011

Installed Base Analysis:

A. Assumptions: (Based on 2010 Fraunhofer study)

- Consumer vs. Commercial split (41% vs. 59%) – HAMM & GREEN³ 2008
- Maintain Desktop vs. Portable split (43% vs. 57%) – Fraunhofer study

Table 1:

Computers	UEC {kWh/year}	Installed base(mu)	% Split
Desktops	220	101	43%
Portable	63	132	57%
Total	131.1	233	

Table 2: 2010 Stock (million units) -- with Commercial projections

	DT	NB	Total
Consumer	101	132	233
Commercial	144.2	191.1	335.3
Total	245.2	323.1	568.3



Table 3: Stock (% units)

	DT	NB	Total
Consumer	18%	23%	41%
Commercial	25%	34%	59%
Total	0.43	0.57	1.0

² Urban, B. et al., 2011. *Energy Consumption of Consumer Electronics in U.S. Homes in 2010*. Prepared by the Fraunhofer Center for Sustainable Energy Systems, Final report to the CEA, December 2011

³ That Computer Is So You, Steve Hamm and Jay Greene, Bloomberg BusinessWeek, Jan. 2008

A. 2012 Assumptions: (Source: IDC and Daniel Research Group reports)

Consumer vs. Commercial split (51/49) -- 2012 shipments⁴

Maintain DT vs. Portable split (35% vs. 65%) - Daniel Research Group⁵

Table 4: 2012 Stock (million units) - Daniel Research Grp, June '13

	DT	NB	Total
Consumer	14.7	91.1	105.8
Commercial	30.1	57.5	250.7
Total	126.3	230.2	356.5

More likely

Table 5: Stock (% units)

	DT	NB	Total
Consumer	12%	40%	51%
Commercial	24%	25%	49%
Total	0.35	0.65	1.0

B. Average UEC(kWh) Analysis⁶:

Table 6: Average UEC (kWh/yr) - With power management (Source: Industry Data)

	DT	NB			
Consumer	187.3	58.3			
Commercial	159.2	50.2			

Weighted Ave UEC (kWh/yr) - With power management (2012 Baseline)

Table 7: Volumes based on Daniel Research Group

	DT	NB	Total
Consumer	26.0	50.2	76.2
Commercial	19.09	11.52	30.6

⁴ Q2 2013 IDC US Quarterly PC Tracker Historical and Forecast Analysis

⁵ Daniel Research Group, United States PC, tablet, & Mobile Phone market size and Forecast, June 2013

⁶ ITI internal analysis, based on weighted average UEC of US consumer and commercial shipping PCs

Weighted Ave UEC (kWh/yr) - With power management (2012 Baseline)

Table 8: Volumes based on Fraunhofer Study			
	DT	NB	Total
Consumer	81.2	23.0	104.1
Commercial	68.45	28.61	97.1

Conclusion: The installed base UEC analysis is largely driven by installed base volume assumptions, consumer and commercial splits (DT/NB), and UEC (kWh) data. It appears that data from the FRAUNHOFER Y2010 study, overstates the installed base consumer volume, as compared to more recent Y2012 consumer and commercial data compiled by the Daniel Research group.

This difference may simply be due to the 2-year time gap between data collection efforts. Daniel Research Group volume is corroborated with eTForecasts which looks at PCs-in-use forecast. In addition the UEC data used in FRAUNHOFER study (Table 1) shows higher UEC values than Industry UEC projections (Table 6). When Industry UEC data is applied to FRAUNHOFER based volume (Table 8) the UEC difference between Table 7 and Table 8 shrinks, as compared to older UEC data in Table 1. In conclusion the actual 2012 baseline UEC for consumer segment is likely to be in between 76 and 104 kWh, lower than the 100kWh threshold established for DOE determinations. The case for classifying computers as a covered device is weak, relying on 2012 baseline values alone. A future trends and installed base assessment is needed to pursue such a determination.

2. Future PC segmentation trends and Installed base changes:

The PC market is undergoing a lot of changes with the huge expansion of ultra-mobility compute devices. This is leading to at least 3 segmentation scenarios for Traditional PCs:

- Case 1: Traditional Desktops and Notebook PCs are being replaced with new more energy efficient PCs (100% replacement rate) with minimal growth in installed base
- Case 2: Traditional Desktop and Notebook retirement rate is much lower than the total yearly sales. This leads to growth in traditional PC installed base
- Case 3: Traditional Desktop and Notebooks replacement rate is much higher than the total yearly sales. This leads to shrinking of PC installed base as majority of older PCs are being replaced by another device type.

The Daniel Research Group forecast closely follows the Case 3 scenario

Table 9:

Installed Bases – Units in Use

	Units In Use (M)			Annual Growth Rate	CAGR
	2012	2013	2017	2013	2012 to 2017
Desktop PCs	126.3	114.1	68.2	-9.6%	-11.6%
Mobile PCs	230.2	234.7	170.6	2.0%	-5.8%
Traditional PCS	356.5	348.9	238.8	-2.1%	-7.7%
Tablet PCs	87.0	140.5	411.6	61.6%	36.5%
Total PCs	443.5	489.4	650.4	10.4%	8.0%
Smart Phones	175.4	226.8	355.0	29.3%	15.1%
Feature Phones	150.6	110.7	18.1	-26.5%	-34.6%
Mobile Phones	326.0	337.4	373.1	3.5%	2.7%
Total Devices	769.5	826.9	1,023.5	7.5%	5.9%

∞ JΔ Daniel Research Group (2013)

Figure 1:

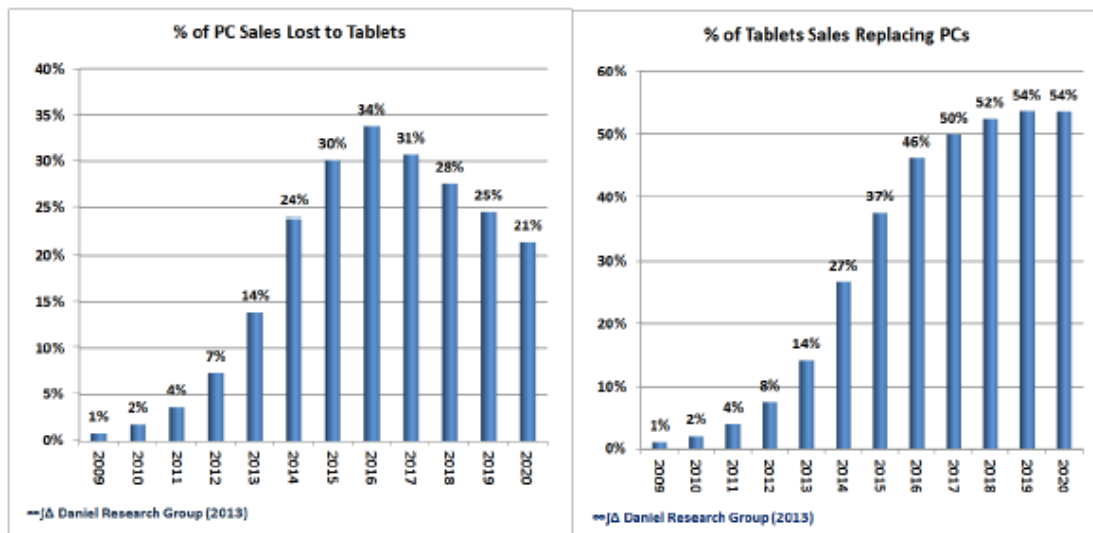


Figure 2:

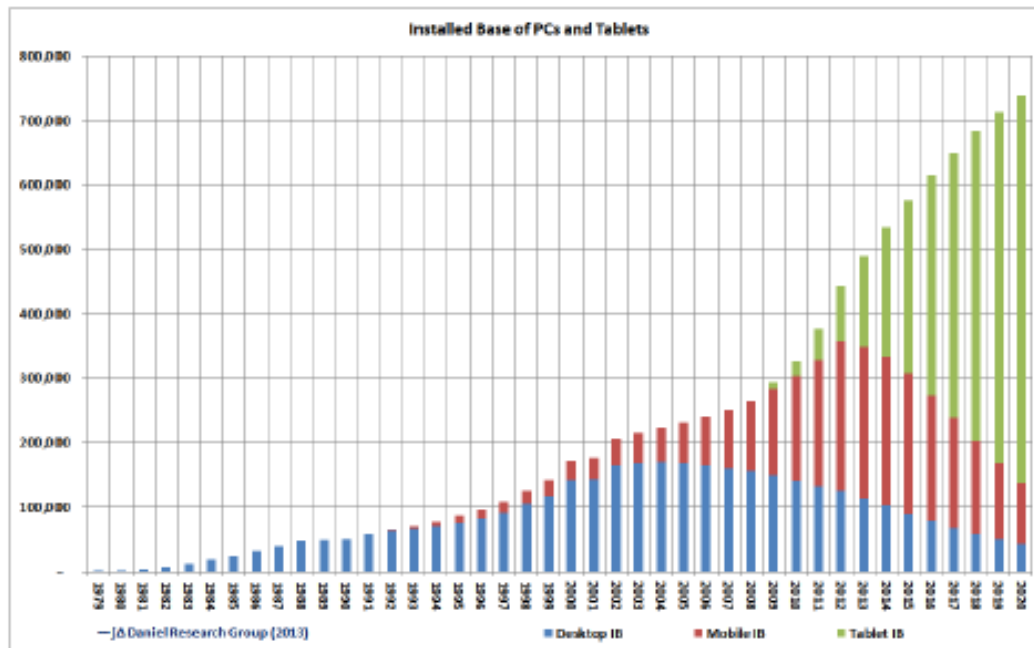


Figure 3:

Consumer/Enterprise Segmentation

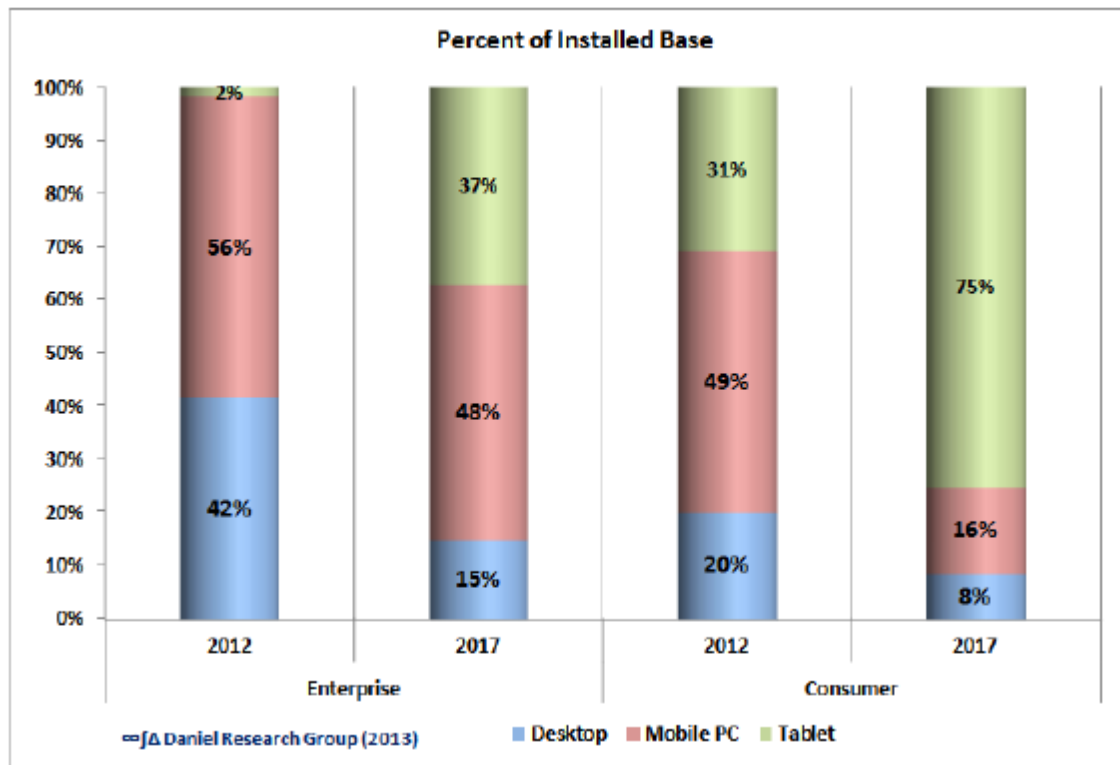


Figure 3 shows Desktops will lose 31% of its consumer installed base units and 58% of its Enterprise installed base units to Mobile PCs and Tablets.

Other Installed Base and future shipment Projections:

eTForecasts⁷ and IDC PC⁸ shipment projections do not paint the same scenario as above. eTForecasts predict modest growth in Computers-in-use (Table 10), while IDC new shipment forecasts shows flat to modest shrinking of PC shipments (Table 11).

Table 10: US Computers-in-Use Growth (Source: eTForecasts)

	1980	1985	1990	1995	2000	2005	2010	2015	2020
PCs-in-Use (mu)	1.40	19.00	51.0	86	177	234	296	392	450-470

Table 11: PC Unit Shipments by Form Factor (2011-2017)
Source: IDC, WW PC 2013-1017 Forecast Update: June 2013

Million units	2011	2012	2013	2014	2015	2016	2017
United States							
Desktop PC	27.3	25.7	22.6	21.6	20.8	20.1	19.39
Desktop PC %	38.1%	38.9%	37.2%	35.8%	35.0%	34.2%	34.0%
Portables	44.3	40.3	38.2	38.7	38.7	38.7	37.65
Portables %	61.9%	61.1%	62.8%	64.2%	65.0%	65.8%	66.0%
Total PC	71.5	66.0	60.8	60.2	59.6	58.8	57.0

Table 12: 2012 shipments by segment
Source: Q2 2013 IDC US Quarterly PC Tracker Historical and Forecast Analysis

	DT	NB	Total
Consumer	8.4	24.7	33.1
Commercial	17.2	15.6	32.8
Total	25.6	40.3	65.9

Table 13: 2012 Stock by segment (% units)

	DT	NB	Total
Consumer	12.7%	37.5%	50.2%
Commercial	26.1%	23.7%	49.8%
Total	0.39	0.61	1.0

Table 14: 2012 Stock by Form Factor (% units)

	Consumer	Commercial	Total
Desktop PC	32.8%	67.2%	100.0%
Mobile PC	61.3%	38.7%	100.0%

Table 15: 2011-2017 Projections based on 2012 consumer vs. commercial % splits (Table 14) within each DT and NB shipments (Table 11)

Million units		Estimates based on IDC CAGR (2011-2017)						
		2011	2012	2013	2014	2015	2016	2017
	Consumer DT	8.9	8.4	7.4	7.1	6.8	6.6	6.4
	Consumer NB	27.1	24.7	23.4	23.7	23.7	23.7	23.1
	Commercial DT	18.3	17.2	15.2	14.5	14.0	13.5	13.0
	Commercial NB	17.1	15.6	14.8	15.0	15.0	15.0	14.6
	Total PC	71.5	66.0	60.8	60.2	59.6	58.8	57.0

Conclusion: Traditional PC Installed base trends show a range of scenarios from extreme shrinkage to flat/slight growth. The US PCs installed base is changing rapidly with higher adoption of lower power laptop and tablet devices over consumer desktop PCs. Traditional Desktops and Notebook PCs are also being replaced with new more energy efficient Desktops and Notebook PCs. **Overall, this dynamics is resulting in net reduction of installed base energy consumption.** Consumer Desktop PCs with potential higher unit energy continue to be

⁷ eTForecasts – Worldwide PC Forecast; http://www.etforecasts.com/products/ES_pcww1203.htm

⁸ IDC, WW PC 2013-1017 Forecast Update: June 2013

the smallest of the consumer and commercial notebook and desktop PC segments with 12.7% of 2012 PC shipments. Overall PC energy consumption in the consumer segment is declining, driven by innovation, market forces, and voluntary programs like ENERGY STAR (Figure 4). Further, the regulatory process simply cannot keep pace with the pace of already realized energy efficiency gains. ITI recommends that the DOE not classify computers as covered devices under Part A of the EPCA, and instead partner with the US EPA to promote the ENERGY STAR program domestically and internationally.

COMPUTERS ENERGY EFFICIENCY - SUPPORTING INFORMATION

Availability of Technologies for Improving Energy Efficiency of Computers

Per the July 12, 2013 Federal Register Notice, the DOE is also seeking information on the availability of technologies for improving energy efficiency of computers. The following information was also shared with the California Energy Commission in May of 2013.

Client Computers 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 a holistic efficiency approach.

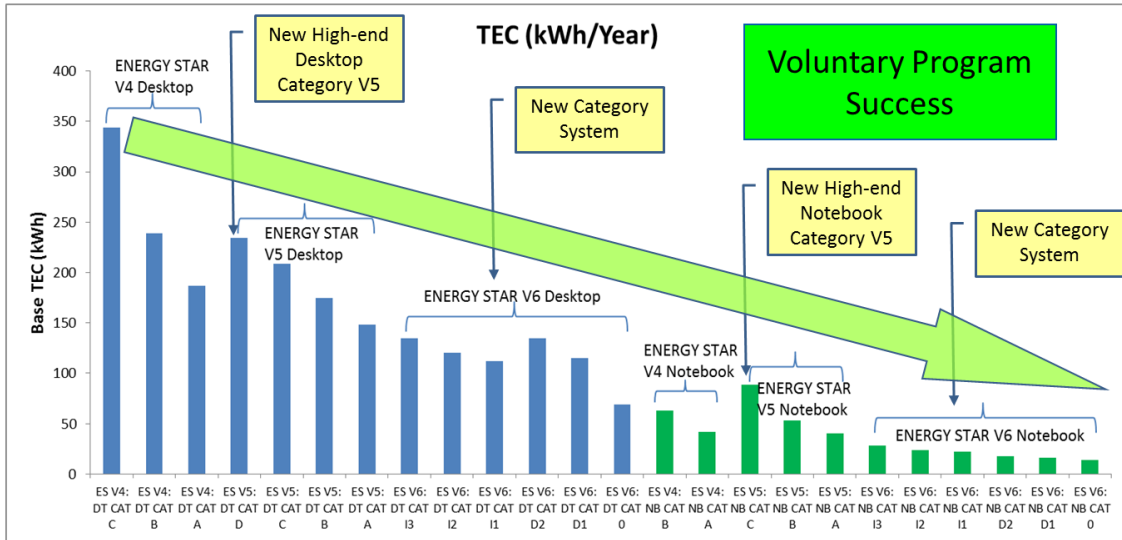
The industry's approach is in 3 areas:

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 innovation⁹
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.

⁹ 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>

ENERGY STAR PC generational improvements (V4 through V6) (Lower Energy Consumption and Additional categories)



Source: EPA/Intel Corp.

Market forces continue to drive down energy consumption

Figure 4

1. Operations, Functions and Modes:

- Power management features of computers at both the system and subsystem levels: Current power management technology is defined by the ACPI¹⁰ (Advanced Configuration and Power Interface) specification. Operating system, system firmware and hardware work in unison to power manage the computer.
 - S states – 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.

¹⁰ www.acpi.info

- Graphics processing units employ many of these same techniques internally. For some examples, see http://www.amd.com/us/Documents/amd_powertune_whitepaper.pdf
 - Computer screens are turned off after a period of mouse/keyboard, and or system inactivity
- **Common settings for these features as shipped and in preset energy saving or performance modes**

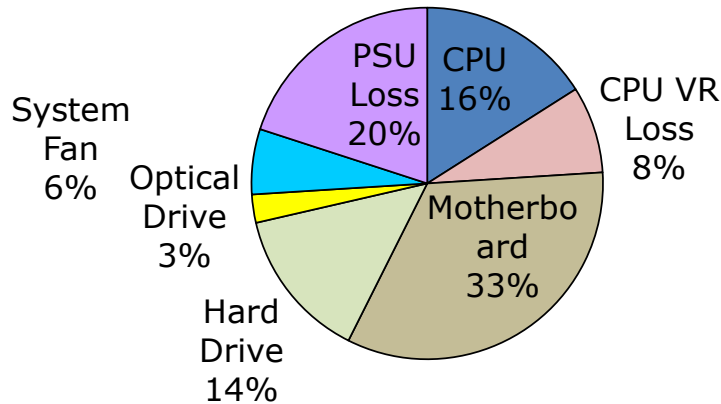
All major computer companies ship PCs with all of these power savings featured enabled by default. Screen power down and Sleep (S3) engagement due to inactivity is set per ENERGY STAR requirement even on systems that don't carry the ENERGY STAR label. Industry position is that PC energy efficiency program 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 in better 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 the California Energy Commission (CEC) and UC Irvine on launching a PC behavioral survey to understand consumer behavior pertaining to PC power management enabling.

- **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 analysis¹¹. 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).

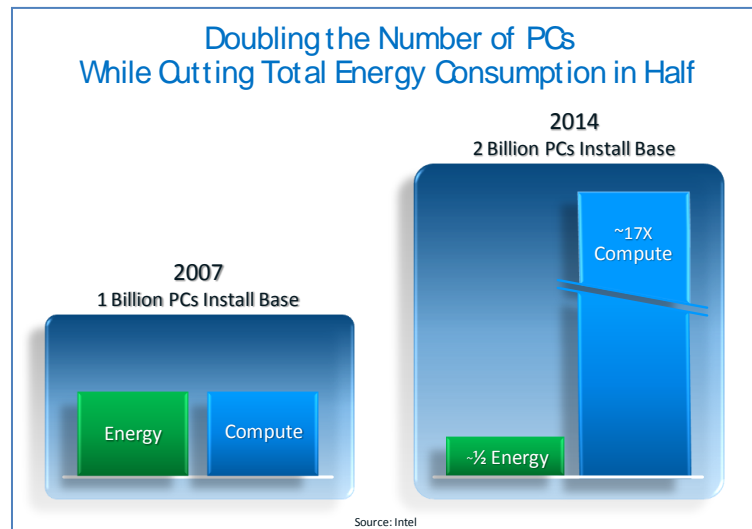
¹¹ Source: Intel Corp.

Figure 5.



- 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
- Power use scales 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:

Figure 6.



- 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
- Certain 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 Edition¹³, 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

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

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 a 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.
- The time computers spend in their various modes both in commercial and residential applications, and frequency that various functions such as “wake on LAN” are utilized
 - 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)

2. Energy Saving Technologies, Components, and Features The time it takes a computer to wake from various sleep modes and elements that contribute to 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.

- **The extent to which efficiency developed for mobile computing is 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.

- **The extent to which efficiency developed for slate devices is 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 – do not 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 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
- 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.
- **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
- **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
- **The degree to which hardware efficiency features are 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
- **The extent to which hardware efficiency features are dependent on proper enabling by users and default enable features**
 - Most PCs are shipped with power management functions enabled for display and system sleep (factory default). Government agencies, 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.

We would welcome the opportunity to discuss any of these comments in greater detail.

Sincerely,



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About ITI

The Information Technology Industry Council (ITI) represents numerous high-tech and electronics manufacturers in the information and communications technology (ICT) sector. Our members are global leaders in all facets of ICT innovation, and have long been leaders in sustainability. Many exceed environmental design and energy efficiency requirements, and lead the way in product stewardship efforts. As a result, the Dow Jones Sustainability Index, the Financial Times Sustainability Index, FTSE4Good and the Global 100 have consistently recognized several ITI member companies for their significant environmental and sustainability achievements. See www.itic.org for more information.