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Computers

Response to California Energy Commission
2013 Pre-Rulemaking Appliance Efficiency
Invitation to Participate

Docket Number: 12-AAER-2A; Consumer Electronics

May 9, 2013

Prepared for:

PACIFIC GAS & ELECTRIC COMPANY	SOUTHERN CALIFORNIA EDISON	SAN DIEGO GAS AND ELECTRIC	SOUTHERN CALIFORNIA GAS COMPANY

Prepared by:
NATE DEWART, ENERGY SOLUTIONS
CLANCY DONNELLY, ECOVA
PETER MAY-OSTENDORP, XERGY CONSULTING

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Summary

The information below provides direct responses to the California Energy Commission's (CEC) Invitation to Participate (ITP) for the 2013 Appliance Efficiency Pre-Rulemaking, regarding computers, including reference to several primary sources, some of which are attached separately (see References for more details). This document includes all of the questions asked in the ITP, even for those with no response.

In summary, CEC has an excellent opportunity to explore energy efficiency standards for computers. While the voluntary program of ENERGY STAR has proven to be helpful in leading the top 25% of products, there are still significant cost-effective opportunities remaining for the rest of the market. We have highlighted data sources that support this conclusion, including testing and teardown analysis results for a few categories of desktops, discrete graphics and power supplies. Some additional testing is in progress and will be available in the coming months. Also provided are primary source references that estimate duty cycle, design life and shipments. Note that for a number of questions we refer to the Natural Resources Defense Council's (NRDC) separate ITP response.

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1 Basic Information

1.1 Product Definition and Scope

We recommend ENERGY STAR 6.0, currently in Draft 3, November 2012 Revision for the product definitions and scope (EPA 2012a) with the exclusion of slates (e. g., iPads and Surface): desktops, notebooks, thin clients, small-scale servers and workstations Performance categories (similar to ENERGY STAR).

We recommend ENERGY STAR 6.0 Draft 3, January 2013 Revision performance categories (EPA 2013a) with one exception: delineation between traditional and integrated desktops. We support NRDC's response on this topic regarding this delineation.

1.2 Existing Test Procedures

For all form factors within the recommended scope, we recommend ENERGY STAR's test method for its 6.0 specification, once it is adopted (EPA 2012b). This test procedure measures power consumption by operational mode. In ENERGY STAR's specification, these wattages are used with mode weighting (or duty cycle) to calculate Typical Energy Consumption (TEC) or kwh/yr.

For internal power supply efficiency test procedure, we recommend the latest EPRI test procedure (2012).

1.3 Sources of Test Data

1.3.1 Pacific Gas and Electric Company Computer Cost Effectiveness (CCE) Project (2012)

From June through December of 2012, Pacific Gas and Electric Company's (PG&E)'s Emerging Technologies Program funded Ecova, Inc. to examine the cost effectiveness of incorporating efficient computer components into typical desktop computer builds. The project team used several baseline system configurations as starting points to document the efficiency of existing equipment on the market. Researchers then swapped various components (power supplies, hard drives, graphics cards, etc.) and measured them for energy consumption using the ENERGY STAR Version 6.0 draft test procedure. The results can be found in the report (PG&E 2012a) provided separately.

1.3.2 Pacific Gas and Electric Company Discrete Graphics Measurements (2012)

PG&E funded Ecova, Inc. to investigate the power consumption of the latest generation desktop graphics cards through a research project conducted in late 2012. The research was documented in a memorandum to the ENERGY STAR program, provided separately (PG&E 2012b).

1.4 Existing Standards and Standards under Development

ENERGY STAR 5.2 is currently in place as a voluntary standard for desktops and notebooks (EPA 2010). As mentioned above, ENERGY STAR 6.0 is currently in development and is in its Draft 3 stage, most recently revised in January 2013 (EPA 2012 & 2013a). EPA anticipates release of the Final Draft spring 2013, with a final specification one month later and an effective date anticipated approximately 9 months after adoption.

ENERGY STAR’s ‘Strategic Vision and Guiding Principles’ (EPA 2012c) highlights that the ENERGY STAR label is intended to typically represent the top 25% of the most efficient products available on the market at effective date. While this voluntary standard is important for encouraging the movement towards lower energy consuming products with a “best-in-class” approach, it does not necessarily address the rest of the market where additional energy efficiency opportunities exist using a cost-effective criterion.

1.5 Product Lifetime

ENERGY STAR reports 4 years (EPA 2013b), however examining this value in the context of annual shipments and stock data suggests the design life is longer. The estimated total stock, using reported California residential stock (KEMA 2010) and a 41% / 59% split between residential and commercial products (Hamm and Greene 2008), is much larger than the estimated stock when using only a 4 year design life and annual shipments data from 2011 and 2012 (IDC 2012, 2013a), (assuming the same for 2009 and 2010). See Section 4 for more details.

The design life for notebooks is estimated to be 2-3 years (Toshiba 2008).

1.6 Product Development Trends

No response.

2 Operations, Functions, and Modes

2.1 What are defined modes of operation for computers?

The definitions from ENERGY STAR Version 6.0 Draft 3 (EPA 2012a) are probably the most widely accepted and appropriate to mandatory energy efficiency standards. These modes are "active," "short idle," "long idle," "sleep," and "off." Otherwise, the naming convention for operational modes in computers varies in published studies of typical computer usage, based on surveying and data collection methods. (Barr et al. 2010; TIAX 2007; Pigg & Bensch 2010; Chetty 2009, ECMA-383). Furthermore, the computer industry's naming conventions for modes may not agree with those used in the energy efficiency community (e.g. Windows XP refers to "sleep" as "standby").

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

System-wide power management settings determine the length of time before the operating system automatically switches the hard disk and the display in non-active modes from idle to sleep, with an optional Wake on LAN (WOL). This function allows the hard disk and display to wake from sleep or off when directed by a network request via Ethernet.

Power management settings of each PC model are determined by the PC manufacturer at shipment, and then can be further adjusted by the user, or administrators in the commercial settings, throughout the life of the unit. Power management capabilities vary slightly across operating systems.

2.3 What are common settings for these features as shipped and in preset energy saving or performance modes?

The ENERGY STAR 5.2 (EPA 2010) and Version 6.0 Draft 3 January revision (EPA 2012a, 2013) require power management settings for all form factors in the product scope (except for slates): 30 minute system sleep (except for Small-scale servers) and 15 minute display sleep, WOL, and Wake Management. Since not all units shipped are ENERGY STAR qualified, these settings may not reflect the broader market.

2.4 What is the power use of computers and their subsystems (such as a graphics card) in the various modes of operation for existing and the next generation computers?

Note: the response below answers this question and question 3.4.

Below we present a summary of findings from PG&E-funded research (PG&E 2012a) into cost-effective efficiency improvements to computers, divided into major project categories (desktop and notebook). We acknowledge that other sources of data exist to supplement these findings (e.g. the ENERGY STAR qualifying products list), but emphasize the CCE project as it represents a detailed snapshot of cost-effective efficiency in several categories of desktop and notebook computers.

2.4.1 Desktop Computers

Methodology

Detailed market research was conducted to identify the most common mainstream desktop computers builds within accepted performance categories. These units were then procured and measured the power consumption of representative systems. The research specifically focused on category DT I1, DT I2, and DT D2 desktops (see section 1.5 above for more detailed descriptions of proposed ENERGY STAR Version 6.0 computer categories). Please note that the original report text refers to earlier versions of the ENERGY STAR Version 6.0 categories, whereas this document presents the results using the latest ENERGY STAR Version 6.0 Draft 3 categories.

During the product selection process, popular online reseller websites (e.g. Shopper.com) were mined for information on the configurations of computers being sold to create an initial database of several thousand different computer models for sale in the July 2012 timeframe. The most common builds for each of the performance categories listed above (detailed build information is available in the CCE final report) were identified. Desktop computer models from leading OEMs were purchased to match the most typical configurations, thus obtaining "baseline" desktop computers most commonly sold in the three performance categories. In the DT D2 category, the team purchased one unit reflecting the most common build and a second high-end model intended for gaming enthusiasts. This unit, although not representative of the most common configuration for DT-D2 units, was intended to examine whether the highest performance desktop computers available could be made more efficient in a cost-effective manner.

Each baseline system was then measured with the proposed ENERGY STAR Version 6.0 test procedure, which documents power consumption in all modes of operation, including off/standby, sleep, short idle, and long idle. Researchers then used the ENERGY STAR Version 6.0 duty cycle to calculate each computer's typical energy consumption (TEC) in kWh per year.

Analysts researched and obtained a variety of energy-efficient desktop computer components, namely hard drives, processors, graphics cards, and power supplies. Components were swapped with each of the baseline systems one by one, and analysts re-measured the systems with the ENERGY STAR Version 6.0 test procedure. The component swap measurements were later used to establish the energy savings achievable through the use of more efficient components. An economic analysis established for each test system which combination of components yielded the greatest cost-effective energy savings over a 4-year product lifetime. The power draw and TEC values for the cost-effective systems compared to the original baseline systems are presented below. The research demonstrated that energy savings on the order of 30% could be achieved cost effectively using desktop components available on the market today. This is based on retail prices for more efficient components, cost-effective savings could be higher when using OEM cost for efficiency only and applicable OEM to retailer markups . Detailed results are available in the final report.

Table 1: Power Draw and Energy Consumption of Baseline and Cost-Effective Efficient Desktop Computers for 3 ENERGY STAR Categories

	DT 0	DT I1	DT I2	DT I3	DT D1	DT D2 "Typical"	DT D2 "Enthusiast"
Baseline System TEC (kWh/year)		**130**	**125**			**225**	**368**
Standby Power (W)		0.14	0.88			0.13	1.49
Sleep Power (W)	Testing results forthcoming	1.49	2.10	Testing results forthcoming	Testing results forthcoming	2.46	3.09
Short Idle Power (W)		29.74	27.90			52.40	82.80
Long Idle Power (W)		28.86	26.50			47.65	81.74
Cost-Effective System TEC (kWh/year)		**92**	**88**			**147**	**278**
Standby Power (W)		0.17	0.73			0.19	2.34
Sleep Power (W)	Testing results forthcoming	1.52	1.90	Testing results forthcoming	Testing results forthcoming	2.74	4.05
Short Idle Power (W)		21.00	19.77			33.62	61.27
Long Idle Power (W)		19.79	18.37			32.27	60.15
Annual Energy Savings (kWh/year [%])		**39 [30%]**	**36 [29%]**			**77 [34%]**	**91 [25%]**

Testing for the remaining three desktop computer categories (DT0, DT I3, and DT D1) is underway, and we anticipate results to be completed by mid-2013.

In the meantime, Figure 1 illustrates the expected market baseline and near-term achievable energy consumption levels. PG&E measurements are shown as bars, whereas the dash marks indicate estimates of energy consumption for to-be tested product categories. Note that the typical computer builds procured and measured were extremely close to passing the proposed ENERGY STAR Version 6 specification (the DT D2 baseline system was already compliant), and systems with upgraded efficient components were able to clear the ENERGY STAR Version 6 levels by large margins.

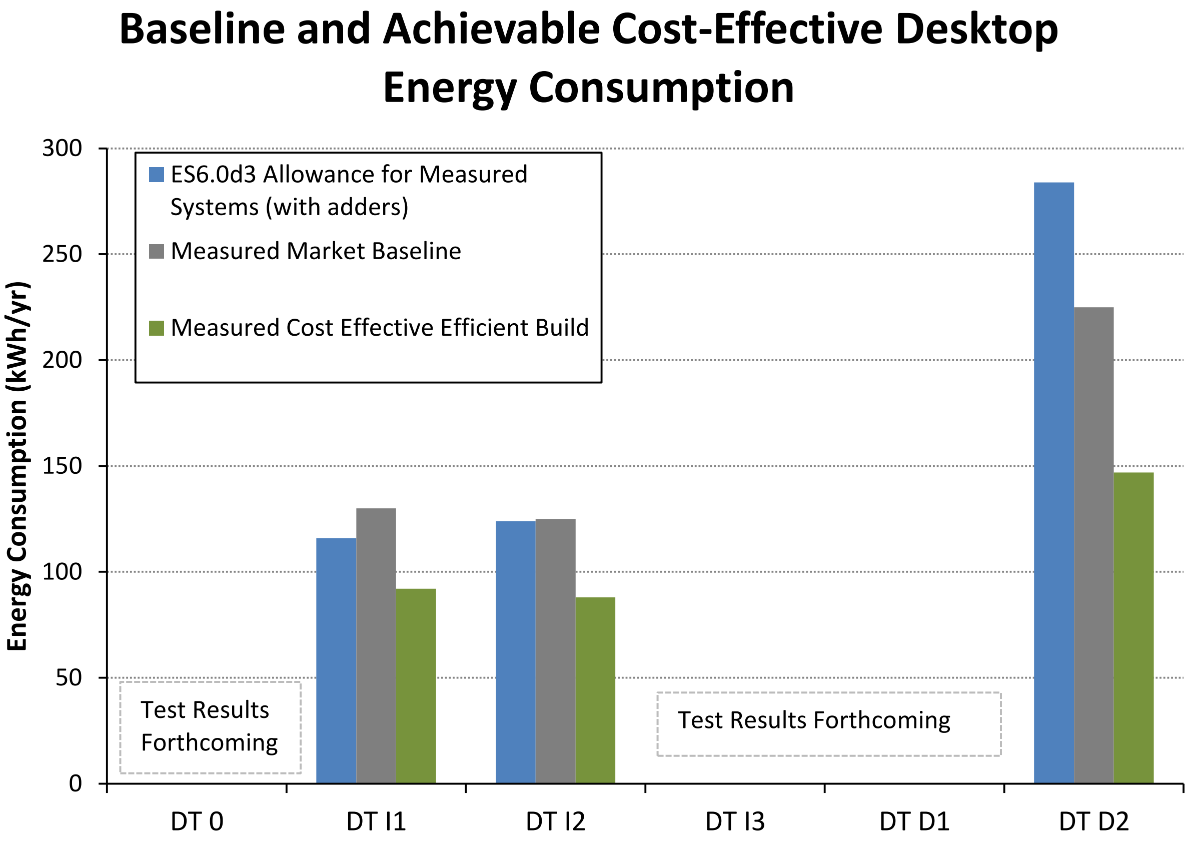

Figure 1: Baseline and Achievable Cost-Efficient Desktop Energy Consumption

2.4.2 Notebook Computers

The CA IOUs continue to investigate cost-effective notebook energy efficiency opportunities. We plan to provide additional supporting data by mid-2013. In the meantime, we support NRDC's response regarding the range of energy use for notebooks.

2.5 How does power use scale with the utilization of hardware such as processors, graphics cards, wireless networking etc.?

No response.

2.6 What components and functions represent a fixed power use while the computer is on or in a sleep state?

No response.

2.7 How much time computers in their various modes both in commercial and residential applications? How frequently are various functions of a computer in utilization such as “wake on LAN?”

As mentioned in 2.1, there are a number of empirical studies that measure the length of time computers are in their various modes (PG&E 2010; Pigg & Bensch 2010; Chetty et al. 2009, Microsoft 2008, ECMA-383, Fraunhofer 2010), however each study has its limitations. ENERGY STAR 6.0 Draft 3 estimates a duty cycle or “mode weighting” based on just two of these studies (Microsoft 2008 and ECMA-383). We recommend the development of a revised mode weighting that assesses the full body of literature to more accurately reflect the mode weighting and therefore energy consumption of computers in the U.S. and California. Below in Table 2 summarizes the studies.

Table 2. Assessment of Duty Cycle Literature

	Desktop				Notebook			Date	Segment	Sample size	Methodology
	Active-idle	Sleep	Off		Active-idle	Sleep	Off				
PG&E / Barr, Harty & Nero	94%	1%	5%		63%	15%	22%	2010	Enterprise (Thin-client, Cross-sector, U.S.)	110,000	Automated tracking and collection.
Ecma-383, 3rd Edition, Annex B	50%	5%	45%		40%	35%	25%	2010	Enterprise (International, technology companies)	500	?
Microsoft, Customer Experience Report	41%	5%	54%		27%	9%	6%	2008	**?**	75,000	Automated tracking and collection.
Pigg & Bensch	49%	51%			29%	71%		2010	Residential (Wisconsin)	81 computers in 50 homes	Automated tracking and collection.
Fraunhofer / CEA	39%	25%	36%		33%	25%	42%	2010	Residential (U.S.)	1,000 homes	Phone survey
Chetty et al.	75%	25%			36%	64%		2009	Residential (U.S)	59 computers in 20 homes	Logging, surveys, interviews

3 Energy Saving Technologies, Components, and Features

3.1 How long does it take a computer to wake from various sleep modes? What contributes to this wake time?

No response.

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

No response.

3.3 To what extent is the efficiency developed for slate devices incorporated in notebook computers?

No response.

3.4 What are the design practices and technologies incorporated into the most efficient computers?

PG&E's CCE project (2012a) conducted in-depth examinations of efficient components for desktop computers. Below we present the top design practices and technologies pertaining to desktop computers. We will provide additional comment and analysis on best practices for efficient notebook computers in future submittals in mid-2013.

Our research indicates that improved design of power supplies, central processing units (CPUs), graphics processing units (GPUs), and hard drives represent significant component-level energy savings opportunities identified in PG&E's desktop computer efficiency research. These are intended to illustrate some, not necessarily the most, cost-effective efficiency pathways. Manufacturers have the flexibility to implement other efficiency improvements which may lead to even higher cost-effective savings.

3.4.1 Internal Power Supplies

Voluntary computer specifications like ENERGY STAR and the utility-sponsored 80 PLUS labeling program[1] have been encouraging higher levels of efficiency in computer power supplies since 2005. Microprocessor manufacturer Intel has also encouraged vendors to achieve higher levels of efficiency through its form factor specifications.[2] A variety of power electronics design techniques can be employed to achieve the higher levels of efficiency required in these specifications. Measurements of the efficiency in baseline and cost-effective efficient internal power supplies, two of each, are shown in Figure 2. Efficiency improvements in power supplies tend to have the greatest impact on active mode power consumption (e.g. idle power), but since power must pass through the power supply during standby and sleep modes, internal power supplies can also help to lower power in these modes as well.

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[1] More information available at http://www.plugloadsolutions.com/80PlusPowerSupplies.aspx.

[2] More information available at http://www.formfactors.org.

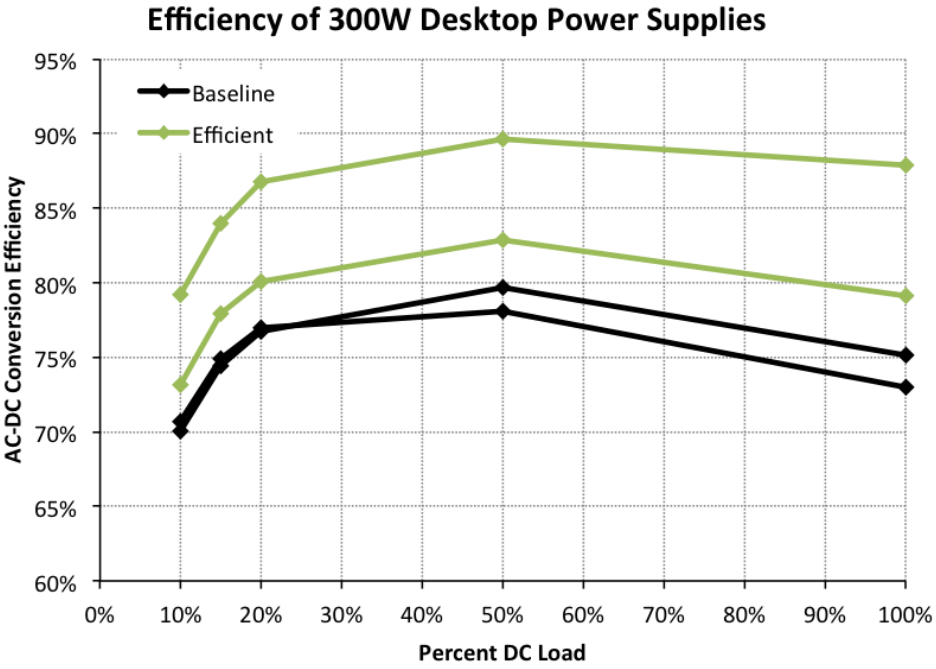


Figure 2: Measured Efficiencies in Baseline and Efficient Internal Power Supplies

All highly efficient desktop computer power supplies on the market today are "switching" or "switch-mode" power supplies, employing a combination of active, solid-state components to rectify incoming ac electricity into dc and to further down-convert that dc electricity to the voltages typically required in computers (e.g. 12, 5, and 3.3V). Detailed discussion of other design techniques for improving efficiency in power supplies has been provided through prior research funded by the California Energy Commission's Public Interest Energy Research (PIER) program.

3.4.2 Central Processing Units

Several trends in CPU design have been contributing to dramatically improved efficiency in recent years. Primarily spurred by unacceptably high thermal emissions in the computer, but also by increased focus on idle power by energy efficiency policy (e.g. via ENERGY STAR), processor manufacturers have placed greater emphasis on lowering CPU power consumption in idle mode. In the 2004 – 2006 timeframe, CPUs and their associated motherboard components began incorporating techniques from notebooks to scale the power consumption of processors to the performance required at any given time by the user. CPUs and the chipsets that support them now dynamically scale the frequency or clock speed of the processor as well as the voltage delivered to the processor to "throttle" power consumption and performance during idle times. As multi-core processors have come to dominate the market, it is now possible to conduct power scaling on individual cores. For example, one core could be heavily taxed with an image processing workload, while the remaining three cores in the processor could sit idle at much lower power consumption.

Beyond improving the dynamic control of CPUs, manufacturers have also made great strides in their silicon fabrication processes, continuing to reduce the size of individual features to nanometers. While this process has dramatically increased the number of transistors in a given part, it has also given manufacturers greater control over losses in the silicon. Tighter fabrication processes have, for example, reduced the overhead losses caused by leakage currents in devices, enabling lower idle power values.

3.4.3 Graphics Processing Units

The two leading vendors of GPUs, AMD and NVIDIA, have both released significant updates to their flagship GPU architectures over the past year. Market research shows that two thirds of NVIDIA's and one quarter of AMD's current discrete desktop GPU product lineup utilize the Kepler or Graphics Core Next (GCN) architectures, respectively, which deliver significant savings relative to GPUs that use older architectures. In general terms, these new architectures allow the GPU to scale the power it demands to match the task it is performing, generating significant savings during idle mode (NVIDIA 2012). This is similar to the power scaling strategies discussed above for CPUs. The GCN architecture and its ZeroCore feature also allow the GPU to power down some components when the computer screen is off or not displaying content (AMD 2012). More than 80% of the GPUs released in 2012 use these more efficient technologies, and the remaining 20% are simply older GPUs that have been relabeled and re-released. In other words, Kepler and GCN represent a sea change in the way discrete GPUs are designed. Test results indicate that these latest architectures can save anywhere from 20% to 75% of discrete GPU energy consumption depending on the performance class of the card (generally, the greater the frame buffer bandwidth of the card, the greater the savings) (PG&E 2012b).

Of course many mainstream desktop computers utilize integrated graphics where the GPU is located on the motherboard, either as a part of its chipset or as an integral piece of the CPU itself (AMD refers to these as APUs or Accelerated Processing Units). The power scaling and power management features discussed for discrete GPUs above apply to integrated graphics as well.

In systems with discrete graphics installed, it is extremely important that any existing integrated graphics is either disabled or utilized as little as possible to minimize its power consumption. This "graphics switching" functionality is a key opportunity for achieving further energy savings in desktop systems with discrete graphics. Graphics switching is currently employed in certain notebook computers that have both discrete and integrated graphics as a means of extending battery life, but we are currently unaware of desktop implementations.

For more information see reference PG&E 2012b, included separately with this response.

3.4.4 Hard Drives

Hard drives present a key energy savings opportunity in desktop computers. Traditional spinning, magnetic hard drives are still by far the most widely used technology. Their power consumption can range by a factor of two from the most to least efficient versions (about 4 to 8 W) depending on the vendor, efficiency of the motor, and spindle speed. Some manufacturers like Western Digital have begun to offer "green" versions of their products that consume less power, although this is sometimes achieved by lowering spindle speeds, which impacts read and write times.

The latest, most efficient, and interestingly *highest* performance drives on the market are solid state drives (SSDs). SSDs use non-volatile flash memory rather than magnetic platters to store content, so require no moving parts and have significantly lower power consumption — anywhere from a fraction of a watt to about 1 W. SSDs are more widely used in mobile devices like notebooks, but are seeing increased penetration in high-performance desktops where users want to maximize read/write speeds.

3.5 What are the incremental costs associated with more efficient hardware?

PG&E's 2012 research into achievable, cost-effective efficiency identified incremental cost data for the four desktop component opportunities outlined above (power supplies, CPUs, GPUs, and hard drives) using retail price points from several online computer parts retailers (e.g. Newegg.com, TigerDirect.com). As noted above in Section 2.4.1, incremental retail prices between products can be higher than the incremental cost of efficiency improvements only, as incremental retail prices can include the costs of non-efficiency related features and components. Table 3 presents a range of incremental costs for the various components based on price differences between the components used in baseline systems and the components installed in the final cost-effective efficient systems presented in Table 1 and Figure 1. Further details are provided in PG&E's final CCE report (PGE& 2012a). Note that the incremental costs for internal power supplies are provided in Section 6.4.

Table 3: Desktop Computer Component Incremental Costs

Component	Incremental Cost ($ retail)	Notes
CPU	$5	In many cases, a fundamental change in CPU type will require a change in processor socket and motherboard as well. It is therefore extremely difficult to isolate the energy and cost impacts of the processor alone except when making upgrades within a given processor family. This $5 incremental cost estimate is for minor upgrades within a given processor family and not for a significant technology shift.
GPU	Negligible for higher performance GPUs.	Recent market data suggest that Kepler and GCN architectures are being offered in higher performance graphics cards (ECMA categories G4 and above) at prices comparable to cards with older technology. In lower performance cards, availability of the newer GPUs is still limited.
Hard Drives	$2 - $6	Incremental costs are relatively low when upgrading to more efficient, conventional spinning HDDs, as shown here. There is still significant incremental cost between conventional HDDs and SSDs.

3.6 How well are hardware efficiency features utilized by computer system software?

No response.

3.7 To what extent are hardware efficiency features dependent on proper enabling by users? Which features are enabled by default?

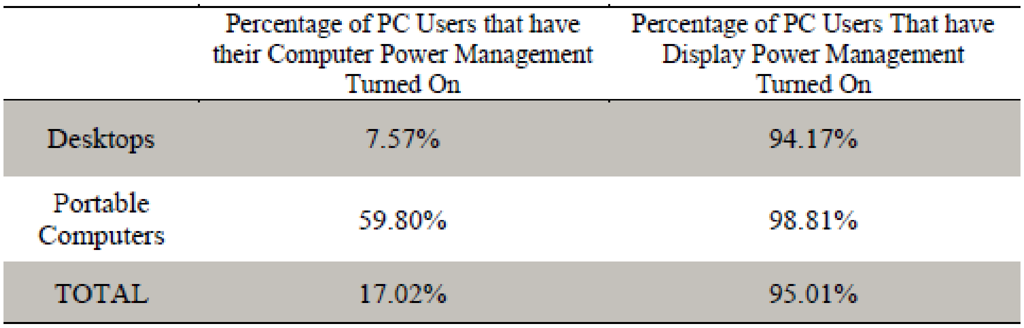
No response.

3.8 What are the power management settings in California's current stock of computers? What are the settings in new computers being offered for sale?

Power Management in Current Stock

No California-specific studies are known, but there are a few studies. Below is the measured power management enablement for a survey of U.S. enterprise units without corporate management, which is approximately 87% of the commercial market (PG&E 2010).

Table 4. Power Management Usage (without corporate power management enforcement)

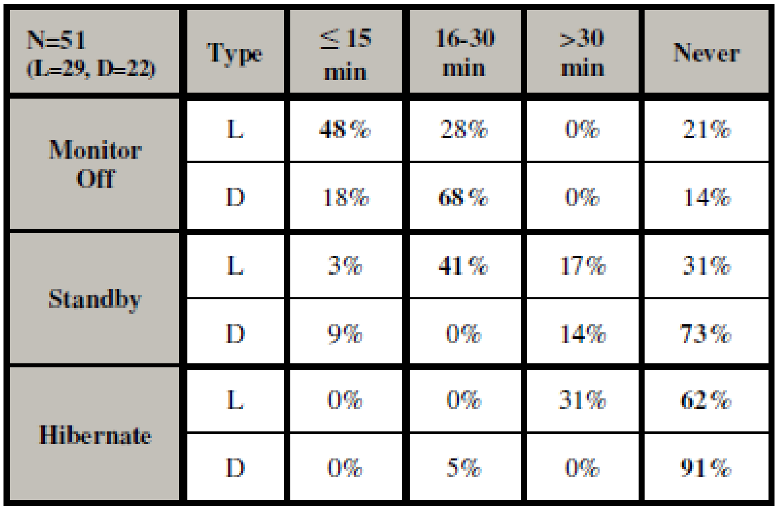


	Percentage of PC Users that have their Computer Power Management Turned On	Percentage of PC Users That have Display Power Management Turned On
Desktops	7.57%	94.17%
Portable Computers	59.80%	98.81%
TOTAL	17.02%	95.01%

Source: PG&E 2010.

In the residential sector, a small sample survey from of U.S. homes shows a range of power management settings (Chetty et al 2009) in Table 5.

Table 5. Machine Power Management AC Settings (L=Laptop, D=Desktop)



N=51 (L=29, D=22)	**Type**	**≤ 15 min**	**16-30 min**	**>30 min**	**Never**
Monitor Off	L	**48%**	28%	0%	21%
	D	18%	**68%**	0%	14%
Standby	L	3%	**41%**	17%	31%
	D	9%	0%	14%	**73%**
Hibernate	L	0%	0%	31%	**62%**
	D	0%	5%	0%	**91%**

Source: Chetty et al. 2009

Another study of Wisconsin homes (Pigg & Bensch 2010) supports results for desktops, reporting that 80% of desktops do not have power management enabled to sleep/hibernate.

Power Management in New Computers

As described in Section 2.1, the current ENERGY STAR specification (EPA 2010) and the Draft 3 of 6.0 (EPA 2012) requires 30 minute system sleep (except for Small-scale servers) and 15 minute display sleep, WOL, and Wake Management. Since not all units shipped are ENERGY STAR qualified, these settings may not reflect the broader market.

4 Market Characteristics

4.1 How many computers are sold each year in California? How many are currently in use? Form factor? Performance category? Commercial or residential? How are these expected to grow?

Shipments

For shipments, there at least two publicly available sources which show some discrepancy regarding estimates of the market size.

For 2011 and 2012, IDC (2013a) reported 71.3 million and 66.5 million total shipments for desktops, notebooks ("portables" and min-notebooks) and workstations, respectively in the U.S. There was a 35% / 65% split between desktops and notebooks in 2011 (IDC 2012) in mature markets (U.S. Western Europe, Canada, Japan) and a 37% / 63% split in 2012 (IDC 2013b). Using the California / U.S. GDP percentage of 13% (BEA 2012), not accounting for workstations, there were approximately 3.2 million desktops and 6.0 million notebooks sold in 2011 and 3.2 million desktops and 5.4 million notebooks sold in 2012.

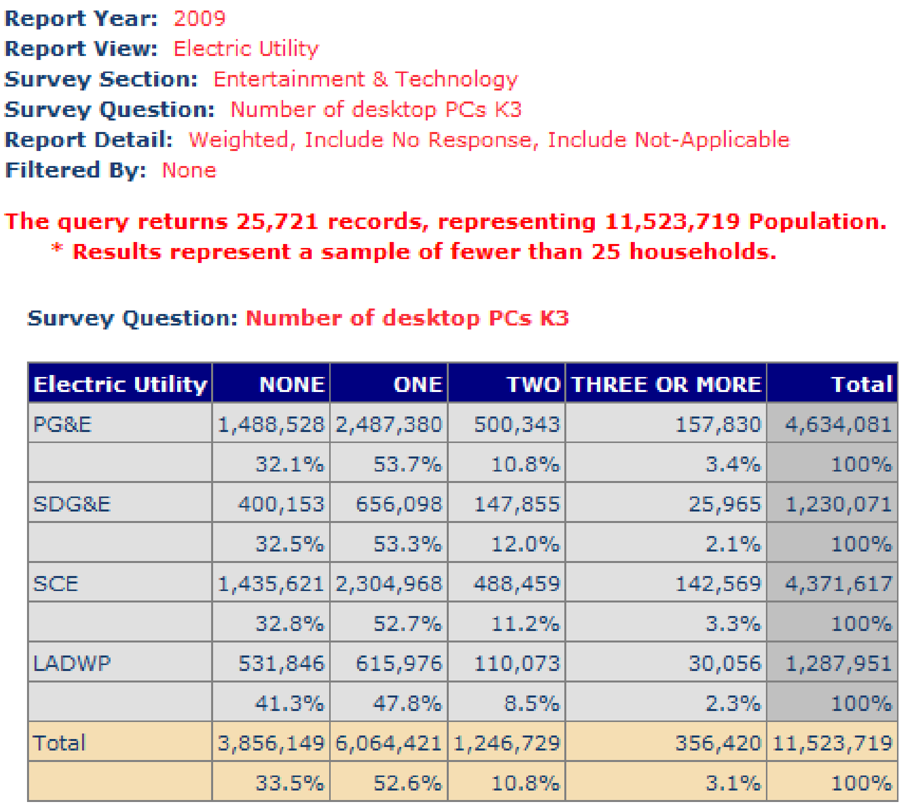
Environmental Protection Agency (EPA) reported sales estimates for U.S, shipments of ENERGY STAR qualified products and the market penetration rate for each (2011). Dividing the shipments by the form factor penetration rate and then multiplying by the California / U.S. GDP percentage of 13% (BEA 2012), results in an estimate of 4.54 million desktops, 6.91 million notebooks and 90,000 workstations.

Future Shipments

In terms of future shipments in mature markets (U.S. Western Europe, Canada, Japan) desktops and notebooks are expected to decline by 5.5% and 3.1% between 2012 and 2013, respectively, and then an additional 2.9% and 1.4% by 2017 (IDC 2013b).

Existing Stock

KEMA 2010 reports at least 9.6 million desktops and 8.6 million notebooks in use in the residential sector, see Figure 3 and Figure 4.



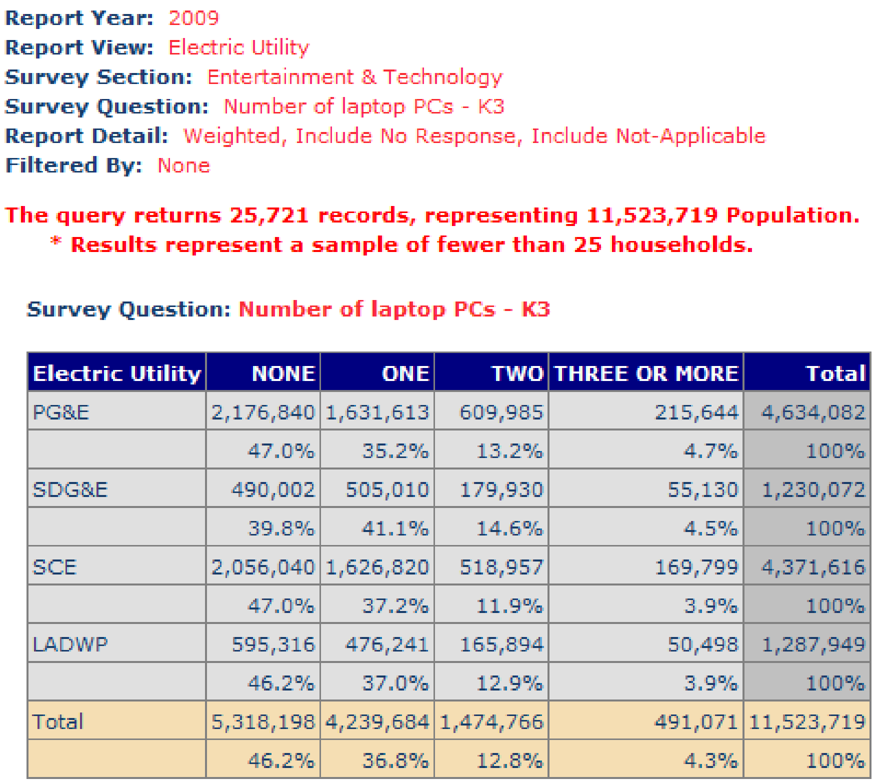
Report Year: 2009
Report View: Electric Utility
Survey Section: Entertainment & Technology
Survey Question: Number of desktop PCs K3
Report Detail: Weighted, Include No Response, Include Not-Applicable
Filtered By: None

The query returns 25,721 records, representing 11,523,719 Population.
*** Results represent a sample of fewer than 25 households.**

Survey Question: **Number of desktop PCs K3**

Electric Utility	NONE	ONE	TWO	THREE OR MORE	Total
PG&E	1,488,528	2,487,380	500,343	157,830	4,634,081
	32.1%	53.7%	10.8%	3.4%	100%
SDG&E	400,153	656,098	147,855	25,965	1,230,071
	32.5%	53.3%	12.0%	2.1%	100%
SCE	1,435,621	2,304,968	488,459	142,569	4,371,617
	32.8%	52.7%	11.2%	3.3%	100%
LADWP	531,846	615,976	110,073	30,056	1,287,951
	41.3%	47.8%	8.5%	2.3%	100%
Total	3,856,149	6,064,421	1,246,729	356,420	11,523,719
	33.5%	52.6%	10.8%	3.1%	100%

Figure 3: Estimated Number of Residential Desktop PCs in California



Report Year: 2009
Report View: Electric Utility
Survey Section: Entertainment & Technology
Survey Question: Number of laptop PCs - K3
Report Detail: Weighted, Include No Response, Include Not-Applicable
Filtered By: None

The query returns 25,721 records, representing 11,523,719 Population.
*** Results represent a sample of fewer than 25 households.**

Survey Question: Number of laptop PCs - K3

Electric Utility	NONE	ONE	TWO	THREE OR MORE	Total
PG&E	2,176,840	1,631,613	609,985	215,644	4,634,082
	47.0%	35.2%	13.2%	4.7%	100%
SDG&E	490,002	505,010	179,930	55,130	1,230,072
	39.8%	41.1%	14.6%	4.5%	100%
SCE	2,056,040	1,626,820	518,957	169,799	4,371,616
	47.0%	37.2%	11.9%	3.9%	100%
LADWP	595,316	476,241	165,894	50,498	1,287,949
	46.2%	37.0%	12.9%	3.9%	100%
Total	5,318,198	4,239,684	1,474,766	491,071	11,523,719
	46.2%	36.8%	12.8%	4.3%	100%

Figure 4: Estimated Number of Residential Laptop (Notebook) PCs in California

An approximate division of 59% to 41% exists between the commercial and residential PC market (Hamm and Greene 2008).

4.2 To what extent is the computer market uniform or different within the state, country, continent, and world?

No response.

4.3 Is there a particular time of the year when new models are released?

No response.

4.4 What is the range of efficiency in the market for computers with similar performance? How much variance is there?

See above response to Section 1.11. There is also a significant range of annual energy consumption in desktops and notebooks, as conveyed in the ENERGY STAR data submitted by NRDC.

4.5 How frequently are computers updated after initial release (firmware and hardware)?

No response.

5 Market Competition for Efficient Products

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

No response.

5.2 What are the current market drivers towards improving computer efficiency?

Some market drivers exist for improving energy efficiency but there are significant per unit cost-effective energy efficiency measures that are not be captured. We support NRDC's summary of the market drivers in response to this question.

5.3 What markets currently place requirements on the efficiency of computers through regulations or procurement requirements?

No response.

5.4 How are consumers able to identify the most efficient products on the market? The least efficient?

ENERGY STAR label provides consumers with a general indication of which products are the most efficient, however, the label has a shelf-life for representing the top 25%; overtime, an increased number of products meet a given ENERGY STAR specification. Moreover, with the most recent proposed Version 6.0 specification, the levels today representative more than the top 25% (PG&E 2012a). There is also no convenient way for consumer to identify the least efficient products on the market.

5.5 What is the current market share of computers that meet ENERGY STAR's computer specifications 4, 5.2, and current draft 6.

As depicted in CCE PG&E 2012a, energy use of typical 2012 desktops was equal was 22% to 42% lower than ENERGY Version 5.2 levels. As depicted above, energy use of typical 2012 desktops meet the proposed ENERGY STAR Version 6.0 Draft 3 levels. While ENERGY STAR is designed to represent the top 25% of the market, these results suggests this not the case, and that a much larger percentage of the market is meeting both the existing and proposed ENERGY STAR specifications. NEEA Market Progress Evaluation Report #4 (2012) prepared by Navigant on the 80 PLUS program, estimated the ENERGY STAR market share for desktops in 2011 at 43%.

6 Other

6.1 What types of operations prevent a computer from automatically entering sleep mode?

No response.

6.2 To what degree do background programs and services affect energy consumption?

No response.

6.3 What product development trends in the computer market may have an impact on power consumption or proper categorization of devices?

No response.

6.4 What are the incremental costs between the different levels of 80 PLUS compliant power supplies and power supplies that do not meet the 80 PLUS specifications? What are the main drivers of these costs?

Preliminary material cost analysis indicates that power supply efficiency improvements are approximately $.80 per 1% increase in efficiency for the manufacturer (iSuppli 2011). NEEA (2012) concludes a weighted average incremental cost of $7 for an average efficiency improvement from non-80 PLUS to 80 PLUS.

To determine the incremental retail cost to the consumer, a mark-up between manufacturer and retailer can be applied. As part of its Battery Chargers rulemaking the Technical Support Document, Department of Energy (2012) estimates the incremental retail markup or "Composite Incremental Markup," to be 1.31-1.35 times that of the incremental manufacture cost for all types of computer accessory battery chargers.

The drivers of the efficiency-related costs: primarily passive components (inductors and transformers, capacitors and non-semiconductor devices) and printed circuit boards that electrically connect all semiconductor devices and passive components, and secondarily transistors and diodes, and thirdly the integrated circuits (ICs).The high cost of the passive components comes for usage of large electrolytic capacitors and magnets, so changing designs and moving to high frequencies can reduce the size and count of costly passive components. Replacing passive conversion with active power conversion can change cost and efficiency rating as well (iSuppli 2011).

7 Any other information relevant to this proceeding

No response.

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