NATURAL RESOURCES DEFENSE COUNCIL

NRDC Comments on
Energy Star Computers Version 6, March 10 2011 Kickoff Meeting

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April 7, 2011

On behalf of the Natural Resources Defense Council (NRDC) and our more than 1.3 million members and online activists, we respectfully submit these comments on the discussion document and materials presented at the Energy Star Computers Version 6, March 10 2011 kickoff meeting.

Desktops and notebooks represent the largest source of electricity use of all electronics devices. They consume approximately 67 GWh, the equivalent output of 23 medium-size coal-fired power plants. This represents approximately 2% of US electricity use, more than all data centers and server rooms in the country. In a context of continued rapid growth of the computer market in the US and globally, capturing energy saving opportunities in computers is critical to support the shift towards a low-carbon society, as well as to reduce mercury emissions and other pollutants from power generation.

Desktops use the most energy and present the largest opportunity for energy savings per unit. Each desktop consumes typically approximately 3 times as much energy as a notebook of equivalent performance capability. However notebooks are growing the fastest: notebooks sales overtook that of desktops in 2008 in the US, and their aggregate energy use is catching up with that of desktops, making it important to capture notebook energy savings opportunities even though they may seem lower than that of desktops on a per unit basis.

The version 5 computer specification has been very effective at increasing the energy efficiency of notebooks where Energy Star market share of 74%. The 27% market share for desktops reflects a low penetration in consumer desktops due largely to qualification criteria for premium graphics capabilities. This needs to be fixed in version 6 so that Energy Star can effectively encourage the market to adopt desktops with the most efficient graphics.

NRDC's analysis shows that there remains major cost-effective energy savings opportunities in both desktops and notebooks. Energy Star has a critical role to play in capturing these savings by

encouraging the provision by manufacturers and the adoption by users of higher efficiency devices.

Our comments below share the results of NRDC's analysis and our recommendations to capture the largest savings opportunities in Energy Star for Computers version 6.

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Summary

Discrete Graphics

Discrete graphics cards have become one of the largest energy consumers in desktop PCs. While their energy efficiency has improved significantly since 2008, there is still a wide margin for improvement to get cards from a non-weighted average of 23 W idle power in 2010 towards 5 W or less when not performing any graphics processing.

Discrete graphics have yet to fully utilize power scalability techniques pioneered by CPUs. With these design and lithography improvements, discrete graphics can further reduce the power they use in idle mode when little or no graphics processing is required.

In order for Energy Star to incentivize the industry to continue the current energy use reduction trend, NRDC recommends EPA sets graphics adders based on the projected consumption of discrete graphics in 2012-2013 when Energy Star 6 will be in effect. This is important because overly generous graphics allowances pose a risk of weakening the entire standard by giving the rest of the system an unwarranted allowance that can be used to qualify units of mediocre energy efficiency.

In order to set the appropriate allowance levels, it is important that EPA has a comprehensive data set that covers the entire discrete graphics market. NRDC recommends that EPA asks manufacturers to provide the idle power use and ECMA categorization of discrete gaming cards released on the market since January 2010. This data does not require any additional testing, it is already measured by card manufacturers as it is an important design criterion for computer OEMs. The availability of this comprehensive data set will allow much more accurate level setting that a smaller sample which may not be representative of the overall market.

Power Supplies

The current Energy Star 5 specification requires internal power supplies (IPS) to meet 80-Plus Bronze (85% efficiency at 50% load) and external power supplies to meet Level V (average of 87% efficiency across 25%, 50%, 75%, 100% load points). NRDC recommends that Energy Star 6 raises IPS requirements to Silver and EPS to an average of 89% efficiency. In addition EPS No Load power should not exceed 150mW for EPS <= 65W, 400mW for EPS > 65W.

NRDC's recommended levels will save 340MW of generating capacity in the US by 2020, or the output of nearly 1 medium-size coal-fired power plant. Energy Star also strongly influences markets in the rest of the world, where the same changes will save nearly 4 medium-size coal-fired power plants.

The technology is available today: there are already a significant number of IPSs and EPSs in the market meeting these levels. NRDC's analysis indicates that the incremental material cost of this increase in standard would be on average $0.30 per notebook and $0.80-$2.00 per desktop. Even including markup, they are cost-effective from a user perspective as they pay for themselves in significantly less than the typical life of the computers.

Energy Star has a critical role to play in scaling user adoption and driving innovation so that more efficient power supplies become affordable for the rest of the market to adopt over the coming years.

Integrated Displays

The display panels of notebooks and integrated desktops account for approximately 35% of PC energy use and are not covered by either the Computer or Display Energy Star specifications. Given that they are an integral part of the computer, including them in the computer specification would help create incentives for system-level energy efficiency in notebooks and integrated desktops. During the March 10 presentation, EPA outlined an approach using a standard allowance based on display size, per the Energy Star Display specification. NRDC supports this approach, and cautions against adding allowances for specific display technologies because of the risk of increasing complexity and reducing the specification's effectiveness by making it too easy to qualify.

Battery Charger Systems

The Energy Star test procedure for computers only measures notebook energy consumption while the notebook is plugged into AC power. It does not measure energy consumption due to battery charging losses during mobile use.

NRDC analysis shows that charging losses represent 6% to 10% or more of notebook typical energy consumption (TEC), and these energy losses are unaccounted for by the current Energy Star specification for computers. The coverage of charging efficiency by Energy Star is important to incentivize the industry to reduce energy losses during charging.

NRDC recommends including efficiency requirements directly in the Energy Star computer specification because it allows to set requirements which are targeted specifically at notebook technology rather than at generic battery charger systems including low-cost and low-tech chargers.

In order to set effective levels for BCS, it is important to have a representative data set for BCS efficiency of notebooks currently on the market. NRDC recommends that EPA requests representative notebook BCS test data either from manufacturers or from an independent third-party laboratory.

TEC Levels

Some of the PCs currently qualified Energy Star use 2 to 4 times as much energy as the best energy performers in their category. We recommend a combination of tightening levels and revising product categorization to ensure that customers can rely on Energy Star to identify the best energy performers in each computer category.

Inclusion of Tablets in the Computer Specification

We support the inclusion of mobile computing platforms in Energy Star. While these platforms are already very efficient due to the fact that they are designed primarily for mobile use in which and battery life is critical, there is still an opportunity for energy savings in battery charging losses. Battery charging efficiency does not impact battery life and therefore is not as much of a priority for manufacturers as active energy use. The computer specification should focus on addressing this opportunity by including specific requirements in the computer specification rather than rely on the generic BCS specification.

Network Connectivity in Test Procedure

The Energy Star 5 test procedure for Desktops, Integrated Desktops, and Notebooks specifies that testing should be performed with a live Ethernet connection if available, and with a wireless connection enabled only if no Ethernet connection is available.

Wireless connection has become ubiquitous in today's computers, while most computers also retain an Ethernet connection. Some user configurations have both connections active at the same time, which enables them to switch transparently from one to the other when docking and undocking a notebook. If this configuration represents a significant portion of the user base, the test procedure should be updated to reflect this and capture the energy consumption from both devices.

In order to confirm the need to update this aspect of the test procedure, NRDC recommends EPA seeks comments and data from industry to assess the network connectivity situation in systems sold today and in upcoming years.

Other Environmental Benefits

NRDC supports EPA's initiative to consider opportunities to include embodied energy criteria in Energy Star. Embodied energy can represent the majority of a product's energy footprint for some energy efficient and short-lived product types. While there are other initiatives looking at this problem, there are no well established programs currently addressing embodied energy in electronics products. Until an effective program emerges, Energy Star is a strong candidate given the strength of the Energy Star brand.

NRDC provides more information on these recommendations below.

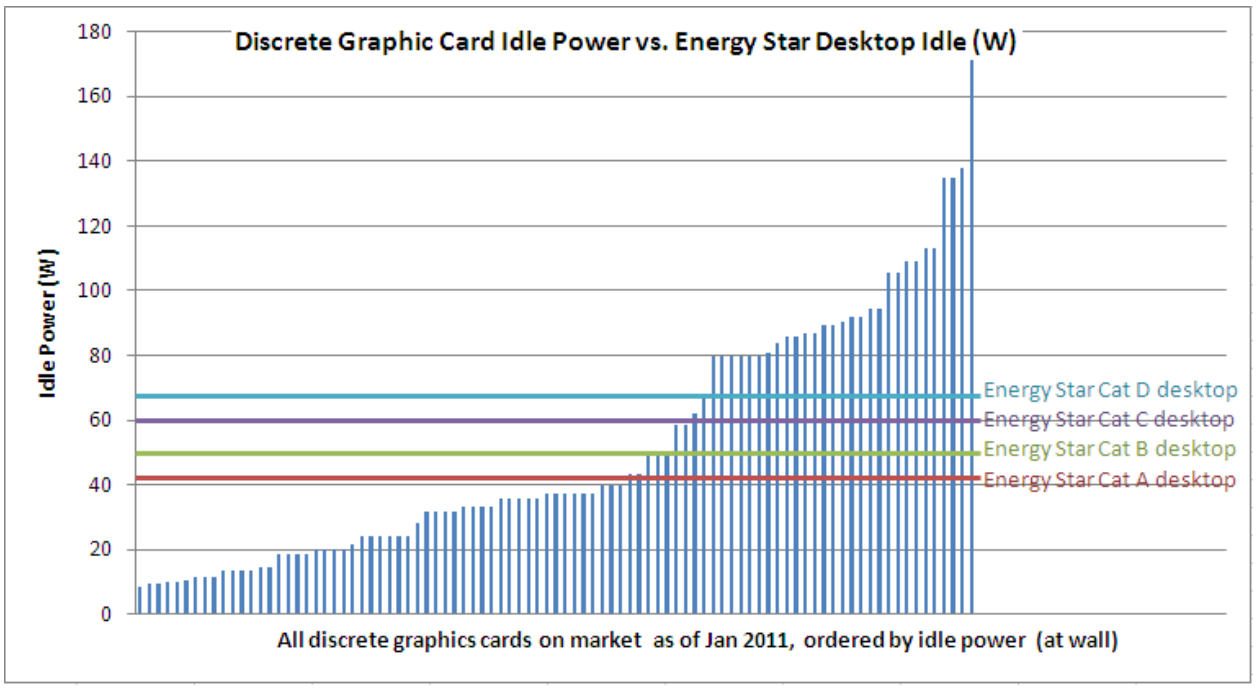
In-Depth Discussion

Graphics

The Problem

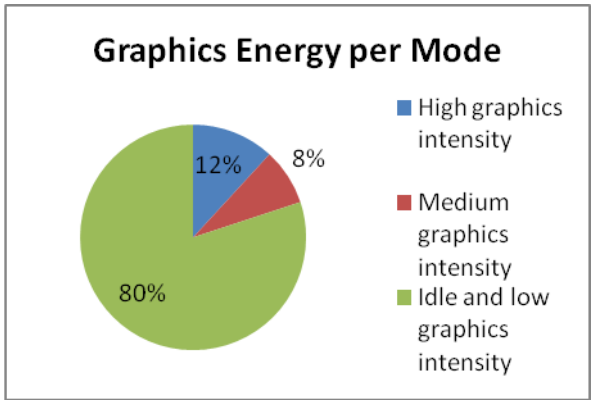
While many computers now use integrated graphics capabilities, a significant proportion still uses discrete graphic cards due to higher graphics performance requirements, particularly in gaming, video editing and CAD applications. The global graphics processor (GPU) market in 2010 was approximately 75 million desktop and 60 million notebook discrete GPUs[1], which represents a substantial share of the overall computer market of approximately 350 million units worldwide in 2010.

Discrete graphics cards have become one of the largest energy consumers in desktop PCs. In desktop PCs that have a discrete graphics card (dGfx), the card often uses as much and in some cases more power than the rest of the PC, as shown by the following chart:



[1] Mercury Research

The most troubling is that most of that energy consumption occurs in idle or low-graphics modes when there is no or little need for graphics processing:



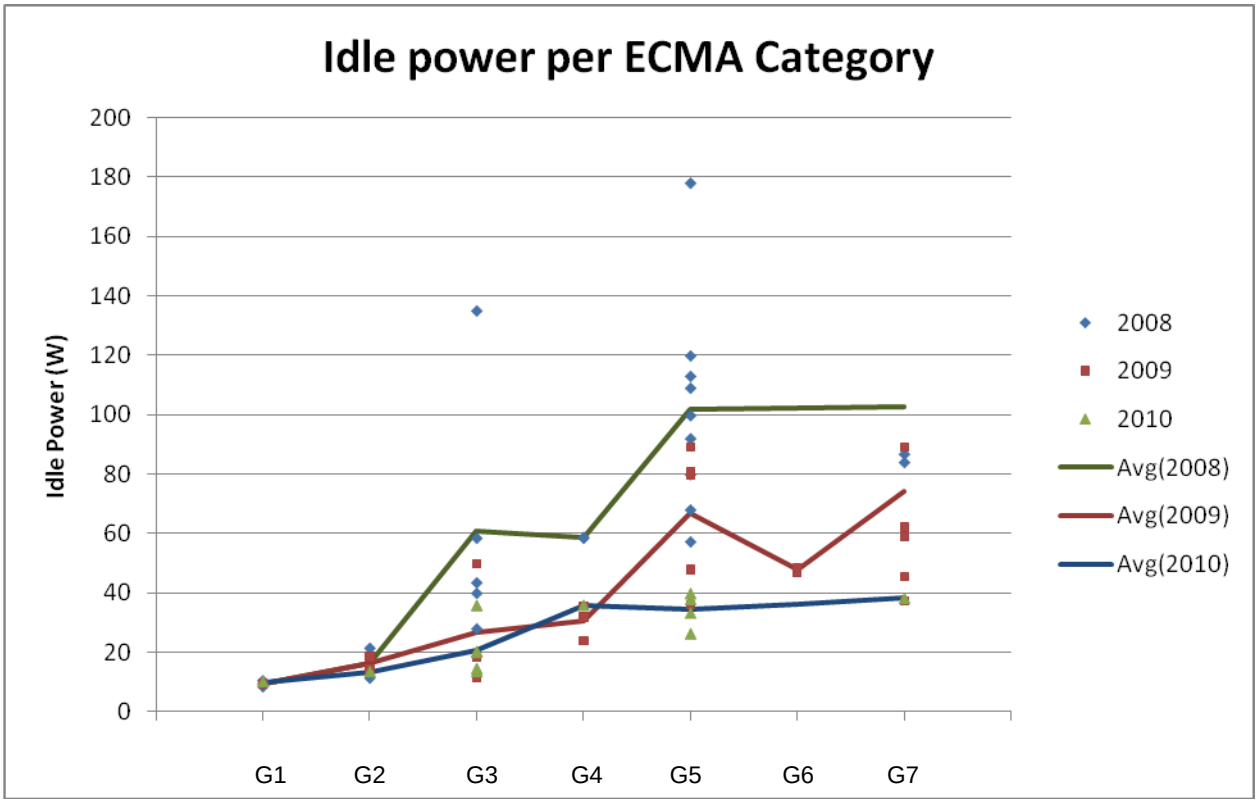
Desktop discrete graphics cards introduced in 2010, NRDC analysis.

Energy Star 5 already addresses graphics energy use by providing allowances for computers with discrete graphics meeting certain criteria. However these allowances are too low and do not currently allow desktop computers with discrete graphics cards to qualify, limiting Energy Star penetration and therefore its effectiveness for desktops.

<u>NRDC's Recommendation:</u>

In the absence of a test method to specifically measure dGfx idle power, NRDC recommends that Energy Star continues to use its current system of allowances but refines these allowances to make it possible for only the efficient computers with the most efficient dGfx to qualify.

NRDC analyzed idle power use by discrete desktop graphics cards introduced on the market from 2008 to 2010:



NRDC analysis based on manufacturer and third party data.

This graph shows that idle power was significantly reduced between 2008 and 2010, but still accounts for a non weighted average of 23 W for cards introduced in 2010.

While the improvement trend from 2008 to 2010 is positive, there still is a wide margin for improvement to get cards from 23 W towards 5 W or less idle power, the level NRDC considers an appropriate long-term target for discrete cards when they are not performing any graphics processing.

Discrete graphics have yet to fully utilize power scalability techniques pioneered by CPUs. With these design and lithography improvements, discrete graphics can further reduce the power they use in idle mode when little or no graphics processing is required.

The energy use of discrete graphics in idle has already considerably decreased since 2008. In order for Energy Star to incentivize the industry to continue this reduction trend, NRDC recommends EPA sets graphics adders based on the projected consumption of discrete graphics in 2012-2013 when Energy Star 6 will be in effect. Energy consumption by ECMA category can be projected using manufacturer and third-party data of card energy consumption since 2008. This is important because overly generous graphics allowances present a risk of weakening the entire standard by giving the rest of the system an unwarranted allowance that can be used to qualify units of mediocre energy efficiency.

Data Requirements:

In order to set the appropriate allowance levels, it is important that EPA has a comprehensive data set that covers the entire discrete graphics market. NRDC recommends that EPA asks manufacturers to provide the idle power use and ECMA categorization of discrete gaming cards released on the market since January 2010. This data does not require any additional testing, it is already measured by card manufacturers as it is an important design criterion for computer OEMs. The availability of this comprehensive data set will allow much more accurate level setting that a smaller sample which may not be representative of the overall market.

Multi-card Configurations (CrossFire, SLI)

Some computers use 2 cards of the same type connected in tandem (aka CrossFire for ATI and SLI for Nvidia). These multi-card configurations use proportionally much more power than they provide additional performance, and in all the cases we have looked at, we have found alternative single card configurations that provide similar performance for significantly lower power:

Energy Star should encourage cards that meet energy efficiency criteria for given performance levels, irrespective of whether this is achieved with a single card or a multi-card configuration. We therefore recommend that additional dGfx receive no additional adder, and multi-card configurations compete with single-card configurations solely on the basis of their energy use.

Power Supplies

The current Energy Star 5 specification requires internal power supplies (IPS) to meet 80-Plus Bronze (85% efficiency at 50% load) and external power supplies to meet Level V (average of 87% efficiency across 25%, 50%, 75%, 100% load points). This is far from the maximum efficiency feasible with today's technology, which is between 91% and 95% depending on power rating and form factor.

In fact, there are currently a substantial number of multi-output IPS models on the market that already meet Silver and Gold levels, per the 80-Plus web site[2]:

IPS Rating	Count
Platinum	20
Gold	**333**
Silver	**239**
Bronze	1059
Standard	1179
Total	2830

80-Plus data for 115V multi-output power supplies, April 2011

Regarding external power supplies, NRDC conversations with power supply industry stakeholders indicate that many models on the market, particularly amongst those used by major computer OEM brands, already achieve 89% efficiency.

[2] http://www.plugloadsolutions.com/80PlusPowerSupplies.aspx

NRDC strongly recommends that Energy Star 6 raises IPS efficiency to Silver and EPS efficiency to an average of 89%. In addition, EPS No Load power should not exceed 150mW for EPS <= 65W, and 400mW for EPS >= 65W.

By 2020, once fully deployed in the market, and after turnover of the current PC stock, these power supply efficiency improvements alone will save 340MW of generating capacity in the US, or nearly the entire output of 1 medium-size coal-fired power plant. Energy Star also strongly influences markets in the rest of the world, where the same changes will save nearly 4 medium-size coal-fired power plants.

NRDC's web research into publicly available high-efficiency designs[3], as well as conversations with industry stakeholders indicate that the cost of improving efficiency from Energy Star 5 to NRDC's proposed efficiency levels for Energy Star 6 are the following:

Internal Power Supplies (multi-output):

Multi-output IPS	**Incremental BOM cost**
200W, same topology, synchronous output rectification	$0.80
400W, LLC topology	$2.00
Market weighted average	**$1.72**

External Power Supplies:

EPS	Incremental BOM cost
65W, 19V, no power factor correction	$0.15
90+W, 19V, with power factor correction	$0.45
Market weighted average	**$0.30**

These are incremental Bill of Material (BOM) costs per power supply, at volumes equivalent to Energy Star's market share.

Incremental BOM costs need to be marked up to account for assembly and distribution along the industry's supply-chain. We used a markup factor of 1.625 per DOE's Battery Charger and External Power Supply Technical Support Document.

The table below shows that the break-even periods for these efficiency improvements are significantly less than the life of the products:

	Average incremental BOM Cost	BOM Markup	Annual Savings	Product life (yrs)	**Breakeven (yrs)**
IPS	$1.72	1.625	$0.87	4-5	**3.2**
EPS	$0.30	1.625	$0.37	3	**1.3**

The proposed levels are therefore cost-effective from a user's perspective.

[3] http://www.powerint.com/design-support/reference-designs/design-examples; 87% EPS: DER-197; 89% EPS: DER-243; IPS costs per discussion with a power supply designer.

NRDC also investigated industry's concerns about size, weight and heat. We found that the proposed efficiency levels would not increase power supply size, weight or heat, and may actually enable to reduce them:

- Heat will be reduced due to lower energy waste, This will require smaller and lighter heat sinks.
- While higher efficiency may require slightly larger transformers in some designs, as well as an increase in the number of components, this is expected to be compensated by the reduction in size of heat sinks, and result in a constant or reduced form factor and overall weight.

In summary, NRDC strongly recommends that Energy Star 6 raises IPS efficiency to Silver and EPS efficiency to an average of 89%. These efficiency levels will result in significant energy savings and are cost effective for the user. Technology that meets these levels already exists with significant deployment in the market. Energy Star has a critical role to play in scaling user adoption and driving innovation so that this technology becomes affordable for the rest of the market to adopt over the coming years.

Integrated Display

The display panels of notebooks and integrated desktops account for approximately 35% of PC energy use (EPA's 03/10/2011 presentation) and are not covered by either the Computer or Display Energy Star specifications. Given that they are an integral part of the computer, including them in the computer specification would help create incentives for system-level energy efficiency in notebooks and integrated desktops. During the March 10 presentation, EPA outlined an approach using a standard allowance based on display size, per the Energy Star Display specification. NRDC supports this approach.

Industry stakeholders indicated that some display technologies use more energy than others because of higher image quality. It is not clear at this time which technologies are concerned, what incremental user value they provide and how much additional energy they really need. NRDC cautions against adding too many allowances which increase the complexity of the spec and the risk of reducing its effectiveness by making it too easy to qualify. For example an overly generous allowance for displays could make it easier to qualify mediocre efficiency notebooks.

The objective of including the display energy in the computer TEC is to encourage the deployment of the most efficient technologies, for example by encouraging LED backlighting over CCFL. This objective must apply to all technologies.

Battery Charger System (BCS) Efficiency

The Energy Star test procedure for computers only measures notebook energy consumption while the notebook is plugged into AC power. It does not measure energy consumption due to battery charging losses during mobile use.

NRDC analysis of test data by Ecos for PG&E, as detailed in Appendix A, shows that charging losses represent 6% to 10% or more of notebook typical energy consumption (TEC), and these energy losses are unaccounted for by the current Energy Star specification for computers.

Charging energy losses vary depending on how often the notebook is used on battery and recharged as shows below:

	Charges per week	Battery Charging Losses (% E* TEC)
Heavy mobile user	10	15.3%
Medium mobile user	7	10.7%
Low mobile user	4	6.1%
Desktop replacement user	1	1.5%

We are not aware of recent notebook mobile usage pattern studies, but we believe that 4 to 7 charges per week represent typical notebook use including business professionals either traveling or taking their notebook to meeting rooms, students using their notebook at lectures and in coffee shops, and home users using their notebook around their home. 4 to 7 charges per week correspond to charging energy losses of 6% to 10% of Energy Star TEC. These conclusions are tentative due to limited test data set. Additional test data, particularly for notebooks of higher power, is required to confirm them.

Notebooks have become very efficient in active mode due to battery life being an important driver in the notebook market, however this incentive does not apply to charge control circuitry. The coverage of charging efficiency by Energy Star is important to incentivize the industry to reduce energy losses during charging.

This can be achieved either by requiring that Energy Star notebooks meet the Energy Star for Battery Charger System requirements, or by including efficiency requirements directly in the Energy Star computer specification.

NRDC recommends including efficiency requirements directly in the Energy Star computer specification because it allows to set requirements which are targeted specifically at notebook technology rather than at generic battery charger systems which cover a broad range of products, many of them low-tech and low-cost products, with battery chemistries different from that of notebooks.

It is important to note that notebook BCS energy is one of the largest energy consumers amongst all consumer BCSs, accounting for approximately 25% of all BCS energy use per DOE's preliminary technical analysis. It is important to set effective levels for notebook BCS efficiency in order to capture this energy saving opportunity.

Neither option requires an incremental testing burden, as BCS testing of every notebook on the market will already be required by the federal standard currently being developed by DOE.

In order to set effective levels for BCS, it is important to have a representative data set for BCS efficiency of notebooks currently on the market. NRDC recommends that EPA requests representative notebook BCS test data either from manufacturers or from an independent third-party laboratory.

This data should be provided using the standard BCS test procedure, and include the following additional information for each test unit:

- Battery energy
- Charge time

- Idle and sleep power per the standard computer test procedure.

This information will help more accurately assess charging losses in the context of the overall notebook energy use and help inform decision-making on this specification.

TEC Levels

Some of the PCs currently qualified Energy Star use 2 to 4 times as much energy as the best energy performers in their category: the chart below shows the ratio between the lowest-in-category energy user and the Energy Star category level:

		Lowest in Category		Energy Star	
	Category	**Model**	**TEC (kWh)**	**Category level* (kWh)**	**Ratio**
Desktop	A	CompuLab Ltd. fit-PC2 XP HD	34.7	148	427%
	B	Apple Mac mini, 2.26GHz	47.7	175	367%
	C	ASUS EB1012P	76.8	209	272%
	D	Lenovo YANGTIAN S300	85.2	234	275%
Laptop	A	Sony VGN-P610/Q	12.0	40	333%
	B	Packard Bell Easynote NJ65	23.5	53	226%
	C	ASUS K52	36.7	88.5	241%

(*) Without adders

We recommend considering a combination of tightening levels and revising product categorization to ensure that customers can rely on Energy Star to identify the best energy performers in each computer segment.

Conclusion

NRDC commends EPA for initiating the revision of the computer specification which covers some of the highest electricity using devices in both the residential and commercial sectors.

NRDC's analysis shows that there are significant and cost-effective energy saving opportunities in both desktop and notebook computers. Energy Star is an important tool to help the market shift towards these higher energy efficiency devices.

Computers are the largest electricity end use among electronic devices in the US and the computer market is continuing to grow at over 10% per year. Capturing energy saving opportunities in computers is critical to support the shift towards a low-carbon society and to reduce mercury emissions and other pollutants from power generation.

We look forward to collaborating with EPA and other stakeholders to develop an effective version 6 of Energy Star for computers.

Appendix A - Battery Charging Energy Analysis

We used test data by Ecos for PG&E of 1 notebook and 2 netbooks:

ID	Type	24h Efficiency (%)	Maintenance Power (W)	No Battery Power (W)	Charge time (hrs)	Battery Capacity (Wh)
BC284	Laptop	69%	0.38	0.27	2.02	52.49
BC286	Netbook	55%	0.55	0.2	2.09	26.89
BC297	Netbook	44%	0.89	0.2	1.87	23.08

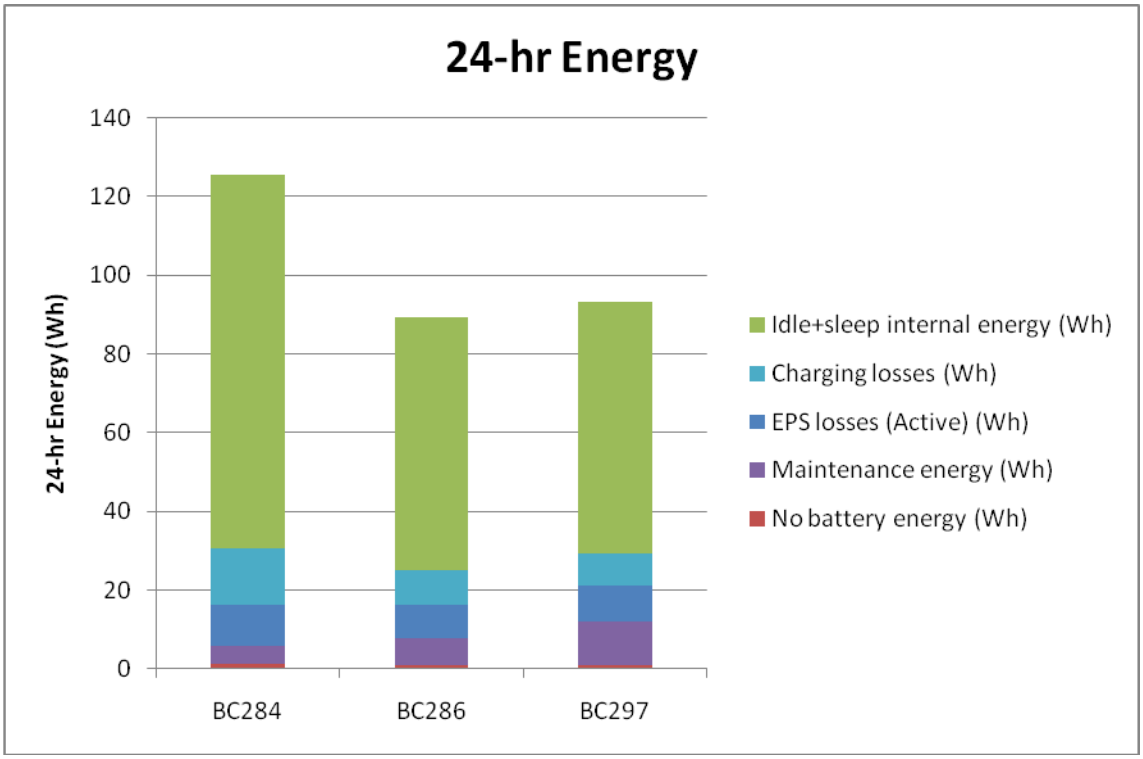
We used the current Energy Star duty cycle for notebooks and added one full charge/discharge cycle per day as follows.

24hr duty cycle	Time	Description
Charge	2.0	Start with empty battery per BCS test procedure, notebook charges to full while Off.
Maintenance	12.4	Notebook Off (battery maintenance mode).
Sleep	2.4	Notebook in Sleep. Total sleep time per Energy Star duty cycle.
Idle on AC	3.2	Notebook Active on AC power. Total AC + battery idle time per Energy Star duty cycle.
Idle on battery	4.0	Notebook Active on battery, till the battery drains completely, notebook returned to initial state.
Total	**24**	

Using the test data, we disaggregated charge and maintenance losses into charging, maintenance and power supply losses as shown below:

ID	Type	EPS losses (Active) (Wh)	No battery energy (Wh)	Idle+sleep internal energy (Wh)	Maintenance energy (Wh)	Charging losses (Wh)	Charging efficiency (%)	Charging losses (% E* TEC)
BC284	Laptop	10.4	0.7	94.9	5.0	8.9	78%	**12%**
BC286	Netbook	8.6	0.5	64.3	7.2	5.4	75%	**11%**
BC297	Netbook	9.3	0.5	64.3	11.7	4.9	74%	**9%**

This indicates that charging losses represent an additional 9%-12% of the notebook Energy Star typical energy consumption. Energy Star TEC already includes EPS and Maintenance losses, but not charging losses.



These results vary depending on how often the notebook is used on battery and recharged as shown below:

	Charges per week	Battery Charging Losses (% E* TEC)
Heavy mobile user	10	15.3%
Medium mobile user	7	10.7%
Low mobile user	4	6.1%
Desktop replacement user	1	1.5%

These conclusions are tentative due to limited test data set. Additional test data, particularly for notebooks of higher power, is required to confirm them.