NRDC
NATURAL RESOURCES DEFENSE COUNCIL

February 24, 2017

Mr. Ryan Fogle
United States Environmental Protection Agency
ENERGY STAR Program
1200 Pennsylvania Ave NW
Washington, DC 20460

Subject: NRDC comments regarding ENERGY STAR Computer Program Discussion Guide Version 7.0

Dear Mr. Fogle,

On behalf of the Natural Resources Defense Council (NRDC), and our more than 1.3 million members and online activists, we respectfully submit the following comments in regards to the ENERGY STAR Computer Program Discussion Guide Version 7.0, January 27, 2017.

NRDC has been an active participant in the development of ENERGY STAR specifications for computers for over a decade. Computers are the second largest electricity end-use among electronic devices after televisions, putting them roughly on par with the energy use of all data centers in the United States. Large and cost-effective energy saving opportunities remain, particularly in desktops but also in notebooks as demonstrated in NRDC's 2016 study "Slashing Energy Use in Computers and Monitors While Protecting Our Wallets, Health, and Planet".[1] As such, energy efficiency in computers is an important opportunity to save American consumers and businesses money on their utility bills, make America's economy more competitive, support job growth, all while reducing greenhouse gas emissions.

NRDC commends EPA for launching the revision of the ENERGY STAR specification for computers. Computer technology has evolved considerably since the version 6 specification was finalized in 2013 based on a data set covering products launched between 2010 and 2012, leading to a large share of the market achieving ENERGY STAR levels in 2017. In fact the California Energy Commission's (CEC) recently adopting mandatory efficiency standards are even more stringent than the levels contained in the voluntary ENERGY STAR version 6.1, which was intended to cover only the top 25 percent of the market when it went into effect.

[1] Delforge P., July 2016, https://www.nrdc.org/resources/slashing-energy-use-computers-and-monitors-while-protecting-our-wallets-health-and-planet

We appreciate the opportunity to provide input into the ENERGY STAR process and offer the following comments for EPA's consideration.

Summary

Our comments cover the following areas:

1. Test procedure: real-world energy use - The ENERGY STAR v6 test procedure is no longer representative of real-world energy use because: a) the idle state as defined by ENERGY STAR is no longer an adequate proxy for real-world idle and light active use, and b) because the test procedure does not capture the brightness of laptop and all-in-one displays as they are shipped. As such, the test procedure will result in dramatic under reporting of actual computer energy use levels and ENERGY STAR-labelled models may not produce the expected energy savings during real-world energy use. This situation is expected to get worse, particularly with the deployment of low-power active modes such as "modern standby", which could make the test procedure obsolete before a replacement is available. It is therefore urgent to evolve the test procedure and include a test and list requirement for active mode in version 7 in order to enable version 8 requirements to be based on data collected using the revised test method.

2. Performance metric - The performance metric used in version 6 ("p-score") needs to evolve to better correlate with typical energy use and avoid products shifting toward higher categories over the life of the specification. ENERGY STAR has an important role to play in policy innovation, so that other policy processes such as California, the European Union's Ecodesign, and others can harmonize with ENERGY STAR rather than try to address the limitations in ENERGY STAR's framework themselves. The latter would likely result in less rather than more harmonization. While we appreciate EPA's intent to complete the update as soon as possible, we encourage ENERGY STAR to address the highest priority issues and opportunities in this specification rather than wait until the next revision which would take at a minimum two years and possibly longer.

3. Power supply low-load efficiency – The current power supply efficiency requirements in ENERGY STAR v6 are important but need to be revised to reflect the evolution of computer technology, and particularly the fact that under ENERGY STAR v7 and the new California standards, idle state may correspond to power supply loads as low as 1 to 3 percent in high-expandability computers, much lower than the lowest test point of 20 percent in ENERGY STAR v6. As such a low-load test point needs to be included in the test method and this test point added to ENERGY STAR power supply efficiency requirements.

4. Power management – NRDC supports EPA's efforts to encourage the use of power management, but recognizes that this is a challenging problem with no simple solution. While it is important to continue to pursue this opportunity, reducing power in all modes remains the surest way to reducing computer energy consumption.

5. Duty cycle and mode weighting – NRDC supports EPA's efforts to update the mode weightings used in the annual energy use metrics to be representative of modern computer technology and use.

Detailed Comments

1. Evolving the test procedure to better represent real-world energy use - We urge EPA to address two major issues in the Version 6 test procedure, a more representative real-world idle and display brightness for all-in-ones and notebooks, in version 7, and not wait for version 8.

The ENERGY STAR v6 test procedure is no longer representative of real-world energy use, because of two main issues:

a) Idle state as defined by ENERGY STAR v6 is no longer an adequate proxy for real-world idle and light active use; and
b) The test procedure does not capture display brightness for notebooks and all-in-one desktop computers as shipped.

a) Idle state as defined by ENERGY STAR v6 is no longer an adequate proxy for real-world idle and light active use

Testing by the California Investor-Owned Utilities (CA IOUs) illustrates the difference in power demand between active use and ENERGY STAR idle state. Figure 1 shows a 2014 Apple MacBook computer drawing 5 watts in ENERGY STAR short idle state, and an average of 12.5 watts in light active state (including web browsing and media streaming). This is a 2.5x difference.

Figure 1 – Sample Light Active Mode Power Profile, CA IOU Testing 2014[2]

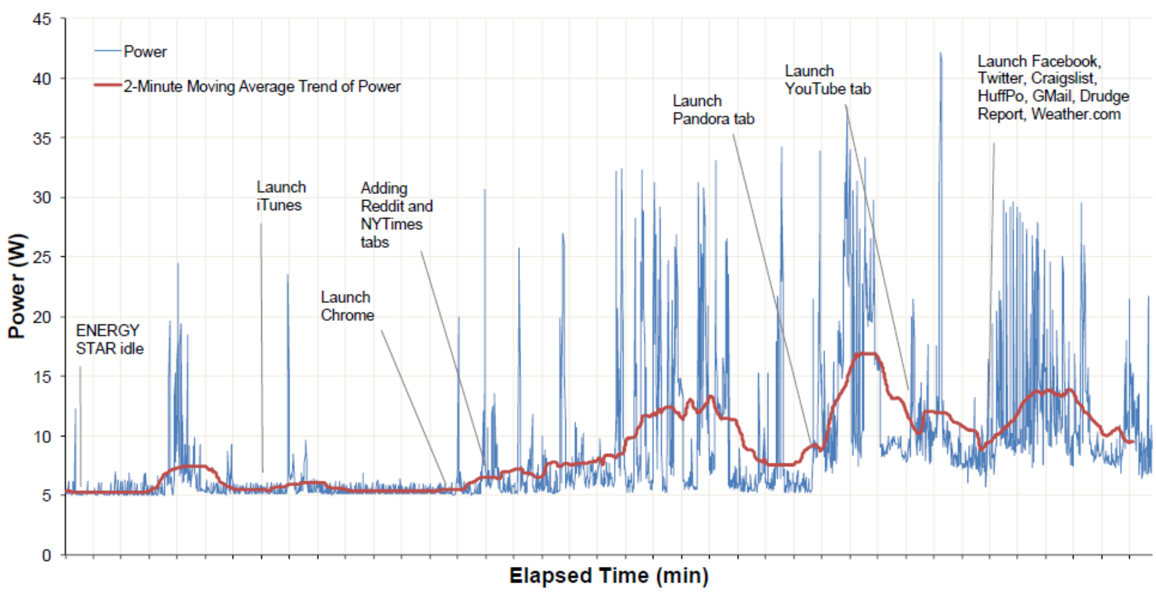
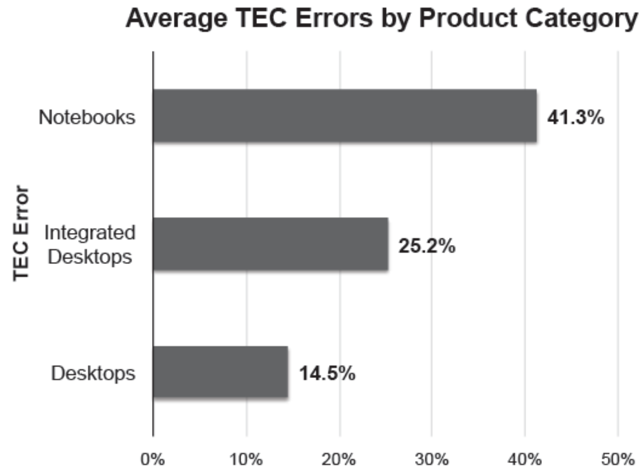


Figure 2 shows that the difference between light active mode and ENERGY STAR idle ranges from 14.5 percent on a sample of 2014 desktop computers to more than 40 percent on a sample of 2014 notebook computers.

[2] http://docketpublic.energy.ca.gov/PublicDocuments/14-AAER-02/TN211731_20160606T163325_California_Investor_Owned_Utilities_Comments_California_Investo.pdf

Figure 2 – Discrepancy between ENERGY STAR Idle and Light Active Mode, CA IOU Testing 2014



It is important to note that this testing was performed in 2014. The differences highlighted in Figures 1 & 2 have likely increased over the past 3 years and are expected to continue to increase by the time version 8 goes into effect, which is at least not until 2020 and probably later, if this issue is not addressed in version 7.

This issue will also get worse with the deployment of new low-power active modes such as "modern standby", where power demand in long idle as defined by ENERGY STAR, and perhaps even short idle, may be dramatically reduced, but this behavior may not occur in real-world idle with windows open and programs running in the background, or in light active mode where dramatic power reductions are also possible using the concept of "sleep between keystrokes" coined by Apple (technically using very low-power C-states of modern CPUs).

Also, continuing to use the current test procedure when modern standby has been broadly deployed in the market would result in very low idle power measurements, which would bear no relation with real-world energy use. This could make the test procedure obsolete before a replacement is available.

Recommendation regarding real-world idle and light active mode:

Idle state is currently defined by ENERGY STAR as the state the computer is in after booting, with no windows open and no applications running. This is a very different state from typical computer use in the real world where applications are loaded and windows open, e.g. multiple browser tabs, email, office productivity software etc., whether users are actively interacting with the computer or not. We propose to characterize real-world idle and active use through the following three modes:

i. **Real-world idle**: The user is not actively interacting with the computer, either because they are away from their desk but the computer is still on, or they are at their desk doing something else. Computers left idle in real-world use almost always have applications loaded and windows open, e.g. multiple browser tabs, email, office productivity software etc. Each of these programs perform a variety of background data and graphic processing work, network communication and disk access, even though the user is not actively interacting with the computer.

ii. **Light active:** users are actively interacting with their computer, performing tasks which require little additional processing beyond real-world idle, such as reading information, occasionally scrolling and navigating through web pages, writing content, and even streaming media content. These activities require little processing power compared to gaming and digital content editing.

iii. **Heavy active**: Gaming, digital content editing, and other computing activities that consume a significant share of the computer's processing resources.

We recommend ENERGY STAR adds the real-world idle and light active modes to the test procedure. We do not recommend adding heavy active at this point because it represents a smaller share of energy use on non-gaming computers, and because it is more challenging to measure in a repeatable and representative manner. Existing modes of short idle, long idle, sleep and off should be retained for backward compatibility.

The two new states, **real-world idle** and **light active mode**, would be tested using a content-driven browser-based benchmark. The benchmark would ensure repeatability (same content over time and across all computers). The content-driven approach would ensure platform independent and neutrality, by avoiding the use of compiled code that can be optimized differently on different platforms. This approach is widely used in the mobile phone industry to benchmark battery life, and it would avoid the pitfalls that doomed the BAPCO-approach attempted for ENERGY STAR v5.

We recommend that EPA and DOE actively support the initiative currently being convened by the Canadian Standards Association to develop such a benchmark for computers.

While the development and validation of this test method may require a little more time than the current version 7 schedule plans for, we believe that with adequate support the benchmark can be developed by end 2017, which should work with a slightly extended ENERGY STAR computer specification development schedule, given that the two new test modes would only be used for reporting power levels, not for inclusion in the typical energy consumption levels.

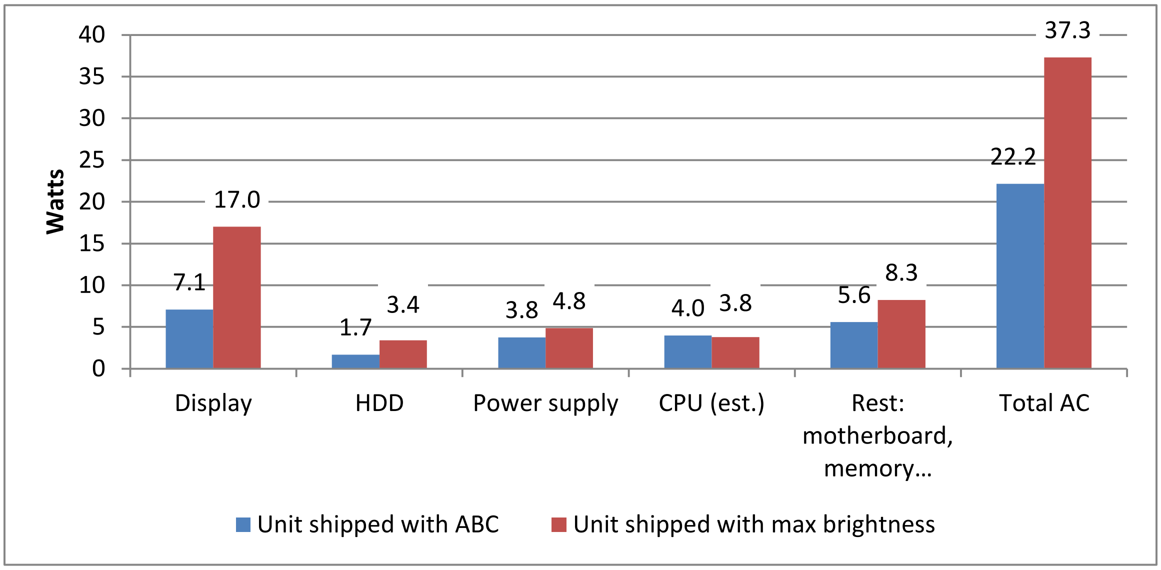
b) The test procedure does not capture display brightness for notebooks and all-in-one desktop computers as shipped.

The second significant issue in the test procedure is about display brightness. The v6 test procedure requires that the displays of all-in-one and notebook computers be calibrated to a fixed brightness prior to testing. The problem is that display brightness has a large impact on power use, and if the brightness setting is not changed by the user, shipping with maximum brightness may result in a much higher energy use as experienced by the user than as measured by ENERGY STAR.

As part of the CEC rulemaking, NRDC and Aggios tested two all-in-one computers with comparable specifications (21.5-inch displays with same resolution and both using IPS technology, and similar computing performance).[3] Both displays were responsible for a large share of system idle power demand (40 and 50 percent). However, one display was shipped with auto-brightness control (ABC) enabled, while the other was shipped with maximum brightness settings. The latter drew 2.4x the power of the former and was responsible for the majority of the difference in short idle power demand between the two computers as shown in Figure 3.

This difference was not captured by the test procedure because both computers were recalibrated and tested at the same brightness. Not only is this not representative of real-world energy use, but it also fails to reward units shipped with ABC enabled and to penalize units shipped with max brightness.

Figure 3 – Impact of Display Brightness on System Idle Power Demand



Recommendation regarding display brightness: One approach would be to test as shipped, with a minimum to avoid an incentive to ship with very low brightness just to qualify for ENERGY STAR.

If ABC is enabled as shipped, and is sufficiently persistent (does not get disabled through unrelated settings changes, per the TV test procedure), it should remain enabled and be tested in realistic lighting conditions to be defined.

[3] http://docketpublic.energy.ca.gov/PublicDocuments/14-AAER-02/TN211601_20160523T103613_Pierre_Delforge_Comments_AggiosNRDC_AllInOne_Computer_Idle_Powe.pdf

2. Performance metric - We encourage EPA to adopt a revised performance metric that better correlates with power demand in idle mode and that ensures stability in category boundaries over time

The performance metric is a critical component of a performance-based specification: it allows setting differentiated power levels for computers of significantly different performance capability (in terms of processing, graphics, disk access, networking, and screen size and resolution), ensuring that ENERGY STAR recognizes the most efficient computers irrespective of their performance capability. A performance metric can be used either to define discrete performance categories, as in ENERGY STAR version 6, or to create a normalized energy by performance capability metric which would allow a single level to be set across all computers.

The version 6 specification uses "P-score" (the product of the number of cores by processor frequency) as the basis for performance categories. While this metric was an improvement over the ENERGY STAR version 5 attribute-based categorization approach, it has significant limitations which led the California Energy Commission to adopt a different approach. The two main limitations of P-score are:

1. P-score doesn't correlate very well with power demand in idle state: modern processors can scale power down to very low levels (1 watt or less) irrespective of frequency and number of cores, which means these two features are not good predictors of idle power. In addition there are many factors other than processor frequency and number of cores that influence idle power demand, such as expandability (linked to power supply size and therefore load point in idle state), motherboard expandability and performance, etc. While there is some correlation between processor performance and these other factors, this correlation isn't very strong, leading to a sub-optimal categorization of products, and making it difficult to set leadership levels that do not exclude efficient products.
2. P-score evolves rapidly, resulting in a rapid shift of products toward higher categories over the life of the specification. Each step increase in the number of processor cores results in large increases in p-score, allowing entry-level or mainstream machines to move to high-end categories they do not belong to.

The California Energy Commission's approach uses an expandability score that represents the ability for a computer to support expansion devices such as graphics cards and USB devices. This expandability score correlates better with power demand in idle, because two of the key factors that influence power demand in idle are:

1. **Power supply size**: the more expandable a computer, the more manufacturers have to oversize the power supply in order to power not just the base computer itself but also potential expansion devices. This oversizing means the computer power demand in idle state is a lower fraction of the power supply maximum power (as low as 1 to 3 percent for high expandability computers), where power supply efficiency is typically 30 to 60 percent.
2. **Motherboard expansion interfaces** themselves which draw some level power in idle state, even when power managed.

While this expandability approach is more accurate, it is also more complex because it requires a lot of information for each computer, and EPA does not have all the required information in its current dataset.

We provide below a list of performance metric options with our initial assessment for EPA's considerations:

Option	Pros	Cons
1. p-score (as in v6)	• Simple, data available	• Poor correlation, category creep
2. Expandability score (as in CEC standards)	• Good correlation	• Complex
3. Power supply size	• Good correlation, simple	• Upsizing incentive, although limited by extra cost of higher-power PSUs (power supplies)
4. Power supply size + number of PCIe lanes supported by the CPU	• Good correlation, simple, better control of upsizing incentive	• PCIe lanes only apply to desktops. Perhaps use only PSU size for notebooks
5. Performance benchmark, scaled to a zero to 100 range to avoid exponential growth	• Potentially better measure of performance capability • Scaling would avoid category creep	• Benchmarks are controversial as they are not technology neutral
6. Thermal Design Power (TDP)	• Good correlation	• Not technology neutral (e.g. Intel/AMD)

NRDC believes the simplified expandability score based on power supply size and PCIe lane supported by the processor offers the most promise, but we are open to other approaches and we encourage EPA to consider all these and potentially other options.

ENERGY STAR leadership fosters international harmonization – ENERGY STAR has an important role to play in policy innovation, so that other policy processes such as California, the European Union's Ecodesign, and others can harmonize with ENERGY STAR rather than need to address the limitations in ENERGY STAR's framework themselves. The latter situation would likely result in less rather than more harmonization. While we appreciate EPA's intent to complete the revision as soon as possible, we encourage ENERGY STAR to revise the performance metric in this specification rather than wait until the next revision which would take at a minimum two years and possibly longer.

3. Power supply low-load efficiency – The current power supply efficiency requirements in ENERGY STAR v6 are important but need to be revised to include low load efficiency requirements in partnership with the 80-PLUS program

Power supply efficiency requirements are a critical piece of ENERGY STAR for the following reasons:

1. **Large energy use and savings opportunity:** Power supplies remain one of the components that use the most energy in a computer (more than half at low load as illustrated below);
2. **Market transformation:** PSU efficiency requirements provide an incentive for efficiency innovation in power supplies, laying the groundwork for market transformation and energy savings across all computers. Transformation of a commodity market like power supplies requires a large volume of sales, which ENERGY STAR and 80-PLUS together can provide; and
3. **Persistence of energy savings:** after the specification has come into effect, and once many computers can meet ENERGY STAR requirements due to technology evolution, power supply requirements continue to provide savings by ensuring that ENERGY STAR computers still use efficient power supplies even if they don't need to in order to achieve ENERGY STAR levels.

While the above applies to both internal (desktop) power supplies (IPS) and external (notebooks and some low-expandability desktops) power supplies (EPS), this is particularly important for IPS which are not regulated and are lagging far behind EPS and even server IPS in efficiency.

However, ENERGY STAR v6 PSU requirements need to be revised to include low load efficiency requirements. The current 20%, 50%, and 100% (of maximum rated capacity) test points are useful for high intensity active mode (at least some of them, perhaps not the 100% point), but they do not cover **light active and idle modes** where typical non-gaming computers spend the vast majority of their time and that are responsible for the majority of computer energy use. In addition, efficiency at low load can drop dramatically. Idle state will correspond to load points as low as **1 to 3 percent** in high-expandability computers, under the upcoming CEC standards and presumably ENERGY STAR v7. 80-PLUS measurements taken in support of the CEC rulemaking shows a range of efficiencies of **27 to 53 percent** at 1% load, and **50 to 83 percent** at 3% load. This large range of efficiencies indicates a large improvement potential at low load. The fact that this savings opportunity has not been captured naturally by the market absent efficiency requirements reinforces the importance of power supply efficiency requirements in ENERGY STAR.

Recommendation: Version 6 already provided incentives for 80-PLUS Silver/Gold and 10% load efficiency. We recommend that EPA make these requirements mandatory and works with the 80-PLUS program and stakeholders to define low-load efficiency requirements that are appropriate for computers that will need to achieve the version 7 and California idle levels

4. Power management – NRDC supports EPA's efforts to encourage the use of power management and to update the mode weightings used in the annual energy use metrics

A computer that uses power management to switch off the display and eventually power down to sleep or off mode after an extended period of user inactivity uses roughly one third of the energy of a computer that stays on 24/7. Yet, studies show that a majority of computers continue to have their power management functions disabled. We strongly support EPA's continued focus on finding solutions to encourage power management to remain enabled. Yet, we recognize that this is a complex issue whose solution remains elusive after more than a decade of efforts by EPA, industry, and stakeholders.

There appears to be a variety of factors causing the continued high rate of computers not to use power management, including:

- Lack of awareness or motivation by users and IT department of the energy saving benefits of power management.
- User inconvenience caused by poor implementation of power management by some applications which cause users to disable power management. For example (real-world example observed many times), when the media player does not temporarily deactivate power management and let the display switch off or the computer auto power down to sleep in the middle of streaming a video, this understandably leads users to manually disable power management. Once they've done this once, they are unlikely to reactivate it later on.
- Long reactivation times: some computers, particularly older computers, tend to take a long time to reactivate from sleep mode, frustrating users.
- Operational issues when waking from sleep: for example some computers (including the author's computer) occasionally lose Wi-Fi connectivity when waking from sleep, requiring a time-consuming connection repair procedure that many users would not know about or have the patience for.
- Software programs that deactivate power management (with good reason per the above video streaming example), but do not reactivate it once the video is finished.
- Operating system issues (bugs) that prevent computers from going to sleep even when power management settings are enabled. The author has experienced this issue on multiple computers and operating systems, including his current one using Windows 8.

These issues are difficult to resolve through ENERGY STAR specification incentives, they require a combination of actions by computer manufacturers, operating system developers, and application developers. Most of these actions are difficult to verify through testing because many issues tend to develop over the life of the computers rather than out of the box. **We recommend EPA facilitates a research project with industry and stakeholders to better understand the root causes of this issue and determine strategies for action which may be within or outside of the ENERGY STAR realm.**

In the meantime, the surest strategy to reduce computer energy use is to continue to drive down power in all modes, but particularly in idle and light active modes. This approach saves energy whether power management is used or not. It is also technically feasible and already broadly used on mobile devices such as tablets and phones. Continuing to reduce idle power levels may also be an effective incentive for industry to deploy "modern standby" and to implement very low-power active states (e.g. “sleep between keystrokes”, technically deep CPU sleep states such as C8 and C10).

5. Duty cycle and mode weighting – NRDC supports EPA’s efforts to update the mode weightings used in the annual energy use metrics to be representative of modern computer technology and use

The mode weightings currently used in version 6 are based on a single 2008 study. Computers and their uses have evolved dramatically since then, in ways which could significantly impact the duty cycle. We support EPA’s intent to update the duty cycle to be representative of modern technology and use.

We would like to point EPA to the following data sources:

1. The duty cycle meta study submitted by the California IOUs during the Version 6 specification development process
2. The 2014 UC Irvine study which found that office desktop computers are turned on as much as 77 percent of the time each day; and they are inactive 61 percent of that time.[4]

Thank you for the opportunity to participate in this specification development process and for your consideration of our comments.

Sincerely,

Pierre Delforge
Director, High Tech Sector Energy Efficiency
Natural Resources Defense Council

[4] https://www.nrdc.org/experts/pierre-delforge/new-study-reveals-computer-insomnia-and-higher-energy-costs-and-pollution