DOCKETED

Docket Number:	14-AAER-02
Project Title:	Computer, Computer Monitors, and Electronic Displays
TN #:	205825
Document Title:	ITI & Technet Comments: Re June 1st Aggios Submission
Description:	Comments on Aggios' Desktop Computer Study
Filer:	System
Organization:	Information Technology Industry Council/Chris Hankin
Submitter Role:	Public
Submission Date:	8/25/2015 12:58:52 PM
Docketed Date:	8/25/2015

Comment Received From: Chris Hankin, Information Technology Industry Council
Submitted On: 8/25/2015
Docket Number: 14-AAER-02

ITI & Technet Comments: Re June 1st Aggios Submission

Additional submitted attachment is included below.

CEC Draft Computer Standards (Docket #14-AAER-2)

2014 Appliance Efficiency Pre-Rulemaking

ITI/TechNet Comments on Aggios' Desktop Computer Study
Date: August 25, 2015

Authors.

The Information Technology Industry Council ("ITI"; http://www.itic.org) and the Technology Network ("TechNet"; http://www.technet.org).
The contacts for our organizations are: Christopher Hankin, 202-626-5753, chankin@itic.org and Andrea Deveau, (805) 234-5481, adeveau@technet.org

I. Brief Overview.

This paper is in response to the Aggios paper titled "Desktop Computer Optimization Analysis and Demonstration Project" and submitted on June 1, 2015. Aggios' paper had claimed "*idle-state power savings on the analyzed desktops of 61% and 54% relative to out of the box configurations through software configuration changes and power supply replacement.*" Industry's analysis and actual measurements refute many of Aggios' claims. While the software optimization provides an opportunity to disable features in idle to reduce power, such opportunities are limited in HVM environment across a very broad desktop ecosystem for reasons outlined in this response. Aggios stated the highest power saving opportunity was to enable CPU package C-states. This feature is already recommended by Intel to be enabled for all shipping systems. Hence such savings are already being realized by system makers who have enabled such power savings.

II. Key Findings.

- **MSI Eco Power board & software**
  - While the MSI Eco Center Pro software provides an opportunity to disable certain features in idle to reduce power, in reality the power savings are not significant for most of the listed features.
  - This is an example of best in class board for power consumption, not reflective of broad desktop ecosystem market realities.
  - The software settings are not unique. However, access to these settings in the OS could only be expected to be used safely by a small fraction of end-users with thorough understanding of computer platforms and trade-offs, and is neither advisable nor cost effective for the majority of computer users in California.
  - There is an unintended consequence of doing more harm to the energy efficiency effort and to users' computer systems, if the settings are not properly managed by less sophisticated end-users. This can easily offset the potential minimal energy savings benefit achieved by a small number of sophisticated end-users.

- **Aggios Testing Procedure**
  - Aggios deviated from ENERGY STAR 6.1 test procedures and did not differentiate between short idle and long idle modes.

- **TEC Calculations**
  - Most of Aggios data were used to the extent possible to perform actual TEC calculations. When there were gaps in data, Industry performed actual measurement to complete the calculation.
  - None of the Aggios systems meet the proposed CEC Desktop TEC targets, even with using the very questionable Pico PSU.

    - Even with the use of very high efficient 80 Plus Platinum power supply on these systems, the proposed CEC TEC targets could not be met.

- **Power Supply Cost**
    - The power supplies used in these examples have a very high cost adder when compared to a normal 80 Plus Bronze power supply.

- **Hard Disk Drive Spin Down**
    - With Windows hard drive spin down time set to 1 minute the hard drive does not stay in a spun down condition for very long.
    - The spin up power is pretty significant and must be considered as part of the overall power consumption of a hard drive.

- **Pico PSU Concerns**
    - The Pico PSU used by Aggios has serious quality issues for it to be considered as a viable replacement for an internal desktop power supply.
    - The Pico PSU is undersized for the system it was used with. A power budget is provided for system DT1a to show the reason and value for an appropriately sized power supply.

III. Discussion.

Table 1: Aggios' system configurations and setup (from report)

	DT1a	DT1b	DT2
	Aggios built systems		Preconfigured OEM system
Processor	Intel Core i5-4690K	Intel Core i5-4690K	Intel Core i5-4690S
Motherboard	MSI* ECO H97M	Asus Z07 Pro (Wi-Fi AC)	HP ProDesk 400 G1 MT
Memory	8GB Total - 2 sticks of 4 GB each, DDR3 1600, Ballistix*	8GB Total - 2 sticks of 4 GB each, DDR3 1600, Ballistix*	4GB Total - 2 sticks of 2 GB each, DDR3 1600, Hynix*
Hard Drive	WD* Blue 1TB	WD* Blue 1TB	Seagate Barracuda1TB
Optical Drive	HP* DVD Burner (SH-216DB/HPTHF)	HP* DVD Burner (SH-216DB/HPTHF)	HP* DVD Burner (SH-216DB/HPTHF)
Power Supply	Seasonic* 400W Fanless (80+ Platinum)	Seasonic* 400W Fanless (80+ Platinum)	HP* 300W (no 80+ rating)

MSI ECO Center Pro Software

System DT1a in the Aggios paper used an MSI motherboard that has a software program that allows a user to change the state of the devices on the motherboard. This software is unique, because these settings can be changed inside an operating system. After any setting is changed a system reboot is required.

Comments and observations on SW and settings: The settings are normally user accessible inside a BIOS setup screen. There is nothing unique about the settings themselves. Not all of these settings are end-user available in all BIOS screens because the end user could inadvertently alter the operation of a computer by changing the wrong settings.

Typically, advanced users are the ones that are expected to change these settings. These settings are normally turned on to enable the max power savings in the default mode. ECO Power screen allows the user to turn on and off different sub components in the system. Turning on and off of these devices requires advanced computer knowledge and a common end-user is not expected to change any default system settings.

All of the features listed on the ECO Power page have a purpose to enable a minimal amount of power to perform that function. However, the overall power saving is not significant. These features are normally powered ‘on’ to perform their function.

- CPU Fan
  - Cooling of the processor is <u>very</u> important for product safety and its lifecycle. If the processor operates above its stated thermal specification, the life the product will be shortened, or worse, it will not operate.
  - All computers currently come with some fan speed control, which factors in the processor temperature, chipset/board temp, and other system components to control the fan speed. Changing the settings of the CPU fan could have an adverse effect on cooling of other parts in the computer. The CPU fan usually cools more than just the CPU and system designers spend engineering time and resources to optimize these settings to cool multiple components around the CPU. Turning off the CPU fan is an option for some

systems but not all. With Fan Speed Control used in computers the fan is set to the lowest RPM allowed by that specific fan.

- System Fan
    - The system and CPU fans work together to cool all the components in the computer chassis. The above comments about the CPU Fan apply here for the system fan as well, in that the fan speed control is tuned in every computer today. Turning off the system fan is an option for some systems but not all. A complete understanding of system thermal profile is needed to turn off any fan in the system (only expected of a sophisticated end-user).
    - This software only allows system fan 1 header to be turned off, but not the system fan 2 header.

- All LEDs
    - LED energy consumption is very small fraction of the overall desktop computer energy consumption. Most LEDs used on motherboards consume around 60 –100 mW. The energy consumption is so small that any difference in measurement at the AC wall socket is more likely to be within the tolerance levels of run to run variance.

    - HDD LED
        - The purpose of the HDD LED is to let the user know when the HDD is being accessed. If the system is in idle mode the HDD should not be accessed very frequently anyway, so turning this feature off will not lead to significant power savings, while leaving the user with no indication.

    - Power LED
        - The purpose of this LED is to inform the user when the system is on. This is very helpful for the end user to know if the system is actually on. Specifically when the display is off (Long Idle Mode), the power LED informs the user that system is on versus in Sleep or Off mode. This is a needed LED function during Idle mode and should not be turned off.

    - Eco Button LED
        - This LED informs the user when the Eco Mode is turned on.

    - LAN port LED
        - This LED shows activity on the network port and informs the user of live network connection. This is very helpful to the end user to know that the network is working. This LED should not be turned off.

- Audio Ports
    - Most computer users use some media that requires an audio function. The end-users would likely not buy computers without an audio feature. When this feature is turned off there is no audio even when the headphones are connected. End users will be forced to return to this control panel to turn on audio whenever they desire to hear sounds from the computer.

- HDMI, DVI, D-sub(VGA) ports
    - This feature turns off all 3 video port outputs. Video output like audio has become a requirement in a computer, and turning it off, only to be turned on later, does not make sense.

- LAN Port
    - One of the advantages of desktop computers is the 1Gb LAN speeds that can be achieved. This consumes very little energy when not used.

- PCI Slots
    - This will only turn off the legacy PCI Slots, and not the newer PCI-Express slots. . Unused newer PCI-Express slots don't consume as much energy, when not used, as compared to legacy PCI slots.

    - The end-users expect that when a device is plugged into the PCI slot it will work. If the PCI slots are turned off by default then extra BIOS configuration would be required to use them. A very high percentage of end users will not know how to turn this function back on in the BIOS screen resulting in warranty calls and product returns that would very likely have larger energy footprints than the total proposed savings.

Power Management screen allows changes to software settings for built in power management of hardware devices. These settings are usually shipped enabled for the majority of current computers.

Summary: While the MSI Eco Center Pro software provides an opportunity to disable certain features to reduce power, in reality the power savings are not significant for most of the listed features. The proposed approach could possibly benefit a small minority of sophisticated end-users, with thorough understanding of computer platform and trade-offs, but is not practicable for majority of the computer users in California. There is an unintended consequence of doing more harm to the energy efficiency effort and to the computer system itself, if the settings are not properly managed by less sophisticated end-users. This can easily offset the potential minimal energy savings benefit achieved by a small number of sophisticated end-users.

Summary of power savings for these features as measured in an Intel lab and reported in the Aggios Study.

Table 3:

Feature	Aggios Data		Industry measured data	
	AC Power (W)	Power savings (W)	Long Idle (W)	Net Power savings from Base (W)
Base System	22.0	---	20.3	---
HDMI / DVI / D-sub port	20.9	1.1	21.4	-1.1
PCI Slots	20.2	0.7	20.8	-0.5
CPU Fan	--	0.4	20.4	-0.1
LEDs	--	0.1	20.6	-0.3

The base system measurements taken in the lab are lower than the Aggios System base measurement. Any SW based power savings are small enough to be lost within run variance on a Windows based system.

All data from the Industry lab were measured twice and the average of the 2 data points is listed above. All Industry data follows the ENERGY STAR Computers Ver 6.1 test procedure, which includes averaging data over 5 minutes. Long Idle measurement is averaged from 15-20 minutes after user activity is stopped.

The only feature in all of the MSI Eco Center Pro software and Aggios report that makes a significant reduction in system level power is CPU package C-states. This feature is already recommended by Intel to be turned on for all shipping systems.

Aggios Testing Procedure Concerns:

In order to prove that a system meets a TEC based methodology requires following an approved testing procedure to verify if a system meets the proposed TEC limits. If this is not the intent, then the study is merely suggesting recommendations for computer use and not demonstrating whether an actual system can meet the proposed TEC limits.

CEC has stated that they are recommending ENERGY STAR* for Computers Ver 6.1 test procedure.

The testing performed by Aggios shows deviations from the ENERGY STAR for Computers Ver 6.1 Test Procedure. The Aggios paper only mentions idle and does not differentiate between Short Idle and Long Idle modes. From an email conversation with the authors, they stated that all of their testing was done with the display off, which most closely follows the Long Idle mode definition. Also they stated that testing was not performed at the required time intervals for Long Idle and Short Idle modes. Lastly, they documented the changes in Windows to force off background tasks that they thought were not needed or where keeping the system at higher power state then what they wanted. These background tasks were:

- Windows Update
- “RanFullMemoryDiagnostic”

This is not a normal use case. Windows doesn’t work correctly for the end user when background tasks are turned off.

TEC Calculations

Since the ENERGY STAR for Computers Ver 6.1 testing procedure was not followed, some modifications need to be made to Aggios data to correctly calculate the measured TEC of their tested systems. The Industry obtained the same hardware used by Aggios to conduct a study of systems DT1a and DT1b. With this data we were able to come up with the rest of the data this is needed to do a correct TEC Calculation of these systems.

As stated previously, the idle data reported by Aggios is most closely related to Long Idle. For a correct TEC Calculation a Short Idle measurement is needed. Using the Industry data we were able to come up with the difference between Short and Long Idle for these systems. Also, Industry was able to measure a Sleep and Off power. There was no reported data for these power states in the Aggios paper. The TEC Calculation follows the ENERGY STAR for Computers Ver 6.1 equation using Conventional Mode weightings.

Calculations are shown for both versions of the power supplies that Aggios used for these systems. Later, in this paper, there will be a section about the quality of the Pico PSU used in this study. With that in mind, data needs to be looked at for both types of power supplies used in this study. For two of the systems a highly efficient 80 Plus Platinum level power supply was used. This power supply also has a high cost adder. Looking at pricing on Newegg.com on April 15 (when the system was demonstrated at the CEC meeting) this power supply price was $110. A comparable 80 Plus Bronze power supply from the same manufacturer costs ~$40 – a huge cost adder of $70, (almost 3x the cost of the 80 Plus Bronze power supply). The 80 Plus Platinum power supply is already a very high cost, top of the line, very efficient power supply. The Industry Is not surprised by the quality of this efficient power supply.

The Pico PSU also has a cost adder of $60 over the standard 80 Plus Bronze power supply mentioned above.
http://www.mini-box.com/picoPSU-160-XT

- $49.50 for DC-DC converter
- $49.95 for AC-DC Converter (192W)
- $99.45 Total cost

These TEC Calculations use as much of the Aggios' data as we can gather from their own paper. For each example the data is listed as from either Aggios' or the Industry. The Industry data was provided to fill in the necessary gaps of data from the Aggios' paper.

TEC Calculation DT1a

- Aggios data is in black
- Industry data is in blue
- Difference between Short–Long Idle (Display off only) = 2.4 Watts
    - Average of 5 different Short vs. Long Idle tests performed the Industry's lab
    - Short Idle: With 400W Platinum
        - 17.6W = 15.3W + 2.4W
            - 15.3W – from State 5 in Aggios paper
            - 2.4W – Difference between Short-Long Idle
    - Short Idle: With Pico PSU
        - 13.9W = 8.6W + 2.9W + 2.4W
            - 8.6W – State 7 in Aggios paper
            - 2.9W – State 6 savings (HDD Spin Down)
            - 2.4W – difference between Short-Long Idle

Table 4:

	DT1a		Comments
	w/ 400W Platinum	w/ Pico PSU	
Short Idle (W)	17.6	13.9	See breakdown of data above table
Long Idle (W)	12.4	8.6	Aggios' data
Sleep (W)	1.3	1.3	Test performed by Industry
Off (W)	0.6	0.6	Test performed by Industry
TEC Calc (kWh)	73.2	56.9	Using ES V6.1 TEC formula
CEC proposed TEC limit (kWh)	56.4		With memory adder

TEC Calculation DT1b

- Aggios data is in black
- Industry data is in blue
- Difference between Short–Long Idle (Display off only) = 0.7 Watts
    - Average of 2 different Short vs. Long Idle tests performed at the Industry's lab
    - Short Idle: 21.0W = 20.3W + 0.7W
        - 20.3W – "BIOS Setup Optimized" from Aggios paper
        - 0.7W – Difference between Short-Long Idle

Table 5:

	DT1b	Comments
Short Idle (W)	21.0	See breakdown of data above table
Long Idle (W)	16.9	Aggios data – "HDD – off"
Sleep (W)	2.2	Test performed by Industry
Off (W)	0.7	Test performed by Industry
TEC Calc (kWh)	90.3	Using ES V6.1 TEC formula
CEC proposed TEC limit (kWh)	56.4	With memory adder

<u>TEC Calculation DT2</u>

This system was not obtained by the Industry. To complete these analysis assumptions were made based on other systems using the same processor and chipset about Sleep and Off power.

- Aggios data is in black
- Industry assumptions are in orange
- Difference between Short–Long Idle – all data from Aggios paper
    - Short Idle: With default PSU
        - 22.0W – from Aggios paper
    - Short Idle: With Pico PSU
        - 14.2W = 9.7W + 3.5W + 1.0W
            - 9.7W – Pico PSU
            - 3.5W – HDD Spin down
            - 1.0W – Display Off

Table 6:

	DT2		Comments
	w/ default PSU	w/ Pico PSU	
Short Idle (W)	22.0	14.2	See breakdown of data above table
Long Idle (W)	17.5	9.7	Aggios data
Sleep (W)	1.4	1.4	Best case assumption for similar system
Off (W)	0.6	0.6	Best case assumption for similar system
TEC Calc (kWh)	93.4	59.3	Using ES V6.1 TEC formula
CEC proposed TEC limit (kWh)	53.2		With memory adder

Summary of TEC Calculations

Table 7:

	DT1a		DT1b	DT2	
	w/ 400W Platinum	w/ Pico PSU	w/ 400W Platinum	w/o default PSU	w/ Pico PSU
TEC Calc (kWh)	73.2	56.9	90.3	93.4	59.3
CEC proposed TEC limit (kWh)	56.4		56.4	53.2	

None of these systems actually meet the proposed CEC TEC limits for desktop computer with the applicable adders. This data is using as much data from the Aggios' paper that they provided. Their study was supposed to demonstrate what might be possible to meet the proposed CEC limits, yet these systems don't meet the limits. Some are close, but they are only close when using a very low quality power supply that would never be used in the industry because performance would be unacceptable to customers. More detail about the Pico PSU later in this report.

Hard Drive (HDD) Spin Down Time

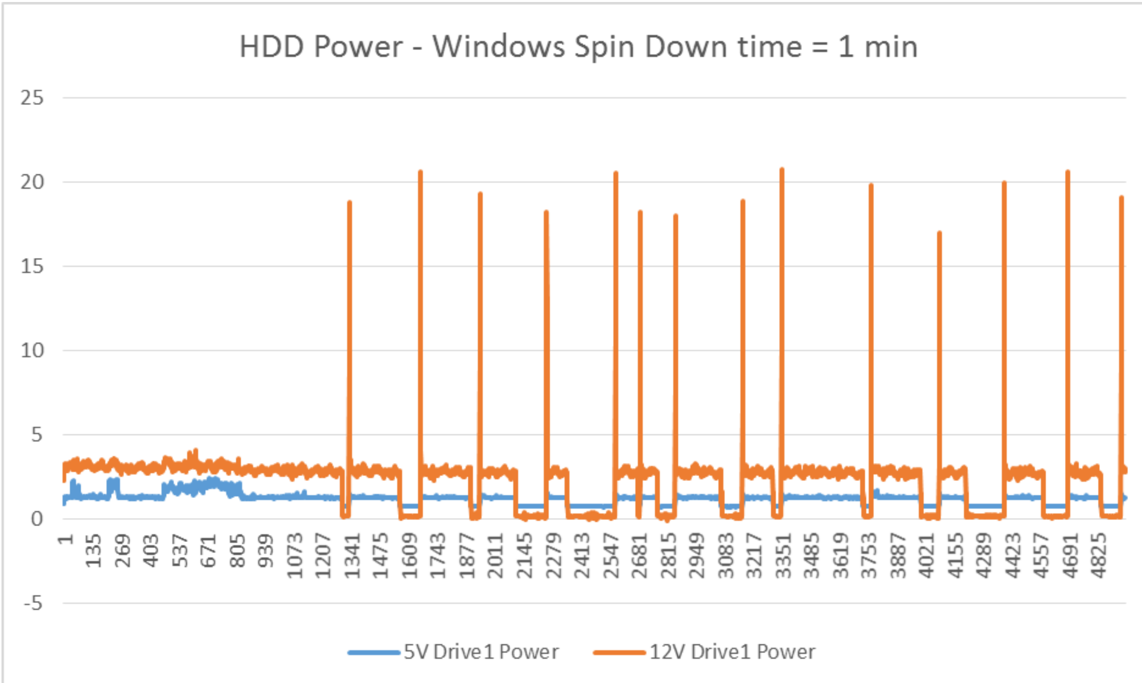
The industry representatives at the June 9-10 meeting went into great detail about how just using Windows hard drive spin down time set to 1 minute is not a “free” power adder.

- Users will not accept this setting and most likely disable this power management feature because of the extra latency introduced.
    - Manufacturers website states spin up time from 10-18 seconds for Seagate (http://www.seagate.com/www-content/product-content/desktop-hdd-fam/en-us/docs/100710254g.pdf) an average of 9 seconds for Western Digital 3.5” hard disk drives.
- The reliability of hard drives goes down with the constant spin down and spin up of the hard drive.
- Extra cache in the hard drive would be required to augment both of these issues which introduce an extra cost adder.

There is another issue that needs to be brought up, and that is about hard drive spin down time set to 1 minute of inactivity inside Windows. How often will the hard drive have to spin back up because the system needs to access information on the hard drive and how much energy does that consume?

The data below shows a Western Digital Blue 1TB hard drive that in Windows had the hard drive spin down time set to 1 minute. This shows what happens when Windows is set to do the spin down on a real system sitting at Idle for 80 minutes. This is an aged operating system, not a fresh install, so most of the activities of a new operating system have already happened. This is the Windows operating system working in a normal condition just like the average user would observe.

It takes around 20 minutes before the hard drive spins down for the first time. The ENERGY STAR* - Computers Ver 6.1 test procedure does allow HDD to spin down but in correct testing the HDD can’t be counted on spinning down because testing has to stop at 20-25 minutes. Also notice that once the HDD does spin down it doesn’t stay off very long. This is in fact what happens during normal conditions in a Windows* operating system.



Looking at the data further there are a few data points to look at:

- Power of the hard drive before it spins down.
- Average power of the hard drive over the 60 minutes where the hard drive is spinning down and back up.
- Notice the spin up power and how often the hard drive does spin up.
- The average time the hard drive stays in the Spin Down mode during this testing is 92 seconds.

All data is averaged over the time specified. The X axis is in seconds.

Table 8:

HDD Status	**5V**	**12V**	**Total**	Data points used (Seconds into test)
No Spin Down (W)	1.27	2.84	**4.11 w**	850 – 1300
Spin Down happens naturally (W)	1.09	1.98	**3.07 w**	1301 – 4955 (last 60 minutes)
Average for complete 80 minutes (W)	1.19	2.25	**3.45 w**	1 – 4955
Average power while Spun down (W)	0.75	0.22	**0.97 w**	Uses all spin down data points
Average power during spin up (W)	1.32	12.32	**13.64 w**	All spikes

While using the Windows hard drive spin down settings set to 1 minute as a "free" change to a power management setting, the power savings is not as high as what Aggios reported. This is all the reasons why this setting is not used by the industry (hard drive reliability, latency, and added cost adder to users to overcome latency) and another solution needs to be investigated for hard drive power savings.

Internal Power Supply Requirements

The Industry has been designing and manufacturing power supplies for computers for many years. To help guide these designs and manufacturing is a publically available power supply design guide. This document provides power supply requirements to the computer industry so that all computer components can work together for the quality experience that end users expect with a computer.

Intel published a public Internal Desktop Power Supply Design guide (rev 1.31) for the entire industry to design power supplies. (http://cache-www.intel.com/cd/00/00/52/37/523796_523796.pdf)   This design guide covers mechanical, electrical, acoustics, environmental, electromagnetic, safety and reliability requirements for an internal desktop computer power supply.

Intel also provides a power supply tested list to show publically what power supplies meet all of the electrical requirements listed in the design guide.

- General landing page – www.intel.com/go/powersupplies
- Specific tested list - http://www.intel.com/cd/channel/reseller/asmo-na/eng/215842.htm

This list shows hundreds of power supplies that have met the criteria.

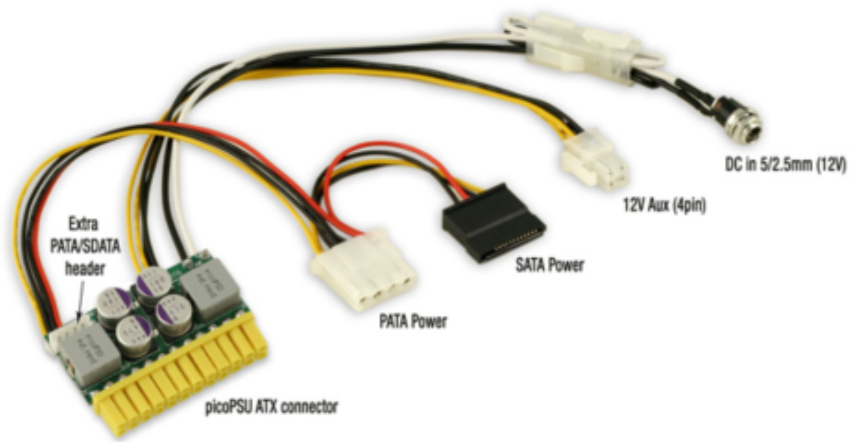
The 80Plus.org website lists all power supplies that have been independently tested for different levels of efficiency.

Comments:
The Pico Power Supply used for the Aggios study is not on either one of these lists. The Industry strongly question any data for any components that don't meet industry standards or are not listed on a good tested list.

There are reviews about this power supply dating back to 2006 (http://www.silentpcreview.com/article601-page1.html). This kind of Pico PSU has been around for that long and still is not used widely in the industry where everyone is looking for any advantage over the competition, because it is not an adequate power supply.

With that in mind, the Industry procured three of the Pico PSU used in the Aggios study and did testing in a manner consistent with the tests performed on all other internal desktop power supplies.

For reference, here is a picture of the Pico PSU. It looks much different than any other internal desktop power supply. First, notice it has limited power connectors for devices inside the computer. It also requires an AC Brick to do the AC to DC conversion. So this is not really an internal power supply replacement. It is a hybrid half AC Brick / half internal power supply.



Here are the loading specifications for this power supply from the User's Manual:

Table 9:

Specifications, picoPSU-160-XT, 160Watts DC-DC ATX Power Supply

Power Ratings

Volts (V)	Max Load (A)	Peak Load (A)	Regulation %
5V	8A*	10A	+/- 1.5%
5VSB	1.5A	2A	+/- 1.5%
3.3V	8A*	10A	+/- 1.5%
-12V	0.05A	0.1A	+/- 5%
12V	8A	15A	Switched input

*At max load, forced air ventilation is required. For fanless or improper ventilation operation de-rate the output of the 3.3 and 5V rails until PSU temperature falls below 65C. Peak load should not exceed 60 seconds. Combined max power output should not exceed more than 200watts.

One issue with the Pico PSU can be observed by looking at the specifications on the 12 Volt Rail. If all current from the 12 Volt rail goes to the processor then this power supply can only support a 45 Watt processor. The processors used for all three systems by Aggios are 95W or 65W processors which require a minimum of 11A continuous and 14A peak.

Table 10:

PSU 12V2 Capability Recommendations		
Processor TDP	Continuous Current	Peak Current
95W	16A	18A
65W	11A	14A
45W	7.6A	12A
35W	6A	10A

Chart shown above is from the referenced Power Supply Design Guide – Page 12, Table 3

The 12V volt rail also provides power to the motherboard, hard drives, and any optical drive. If a minimum amount of power goes to those three components, like 1 amp, then the Pico Power Supply can only provide 7.0 Amps to the processor. A more realistic approach would limit the Pico PSU to only supporting a 35 Watt processor.

Using the Power Supply Design Guide and the testing list mentioned earlier, testing is completed using a rack like the one shown in the picture to the right from the Intel lab.

This test equipment (Chroma ATE 8000) and test procedure was used to perform a standard internal desktop power supply test on the Pico PSU-160-XT. The table below lists the results from this testing.

During testing some of the individual tests would not even run. These tests were classified as a failure and skipped so the software could continue with the rest of the tests.

Table 11:

Test Criteria	# of Tests	# of Pass	# of Fail
Line Regulation	**6**	**4**	**2**
Load Cross Regulation	**32**	**0**	**32**
Efficiency for ErP	**3**	**3**	**0**
Efficiency for Energy Star	**Meets 80+ Bronze levels**		
Power Factor for Energy Star & 80 Plus	**2**	**2**	**0**
Ripple & Noise Test	**4**	**0**	**4**
Dynamic Load	**48**	**0**	**48**
12V2 Peak Loading Test	**2**	**0**	**2**
Timing T1-T6	**24**	**18**	**6**
12VDC/5VDC/3.3VDC Power Sequencing Test	**6**	**0**	**6**
Hold Up Time	**2**	**0**	**2**
Short Circuit Protection	**12**	**0**	**12**
Over Current Protection	**12**	**12**	**0**
Energy Hazard Safety Criteria (240VA)	**8**	**0**	**8**
12V2 Load 16A Continue & 18A Peak	**2**	**0**	**2**
12V2 Min Load 0A	**4**	**0**	**4**
Totals	**167**	**39**	**128**

The Pico PSU is rated at a total power of 160 Watts, depending on the AC Brick used with the Pico PSU it might even be less. Looking at one of the websites that sell the Pico PSU there are both a 150W and 192 W AC Brick that could be used with it. Either 150W or 160W are both undersized for the any of the three example systems used by Aggios. Below is the table that would be used to size the power supply correctly for the DT1a system.

Table 12:

Component	Quantity	Max Power
Processor	1	95 W
Motherboard + memory + fans	1	20 W
PCI-E slots (25W each)	3	75 W
USB ports (5W each)	9	45 W
HDD / ODD (10W each)	6	60 W
Total		295 W

CPU VR loss could also be added to this chart. For this power budget the processor VR loss included in the Motherboard power.

This power budget shows why the most common size for power supplies of basic simple configuration are around 300 watts. Even if the system is sold with no PCI-E slots used then the system still requires a 220 Watt power supply, significantly more than 160 Watts for the Pico PSU.

In summary, the Pico PSU is not a power supply that would be used in any production environment and is drastically undersized for these example systems.

IV. Conclusion.

Aggios' study took an idealistic approach to looking at maximizing desktop computer energy savings through SW and HW optimization techniques focusing on enabling package c-states, switching off components in the idle states, disabling the background processes and changing the power supplies. Such techniques are not new and are routinely used by the Industry when practicable and cost effective. Industry has demonstrated in the above analysis that not all savings claimed could be realized based on measured data and eco system and end-user factors. While the MSI Eco Center Pro software provides an opportunity to disable certain features in idle to reduce power, in reality the power savings are not significant for most of the listed features. The proposed SW approach could possibly benefit a small minority of sophisticated end-users with thorough understanding of computer platform and trade-offs, but is neither advisable nor cost effective for the majority of the computer users in California. The power supplies proposed by Aggios have a $60-$70 cost adder over an 80 plus Bronze power supply, and the Pico power supply has other serious quality issues which should prevent it from being considered as a viable replacement for an internal desktop power supply. The Aggios' study did not consider the impact of HDD spin up power (after spin down), which is significant and must be considered as part of the overall power consumption of a hard drive.

Furthermore, the Aggios' study lacked rigorous testing methodology and TEC calculations, and even with all proposed savings (with many unrealistic) and power supply cost adders, the tested systems could not meet CEC proposed targets.

Finally, this analysis shows that this study should also not be used as a basis for setting potential TEC limits.