ENERGY STAR® Computer Specification Revision Progress Update
Proposed Levels for Final Specification
8/26/06

At the May 18th, 2006 working session in Washington, DC, EPA relayed that it would consider a new dataset, rather than continue to amend the dataset used to propose levels for Draft 2, when proposing levels for the final ENERGY STAR specification. In the past month, stakeholders have shared with EPA data for desktops, notebooks, workstations and desktop-derived servers. EPA has evaluated the data submitted through August 25th to develop the levels proposed in this Update Document. All data was used for the analysis with the exception of the exclusions noted below. This update makes these proposed levels, and EPA's rationale for proposing them, available for stakeholder comment before being written into the final specification. This document first addresses desktops and notebooks, and then addresses workstations. This communication also includes a masked version of EPA's dataset for these products.

Finally, this document provides a slightly revised timeline for the remainder of the specification development process. The schedule has been extended by a few weeks to account for the delay of this document resulting from many data submissions post August 4, 2006 and to allow stakeholders ample time to comment on the EPA proposals. EPA welcomes any comments stakeholders have on these proposed levels and analysis **up to, but no later than, September 15th, 2006.** Please share all comments with Katharine Kaplan Osdoba, EPA, at osdoba.katharine@epa.gov or Arthur Howard, ICF International, at ahoward@icfi.com. Comments specific to workstations can also be directed to Thomas Bolioli at tbolioli@terranovum.com.

I. Desktops and Notebooks

Dataset Contents and Exclusions

Table 1 gives a summary of the contents of the final dataset used for Idle and low power levels, while Table 2 gives passage rates for the different specification requirements. Please note that, due to a lack of data relevant to desktop-derived servers, this category has been combined with desktops. A desktop-derived server will, therefore, have to meet the desktop power levels, based on the desktop category appropriate for its characteristics and configuration. As noted in the Draft 3 specification, desktop-derived servers remain exempt from the Sleep requirement for Tier 1.

Table 1. Power Level Data Representation

	Desktops	Notebooks
Data points	141	89
Manufacturers Represented	6	6
Unique Models Represented	55	64

Table 2. Specification Qualification Rates

	Desktops	Notebooks
Idle State	28%	30%
Sleep Mode	90%	72%
Standby (Off Mode)	79%	81%
All Requirements	21%	25%
Overall Specification (all Desktops and Notebooks)	22%	

The final dataset consists of many different models, as well as multiple configurations of these models, submitted by a diverse group of manufacturers. Some data were excluded from this analysis in order to prevent double counting of individual configurations; data removed for the analysis have been summarized below:

- Duplicate models not varying in configuration or power consumption;
- Duplicate configurations tested under the 230V test condition;
- Duplicate configurations with alternate Wake-On-LAN (WOL) settings (these data points were still used for the low power adder analysis). In these cases, the units with WOL were used by default for the analysis;

- Notebooks tested with the screens on where EPA could not secure corrected data (test procedure requires the screen off); and
- Products with noted power measurement errors where EPA could not secure corrected data.

Approach to the Internal Power Supply Requirement

Of the total 141 desktop data points in EPA's dataset, 55 (or 39% of) units included power supplies with 80% or greater efficiency. This low level of prevalence of efficient power supplies in the data submitted meant that power supply efficiency would be virtually the only factor determining which units qualified for ENERGY STAR. In fact, if EPA factored in the power supply efficiency requirement, power modes would need to be set unacceptably high in order to meet the target qualification rates. EPA also understands that 80% efficient power supplies will be available in large, consistent supply from multiple manufacturers when this specification goes into effect.

Furthermore, it was important to analyze the Idle power levels and power supply efficiencies both individually and together to fully understand their interactive effects. For example, many of the models that meet the proposed Idle, Sleep, and Standby power levels without an 80% efficient power supply would ultimately be shipped with a more efficient power supply to gain ENERGY STAR recognition, which would in turn further reduce those power levels. So it was important for EPA to understand the percentage of units that would qualify for the proposed levels separate from the power supply requirement, mirroring the approach EPA has used for external power supplies, telephony products, and other complementary specification requirements.

To this end, EPA used the following assumptions, based solely on manufacturer submitted data, to adjust manufacturer shared data as follows:

- Products without reported efficiency levels were assumed to have an efficiency equal to the average of all power supplies with reported efficiency numbers;
- Products indicating "non-80%" for power supply efficiency were assumed to have an efficiency equal to the average of all the power supplies with reported efficiencies of less than 80%;
- All non-80% efficient power supplies were then adjusted to an 80% efficiency level. This was a somewhat conservative estimate, as in reality the average qualifying power supply exceeds an 80% efficiency by at least a few percent.

For products indicating efficiency levels of greater than or equal to 80%, the originally reported power levels were used for the analysis. For products with a power supply efficiency of less than 80%, the power values for Idle, Sleep and Standby were then adjusted based on an upgrade to an 80% efficient power supply. The result of this adjustment lowers the power consumption by 6-8% for models not tested with 80% minimum efficiency power supplies.

Desktop and Notebook Low Power Levels

Table 3. Proposed Tier 1 Low Power Levels

	Standby (Off Mode)	WOL Adder (Standby)	Sleep Mode	WOL Adder (Sleep)	DIMM Adder (Sleep)
Desktops	**2.0 W**	**+ 0.7 W**	**4.0 W**	**--**	**--**
Notebooks	**1.0 W**	**+ 0.7 W**	**1.7 W**	**--**	**--**

Low power adders were determined through a combination of direct comparison (a comparison of identical configurations with different WOL settings or a different number of memory DIMMs), overall dataset averages, and final qualification percentages. EPA completed an initial analysis to determine the appropriateness of each adder and potential associated levels. These initial levels were then inserted for the overall analysis and adjusted accordingly. The final levels were set so that more than 70% of units qualify for each low power mode. This was done to disqualify only those models with the highest power consumption in these modes, since the additional power savings achievable by this revised specification for low power is relatively small in comparison to that of the Idle state. EPA also recognizes the significant strides made by manufacturers in these low power modes in the last decade. For the low

power mode analysis, all systems not connected to an active network switch for testing were excluded, as they may not accurately reflect the true increase in power consumption from WOL enabling.

WOL
EPA comparisons showed strong support for a WOL adder from Standby. However, the analysis for WOL from Sleep showed mixed results, and direct comparison data was only available for seven models representing a single manufacturer. Therefore EPA is proposing to eliminate the WOL adder for Sleep, as it is not supported by the data submitted. The final values for Sleep, Standby and the WOL adder were determined by looking at the overall dataset both with and without WOL enabled (for products tested in both conditions). EPA set the proposed levels such that they treat WOL and non-WOL systems as equitably as possible, advantaging neither. Charts for desktop and notebook low power levels can be found in Figures 1 and 2 in the Appendix. Although the notebook data showed a stronger difference between WOL enabled and disabled in Sleep, the power consumption in this mode was low enough that EPA feels comfortable proposing one level achievable by both systems with WOL enabled and disabled.

Memory Adder
Initial analysis of data submitted showed a weak correlation between increased memory and increased Sleep power. EPA has, therefore, eliminated this adder. The data show that the proposed Sleep limit gives ample room for models to qualify with high memory configurations of up to 4 DIMMs. A chart of power use in Sleep for different DIMM numbers can be found in Figure 3 in the Appendix.

Desktop and Notebook Idle State Levels

Table 4. Proposed Tier 1 Low Power Levels

	Idle State Category A	Idle State Category B	Idle State Category C
Desktops	**50.0 W**	**65.0 W**	**95.0 W**
Notebooks	**14.0 W**	**18.0 W****	**N/A**

** Category B for notebooks defined as notebooks with *at least* 128 MB of dedicated, non-shared video memory.

EPA aims to propose challenging but fair levels for desktops and notebooks. EPA has proposed levels slightly more stringent than 25% for the following reasons:

- The collection of a new dataset was implemented following stakeholder's insistence that products sold during the Tier 1 timeframe would be based on new, more advanced platforms, yet the new EPA dataset, especially that of desktops, still contains large numbers of older processor architectures - i.e., those introduced over six months ago. EPA believes that architectures introduced in the last six months (as well as those announced on manufacturers' roadmaps for near-term introduction) will dominate computer sales during the labeling period in question - July 2007 to January 2009. These new architectures trend toward delivering much greater performance at lower power levels (a trend verified by the data associated with more advanced platforms submitted by industry), EPA believes that the mix of products sold in mid-2007 will achieve a higher pass rate than the mix of products in the current datasets.
- EPA's assumptions about increased power supply efficiency were conservative in assuming a base level of 80% efficiency for any units not meeting the power supply levels or those simply indicating "80%+". EPA understands that many power supplies available on the market which meet the power supply criteria have efficiencies a few percentage points greater than 80%, which would result in lower power values and increased qualification rates.

Notebook data submitted by industry showed a wider variability in Idle power consumption than in past datasets. As a result, EPA is proposing that notebooks be categorized by dedicated, non-shared video memory as mentioned in the Draft 3 specification. Based on the data analysis, a minimum of 128 MB seems to be an effective division point for Category A and B notebooks. EPA is proposing levels of 14 W for Category A and 18 W for Category B to reach the 25% qualification rate for these products. Figures 4 and 5 in the Appendix show the Idle power of the different desktop and notebook units for each category. Non-qualifying models falling under the proposed Idle levels did not meet the requirements for Sleep and/or Standby.

II. Workstations

Summary/Background

Recognizing that workstations presented both a unique set of challenges and opportunities, EPA instituted a modified Typical Energy Consumption (TEC) approach -- a term adapted from the recent ENERGY STAR imaging specification. This modified approach gives a weighting to each of the particular power modes and allows manufacturers flexibility in determining how best to utilize an energy budget to increase efficiency in a way that is natural to their particular architecture. In addition, in order to ensure that machines of varying levels of performance will be able to attain the ENERGY STAR classification, EPA agreed to employ a scalable classifier based on maximum energy consumption to allow machines with varying degrees of performance to qualify. Upon analyzing the dataset, it became clear that a simple classifier creates an unfair bias, and so EPA is proposing a modification to the maximum energy consumption classifier to correct for this. The original method, as proposed by industry and included here to facilitate comparison, is provided below and is then followed by the proposed, augmented methodology.

Dataset Contents

The EPA workstation dataset includes 51 records consisting of 19 unique models and a sample of each major platform architecture in the market today. No records were excluded from the analysis, but some records were changed after data validation identified errors and anomalies. All vendors were consulted in these cases and in every case provided or agreed to the final value. The levels proposed in this Update Document reflect a 25% qualification rate for workstations.

Max Power Test

To determine the Maximum Power of a particular machine, it is proposed that a combination of two freely available benchmarks, Linpack 1000 and SPEC viewperf 9.0, be run simultaneously on the unit under test (ignoring the performance scores). Linpack would be run with an array size of n where n would be determined based on Equation 1. Linpack Array Size. Linpack is compiled on a platform-by-platform basis and the compiler switches/optimizations are specified in Table 5 below. SPEC viewperf is compiled and run according to SPEC provided instructions.

Equation 1. Linpack Array Size

$$n = \sqrt{\frac{(BytesRamInstalled/8)}{1000}}$$

Table 5. Linpack Compilers and Optimizations for Different Platforms

Platform	Compiler	Optimization	URL
Intel x86/ia64	TBD	TBD	http://www.intel.com/cd/software/products/asmo-na/eng/perflib/mkl/266857.htm
AMD x86/64	TBD	TBD	
Sun sparc	f90	-xO4	
IBM powerPC	TBD	TBD	

Original TEC Approach and Scalable Classifier

The original TEC method and scalable classifier is provided here to facilitate comparison to the proposed approach below. The original proposed requirement was determined by weighting each power mode by a

factor (represented by the percent time spent in that mode) and dividing the sum of the weighted powers for each mode by the maximum power consumption (with a slight adjustment for number of disk drives) as seen in Equations 2 and 3 below:

Equation 2.

$$TEC\% = \frac{(\%TimeOff \times PowerOff) + (\%TimeSleep \times PowerSleep) + (\%TimeIdle \times PowerIdle)}{MaxPowerConsumption + (\#HardDrives \times 5watts)}$$

Equation 3.

$$TECbudget = 0.34 \times (MaxPowerConsumption + (\#HardDrives \times 5watts))$$

Where:

- PowerOff, PowerSleep, PowerIdle and MaxPowerConsumption are measured values, tested in accordance with the established test procedures
- %TimeOff = 10%
- %TimeSleep = 20%
- %TimeIdle = 70%
- Workstation Level: (expressed in % of max) 34%

Under this proposal, a workstation would earn the ENERGY STAR label if the calculated TEC% is <= 34%.

Observations

This original TEC scalable classifier based on the maximum power consumption biases towards high-end configurations with second processors and significant memory. This bias occurs within each model's various configurations and not between low-end models and high-end models *per se*. The implication of this inherent bias is that a customer who wishes to purchase a low-end configuration might have to buy a higher capability machine in order to purchase ENERGY STAR, despite not needing that capability. This potential outcome may reduce program savings if customers purchase machines that require more power, regardless of how efficient those machines are in absolute terms. Figure 6 in the Appendix illustrates the bias the original TEC proposal had towards high end configurations. Furthermore, Figure 7 in the Appendix shows the trend line and linear regression calculation for a comparison between TEC and max power. This calculation served as the basis for the revised TEC percent of max classifier.

Proposed TEC Approach and Scalable Classifier

The newly revised TEC approach was developed to improve the TEC budget so that different configurations of the same model have approximately the same chance of meeting the proposed specification level. This newly proposed approach is as found in Equations 4 and 5 below. Note that they maintain the original formula at their core, but adjust the result based on extra processors, cores, and memory DIMMs. In addition, the TEC Power budget calculation is adjusted with the addition of an intercept instead of being a straight percentage of maximum power. Figure 8 in the Appendix shows a plot of the observed TEC values and the TEC budgets being proposed for each given machine.

Equation 2.

$$TEC = \sum (\%TimeOff \times PowerOff) + (\%TimeSleep \times PowerSleep) + (\%TimeIdle \times PowerIdle)$$

Equation 3.

$$TECbudget = Slope \times MaxPower + (Intercept - k)$$

Where:

- PowerOff, PowerSleep, PowerIdle and MaxPowerConsumption are measured values, tested in accordance with the established test procedures

- %TimeOff = 10%
- %TimeSleep = 30%
- %TimeIdle = 60%
- $MaxPower = MaxPowerConsumption + (\#\ HardDrives \times 5Watts)$
- $k = \left((\#of\ \mathrm{Pr}ocessors \times \#ofCoresPerPackage) \times 2.5 + (\#ofDimms \times 0.25)\right)^{1.6}$
- Slope = 0.43
- Intercept = -8

A workstation would earn the ENERGY STAR label if the TEC value, calculated from the power mode measurements, is less than or equal to the calculated TECbudget.

Conclusions

On a population basis, the Original TEC (straight percent of max) has most machines either passing by large amounts or failing by large amounts of around 20% or more. In comparison, the revised percent of max has most machines passing or failing by much smaller amounts, i.e. about 10%. The k Factor is then applied inversely to reduce the power budget on highly loaded configurations. This allows lightly loaded configurations to have higher power budgets. The net result is an ENERGY STAR specification where all configurations of a particular model have roughly the same revised TEC percent of max.

Areas for Improvement

EPA would like to point out areas where it believes that industry input would be particularly beneficial.

- Linpack Array Sizing: There are concerns that "Equation 1. Linpack Array Size" is too simplified and fails to account for effects on the graphics portion of the max power test.

III. Timeline and Remaining Steps

EPA has extended the timeline slightly, allowing for the receipt and analysis of data post August 4, 2006, and to allow for greater time for stakeholders to review the proposals included in this document as well as the Draft Final Specification, to be released on September 22, 2006. As always, EPA welcomes stakeholders' feedback on these proposed levels and looks forward to working with interested parties to finalize this specification.

August 26th - EPA releases Update Document with proposed levels
September 15th – Comments due on the draft levels and other elements of the Update Document
September 22nd – EPA releases Draft Final Specification with levels
October 13th - Comments due on Draft Final Specification
October 20th – EPA distributes Final Specification
July 20, 2007 – All Tier 1 requirements take effect, pending EC approval

Appendix – Power Charts

Figure 1.

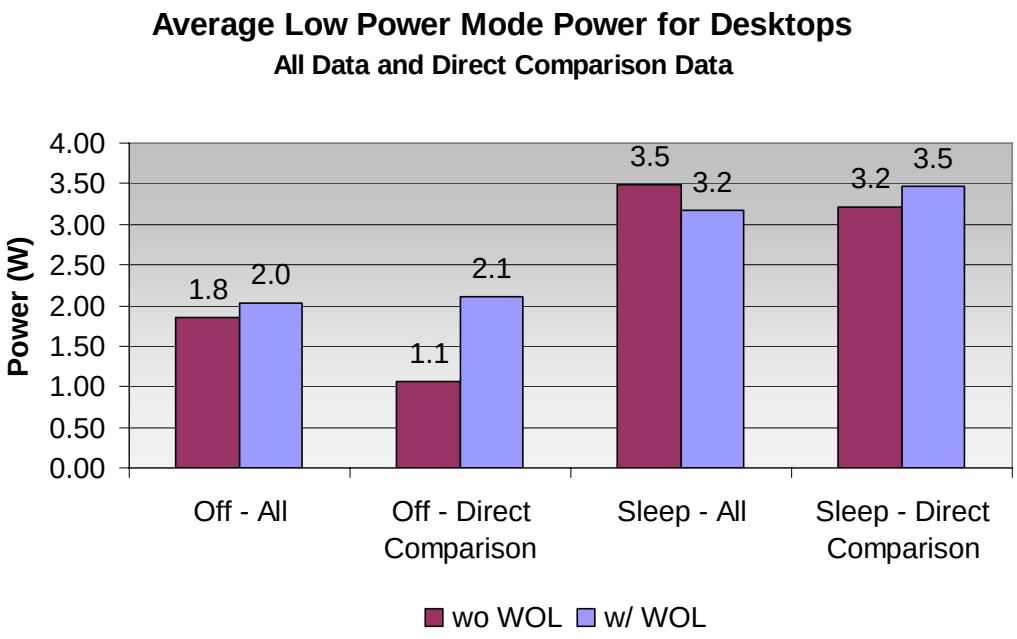

Figure 2.

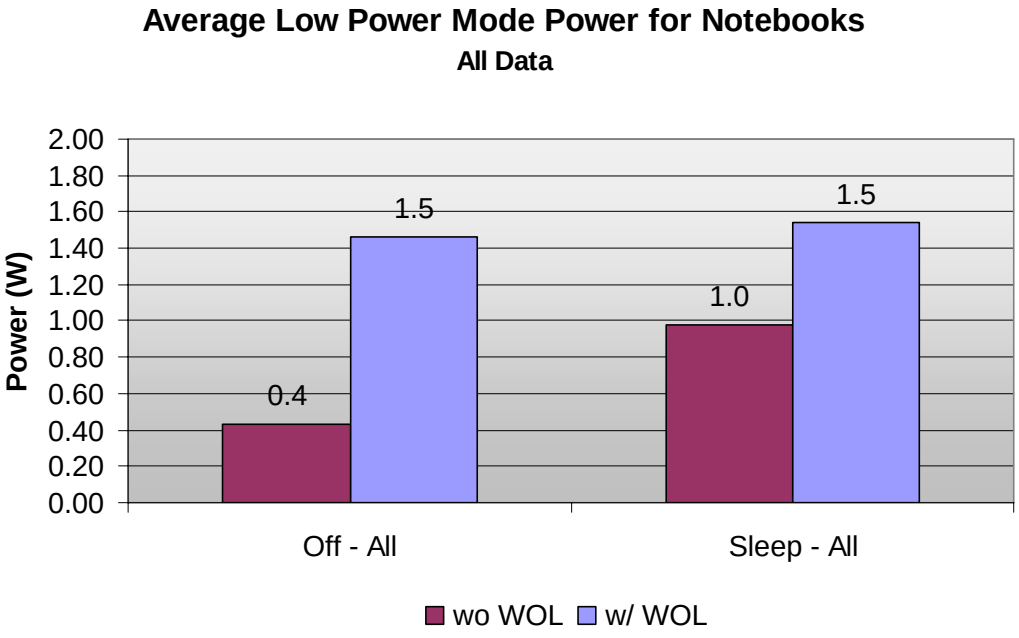

Figure 3.

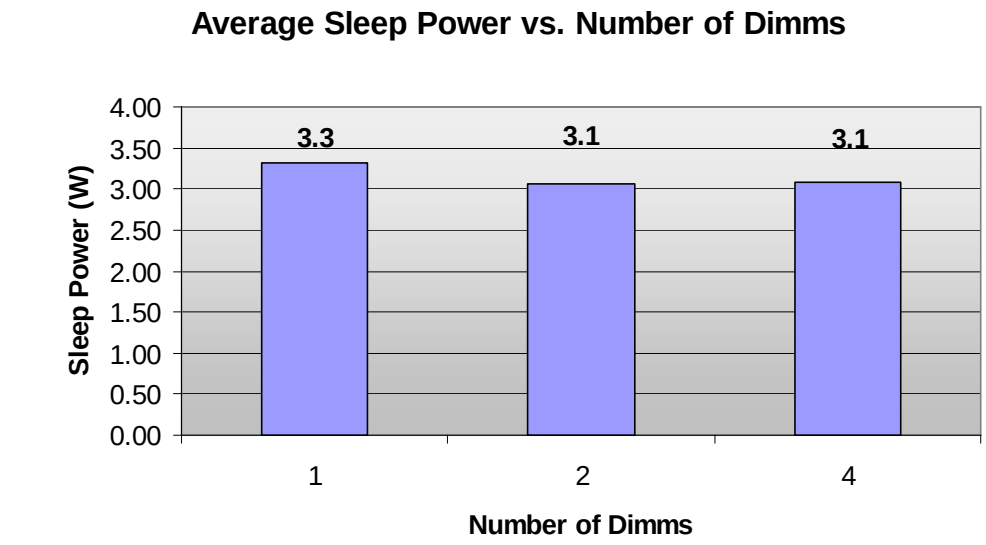

Figure 4.

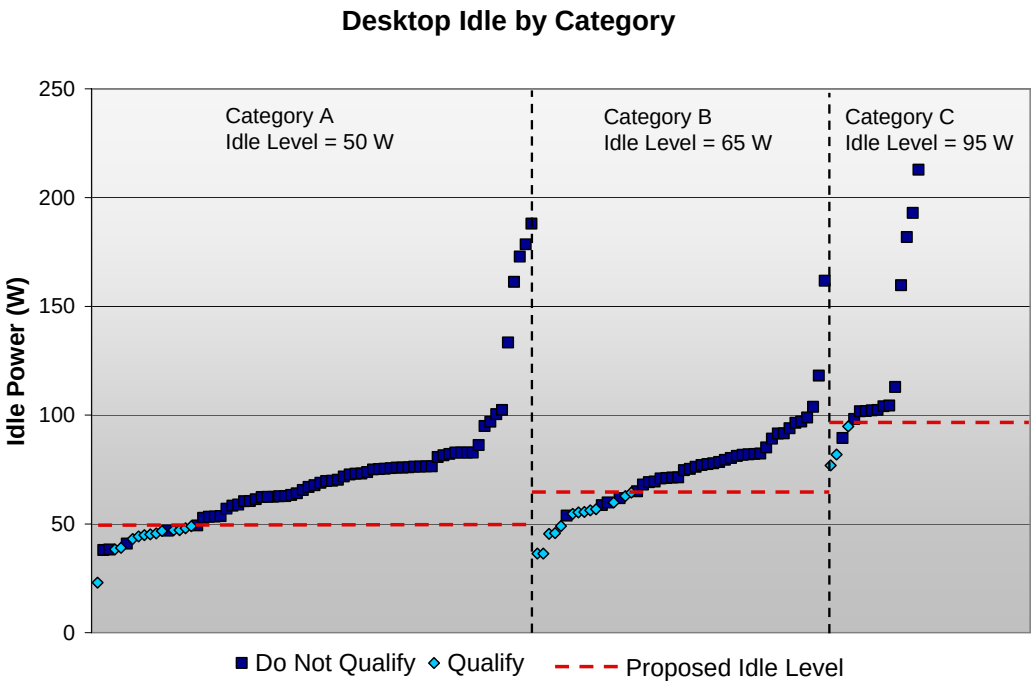

Figure 5.

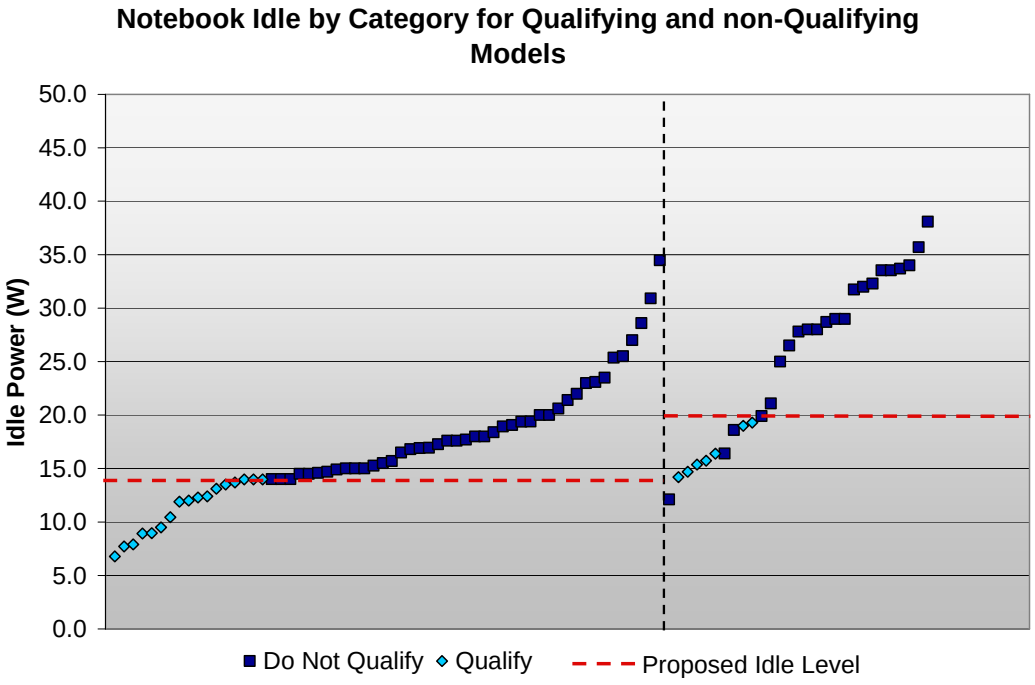

Figure 6. TEC Percentage Comparison Across Models (Records Sorted based on processors and DIMMs)

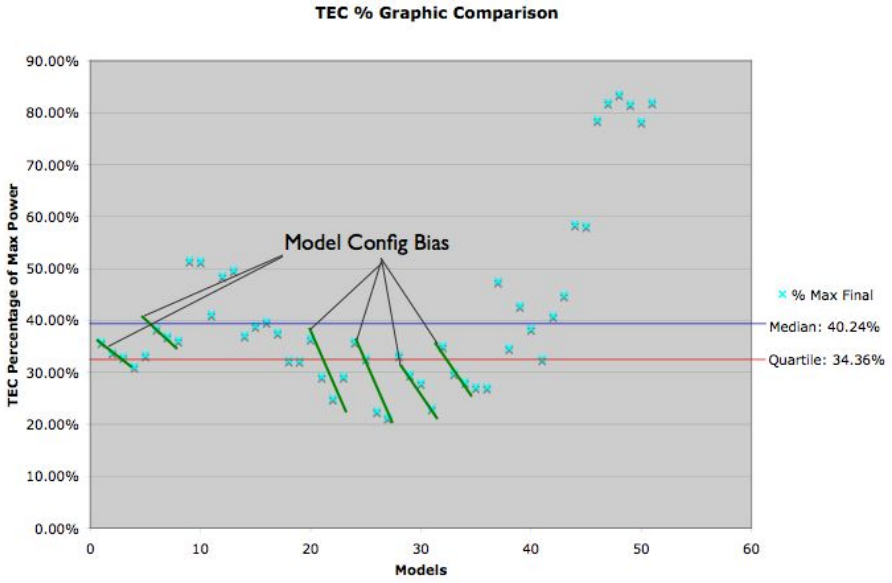

Figure 7. Energy vs. Max Power Comparison and Linear Regression

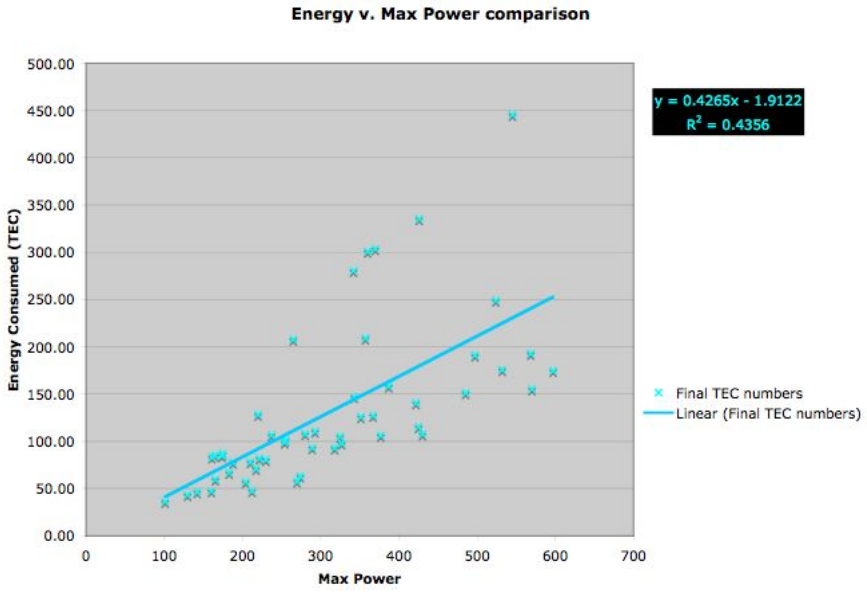

Figure 8. Energy v. Max Power Comparison After Skew Correction