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ITI/TechNet Comments on Computers

Additional submitted attachment is included below.

CEC Final Draft Staff Report for Computers (Docket #14-AAER-2)

Appliance Efficiency Pre-Rulemaking

ITI/TechNet Comments on CEC Staff Report
May 23, 2016

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1. INTRODUCTION.

At the April 26th Workshop, ITI and TechNet (also referred to hereafter as "industry"), reflected on the very active consultations that had been held since last spring's Workshop, to include the two shareholder face-to-face meetings and fairly constant communications with CEC staff and other key shareholders. These consultations resulted in agreements with fellow stakeholders in some areas, and clarified facts in other areas. While this progress was limited, as stated at the April 26th Workshop, we were surprised that it was not more adequately reflected in the Final Staff Draft.

As we also stated at the Workshop, industry sees the Final Staff Draft as not technically feasible, nor cost effective, and asserts that its promulgation as-is would significantly limit choices for Californians and more generally dis-serve their best interests.

ITI and TechNet have pledged to continue to engage constructively with the CEC and key stakeholders to get this important rulemaking right. As we noted at the Workshop, if we are to achieve the agreed goal of a technically feasible, cost effective Final Rule by year's end, then much collaboration and significant changes are requisite.

In this regard, we appreciate the constructive dialogue that occurred during the Workshop, and the intense consultations that have occurred since then. Needed progress is being made. Some of this progress is reflected in these written comments. As many key issues remain in play, we may wish to submit further comments to the docket as agreed solutions come together.

As stated both at the Workshop, and in various consultations since, the Final Staff Draft's proposed 1/1/18 effective date is not tenable for Desktop (DT) and All-in-one (AIO) computers, and would greatly dis-serve California's citizens and businesses. A Final Rule can and should advance the State's climate and energy efficiency goals while also not reducing Californian's access to promising future technologies, choice in technology purchases, nor California's future competitiveness. This is not possible with a 1/1/18 effective date, and hence Industry does not plan to docket any alternate proposal. Industry comments and proposals for DT/AIO computers in this document are based on 24 months implementation (1/1/2019), after a final regulation is adopted.

2. SUMMARY OF KEY ISSUES

2.1 Scope/Definitions of CEC Computers Regulation

Scope of CEC Computer Regulation:
The scope of California's Computer energy efficiency regulations should target "mainstream" high shipment volume computers, and should exclude TEC requirements for "high performance" low shipment volume computers that provide customers with higher performance and as a result consume more power (including while computer is in an idle state). Industry proposes that following types of computers (with industry proposed definitions) to stay in scope but with alternative compliance requirements that exclude TEC:

- Performance Desktop Computers:
- Gaming Desktops
- Mobile workstations
- Gaming Notebooks

CEC's Final Staff Draft does not address 'In scope' and 'out of scope' products in details. This leaves room for ambiguity. For example Mini PCs are not included as part of desktop systems.

Definitions:

In general Industry position is for CEC to align with ENERGY STAR v6.1 Computers Specification on product definitions. ENERGY STAR remains the harmonization point to align definitions across global regulatory jurisdictions. In some areas Industry and IOUs/NRDC collaborated to refine some product definitions[1] and shared it with CEC. These proposed changes were not addressed in CEC's latest draft.

Since the workstation as defined by ENERGY STAR has evolved, industry and stakeholders collaborated to propose changes to workstation definition. CEC while adopting the workstation definition created linkage to new 'expandability adder'. Industry is requesting CEC to utilize the workstation definition as proposed (Appendix A) without reference to an "expandability" adder that is unique to CEC.

As discussed above, industry has proposed definitions and criteria to exempt high-end PCs from TEC requirements provided these systems meet 100% of system definition and qualification criteria (Section 3). Industry is investigating CEC proposal for high-end desktop PC exemption based on expandability score.

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[1] http://docketpublic.energy.ca.gov/PublicDocuments/14-AAER-02/TN206287_20151006T100251_California_Investor_Owned_Utilities_Comments_CEC_Title_20_Compu.pdf

2.2 PCs – Methodology & Framework

Categories:

The Final Staff Draft's one size-fits-all approach is not reflective of international standards or of the globally accepted PC category approach (comparing like products within a product category). Freezing expandability score criteria for the next 5-7 years will likely stifle form factor innovation. Scalable product category approach is designed to account for innovation. Categorization enables industry to design & manufacture products for global markets using a common predictable approach. It reduces the number of adders to a manageable number. Scalable category criteria provide implementation flexibility, headroom for configuration variation and allow for future innovation.

Expandability:

- Expandability score is a new concept and the current proposal understandably is very preliminary and does not fully account for current form factor differentiation
  - Does not consider soldered down components with the same capabilities e.g. a PCIe x 16 soldered down w/o a physical slot

- It does not scale –expandability score acknowledges the presence of additional motherboard components by accounting for it in PSU sizing, but the expandability score itself does not sufficiently scale to cover the additional power required by the component itself, e.g. additional NICs, discrete SATA controllers, discrete USB controllers, PCIe switches, premium audio, etc**.**

- Desktop PC configuration complexity makes it challenging to develop an all-inclusive "Expandability Score". There is no mechanism to adopt future power delivery requirements into expandability score, e.g. adding wireless charging dock to an AIO base would factor in the PSU sizing but there's nothing in expandability score that would tell us how to do this.

- Regarding implementation it will be difficult to test and verify the "Expandability Score" for a given system and to correctly identify/control the distribution of configurations that may not comply with the limits (definition implies populated slots/ports vs. scoring refers to slots/ports present but not necessarily populated).

- Regarding global adoption WW regulators may not accept the "Expandability Score" and stay with the category approach they now use. Different energy compliance methods for different regions increase cost and risk for industry.

- There is an opportunity for possible compromise on CEC's expandability score proposal and Industry continues to address this with CEC.

TEC Target Setting/Energy Savings:

- CEC's target setting approach based on cost effectiveness assumptions ($18 BOM adder) and technical feasibility assessment is not realistic without impacting user experience.

- Industry projections are >$125 BOM adder (best case) through combination of measures (HDD, PSU, VR, MB, etc.) to achieve 50kWh target without compromising user experience.

- In addition to cost, there are lead-time issues. Most HW changes and re-design require > 24 months to enable new solutions in the market (after the adoption of final rule).

Allowances for additional capability:

- Industry agrees with CEC's proposal to right-size the additional storage adders based on storage type.

- Industry appreciates CEC's intent to simplify memory adder (based on module approach). However, this is not workable given that memory is not always attached as a module (limits FF innovation; limits z-height in mobile systems). This approach may have an unintended consequence and may encourage the use of lower capacity DIMMs, which consumes more energy. Instead, the focus should be to incentivize higher capacity DIMM's which consumes less energy.

- Industry believes adders should be based on capability and not physical implementations.

- CEC did not address industry's proposal for total system memory bandwidth to account for future innovations and resulting higher bandwidth in integrated graphics based systems (see attached). Industry is proposing adders below.

- CEC has not addressed any populated slots beyond discrete graphics cards. Examples: wireless and high speed Ethernet (10 Gb) networking, RAID, Video capture, Audio, Data Acquisitions, NVM storage, Thunderbolt. Power range is from 2-14+ watts. Industry is proposing adders based on measured data.

CEC proposed power management incentives:

- CEC's TEC mode weighting incentive to remove end-user capability to disable power management will likely constrain the end-user and negatively impact usage experience (details below).

2.3 Technical Feasibility and Cost effectiveness

Feasibility

- Manufacturers cannot update design criteria until a regulation is published and is not subject to additional changes. Manufacturers adhere to technology roadmaps that incorporate new technology enhancements. 12 months between publication of a final rule and effective date does not provide adequate time to introduce major design changes to shipping models that are undergoing global Safety, EMI, and Environmental certifications

- Major motherboard and chipset design changes typically require a minimum of 24 months to verify, implement and certify for the global marketplace

- Industry requests CEC to allow models that are already on the market (announced to the public and available for purchase) before the effective date be grandfathered i.e. not subjected to the regulation and be allowed to continue shipments in the state of California until products are no longer offered for sale because it has reached end-of-life.

- New models introduced to the market (announced to the public and available for purchase) after the effective date would comply with all CEC criteria

- As stated at the April 26th Workshop, a single category approach with a 50 kWh limit does not comprehend the power and performance relationship or the current state of most Desktop Computers.

  To further reduce idle mode power, modifications to designs must include
  - New Power Supply's with increased efficiency at low loads
  - New CPU's/Chipsets/Motherboards
  - 2.5" or SSD hard drives
  - Discrete Graphics cards with reduced idle power
  - Integrated Display improvements
  - Expandability cards (NIC, Sound, TV tuner, etc.) with lower idle power
  - Operating Systems enhancements that are inclusive of all manufacturers that will allow computers to remain in lower-power idle state with the ability to schedule or delay background tasks
  - Anti-virus, Spyware, Malware, and other Security enhancements
  - Global EMI, Safety, Environmental, and other certifications

- The proposal of 24 months is predicated on all of the various hardware and software meeting their design schedules and being stable enough for introduction to the global marketplace.

- If any of the various parts/pieces required for a fully functional computer is delayed, the resulting impact to customers in the state of California could be substantial.

Cost Effectiveness

- Industry's analysis of the CEC proposed cost increase of $21.00 as referenced in Table 3: Midrange System Short Idle Mode Comparison (page 31) and $18.00 referenced in CHAPTER 6: Energy Savings and Cost-Effectiveness (page 35) do not align with current industries cost projections.

- Any solution to achieve the proposed limits must be available from multiple vendors for each hardware and software component.

- The more stringent design limits must take into account manufacturing variability that stipulates designs is more efficient to ensure compliance is maintained and which ultimately increases cost for each component. We strongly recommend CEC work closely with industry so that the true costs of compliance to the regulation is represented in the cost analysis.

2.4 Power management

- Industry had worked with CEC and other advocates to draft language addressing multiple situations where computers are shipped with non-traditional power management schemes
    - CHAPTER 8 - Proposed Regulatory Language for computer power management addressed one of several situations involving computers shipped without a "traditional power management scheme"
    - Shipping computers without an Operating System (OS) installed (when requested by customers)
- However, there are a number of other situations where the regulatory language will prohibit shipping computers with Operating Systems (OS) providing "non-traditional power management schemes", or where there is ambiguity about how to comply with other requirements involving power management.
- **Power management – TEC incentives**: Industry is concerned about the unintended consequences of incentivizing additional TEC headroom, when the end-user is not allowed to disable the power management settings. While the intention appears to be good to promote PC power management, such an incentive could likely lead to issues that will ultimately impact the user experience. Industry is posing some questions and requesting CEC to consider them before the final rule is adopted.

3. INDUSTRY PROPOSAL & WAY FORWARD

3.1. Scope/Definitions/Framework

Product Scope:

- **In Scope:**
    - Desktops, Integrated Desktops, Portable all-in-one computers, Thin Clients
        - Mini PCs should be part of desktop PC
    - Notebooks (including 2 in 1 per ENERGY STAR definition)
    - Workstations (with changes in definition – Appendix A)
    - Small-scale servers
- **In Scope but exempt from CEC TEC requirements (High-end systems)**
    - Professional desktops (must meet definition and qualification criteria – Appendix A)
    - Gaming desktops (must meet definition and qualification criteria – Appendix A)
    - Mobile workstations (must meet definition and qualification criteria – Appendix A)
    - Gaming notebooks (must meet definition and qualification criteria – Appendix A)
- **Out of scope:**
    - Mobile Thin Client (currently under ENERGY STAR v6.1 Notebooks)
    - Tablets/slates (per ENERGY STAR v6.1 definition)
    - Other current and future mobility compute products (Example: Compute sticks)
    - Remaining out of scope list from ENERGY STAR v6.1 (section 2.2)

Product Definitions:

- Industry position is for CEC to align with ENERGY STAR v6.1 Computers Specification on product definitions
- Industry would request CEC to adopt new workstation definition (Appendix A) and minor product definitions[2] refinements proposed by industry/advocates
- Adopt industry proposed High Performance PCs (Desktop, Notebooks) definitions and CEC qualification criteria:

  Note: All high performance PCs defined are to be exempt from CEC's system TEC requirements provided they meet 100% of system definition and qualification criteria. [Industry is currently investigating CEC proposal for high-end desktop/AIO PC exemption based on expandability score].

Framework: Industry proposes CEC to align with ENERGY STAR v6.1 computers framework (with exceptions as noted), TEC mode weightings including full network connectivity mode weightings.

3.2. Product Categories/Adders Proposed Framework (Based on ≥24 months implementation period for Desktop/All-in-One PCs)

Desktop/All-in-one (DT/AIO) PCs Categories:

- In order to maximize the energy efficiency of specific system configurations while enabling the wide range of desktop PC experiences spanning from basic productivity, to professional and virtual reality applications, there is a need to establish:
  - **Classes of systems with higher base TEC allowances based on the system capability**
  - **TEC adders for components that are not part of the base TEC**

- Industry is of the view that a few critical expandability criteria remain the best proxy to categorize systems. However this bare-bones criterion must be complemented with TEC adders to fully account for shipping system capability.

- In the Industry proposal below (Table 1), base TEC consists of:

  - **Base TEC** = Chassis (including chassis fans, LEDs, etc.) + motherboard (components) + base CPU (below certain capability) + power supply.

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[2] http://docketpublic.energy.ca.gov/PublicDocuments/14-AAER-02/TN206287_20151006T100251_California_Investor_Owned_Utilities_Comments_CEC_Title_20_Compu.pdf

- **Categorization criteria**: Industry looked at various options to categorization systems, including performance score, I/O bandwidth (Gb/sec), type of GPU, etc. Industry agreed to align with CEC proposed expandability score as a way to bucket systems within each category (Entry systems, mainstream, and performance).

- **Base TEC limits (kWh/year):** Industry proposal is based on idle power improvement projections in 2019 and beyond new shipments. This is based on applying CEC adders based on final draft report. (Note: This proposal does not address new CEC proposal on AIO display adder changes).

Table 1

Category[1]	System Type	Current Base TEC (kWh)[2]	Proposed Base TEC limits (kWh)[3]	% TEC Improvement[4]	Expandability score criteria[5]
DT-0 (DT/AIO)	Base, Entry	Base	50 (Base)	Base	<250
DT-1 (DT/AIO)	Mainstream	126	80	37%	250-425
DT-2 (DT/AIO)	Performance	140	100	29%	425- 650

Table 1 Notes:

1. Category: Nomenclature based on Industry submitted proposal.
2. Current base TEC: Current levels based on taking 75% percentile of each category dataset. DT-0 is set to CEC base (50kWh, minimum proposed requirement)
3. Proposed base TEC Limits: New category limits proposal. DT-0 is set to 50kWh (CEC base)
4. % TEC Reduction: Represents % TEC reduction goals for the new proposed limits
5. Expandability score: Alternative method for defining categories based on CEC proposed expandability score

- **Base TEC limits justification:** Industry proposal is based on aggressively reducing idle power by 29-37% across DT-1 and DT-2 categories, from current TEC base using Industry dataset. The aggressive idle power improvements are further demonstrated by analyzing the % of current shipping systems that will fail the proposed limits (Table 2). This effort will require very significant hardware, software and ecosystem investment to enable mainstream and performance computers to meet CEC requirements.

Table 2

Category	Current % fail rate to proposed limits
DT-0 (DT/AIO)	37.7%
DT-1 (DT/AIO)	89.7%
DT-2 (DT/AIO)	87.9%

Desktop/AIO PCs Adders Description and Framework:

- **CPUs/APUs/SOCs:** A new class of TEC adder is being proposed based on system memory bandwidth (above the base), that applies to all systems and covers system memory bandwidth (SYS_MEM_BW)[3] and associated CPU/APU/SOC.
    - System memory BW serves as a proxy for processor capability
    - System memory BW adder will coexist with other proposed adders (it does not replace other proposals)
    - Products following historical BW growth trend should be covered by Base TEC while step-function improvement capability should be eligible for an adder (see detailed proposal in appendix C)

- **System Memory:** As addressed earlier industry appreciates CEC's intent to simplify memory adder (based on module approach). However, this is not workable given that memory is not always attached as a module (limits FF innovation; limits z-height in mobile systems). Industry proposes CEC to align system memory adders based on CEC Draft 1 approach (0.8 kWh per GB RAM).

- **Storage (HDDs, SSDs, ODDs):** Industry agrees with CEC's proposal to right-size the additional storage adders based on storage type

- **Discrete GPUs:** Industry proposes to align with an equation based allowance system tied to frame buffer bandwidth[4] (Appendix B).

- **Energy Efficient Ethernet (EEE):** Industry agrees with CEC to align with ENERGY STAR v6.1 framework, including the allowance

- **Integrated Display (for AIO systems):** Industry agrees to align with CEC Final Staff Draft with 20% reduction from Draft 1 **[Note: This does not address new CEC proposal on AIO display adder changes]**

- **Discrete Audio and TV Tuner:** Industry is proposing to align with ErP Lot 3 regulation with further reduction in ErP Lot 3 adders (Table 3)

- **External Display adder:** Industry proposes desktop computer testing to be done with a single 1080p (1920x1080) display, in lieu of an adder approach

- **Expandability Score:** Industry proposes to add a score of 100 for systems that support at least 4-channels of memory, or at least 256 bits memory interface on the CPU (See Appendix E for justification based on power data).

- **Use of Expandability Score for high-end system exemption:** Industry prefers exemption criteria based on proposed system definitions already submitted.

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[3] See Table 5 & 6 for proposed system memory bandwidth (SYS_MEM_BW) adder thresholds

[4] See APPENDIX B for proposed equation based allowance system

Should CEC decide on using expandability score as exemption criteria, Industry proposes:

a) Expandability score of >650 (instead of current CEC proposal of >750)
OR
b) Computers incorporating a 600 W or greater power supply AND at least one discrete GPU with a frame buffer bandwidth of 400 GB/s or greater for Tier 1, or 600 GB/s or greater for Tier 2

- **Security and Manageability:** Currently there is no power adder for systems supporting security and manageability even though they consume significantly more power in idle mode. Some systems add dedicated hardware encryption engines (Example: Dell OptiPlex 9020 micro), where these chips consume energy. Industry showed measured data in its submission[5] to CEC docket that short and long idle power between two similar systems with and without security and manageability is 6.1W and 5.7W respectively. Industry is proposing 30kWh adder for systems supporting security and manageability. Industry is ready to address this further.

- **Add-in cards (AIC):** Industry is proposing adders for the following populated devices. The adder proposal is based on measured data (Appendix E). These expansion cards are expected to have significant power consumption in idle mode. The adders will only apply with these devices are populated when tested.

Table 3

Type of Device	AIC Proposed TEC Adder (kWh)
Legacy Port	10
TV Tuner	10
Wired Ethernet - 1Gb - <10Gb (beyond the 1st Network)	10
RAID - 2 port	10
SATA & USB (Add-in Card only)	10

[5] See ITI submission to CEC docket (page 11) comparing system idle power differences of two systems with & without Security (TPM, hardware encryption engines) & Manageability.
http://docketpublic.energy.ca.gov/PublicDocuments/14-AAER-02/TN205339_20150713T141604_Chris_Hankin_Information_Technology_Industry_Council_Comments_J.pdf

Wi-Fi	10
RAID - 4 port	20
Discrete Audio	20
Wired Ethernet10 Gb+	25
NVM PCI-E Storage	35
RAID - 8 port	60
Security Video Cards	TBD
Video Capture Cards	TBD

Note: Legacy Port = (Parallel Port, Serial Port, Firewire, eSATA)

Notebook PCs Approach:

- **Notebook Categories:** Industry supports CEC final staff draft position to have a single target of 30 kWh/year plus applicable adders. Notebook form factors have already made huge year over year energy consumption improvements driven by battery life and market forces. Industry agrees with CEC assessment[6] that potential energy savings impact for notebooks is not significant. Industry is of the view that there is not enough return on investment (ROI) to focus on energy consumption reduction of notebooks PCs.

- **Notebook exemptions:** Industry is proposing to exempt high-end mobile workstations and gaming notebooks from TEC requirements (if they met 100% of industry proposed definition – Appendix A). System level TECs for these type systems vary widely and it is not feasible to propose multiple TEC limits. These systems will need to comply with power management enabled as-shipped and an External Power supplies (EPS) must comply with DOE's Mark VI energy efficiency standards.

Notebooks PCs Adders Description and Framework:

- **CPUs/APUs/SOCs:** A new class of TEC adder is being proposed based on system memory bandwidth (above the base), that applies to all systems and covers system memory bandwidth (SYS_MEM_BW)[7] and associated CPU/APU/SOC.

    - System memory BW serves as a proxy for processor capability
    - System memory BW adder will coexist with other proposed adders (it does not replace other proposals)

[6] Source: CEC Final Draft Staff Report, March 30, 2016

[7] See Table 5 & 6 for proposed system memory bandwidth (SYS_MEM_BW) adder thresholds

- Products following historical BW growth trend should be covered by Base TEC while step-function improvement capability should be eligible for an adder (see detailed proposal in appendix C)

- **System Memory:** As addressed earlier industry appreciates CEC's intent to simplify memory adder (based on module approach). However, this is not workable given that memory is not always attached as a module (limits FF innovation; limits z-height in mobile systems). Industry proposes CEC to align system memory adders based on Draft 1 approach (0.8 kWh per GB RAM).
- **Storage (HDDs, SSDs, ODDs):** Industry agrees with CEC's proposal on 2.6 kWh/yr.
- **Discrete GPUs:** Industry proposes to align with an equation based allowance system tied to frame buffer bandwidth[8] (Appendix B).
- **Energy Efficient Ethernet (EEE):** Industry agrees with CEC to align with ENERGY STAR v6.1 framework, including the allowance
- **Integrated Display:** Industry agrees with CEC to align with ENERGY STAR v6.1 framework, including the allowance

3.3. Power Management:

(NOTE: Appendix D, being filed separately, features an Excel file that identifies specific issues/questions involving power management.)

ITI members worked with CEC and other advocates to identify and resolve a number of problems associated with the computer power management and associated Total Energy Consumption (TEC) requirements specified in CEC's first Staff Report regulatory language. With exception of one specific instance, the remainder of the problems industry identified has not been resolved in CEC's "Final Draft" Computer regulatory language.

ITI members are and will continue to work with CEC to resolve the problems associated with computer power management and associated Total Energy Consumption (TEC) requirements outlined below.

1. CEC regulatory language imposes power management requirements based on characteristics of traditional power management solutions, such as solutions provided in Microsoft Windows, Apple iOS Operating Systems. If CEC's regulatory language is not revised to address the issues industry has identified, manufacturers will no longer be able to sell computers in California with alternative operating systems / power management solutions listed below.

[8] See APPENDIX B for proposed equation based allowance system

a. Computers configured with Microsoft FreeDOS Operating System for commercial customers:
When requested by commercial customers, some computers are configured and shipped with a Microsoft FreeDOS Operating System that is used by the customer's IT Departments to boot up the computer one-time enabling installation of the customer's customized software image (that typically includes a full-featured Operating System such as Microsoft Windows). After using the FreeDOS Operating System one time, the IT Departments install their customized Operating System that is typically a full-featured Operating System (such as Microsoft Windows) that includes power management capability for use over the life time of the computer. This practice makes the installation of the customer's customized Operation System easier and prevents complications such as potentially being required to pay for an Operating System twice. E.g. once for the Operating System installed on the as-shipped computer and another for the Operating System included as part of the custom software image. Computer Manufacturers do not ship all configurations within a Computer Model Family with a FreeDOS Operating System, because FreeDOS is not a full-featured Operating System

b. Computers configured with a LINUX based Operating System:
There are some configurations within Computer Model Families that are sold to customers who need a very basic Operating System, such as the open source LINUX based Operating System variants. These customers are typically commercial customers who do not need or want to purchase a full-feature Operating System. Computer Manufacturers do not ship all configurations within a Computer Model Family with a LINUX based Operating System. Computers configured with the open source LINUX Operating Systems are a very low percentage of total computers shipped as indicated by the data that has been provided to CEC. Computers configured with one of the open source LINUX based Operating Systems, will not be legal for sale if the current regulatory language for computer power management is unchanged.

c. Computers configured with a Chrome Operating System:
There are some configurations of smaller Notebook Computers that are configured with a Google Chrome Operating System. Computers configured with a Chrome Operating System do provide power management functionality for the computer and connected displays. However the power management functionality provided for the computer, does not fit CEC's currently proposed definition of "Sleep Mode". And if unchanged, will prevent sales of computers with a Google Chrome Operating System in California.

ITI members have provided CEC with details about how the Google Chrome Operating System provides power management of connected displays and power management functions and recommendations for resolving this issue in this response and the detailed spreadsheet (also shown in Appendix D).

d. Computers configured with an Android Operating System:
There are some configurations of smaller Notebook Computers that are configured with an Android Operating System. Computers configured with an Android Operating System do provide power management functionality for both connected displays and the computer. However the power management state for the computer functionality provided for the computer, does not fit CEC's currently proposed definition of "Sleep Mode". And if unchanged, will prevent sales of computers with an Android Operating System in California.

ITI members have provided CEC with details about how the Android Operating System power management functions and recommendations for resolving this issue in this response and the detailed spreadsheet (also shown in Appendix D).

2. CEC's regulatory language definition for Sleep Mode requires a minor revision to make it less specific to traditional "Sleep Modes" (like ACPI S3). ITI members have provided recommendation for revising the CEC Sleep Mode definition in our detailed spreadsheet and as discussed below.

3. CEC's regulatory language specifying power management requires clarification consistent with the ENERGY STAR Computer Program Requirements that recognizes use of "alternative low power modes" when the product does not support "Sleep Mode". Examples of these low power modes include "Long Idle", Modern Standby, and it is likely there will be other yet to be defined modes in the future.

4. CEC's regulatory language specifying the TEC requirements should also include the clarification discussed above regarding use of "alternative low power modes" in the TEC formula, when the computer does not support "Sleep Mode" as discussed below.

5. CEC power management requirements need to include an exemption for Rack Mounted Workstations that do not support System Level Sleep Mode Power Management requirements for the following reasons:
   a. Rack Mount Workstations reside in datacenters and is managed like a server
   b. Used in a 24/7 datacenter operation environment with minimal unscheduled downtime
   c. Operates in a simultaneous multi-user environment capable of serving several users (not a single user computer covered under the CEC defined Workstations)
   d. Due to the large amount of system memory, response times to recover from S3/S4 do not allow manufactures to meet SLA requirements related to response time and availability.

We appreciate CEC's willingness to continue working with industry to get power management and TEC requirements right and anticipate being able to resolve these issues with CEC prior to the Computer appliance efficiency regulation being finalized. Recommendations for revising the CEC Computer Power Management and TEC formula regulatory language to address all of the issues ITI members are outlined below.

1. Revise the definition of Sleep Mode to make it less specific to a traditional "Low Power Sleep Mode" such as ACPI S3. The spreadsheet detailing industry recommendations provided to CEC recommends a minor change to CEC's Sleep Mode definition to accomplish this recommendation (also shown in Appendix D).

2. Add language to the power management requirements (sections listed below) consistent with ENERGY STAR Computer power management requirements recognizing use of "alternative low power modes" when the product does not support "Sleep Mode". Examples of these low power modes includes "Long Idle", Modern Standby, and likely other yet to be defined modes in the future. This change to the power management requirements is intended to permit selling computers configured with non-traditional power management solutions such as those provided in the Google Chrome, Android and other operating systems that provide alternative low power modes (such as Long Idle, Modern Standby, etc.). Industry has provided CEC with recommended regulatory

language to address this issue in a detailed spreadsheet to accomplish this recommendation (also shown in Appendix D).

3. Revise the power management requirements to permit computer manufacturers to sell some configurations of computers with the Microsoft FreeDOS and LINUX based Operating System when requested by commercial customers (for one-time use by IT Department enabling installation of customers' software image) for the reasons described above.

4. Revise the regulatory language specifying use of the Total Energy Consumption (TEC) metric to enable use of "alternative low power modes", when the computer does not support "Sleep Mode". For Notebooks, Desktops, and Integrated Desktops that use an alternative low power mode in place of system sleep mode (systems that do not support a traditional ACPI S3 sleep mode), alternative low power states or modes may be used instead of power in Sleep mode in the TEC equation for qualification if the alternative low power mode is less than or equal to 10 W. In such instances (P_{SLEEP} X T_{SLEEP}) is replaced by (P_{LONG_IDLE} X T_{SLEEP}).

CEC Regulatory Reference Sections requiring revision (also listed below in the table)
- Sleep Mode definition - Page 41 (actual 53) Chapter 15, section1602 (v) "Sleep Mode"
- Power Management Requirements - Page 44 (actual 56), Chapter 15, section 1605.3 (v) (4) (B) (3) and Page 45 (57 actual) Section 1605.3 (v) (5) (C) and (D), and:
- Power Management Requirements - Page 44 (actual 56) Chapter 15, section 1605.3 (v) (4) (B) (3) and Page 45 (57 actual) Section 1605.3 (v) (5) (C) and (D)

ENERGY STAR Computer Program Requirements, Ver. 6.1 references applicable to computer power management and TEC Formula (when system does not support Sleep Mode):
- Power Management Requirements [section (3.3)(3.3.1) (i-iv), and Table 2

Calculated Typical Energy Consumption (E_{TEC}) for Desktop, Integrated Desktop, and Notebook Computers per Equation 1 and use of alternative low power mode reference is section (3.5)(3.5.1)(iv)

- We recommend reviewing each case to determine if CEC wants to permit or prohibit selling computers configured with OS software that does not conform to the requirements CEC specified

- Manufacturers need flexibility when TEC based power consumption limits are met:
  - Power management requirements should permit shipment of all computers when the TEC based power consumption limits are met.

- We appreciate CEC's willingness to continue working with industry to get power management requirements right.

- Once CEC has determined if they will permit continued sales of computers configured with software providing non-traditional power management schemes, we can work collectively to determine how to specify the regulatory requirements to eliminate ambiguity and accomplish CEC's goals.

4 INDUSTRY RECOMMENDATION ON REGULATORY LANGUAGE

Description	Page	Key Concerns	Industry Recommendations
1601 Scope	39	• Computers product scope details not listed	• Add type of computers in-scope, in-scope but exempt from TEC requirements and out of scope products (see industry proposal section 3.1above)
1602 Definitions	39-42	• Industry proposed changes not addressed. Some new definitions need to be updated	• Adopt modified product definitions that ITI/IOUs agreed (DT/AIO; WS; etc.) • Add out of scope product definitions, where available • Add new definitions for high-end system exemptions, system memory bandwidth, alternative low power mode, etc. • Add "Hybrid Graphics: Functionality that allows Discrete Graphics to be disabled when not required in favor of Integrated Graphics"[9]. • Sleep Mode definition - Page 41, section1602 (v) "Sleep Mode" per above
1604 Test Methods for specific appliances (computers)	42-43	• Test methods are not updated to account for net changes from ENERGY STAR test methods	• CEC should address industry outlined concerns and questions with respect to TEC weighting to be used to incentivize user inability to disable power management. • Add TEC equation changes under different usage and power management scenarios • Add power measurement test procedure changes for always connected systems • Add high-end systems desktop and mobile systems, and small volume manufacturer that meeting definition and minimum requirements are to be exempt from TEC requirements (see industry proposal for high-end system exemption from TEC) • Update (4)(D), 'A computer monitor used in the testing of desktop computers shall have a native resolution of 1920x1080 pixels and use progressive scanning. The computer operating system shall be set to operate at 1920x1080 pixels and progressive scanning.', add *"The display interface used for testing must follow this connector priority order: Display Port, HDMI, DVI, VGA, Other."* • Expandability Score (4)(C) Add to the table under Port Type '4-channel memory, and under 'Port score' add score (see industry proposal and justification) • Add criteria for systems to qualify for full networking connectivity (industry will have a proposal)

[9] Note: This functionality allows lower power and lower capability integrated GPUs to render the display while on battery or when the output graphics are not overly complex while then allowing the more power consumptive but more capable discrete GPU to provide rendering capability when the user requires it.

Description	Page	Key Concerns	Industry Recommendations

1605.3 State Standards for Non-Federally Regulated Appliances	44-45	• Not comprehensive, does not address all system requirements and scenarios	• (1605.3)(4)(B) needs to address all power management scenarios/language that industry proposed (Appendix D – See separate Excel file)
			• Add appropriate power management sections from ENERGY STAR v6.1 Computers (3.3)(3.3.1)(i-iv). At minimum must add (3.3)(3.3.1)(iv) regarding products that do not support sleep mode by default.
			• Table V3 - change Desktop and Thin Clients implementation dates to January 1, 2019 (24 months after regulation adoption)
			• Update Table V3 with Desktop and Thin Clients with categories and base TEC limits (Table 1 above), including expandability score treatment
			• Table V4 changes: Update memory adder to align with CEC draft 1 (see industry concerns); delete expandability score as an adder; include other industry prosed add-in card and device down adders (Table 2 above); update AIO display adder equation to reflect 20% reduction; replace "Discrete Graphics" by "First Discrete GPU"; replace "Additional Discrete Graphics" by "Each Additional Discrete GPU"; Add "The Discrete GPU adders are not applicable to integrated desktop and notebook computers that are tested with the hybrid graphics functionality enabled by default."
			• Table V4: Update Discrete GPU adders tier 1 and 2 schedule:
			  ○ Tier 1: Discrete GPU adders will be effective no sooner than 1/1/18[10].
			  ○ Tier 2: Discrete GPU adders will be effective no sooner than 1/1/20.
			• Table V4: Update Discrete GPU adder equations (see Appendix B)
			• 1605.3 (v)(5)(A). Modify power supply requirement to read "be powered by a power supply that meets the 80Plus Gold performance standards *or an external power supplies (EPS) with DOE's Mark VI energy efficiency standards*"
			• 1605.3 (v)(5)(D), update power management to include workstations that do not support sleep mode by default (see Industry proposal on power management scenario)

[10] This applies to Notebook computers. Industry proposal for DT/AIO implementation is for 24 months (1/1/2019) implementation, after the final regulation is adopted.

Description	Page	Key Concerns	Industry Recommendations
1606 Filing by manufacturers : Listing of Appliance in the Database (computers)	46	• Table X is incomplete and will need to be updated as the standard becomes stable	• Table X changes: ○ Replace “Discrete Graphics” by “Discrete GPU” ○ Replace “ Bandwidth in Gigahertz” by “Bandwidth in Gigabyte per second” ○ Add “For integrated desktop and notebook computers, does the computer enable hybrid graphics functionality during testing?” “Yes/No” ○ The display connector used for testing will need to be clearly identified as well as its corresponding Discrete GPU adder. ○ Note: There will be other changes expected through the rulemaking process

APPENDIX A:

DEFINITIONS:

Workstation Definition:

"Workstation" means a high-performance single/multiple user computer used for graphics, Computer Aided Design, software development, financial and scientific applications among other computation intensive tasks. Workstations covered by this specification (a) Do not support altering frequency or voltage beyond the CPU and GPU manufacturers' operating specifications; and (b) Have system hardware that supports error-correcting code (ECC) that detects and corrects errors with dedicated circuitry on and across the CPU, interconnect and system memory.

In addition, a workstation meets three or more of the following criteria:

a) Support for one or more graphic/compute accelerators
b) Support for greater than or equal to 4 lanes of PCI-express. Each lane with bandwidth greater than or equal to 8 Gb/s.
c) Contains five or more expansion slots or ports. Each slot or port with a bandwidth greater than or equal to 5 Gb/s.
d) Provide multi-processor support for 2 or more processors (shall support physically separate processor packages/sockets, i.e., requirement cannot be met with support for a single multi-core processor)
e) Qualified by two or more Independent Software Vendor (ISV) products. Certifications must be completed or in process at the time of product introduction.

Proposed High Performance PCs (Desktop, Notebooks) definitions and CEC qualification criteria:

Note: All high performance PCs defined below are to be exempt from CEC's system TEC requirements provided they meet 100% of system definition and qualification criteria. [Industry is currently investigating CEC proposal for high-end desktop/AIO PC exemption based on expandability score].

- **Professional desktop definition:** A high-end desktop computer that has high performance, single/multi user processing capabilities, typically used for graphics, computer-assisted design (CAD), software development, and

financial and scientific applications among other computer-intensive tasks. In addition, the high end professional desktop must meet all of the following criteria:

1. contains ≥6 physical processor cores in the central processing unit (CPU); and
2. integrated GPU providing total system memory bandwidth of ≥226 GB/sec, or discrete GPU(s) providing a frame buffer bandwidth ≥ 192 GB/s per GPU; and
3. provides expansion capabilities through four or more expansion slots or high-bandwidth external I/O connections of at least 10 Gb/s each, not including dedicated display ports; and
4. support ≥4 independent displays

Professional Desktops: Industry Proposal for CEC compliance:

- Meets all of system definition
- Power supplies meet 80PLUS® Gold efficiency requirement (not required to be certified by 80PLUS® program)
- Power Management setting enabled as-shipped (per ENERGY STAR v6.1 framework)

- **Gaming Desktop definition:** A high-end gaming desktop computer must meet ALL of the following criteria:

1. contains ≥6 physical processor cores in the central processing unit (CPU); and
2. Integrated GPU providing total system memory bandwidth of ≥226 GB/sec, or discrete GPU(s) providing a frame buffer bandwidth ≥ 192 GB/s per GPU; and
3. supports a minimum 16GB of system memory; and
4. contains minimum of 8 USB ports with at least 2 that support at least 10Gb/s; and
5. supports lighting and special effects such as RGB LED based chassis lighting that can be controlled by either user configurable lighting settings, or by in-game events or PC system events.

- **Gaming Desktops: Industry Proposal for CEC compliance:**
  - Meets all of system definition
  - Power supplies meet 80PLUS® Gold efficiency requirement (not required to be certified by 80PLUS® program)
  - Power Management setting enabled as-shipped (per ENERGY STAR v6.1 framework)

- **Mobile workstation definition:** Means a high-performance, single-user computer primarily used for graphics, Computer Aided Design, software development, financial and scientific applications among other compute intensive tasks, and which is designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an AC power source. Mobile workstations utilize an integrated display and are capable of operation on an integrated battery. Most mobile workstations use an external power supply and have an integrated keyboard and pointing device. In addition, a mobile workstation must meet ALL of the following criteria:

1. qualified by 2 or more Independent Software Vendor (ISV) product certifications; these certifications can be in process, but shall be completed within 3 months of qualification; and
2. has at least one integrated GPU meeting the minimum system memory bandwidth of ≥134 GB/sec or discrete GPU(s)providing a frame buffer bandwidth ≥ 96 GB/s per GPU; and
3. supports the inclusion of two or more internal storage devices; and
4. supports at least 32GB of system memory

- **Mobile Workstation: Industry Proposal for CEC compliance:**
  - Meets all of system definition
  - External Power supplies (EPS) must comply with DOE's Mark VI energy efficiency standards.
  - Power Management setting enabled as-shipped (per ENERGY STAR v6.1 framework)
  - Battery charger system (BCS) energy efficiency must comply with DOE or CEC efficiency standard (whichever is in effect)

- **Gaming Notebook Definition**: A Gaming Notebook computer must meets ALL of the following criteria:
  1. contains ≥ 4 physical processor cores in the central processing unit (CPU); and
  2. Integrated GPU providing total system memory bandwidth of ≥134 GB/sec, or discrete GPU(s) providing a frame buffer bandwidth ≥ 96 GB/s per GPU; and
  3. supports a minimum 8 GB of system memory; and
  4. supports Optional second storage device such as RAID Hard Drive ; and
  5. contains super speed USB 3.0 Ports; and
  6. supports lighting and special effects such as RGB LED based chassis lighting that can be controlled by either user configurable lighting settings, or by in-game events or PC system events.

- **Gaming Notebooks - Industry Proposal for CEC compliance:**
  - Meets all of system definition
  - External Power supplies (EPS) must comply with DOE's Mark VI energy efficiency standards.
  - Power Management setting enabled as-shipped (per ENERGY STAR v6.1 framework)
  - Battery charger system (BCS) energy efficiency must comply with DOE or CEC efficiency standard (whichever is in effect)

APPENDIX B – DISCRETE GRAPHICS ADDER FRAMEWORK

The graphics adders are used to increase the allowable energy consumption of a basic system that includes at least one discrete graphics processing unit (GPU).

Discrete GPU Adders in CEC Final Draft table V-4, should be updated with these equations

Table 4:

Function	Desktop and Thin-Client Adder (kWh/year)	Notebook Adder (kWh/year)
First Discrete GPU (before January 1, 2020) Where "B" is frame buffer bandwidth measured in GB/s	60.9*TanH(0.0038*B-0.137)+27.9	29.3*TanH(0.0038*B-0.137)+13.4
First Discrete GPU (after January 1, 2020) Where "B" is frame buffer bandwidth measured in GB/s	38*TanH(0.006*B-0.27)+21.6	17.8*TanH(0.006*B-0.27)+10.1
Each Additional Discrete GPU	11	5.5

APPENDIX C: CPU/APU/SOC ADDER FRAMEWORK

TEC Adders for System Memory and CPUs/APUs/SOCs

Today's PC systems implement multiple topologies for CPU, Graphics and memory due to various performance, power, and form-factor needs. To cover the range of PC segmentation from Entry level to High-end, multiple instances of CPU (typically up to 2 physical sockets– for high-end desktops that don't meet Workstation classification) and Graphics (typically up to 3 devices – add-in card or motherboard-down) can exist within a single PC system. Memory is required to support each instance of CPU or graphics in the system.

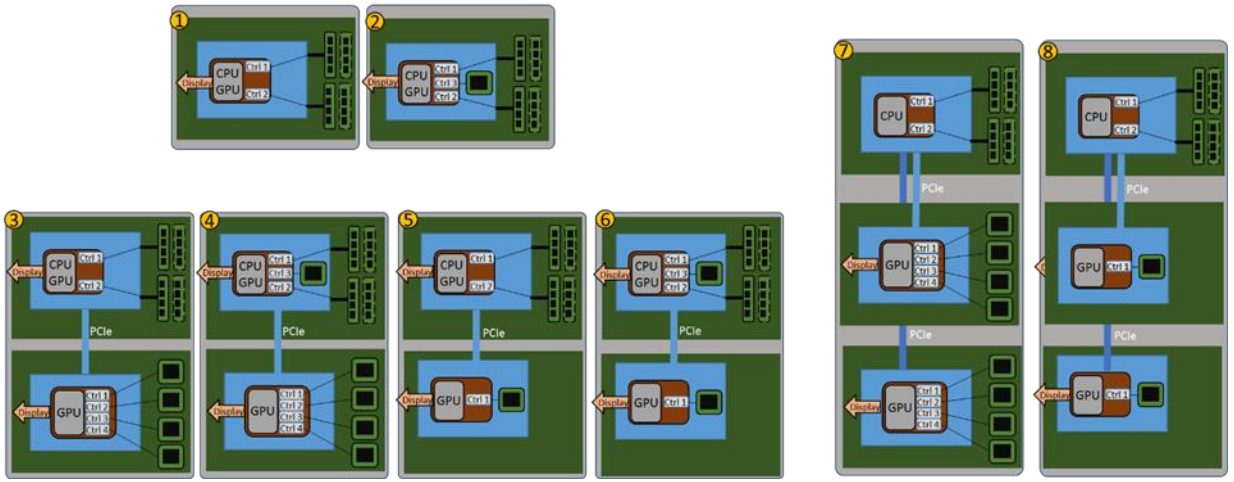

Figure 1: 1-Mainstream Integrated Graphics, 2-Performance Integrated Graphics, 3-Mainstream Discrete Graphics, 4-Performance Integrated & Discrete Switchable Graphics, 5-High Performance Discrete Graphics, 6-High Performance Integrated & Discrete Switchable Graphics, 7- Desktop with two mainstream Discrete Graphics, 8- Performance Desktop with two High Performance Discrete Graphics

There are two aspects of memory design within a PC system to consider in order to properly account for its energy footprint:

1) **The number of memory devices:** Current memory technologies expend power even in idle or light-load conditions. The Energy Star 6.1 formula uses 0.8 kWh /GB of installed memory. This level of energy consumption is consistent with current system memory technologies such as DDR3, DDR4 (roughly ~100mW DC at idle) per DRAM device. For the 2017 timeframe and beyond, memory vendors will be using 8Gb density per DRAM device so 0.8 kWh/GB remains a good representation of memory energy consumption for the addressable future. Note that memory PHY power can be improved by improving its proximity to the host logic, e.g. DIMM -> motherboard -> on package. This increasing level of integration is not a panacea for energy reduction due to the added cost of such technologies (typically over 2X the cost of conventional technology). We propose that the same TEC adder of 0.8 kWh/GB of memory continue to be used for System memory (i.e. memory attached to a CPU or integrated CPU/GPU).

2) **The arrangement of DRAM devices to produce the desired aggregate bandwidth:** Memory can be arranged in a high bandwidth configuration to service its associated compute resources. In this scenario, memory controller logic proportional to the memory bandwidth will exist on the host silicon. Since high performance compute engines require a proportional amount of bandwidth to scale up in performance, it necessarily follows that high performance systems, whether it be multiple CPU or GPUs, tend to have higher energy expenditure in their memory controller design. To account for this increase in memory subsystem energy, we propose new TEC adders based on system memory bandwidth tiers. This will be additional to the existing G1-G7 tiers, since the current FB_BW tiers do not include the system memory BW in its calculations – it's only reserved for discrete graphics memory. The existing FB_BW definition does not account for future high performance integrated graphics implementations. Due to the industry's trend for increasing levels of integration, high bandwidth memory subsystems will exist in both SoCs (examples 2,4,6 in Figure 1) and in discrete graphics solutions (examples 5,6 in Figure 1). While the integration may lead to the reduction of the number of memory subsystems present in the system, it does not absolve each individual memory subsystem of its energy requirements.

Due to the co-existence of both topologies (Refer to the topologies in Figure 1) in the market, we propose a holistic *System Memory Bandwidth (SYS_MEM_BW)* additive approach that accounts for growth in memory bandwidth in either integrated or discrete graphics implementations. Systems with discrete graphics can continue to use traditional discrete GPU adders. We propose a new class of TEC adders based on system memory bandwidth (see below) that applies to all systems, and covers system memory bandwidth and associated CPU/APU/SOC.

Table 5: CPU/APU/SOC Approach:

Proposed System Memory Bandwidth Adder (SYS_MEM_BW = motherboard memory BW + in-package BW) [BW = bit-width * bit-rate]	CPUs/APUs/SOCs DC Power, Watts
DT and AIO adder (SYS_MEM_BW > 146 GB/sec)	Equation CD
Notebook adder (SYS_MEM_BW > 134 GB/sec)	Equation CN

- SYS_MEM_BW= System Memory Bandwidth, GB/sec:
  - Equation CD (kWh) = 22.78 * tanh (0.006 * (SYS_MEM_BW-70) + 0.15) - 12.33
  - Equation CN (kWh) = 9.11 * tanh (0.006 * (SYS_MEM_BW-70) + 0.15) - 4.45

- **Table 6 (Example of CPU/APU/SOC SYS_MEM_BW adders for AIO/DT, and Notebooks, using equation):**

System Memory Bandwidth (SYS_MEM_BW) (GB/s)	DT and AIO Proposed TEC Adder (kWh)	System Memory Bandwidth (SYS_MEM_BW) (GB/s)	Notebook Proposed TEC Adder (kWh)
42	0.0	46	0.0
50	0.0	54	0.0
58	0.0	62	0.0
66	0.0	70	0.0
82	0.0	86	0.0
98	0.0	102	0.0
114	0.0	118	0.0
130	0.0	134	0.0
146	0.0	150	0.6
162	1.5	166	1.2
226	5.8	230	2.9
290	8.2	294	3.8
354	9.4	358	4.2
546	10.3	550	4.6
1058	10.4	1062	4.7
2082	10.4	2086	4.7

Table 6 notes:

1) SYS_MEM_BW TEC adder applied only if system memory bandwidth exceeds threshold values.

2) The proposed adders for Desktop/AIO CPUs and Notebook CPUs are different due to differing performance requirements which drives the choice of silicon technology manufacturing processes and design parameters.

Proposed System TEC calculations:

1) Desktop/AIO TEC = Base TEC + 0.8kWh/GB of system memory + discrete GPU adders + new SYS_MEM_BW adders (if above threshold) + other TEC adders (for example HDD)
2) Notebook TEC = Base TEC (scaled for notebooks) + 0.8kWh/GB of system memory + discrete GPU adders + new SYS_MEM_BW TEC adders (if above threshold) + other TEC adders (for example HDD)

APPENDIX D (Power Management)

Note: Power Management Scenarios is provided in separate Excel file, submitted to CEC docket along with this submission.

APPENDIX E (Supporting Data)

Table 7: Add-in-Card Measured Data

Type of Device	Idle AC power measured	TEC Calculation	AIC Proposed TEC Adder
Legacy Port	2.5	11.0	10
TV Tuner	2.1	9.2	10
Wired Ethernet - 1Gb - <10Gb (beyond the 1st Network)	2.2	9.6	10
RAID - 2 port	1.75	7.7	10
SATA & USB (Add-in Card only)	3.2	14.0	10
Wi-Fi	2.9	12.7	10
RAID - 4 port	4.33	19.0	20
Discrete Audio	5	21.9	20
Wired Ethernet 10 Gb+	5.5	24.1	25
NVM PCI-E Storage	8	35.0	35
RAID - 8 port	14	61.3	60
Security Video Cards			TBD
Video Capture Cards			TBD

Note:

- Legacy Port = (Parallel Port, Serial Port, Firewire, eSATA)

APPENDIX E (Supporting Data)

Justification for granting expandability score of 100 for 4-channel memory support:

Criteria: Systems supporting at least 4-channels of memory, or at least 256 bit memory interface on the CPU

Rationale: Expandability score is built around power supply sizing for the total system. In a Non-Exempt Desktop computer the processor TDP that is used for Power Supply sizing can be 45 watts, 65 watts and a few are up to 91 watts. All of these processors support only 2 channels of memory. The only desktop processors that support 4 channels of memory are 140 watt TDP. Power supply sizing also has to take into account the VR Efficiency and turbo options of these processors for peak loading. A processor can turbo 125% over the TDP level, and VR efficiencies are ~90% for the processor rails. Also these processors are expected to reach full power more than other desktops because of the workloads they are expected to handle. These higher power processors are available to provide such a level of performance. Therefore 140 watt, with 125% Turbo delivers 175 watts, and VR efficiency moves the total up to 195 watts. The other desktop processors only need a power supply size of 100 watts to handle the peak loads. Therefore the power supply size for processors that support 4 channels of memory will need to be 100 Watts higher than computers based on other desktop processors.

Some Data Examples: The examples below shows data and calculations for 6 systems built with similar processors that all support 4 channels of memory. The bottom 3 systems have a smaller motherboard and therefore lower Expandability Score, but the power draw is similar to the larger systems and on a different scale compared to the average value of the DT-2 Category systems.

Table 8: Add-in-Card Measured Data

Exempt Systems	Expandability Score	Total I/O Bandwidth	Measured TEC	Short Idle (W)
A	745	528	410.07	91.35
B	810	720	420.55	95.29
C	750	660	334.19	73.8
D	575	404	353.01	80.54
E	575	404	356.72	81.4
F	575	404	382.70	87.32
Average DT-2 Category system	495	194	174.6	39.8