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California Investor Owned Utilities - Comments re Proposed Amendments to Title 20 Computer and Monitor Regulations

Additional submitted attachment is included below.

Computers and Computer Monitors

Codes and Standards Enhancement (CASE) Initiative
For PY 2017: Title 20 Standards Development

Response to Express Terms for
Amend Title 20 Computer and Monitor Regulations
20-AAER-03

November 16, 2020

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

The Codes and Standards Enhancement (CASE) initiative supports the California Energy Commission's (Energy Commission) efforts to update California's Appliance Efficiency Regulations (Title 20). The three California Investor-Owned Utilities (IOUs) – Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E) – sponsor this effort (herein referred to as the Statewide CASE Team). The Statewide CASE Team's goal is to prepare and submit proposals for cost-effective enhancements to the energy and water efficiency standards for various products sold in California.

Computers and computer monitors have been subject to energy efficiency standards in California since 2016. These technologies are characterized by rapid technological change. To avoid impeding the innovation and introduction of new technologies in computers and computer monitors, the Energy Commission is able to conduct expedited rulemakings to update the regulations as needed. Earlier this year the computer and computer monitor industry made the Energy Commission aware of a number of new technologies and requested adjustments to the existing regulations. The Energy Commission published proposed changes in 45-Day Express Terms on October 1, 2020.[1] In this document, the Statewide CASE Team presents comments, test results, and recommendations related to the Energy Commission's proposed changes.

The current expedited rulemaking addresses four new technologies:

- Notebook computers that exhibit cyclic power draw when connected to mains electricity that is related to charging and discharging the battery
- Notebook computers with multiple screens
- Computers with Ethernet bandwidths of more than one and less than ten gigabit per second (Gb/s)
- Computer monitors with refresh rate of 300 Hertz (Hz) or more

In the 45-Day Language, the Energy Commission proposes definitions, test procedure modifications or clarifications, and additional total energy consumption (TEC) allowances to accommodate each new technology. The Statewide CASE Team obtained notebooks with cyclic power draw, multi-screen notebooks, and high-speed Ethernet add-in cards, and worked with an accredited laboratory to test the appropriateness of the proposed changes. The Statewide CASE Team supports most of the changes, including:

- Test procedure modifications for notebook computers that exhibit cyclic power draw related to battery charging
- Test procedure modifications for notebook computers with multiple screens
- A new adder for systems with greater than one and less than ten Gb/s Ethernet

The Statewide CASE Team also agrees with the Energy Commission's proposal to allow multi-screen notebooks to claim a display adder for each screen that can display the test image in most cases, but questions the need for that adder for displays that do not draw power when displaying a static image.

[1] https://efiling.energy.ca.gov/GetDocument.aspx?tn=234975&DocumentContentId=67850

The Statewide CASE Team was unable to test or inspect fast refresh rate computer monitors, which are not yet available on the market. However, the Statewide CASE Team expresses concern about the upward trend in power requirements for gaming computer monitors. The Statewide CASE Team will track these computer monitors once they are available to the public, but until then has no means to evaluate the appropriateness of the proposed adder.

The following sections contain more detailed responses to the changes proposed for each new technology.

2. Cyclic Power Draw in Notebooks

The Energy Commission's current test procedure for computers requires the measurement of power in four operating modes (short idle, long idle, sleep, and off). A laboratory administering the test procedure logs power draw for five minutes in each mode, calculates the average over that time and uses the average to estimate total energy consumption (TEC). This test procedure implicitly assumes that computers have relatively stable power and that the five-minute measurement interval is representative of power draw over longer periods of time. The computer industry reported that some computers exhibit cyclic power consumption behavior and that a five-minute measurement period might not be long enough to be representative of average power draw over the course of a year, particularly for certain notebook computers that run regular charge-discharge battery cycles as part of normal operation. The Energy Commission has proposed modifications to the test procedure for such notebook computers that are not able to operate without their batteries.[2] The proposed modifications would extend the test intervals of each mode (short idle, long idle, sleep, and off) to measure average power over one or more complete charge-discharge battery cycles.

The Statewide CASE Team worked with an accredited lab to test three notebook computers identified by the computer industry as exhibiting cyclic behavior to test the proposed test procedure modifications and better understand the behavior. The Statewide CASE Team found that the proposed test procedure modifications were adequate to capture cyclic behavior. The cycles observed consisted of long periods of minimal power use (less than 0.1 watt (W)) and shorter periods of abrupt power increase followed by a decay in power, characteristic of a battery charge cycle as shown in Figure 1. This behavior was present in all four modes. The length of the cycles varied by mode, ranging from one to two hours in short idle to 11 to 28 hours in off as shown in Table 1. The notebooks performed similar charging intervals in their various modes of operation; charging intervals lasted about 30 to 40 minutes and consumed about four to five watt-hours (Wh) of energy.

Each notebook tested during this effort was able to operate without its battery. Tests conducted with the battery removed showed stable power use with no cycling, confirming that the cyclic behavior is related to battery charging. Average power draw with the battery removed was similar to the average power draw over a full cycle for each of the notebooks tested as shown in Table 1.

The Statewide CASE Team only tested notebook computers that were able to operate without batteries and is not aware of any notebook computers that are unable to operate without their batteries and demonstrate cyclic behavior. The current computers test procedure requires that

[2] The Energy Commission's test procedure requires the battery of a notebook computer to be removed for testing if it can operate without it.

batteries be removed during testing if computers can operate without them. To test compliance of these models with the regulation, each of the notebook computers tested by the Statewide CASE Team would be tested according to the present test procedure, and therefore would not require testing of full cycles. Nonetheless, the Statewide CASE Team finds that the proposed test procedure for notebooks with cyclic behavior and unremovable batteries is adequate to measure average power draw of these types of systems.

Table 1: Power and Cycle Length Measurements for Notebooks with Cyclic Behavior

Unit Under Test	Mode	Battery Present				Battery Removed
		Full Cycle		Charging Interval		
		Duration (hours)	Average Power (W)	Duration (minutes)	Energy Consumed (Wh)	Average Power (W)
A	Short idle	1.9	2.8	33	5.1	2.9
	Long idle	6.3	0.74	33	3.9	0.98
	Sleep	16	0.40	38	4.6	0.38
	Off	24	0.31	37	4.5	0.28
B	Short idle	1.8	2.9	33	5.1	3.2
	Long idle	5.2	0.85	32	3.8	0.96
	Sleep	18	0.40	40	4.6	0.39
	Off	28	0.29	39	4.7	0.27
C	Short idle	1.3	3.3	30	4.3	4.1
	Long idle	3.0	1.2	32	3.4	1.9
	Sleep	11	0.43	39	3.9	0.38
	Off	11	0.41	39	3.8	0.38

Source: Statewide CASE Team.

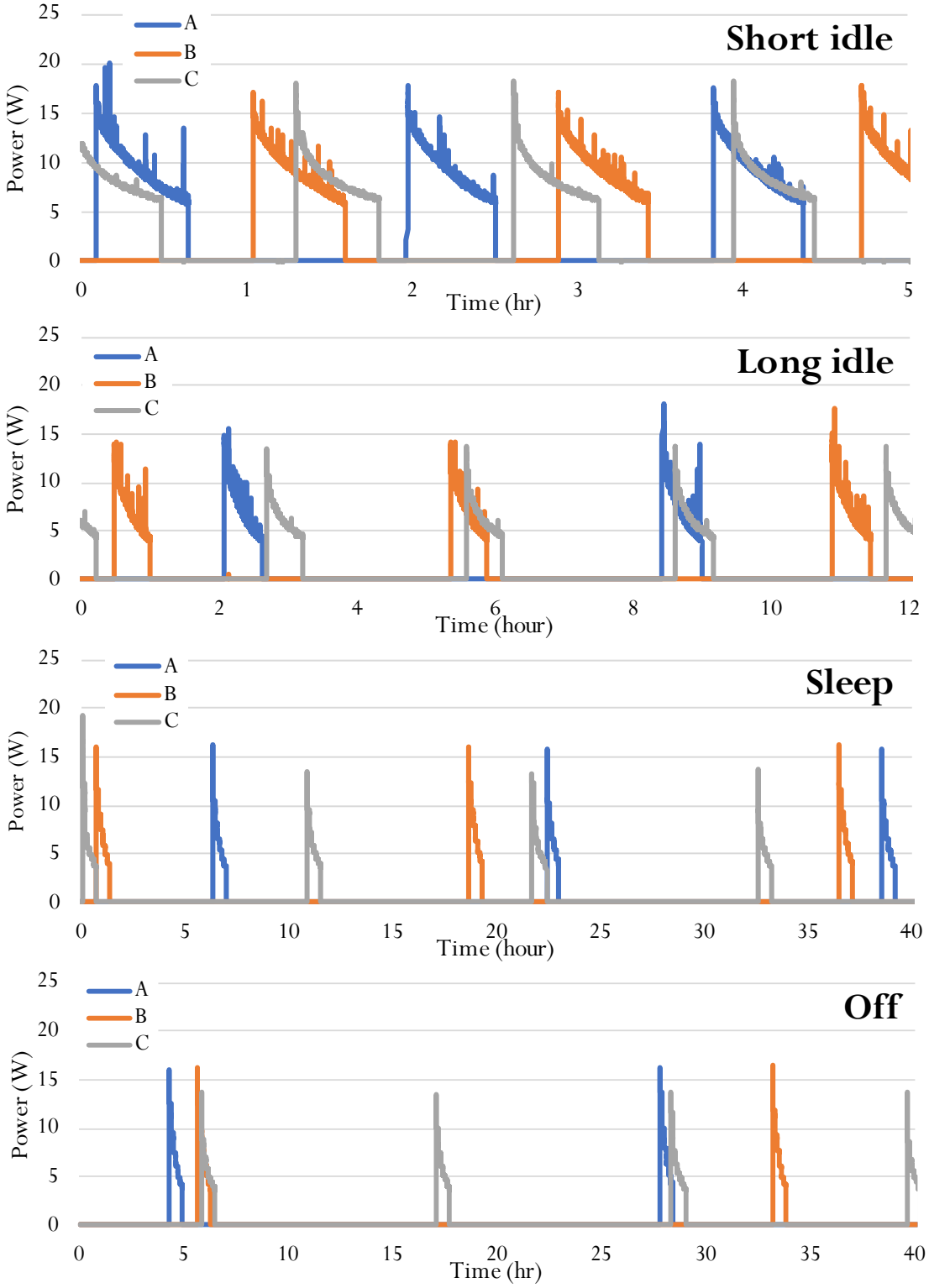

Figure 1: Power measurements for three notebooks with cyclic behavior.

Source: Statewide CASE Team.

3. Multi-Screen Notebooks

The Energy Commission proposes updates to the test procedure and display adders for multi-screen notebook computers. This type of notebook computer was first introduced in 2006, failed to gain significant market share, and is now being reintroduced. In some of these notebook computers, both screens use the same display technology – predominantly liquid crystal display (LCD) panels – and in some cases include touch capability. These computers allow the user to view more information at the same time than single-screen notebook computers. Other configurations provide flexible user input options by incorporating a different display technology, such as E ink, as the secondary display that shows static content such as a touch screen keyboard, a sketchpad, or an e-reader.

The Energy Commission has proposed two changes to address multi-screen notebooks in the computers regulation. These changes include (1) test procedure modifications that instruct the tester to configure each secondary screen in the same manner as the primary screen, and (2) allowing a display adder for each integrated display that is enabled as shipped and can display the test image.

The Statewide CASE Team worked with an accredited lab to test the proposed changes on two notebooks: one notebook with an LCD secondary display (system D) and one with an E ink secondary display that can be used as an e-reader, keyboard, or stylus pad (system E). To estimate incremental power of the secondary display and evaluate the appropriateness of allowing additional adders for secondary screens, each system was tested with and without an active secondary screen.

Results are shown in Table 2. Estimated incremental power of the secondary LCD screen of system D is 2.3 W, equivalent to 6.0 kilowatt-hours per year (kWh/yr) using the conventional duty cycle. Manufacturer specifications do not list the screen resolution or color gamut of the secondary screen. Assuming the secondary screen has the same resolution (2.1 megapixels) and color gamut (100 percent of sRGB,[3] enhanced performance display) as the primary screen, the proposed display adder would be 4.9 kWh/yr.

Table 2: Secondary Screen Characteristics and Estimated Energy Consumption

Unit Under Test	Secondary Screen Characteristics and Test Results					
	Screen Type	Screen Area (inch^2)	Screen Resolution (megapixels)	Short idle Incremental Power (W)	Short Idle Incremental TEC (kWh/yr)	Estimated Adder for Secondary Screen (kWh/yr)
D	LCD	39.4	2.1 (estimated)	2.3	6.0	4.9
E	E ink	49.8	2.1	0.2	0.5	0.0

Source: Statewide CASE Team.

[3] sRGB (or standard Red Green Blue) is an internationally standardized color space developed for computer monitors and printers.

The E ink secondary display in system E was unable to display the test image. The Statewide CASE Team understands, based on correspondence with Energy Commission staff, that this system would therefore not qualify for a secondary display adder. The E ink display draws very little power: 0.2 W, equivalent to 0.5 kWh/yr in energy use for the conventional duty cycle. E ink displays draw power only when changing pixel color and do not draw power when showing a static image.[4] The minimal power draw measured is likely due to the display backlight.

Although the system tested could not display the test image, other E ink displays may be able to do so and qualify for a secondary display adder. Because E ink displays draw minimal power, however, the Statewide CASE Team recommends that the secondary display adder not apply to screens that draw no or minimal power when displaying a static image. In addition, the Statewide CASE Team recommends clarifying that the adder does not apply to secondary screens that cannot display the test image by updating the proposed language in Table V-8 with the changes in red type (deletions shown with strike out text (~~example~~); additions are underlined (example)):

> *For a multi-screen notebook, this adder is applied for each integrated display that is enabled when shipped and ~~shall~~ is capable of showing and configured to show the ~~same~~ test image during testing.*

The Statewide CASE Team finds that the proposed adder is appropriate for LCD screens, and that the proposed test procedure clarifications provide adequate instructions for the tester to ensure that multi-screen systems are tested properly.

4. Computers with High Bandwidth Ethernet

Increasing Ethernet bandwidth has led the Energy Commission to propose a new adder of ten kWh/yr for computer systems with Ethernet bandwidths greater than one Gb/s and less than ten Gb/s. To assess the appropriateness of the proposed adder, the Statewide CASE Team worked with an accredited lab to test four 2.5 Gb/s Ethernet add-in cards in a desktop computer, estimating incremental power as the difference in power of the computer with and without the card.

Incremental TEC ranged from 9.8 to 18 kWh/yr as seen in Table 3. Because Ethernet functionality integrated into the computer is expected to be better optimized in terms of power than Ethernet functionality on add-in cards, the Statewide CASE Team believes the proposed adder of ten kWh/yr is appropriate at this time. The Energy Commission should monitor the energy use of computers with high bandwidth Ethernet as they become available on the market to ensure that the adder continues to be appropriate.

Table 3: Incremental TEC of Network Cards Tested

	Incremental TEC (kWh/yr)				
Unit Under Test	**Short Idle**	**Long Idle**	**Sleep**	**Off**	**Total**
Network card 1	11	3.6	1.8	0.01	17
Network card 2	9.4	3.7	1.9	0.01	15
Network card 3	6.7	2.5	0.64	0.00	9.8
Network card 4	12	3.8	1.7	0.01	18

Source: Statewide CASE Team.

[4] For example, see https://www.eink.com/benefits.html

5. Fast Refresh Rate Computer Monitors

In response to the development of gaming computer monitors with faster refresh rates than previously available, the Energy Commission is proposing a new adder to allow these models to be sold in California. The Energy Commission defines these fast refresh rate gaming computer monitors as computer monitors with maximum refresh rates (MRR) of 300 Hz possessing incremental hardware that matches the refresh rate of the computer monitor to that of the graphics processing unit in the computer that is driving it. The adder increases with MRR; it ranges from 25 percent of the base on-mode power allowance ($E_{on\text{-}max}$) for computer monitors with MRR of 300 Hz to 70 percent of $E_{on\text{-}max}$ for computer monitors with MRR of 480 Hz and greater.

Fast refresh-rate computer monitors expected on the market in coming months have MRR of 360 Hz.[5] These computer monitors would claim an additional 40 percent of $E_{on\text{-}max}$ in addition to the gaming computer monitors allowance of 30 percent of $E_{on\text{-}max}$. For example, the ASUS PG259QN, a 24.5 inch, 2.07 megapixel, 360 Hz computer monitor, would claim an $E_{on\text{-}max}$ of 16.1 W, and combined gaming computer monitor and fast refresh rate computer monitor adders of 11.3 W, for a total of 27.4 W – 70 percent greater than a standard computer monitor of the same size and resolution.[6]

Because these models have not yet been released to the market, the Statewide CASE Team was unable to obtain fast refresh-rate computer monitors to test. However, the continued growth of power allowances for gaming computer monitors raises concern. The video used during on-mode power tests is 60 Hz, and no graphics processing capability requirements of the attached computer for the test. Consequently, it is likely that gaming computer monitors are displaying the test video at 60 Hz during the test, suggesting that the graphics hardware on these computer monitors may draw significantly more power when not needed, a potential missed opportunity to improve power management in these type computer monitors. If increased refresh rate becomes a more common feature of displays in the future, it has potential to increase energy use of computer monitors. In addition, fast refresh rate computer monitors must be paired to computers with fast refresh rate graphics cards, further increasing the power impacts of gaming systems. Unfortunately, because the Energy Commission is setting the adder based on confidential industry data and before any of the products it applies to are available to the public, the Statewide CASE Team and other energy efficiency advocates have no means to evaluate the appropriateness of this adder. The Statewide CASE Team plans to monitor and track this technology as it evolves.

6. Conclusions

In the current expedited rulemaking, the Energy Commission proposes definitions, test procedure modifications or clarifications, and TEC allowances to accommodate new computer and computer monitor technologies. The Statewide CASE Team supports most of these changes, including test procedure modifications for notebook computers with cyclic power draw related to battery charge cycles and multi-screen notebook computers, and the new adder for computers with one to ten Gb/s Ethernet. The Statewide CASE Team also agrees with the Energy Commission's proposal to allow multi-screen notebooks to claim a display adder for each screen that can display the test

[5] https://www.theverge.com/2020/9/2/21418080/nvidia-g-sync-reflex-360hz-refresh-rate-gaming-monitors-alienware-msi-asus-acer

[6] Product information page: https://rog.asus.com/us/Monitors/23-to-24-5-Inches/ROG-SWIFT-360Hz-PG259QN-Model/

image in most cases, but questions the need for that adder for displays that do not draw power when displaying a static image. The Statewide CASE Team expresses concern about the increasing power demand of gaming computer monitors with fast refresh rates and is unable to evaluate the appropriateness of the proposed adder until these products or energy use data become available.