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California Investor Owned Utilities Comments: Electronic Displays - Response to Final Staff Report

Additional submitted attachment is included below.

Electronic Displays

Codes and Standards Enhancement (CASE) Initiative
For PY 2016: Title 20 Standards Development

Response to Final Draft CEC Staff Report,
Revised Analysis for **Computer Monitors and Signage Displays**

Docket #14-AAER-2

May 23, 2016

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1 Executive Summary

The Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas (SCG), San Diego Gas & Electric (SDG&E) Codes and Standards Enhancement (CASE) Initiative Project seeks to address energy efficiency opportunities through development of new and updated Title 20 Standards. Individual reports document information and data helpful to the California Energy Commission (CEC) and other stakeholders in the development of these new and updated standards. This document provides recommendations and supporting analysis in response to the CEC's Staff Report.

Energy use in California from electronic displays – computer monitors and signage displays – is significant and has been growing in some sectors. Computer monitors are ubiquitous in homes, offices, and other commercial settings. They are increasingly used as second screens with notebooks and in extended desktop display setups in home and office environments. Additionally, higher resolutions models (4K and 5K) are being introduced on the market, which can consume as much as five times as much power as a similarly sized regular high-definition model. Monitors account for a significant portion of electricity consumed in computing use. Signage displays are a growing presence in commercial settings, such as retail, restaurant, transit, and hospitality. The California Investor Owned Utilities (CA IOUs) generally support the energy efficiency standards for electronic displays proposed by the California Energy Commission (CEC) in the updated staff report. Specifically, **we strongly support CEC's proposal regarding the modal power requirements for computer monitors between 17 and 29 inches**. Technical data and market information we have docketed with CEC since 2013 support CEC's conclusion that On Mode limits for computer monitors between 17 and 29 inches outlined in the updated staff report are cost-effective and technically feasible across the wide range of computer monitor screen sizes, resolutions, and feature sets.

The comments below outline other recommendations for improving, clarifying, and updating the proposed standards for electronic displays based on the most up-to-date data. Specifically, the following recommendations are outlined in detail in this response document: coverage of models less than 17 inches; modified On Mode levels for models greater than 29 inches; use of screen area to distinguish size bins; smaller allowances for enhanced performance displays (EPDs); and recommendations for signage display requirements. Electronic display standards if adopted as outlined in this letter would address some of the statewide policy objectives of Zero Net Energy California Long Term Energy Efficiency Strategic Plan and AB32 energy efficiency goals. We appreciate careful consideration of the following comments.

2 On Mode Proposal

2.1 Feasible for Monitors 17 to 29 Inches

Since 2013, with the submission of the initial CASE report and the other technical reports and responses docketed with CEC throughout this rulemaking, the CASE Team's extensive analyses conclude that the computer monitor On Mode levels (P_{ON_MAX}) proposed by CEC in Table 9[1] of the updated staff report (shown in Figure 2.1) are both cost-effective and technically feasible (CA IOUs 2013, 2014, 2015a, 2015b). Based on CEC's analysis in the updated staff report, and supported by our docketed CASE Report and associated technical reports, implementing the proposed On Mode levels has the potential to almost halve the average energy use for a typical monitor, without sacrificing functionality or performance, using widely available, off-the shelf technologies. The CASE Team has further recommendations on modifications to the On Mode levels for models less than 17 inches and greater than 29 inches noted in Sections 2.3 and 2.4 below.

The ENERGY STAR® program has been successful at addressing the most efficient models on the market, as evidenced by the high market penetration of ENERGY STAR models since the Version 6 specification took effect in 2013. By the end of 2014, an estimated 88% of computer monitors on the market qualified for ENERGY STAR (EPA 2015a). However, in looking at model specific data, there have been fewer efficiency gains among the popular screen sizes since 2010. Figure 9 in CEC's updated staff report shows minimal efficiency improvements over the past five years for models that have been able to meet the Version 6 On Mode levels (CEC 2016a). For these reasons, efficiency standards are necessary to address the opportunity to realize cost-effective energy savings.

Figure 2.1 CEC Proposed Modal Power Requirements – Computer Monitors

Diagonal Screen Size in inches (d)	On Mode in Watts (P_{ON_MAX})	Sleep Mode in Watts (P_{SLEEP_MAX})	Off Mode in Watts (P_{OFF_MAX})
Resolution (*r*) Less Than or Equal to 5.0 MP			
17"≤d<23"	(4.2*r) + (0.02*A) +2.2	0.5	0.3
23"≤d<25"	(4.2*r) + (0.04*A) - 2.4	0.5	0.3
25"≤d	(4.2*r)+(0.07*A)- 10.2	0.5	0.3
Resolution (*r*) Greater Than 5.0 MP			
17"≤d<23"	21 + (0.02*A) +2.2	0.5	0.3
23"≤d<25"	21 + (0.04*A) - 2.4	0.5	0.3
25"≤d	21 + (0.07*A) - 10.2	0.5	0.3

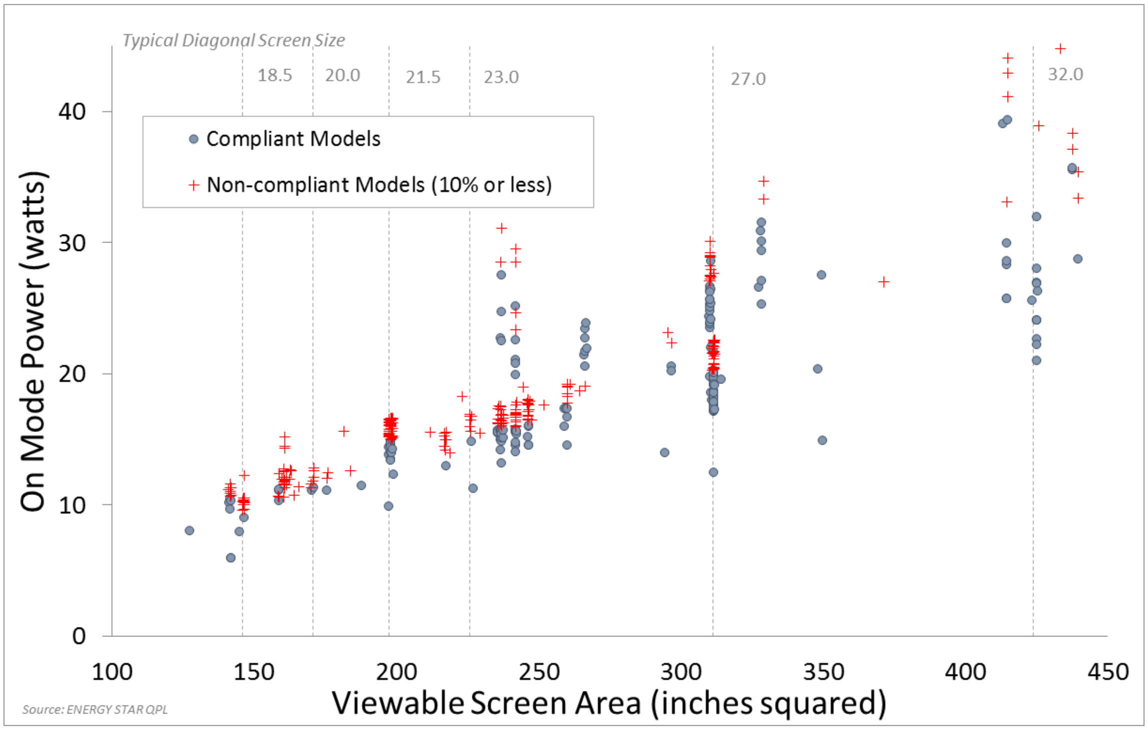
Source: Table 9 in CEC Staff Report

The CASE Team analyzed ENERGY STAR's Qualified Product List (QPL) to address concerns by industry that monitors would not be able to meet the On Mode power requirements proposed by CEC. Figure 2.2 shows the **451 models** 17 inches and greater, available on the market today, that currently meet (169 models) or are within 10 percent of CEC's On Mode proposal (an additional 282 models). The 282 non-compliant models within 10 percent exceed the On Mode levels by between 0.06 and 3.84 Watts (W), with the average model exceeding the levels by 1.09 W. That is, the average efficiency improvement that the 282 models would have to make to be *minimally*-compliant with CEC's On Mode level is a little more than **one watt**. Given the fact that a number

[1] The CASE Team also notes that tables with the modal power requirements in different sections of the updated staff report, Table 9 (Chapter 11) and Table V-3 (Chapter 15), are inconsistent in regards to the largest screen size bin. Based on Slide 13 of CEC's presentation at the April 28 workshop (CEC 2016b), we believe the table in Chapter 11 is the correct proposal and the table in Chapter 15 includes a typo.

of low cost efficiency improvements are available, we assume that most manufacturers will implement design options for these models resulting in a larger than 1.09 W difference.

Figure 2.2 451 Monitor Models 17 Inch and Greater – Compliant and Non-compliant by 10 Percent or Less



Source: CASE Team analysis

Table 2.1 below shows the number of models, number of manufacturers, and panel types of the complying and the non-complying models within 10 percent from our review of the ENERGY STAR QPL. As shown in Table 2.1, a wide range of models, manufacturers, and panels are represented. These models either have to make 1) no additional modifications or 2) employ relatively minor modifications (average reduction in power consumption by 1.09 W) in order to meet CEC's proposed On Mode power requirements. The data in Table 2.1 highlights the technical feasibility of CEC's proposal. It is important to note that all panel types are able to meet On Mode requirements in all the screen size bins. In reviewing a sampling of the 451 models that are able to meet or are close to meeting CEC's proposed On Mode requirements, the CASE Team was able to find computer monitors of various price points between $130 and $1,400. In addition, monitors with the following features are represented in the 451 models: 4K resolution, curved screens, USB 3.0 quick charge, and gaming monitors.

Table 2.1 Characteristics of 451 Compliant and <=10 Percent Non-Compliant Monitor Models from ENERGY STAR QPL

Diagonal Screen Size in Inches (*d*)	Models	Range of Resolutions Represented	Manufacturers Represented	Panels Types Represented
17” ≤ *d* < 23”	155	1.05 – 2.07 MP	24	IPS, TN, VA
23” ≤ *d* < 25”	134	2.07 – 8.29 MP	18	IPS, TN, VA
25” ≤ *d*	162	2.07 – 8.29 MP	18	IPS, TN, VA
Total	451	1.05 – 8.29 MP	30	IPS, TN, VA

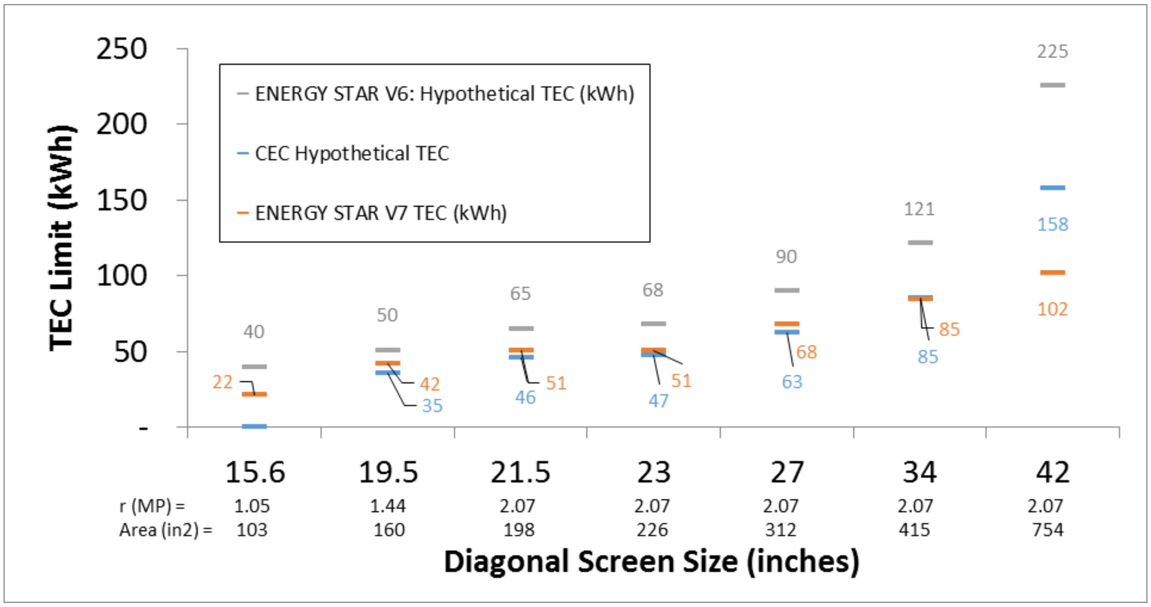
MP: Megapixel; IPS: In-plane Switching; TN: Twisted Nematic; VA: Vertical Alignment

Source: CASE Team analysis

2.2 CEC’s On Mode Proposal and ENERGY STAR Version 7

In the Executive Summary of the updated staff report, the CASE Team noted a typographical error in the following statement: “*The proposed regulations are similar to the ENERGY STAR Version 7.0 Standards but are about 30 percent more stringent*” (CEC 2016a). Based on the CASE Team’s analysis, the proposed CEC regulations are about 30 percent more stringent than the Version 6.0 specification, effective since 2013, not Version 7, which will take effect later in 2016. As shown in Figure 2.3 and Table 2.2, using the same duty cycle assumptions as ENERGY STAR, the CEC proposals for On and Sleep Modes (calculated into a hypothetical Typical Energy Consumption [TEC] value to be able to compare to Version 7) closely match the Version 7 levels, with one major exception: 42 inch and larger. In this size category, the proposed CEC level is significantly more lenient (greater than 50 percent) than the ENERGY STAR level.

Figure 2.3 Comparison of ENERGY STAR Versions 6 and 7 and CEC Proposal Levels



Source: CASE Team analysis

Table 2.2 Comparison of ENERGY STAR Versions 6 and 7 and CEC Proposal Levels

Diagonal Screen Size (in)	Example Resolution (MP)	Example Screen Area (in-sq)	ENERGY STAR V6: Hypothetical TEC (kWh)	ENERGY STAR V7 TEC (kWh)	CEC Proposal: Hypothetical TEC (kWh)	CEC Proposal: % Difference from V6	CEC Proposal: % Difference from V7
15.6	1.05	103.36	39.67	21.64	-	N/A	N/A
19.5	1.44	160.46	50.46	42.02	35.45	30%	16%
21.5	2.07	198	64.93	50.59	45.87	29%	9%
23	2.07	226	67.72	50.80	47.34	30%	7%
27	2.07	312	89.61	68.09	62.67	30%	8%
34	2.07	415	121.19	84.69	84.77	30%	0%
42	2.07	754	225.12	101.69	157.53	30%	-55%
Average						30%	-3%

Source: CASE Team analysis

2.3 Cover Monitors Less than 17 Inches

The current staff report excludes displays smaller than 17 inches diagonal length. The CASE Team recommends smaller displays to be included in the regulation and subject to the On Mode levels proposed in Table 5 of CEC's initial staff report published in March 2015 (CEC 2015). Sixty percent of the monitors less than 17 inches on the QPL can meet these levels. Another 25 percent of models are within 20 percent of the draft 1 proposal, and all models are within 30 percent of that level. The On Mode levels proposed in the 2015 CEC staff report are technically feasible for these smaller displays. The CASE Team, supported by published research, outlined efficiency improvements such as the inclusion of reflective polarizing film and/or more efficient LEDs that can yield a power reduction of 20 to 30 percent (CA IOUs 2014; Park 2013). The CASE Team concludes that meeting the On Mode levels proposed in the initial CEC staff report does not require LCD panel redesign for higher transmissivity, as highlighted in several presentations from stakeholders during CEC's April 26 workshop. Although these stakeholders noted that panel manufacturers will not invest in redesigned LCD panels for these display sizes, the CASE Team has gathered information suggesting that panels used in integrated desktop and notebook computers can be used in standalone displays. Because we expect notebook computers especially to continue to be sold in sizes below 17", we anticipate these panels will continue to be improved and could be used to help stand alone displays comply with the standard, if necessary.

Omitting smaller displays from regulation also creates a potential loophole in the regulation. Although the market share of smaller displays is low and decreasing based on current market trends, including them in the regulation will prevent potential increases in power consumption that may result if manufacturers implement inferior, cheaper, inefficient components in these displays.

2.4 Modify Levels for Monitors Greater Than 29 Inches

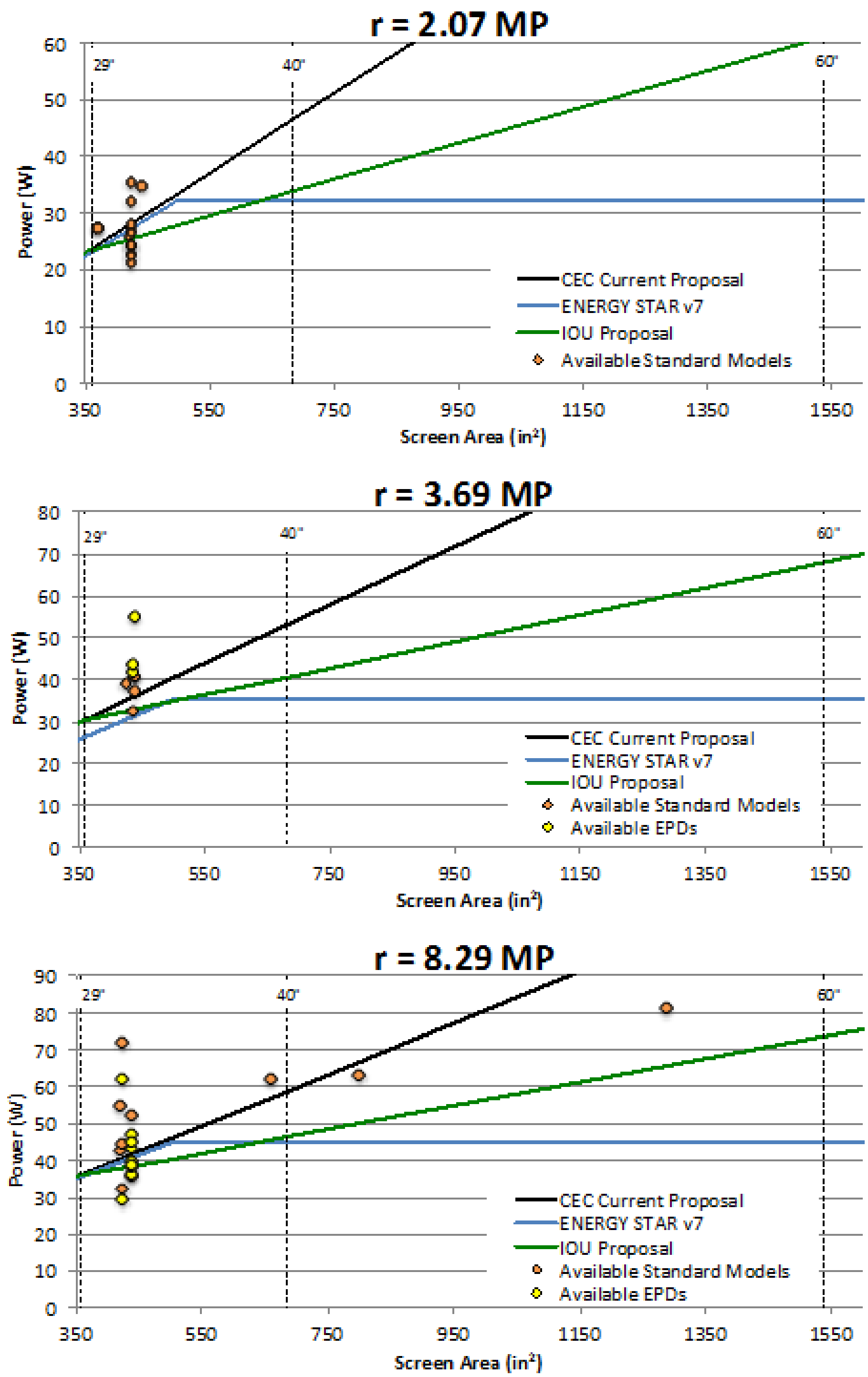
To provide appropriate maximum power levels in the 25 to 29 inch size range, the largest size bin in the updated staff report has a steep slope that results in very large maximum power levels for the largest displays (those more than 29 inches). To prevent increasing energy use by large displays, the IOUs propose an additional bin that includes displays 29 inches and larger as shown in Table 2.3. The CASE Team proposes a maximum power equation that has a shallower slope and therefore prevents very large power allowances for the largest screen sizes shown in Figure 2.4. Also in Table 2., the CASE Team proposes using screen area instead of the diagonal screen size for the size bins. This update simplifies the On Mode power calculation, aligns with the updated ENERGY STAR approach, and avoids inconsistencies that arise because of widescreen displays and a range of aspect ratios that are available in monitors today. More details on this recommendation, including an example, are provided in Section 2.6.

Table 2.3 CASE Team Modal Proposal

Screen Area in Square Inches (A)	Maximum On Mode Power in Watts (P_{on_max})	Maximum Sleep Mode Power in Watts (P_{sleep_max})	Maximum Off Mode Power in Watts (P_{off_max})
Resolution (r) less than or equal to 5.0 MP			
$A < 62$	(4.2*r) + (0.04*A) + 1.8	0.5	0.3
$62 \leq A < 123$	(4.2*r) + (0.01*A) + 3.5	0.5	0.3
$123 \leq A < 226$	(4.2*r) + (0.02*A) + 2.2	0.5	0.3
$226 \leq A < 267$	(4.2*r) + (0.04*A) -2.4	0.5	0.3
$267 \leq A < 359$	(4.2*r) + (0.07*A) -10.2	0.5	0.3
$359 \leq A$	(4.2*r) + (0.032*A) + 3.29	0.5	0.3
Resolution (r) greater than to 5.0 MP			
$A < 62$	21 + (0.04*A) + 1.8	0.5	0.3
$62 \leq A < 123$	21 + (0.01*A) + 3.5	0.5	0.3
$123 \leq A < 226$	21 + (0.02*A) + 2.2	0.5	0.3
$226 \leq A < 267$	21+ (0.04*A) -2.4	0.5	0.3
$267 \leq A < 359$	21 + (0.07*A) -10.2	0.5	0.3
$359 \leq A$	21 + (0.032*A) + 3.29	0.5	0.3

r: Screen resolution in Megapixels (MP); orange shaded rows indicate newly proposed size bin

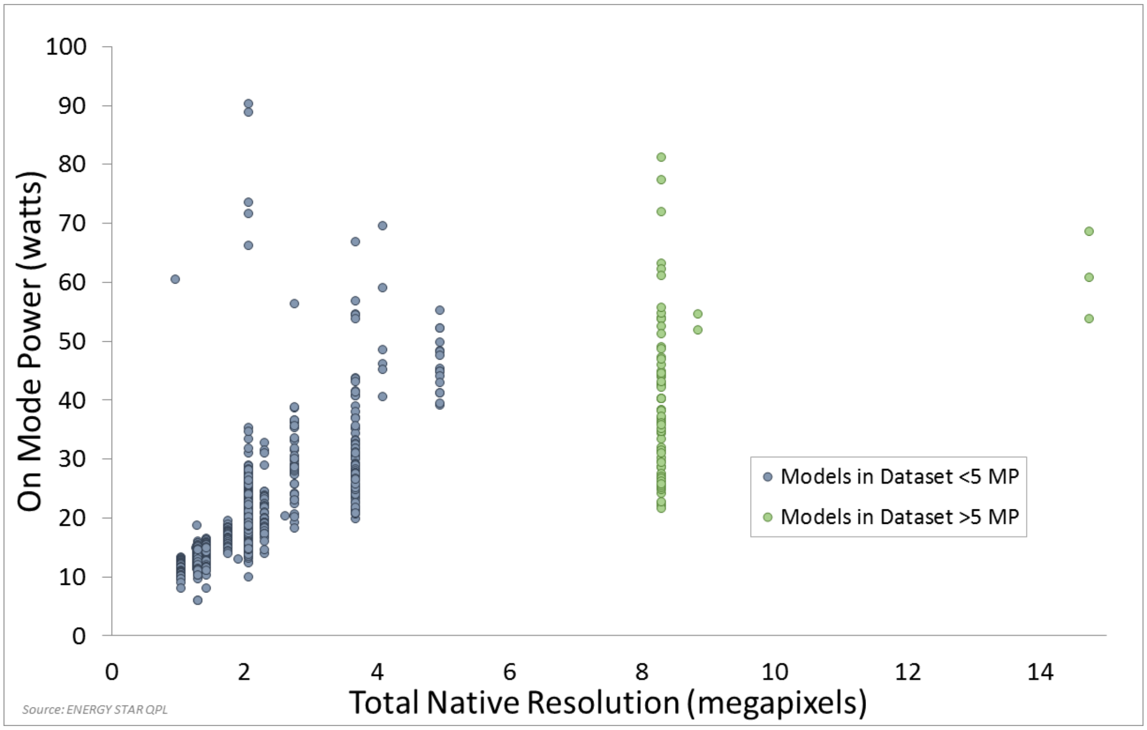
Figure 2.4: IOU Proposed Maximum On Mode Power Limits, with Additional Size Bin for 29 Inches and Larger Displays



2.5 Support Resolution Allowance

The CASE Team strongly supports CEC's proposal of a constant resolution allowance greater than 5 megapixels (MP). For LCDs, higher resolution does increase power draw to some extent. Higher resolution means more pixels, increasing the area of the electronics that control pixel operation, and reducing the transmissivity of the panel. To maintain screen luminance, this requires increased output from the backlight, which correlates to increased display power. This was the rationale for including a power adder based on resolution into the CASE Team's originally proposed On Mode requirements (CA IOUs 2013). While we continue to support a resolution allowance that scales with size up to a certain point, our analysis of the model specific data shows that there in an incremental power demand as resolutions increase up to 5 MP. Past that resolution, the incremental power demand decreases as resolution gets higher as shown in Figure 2.5.

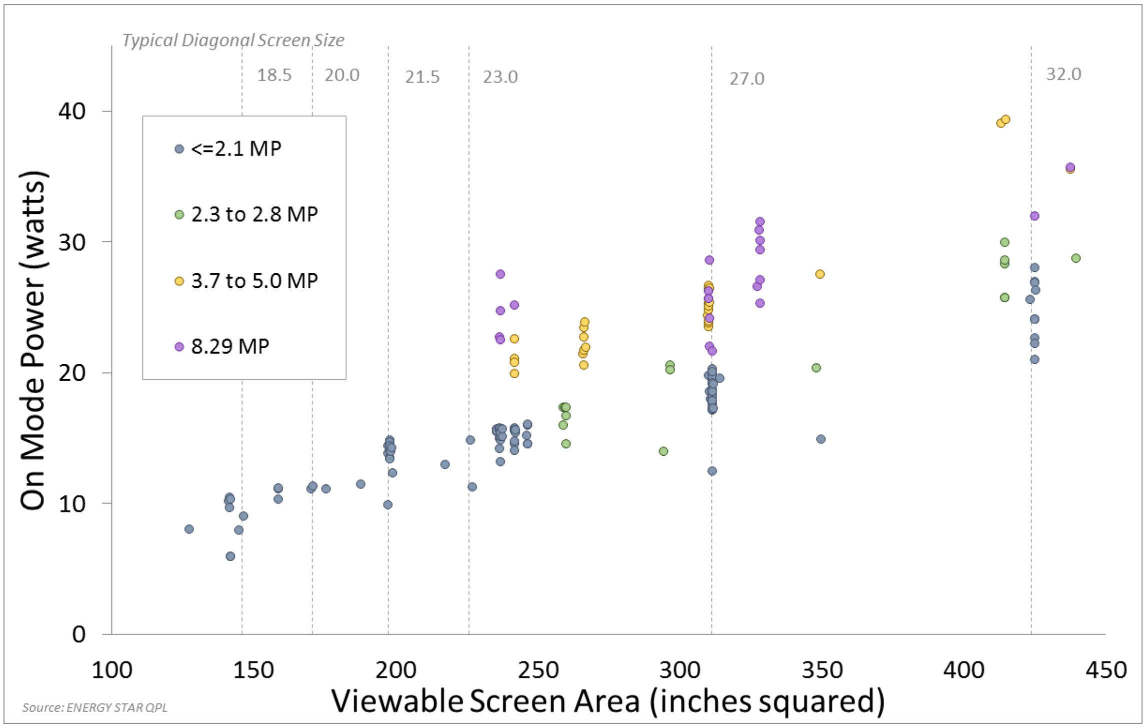
Figure 2.5 Comparison of On Mode Versus Resolution for Computer Monitors



Source: CASE Team analysis

The constant resolution allowance past 5 MP also addresses the previous concern the CASE Team commented on that using that previous CEC proposal, a high-resolution model could consume almost five times as much power as similar size efficient model while still meeting the On Mode limits (CA IOUs 2015a). Figure 2.5 shows all the models at multiple resolutions available today from multiple manufacturers that would meet the updated CEC proposal. In addition to the standard 2.07 MP models, some of the newest, highly featured 4K models (noted as 8.29 MP) are able to meet the updated CEC On Mode proposal. These models, some of the newest on the market today, would not have to make any modifications to meet the proposed requirements.

Figure 2.6 Computer Monitors 2.07 MP and Greater That Meet On Mode Requirements



Source: CASE Team analysis

2.6 Propose Area to Define Size Bins

In the original CASE Report docketed in 2013, the CASE Team proposed that CEC leverage the ENERGY STAR V6 framework, which used diagonal screen sizes in defining the size bins. Upon further investigation by the CASE Team and an updated ENERGY STAR framework in the Version 7 specification, we are updating our original recommendation. Because display power is related to screen area rather than screen diagonal (Figure 4.1, CA IOUs 2014), the CASE Team recommends defining size bins in terms of screen area. This update simplifies the On Mode power calculation, aligns with the updated ENERGY STAR approach, and avoids inconsistencies that arise because of widescreen displays and a range of aspect ratios that are available in monitors today.

To illustrate these inconsistencies, consider two popular display sizes and resolutions on the market shown in Table 2.Table . The first has a 28-inch diagonal screen size and an aspect ratio of 16:9. Its screen area is 328 in-sq. The second display has a larger diagonal screen size of 29 inch, an aspect ratio of 21:9, and an area of 296 in-sq. Despite having a smaller screen area, the second display would fall into a larger size bin than the first, if the bins were based on screen diagonal. Using area to define the bins eliminates this inconsistency.

Table 2.4 Example of Two Displays, the Larger of Which Falls into a Smaller Bin if Bins are Based on Screen Diagonal Rather than Area.

Diagonal Screen Size (in)	Resolution	Aspect Ratio	Screen Area (in-sq)	Diagonal Bin
28	1920 x 1080	16:9	328	25" ≤ *d* < 29"
29	2560 x 1080	21:9	296	29" ≤ *d*

The size bins appear to have been defined for an aspect ratio of 16:9, which, as the aspect ratio of 1080p and 4K displays, is the most popular aspect ratio on the market today. Thus, the CASE Team has provided recommended screen area limits for the CEC size bins assuming an aspect ratio of 16:9 (Table 2.).

3 Sleep and Off Modes Proposal

3.1 Sleep and Off Modes

The IOUs support CEC's updated proposed sleep and Off Mode power limits of 0.5 W and 0.3 W, respectively. The CASE Team has evaluated the CEC's analysis and agrees that these levels are technically feasible and already achieved by about **85 percent of currently available monitors**.

3.2 Feasible for Monitors with Networking and Data Connections

The updated CEC proposal shows that a large proportion of monitors with network and/or data connections would comply with the proposed levels. These displays likely use power management techniques that allow the network and data ports to enter a low power state when unoccupied or not transmitting data. Note that the proposed test procedure requires the following if the display has network and bridging capabilities: 1) one connection to a live network, but no data transferred and 2) a hub connection.

Ethernet and Wi-Fi connections with power management idle at levels sufficiently low to comply with the proposed standard. An Ethernet link with EEE draws about 0.1 to 0.3 W in idle mode (i.e., display sleep mode), and a power managed Wi-Fi link draws 0.04 - 0.25 W in idle mode (May-Ostendorp et al. 2013). USB data ports draw on the order of tens of milliwatt (mW)when in sleep mode or no device is attached[2].

The CASE Team also examined the ability of new technology, such as USB Type-C Power Delivery, and features such as touch screens on the sleep and Off Mode power requirements. Power delivery technologies are of particular interest because the monitor must be able to deliver up to 100 W of power to a USB-connected device. Power delivery ports have two impacts on a display's standby power: the power required to monitor the port for a connection or the commencement of power/data delivery, and power supply losses associated with using a larger

[2] http://am.renesas.com/media/applications/key_technology/connectivity/usb/usb_product_guide.pdf

power supply that can power both the monitor and the USB connected devices. The first impact is small; unoccupied and idle USB Type-C controllers in this mode can draw minimal power of approximately tenths of a mW.[3] The second impact is potentially of concern; the larger power supplies needed to support the power delivery feature may incur larger losses in Sleep Mode than those power supplies typically used for monitors without power delivery. At least two power supply solutions that mitigate standby losses, however, are currently available. For power supplies on the order of 150 W and smaller, a "single converter" supply can be designed to be efficient at very low and full loads. A 150W supply from Power Integrations, for example, can deliver 250mW of DC power while drawing 450 mW of AC power from the mains[4]. Alternatively, and for power supplies larger than about 150 W, a standby supply can be use to supply low power modes. This solution, commonly used in televisions, is expected to cost more than the single converter solution, but the CASE Team expects displays with larger power supplies are likely to have premium features and be marketed to a less cost-sensitive consumer.

3.3 Feasible for Touch Screens

Some stakeholders expressed concern at the April 28 staff workshop that CEC's sleep and Off Mode limits were too stringent to accommodate additional features. Although industry did not list specific features, the CASE Team identified touch screen capability as one such feature that potentially requires additional power in Sleep Mode, during which the display may monitor for a touch on the screen to wake up. Additional power should not, however, be required by touch screens or any other additional feature in Off Mode since the display by definition is reactivated by a hard or soft switch. The CASE Team surveyed the touch screen market and compiled data for touch screen monitors for which we could identify the touch screen technology type as well as Sleep and/or Off Mode power.

At least four touch screen technologies are present in displays on the market today: resistive, capacitive, optical/infrared, and surface acoustic wave (SAW). Resistive and SAW appear to be rarely used in computer monitors; the IOUs found only one model for each of these technologies through an internet search and were not able to determine Sleep and Off Mode power information for these models. Capacitive touch screens are the most prevalent touch technology in computer monitors. They are also a popular choice for mobile products and use can use minimal power when waiting to detect touch input[5]. Of the 13 computer monitors identified with power information, 63 percent would comply with the CEC's updated Sleep Mode power limit (Figure 3.1). Optical touch screens use infrared LEDs to create a grid of light across the screen and sensors that detect the interruption of that light and the coordinates of the touch. Thus to wake the display from Sleep Mode with a touch on the screen, lights and sensors must be active. Of the six optical touch screen models we identified, all but one would comply with the CEC's Sleep Mode proposal (Figure 3.1). In Figure 3.1, Sleep (black dashes) and Off (grey dashes) Modes are displayed for capacitive (left) and optical (right) touch screen displays. The green lines show CEC's proposed limits of 0.5 W and

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[3] See for example LatticeSemi and Rhom USB Type-C Power Delivery data sheets:
http://www.latticesemi.com/en/Products/DesignSoftwareAndIP/IntellectualProperty/ReferenceDesigns/ReferenceDesign04/USBTypeCPowerDeliverySolution.aspx,
http://rohmfs.rohm.com/en/products/databook/datasheet/ic/interface/usb_pd/bm92t30mwv-e.pdf

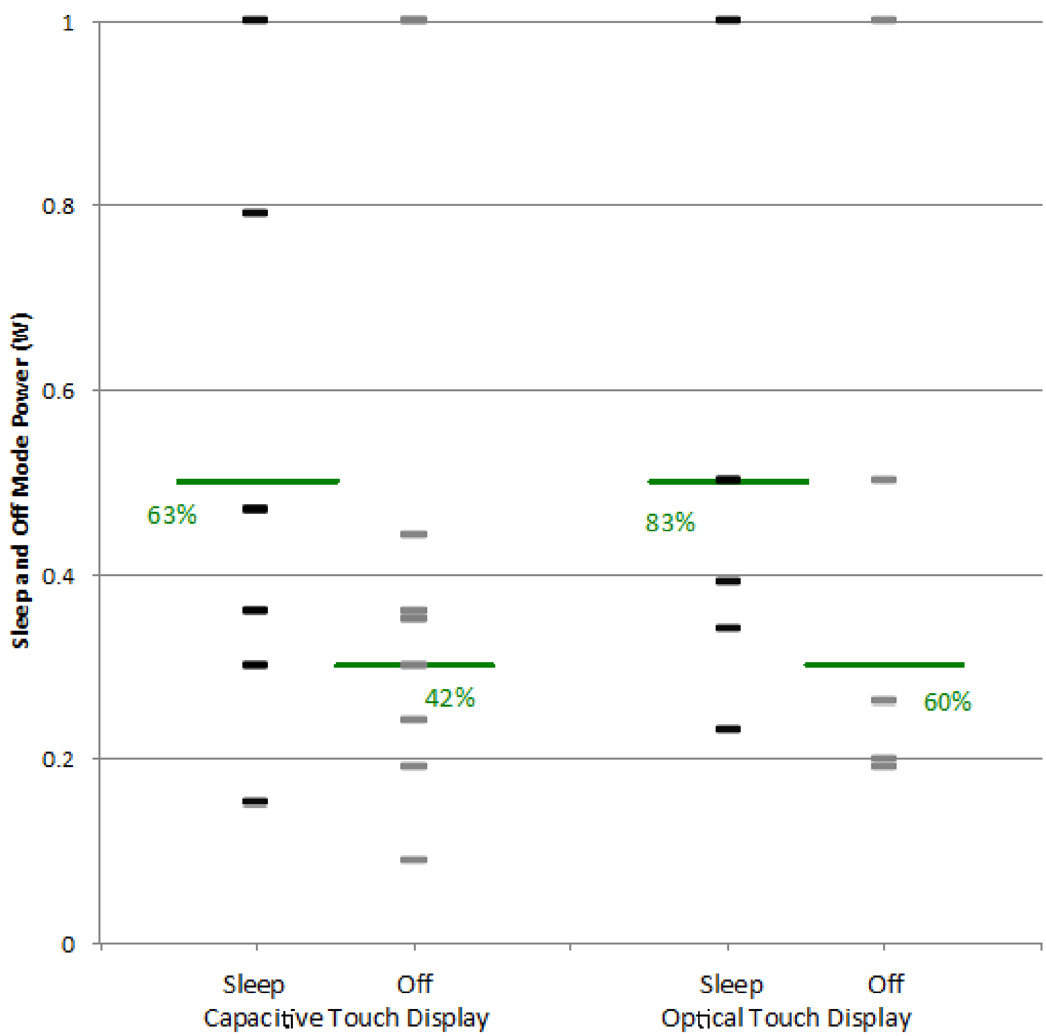
[4] https://ac-dc.power.com/design-support/reference-designs/design-examples/der-437-150-w-aio-power-supply/

[5] A Texas Instruments capacitive touch screen controller, for example, draws 11 μW when waiting for a touch: http://www.ti.com/lit/an/slyt513/slyt513.pdf

0.3 W for Sleep and Off Modes, respectively. The percentage of models that would comply with each modal power level is shown in green type. We show power data up to 1.0 W for clarity, however, not shown are two capacitive touch screen models with Sleep Mode power of 2.0 to 2.5W. The calculated compliance rate of 63 percent includes these two models.

Based on the available information, the CASE Team finds that touch screen monitors can comply with the CEC Sleep and Off Mode levels of 0.5 W and 0.3 W and support this change.

Figure 3.1 Touch Screen Monitors: Sleep and Off Modes



Source: CASE Team analysis

4 Enhanced Performance Displays (EPDs)

4.1 Modify Levels for EPDs

In the second draft of the staff report, the CEC has increased adders for EPDs from 0 to 10 percent for color gamut support of 32.9 percent to less than 38.4 percent of CIE LUV (referred to as Type

I on the ENERGY STAR QPL and in the following discussion), and from 40 to 50 percent for color gamut support of 38.4 percent of CIE LUV (Type II) or greater. The CASE Team argues that these adder increases are not necessary, and that the CEC should instead use its originally proposed adders.

In both drafts of the staff report, the CEC presents data that shows 41 percent of Type I EPDs already comply with the On Mode proposal without an adder. These EPDs are increasingly available on the market, and are often not marketed to the consumer as EPDs, leading us to infer that this degree of color support may become the norm in the coming years. Granting an adder to Type I displays could lead to unnecessary increases in energy use and inefficient designs penetrating the market. The CEC should not grant an adder for displays with color gamut support less than 38.4 percent of CIE LUV.

Broader color gamut displays that support 38.4 percent of CIE LUV or more do have power requirements beyond those of standard displays. To create the wider range of colors, these Type II displays use colored LEDs, which are less efficient than the white LEDs used in standard displays and Type I EPDs. Type II EPDs may also use more saturated color filters, which are less transmissive and therefore require more backlight to generate the required screen brightness. Market research by the IOUs shows that Type II EPDs of every size and resolution can comply with a 40 percent adder on the IOUs proposed levels (Figure 4.1). Note that these levels include the large size bin and resolution cap summarized in Table 2. above. Our recommended adders are summarized in Table 4.1 below.

Table 4.1 Calculation of On Mode Power Allowance for Enhanced Performance Displays

Color Gamut Criteria	On Mode Power Allowance in Watts (P_{EP})
Type I: Color Gamut support is 32.9% of CIE LUV or greater (99% or more of defined sRGB colors)	-
Type II: Color Gamut support is 38.4% of CIE LUV or greater (99% of Adobe RGB)	$0.4 * P_{ON\_MAX}$

P_{ON_MAX} = On Mode Power in Watts

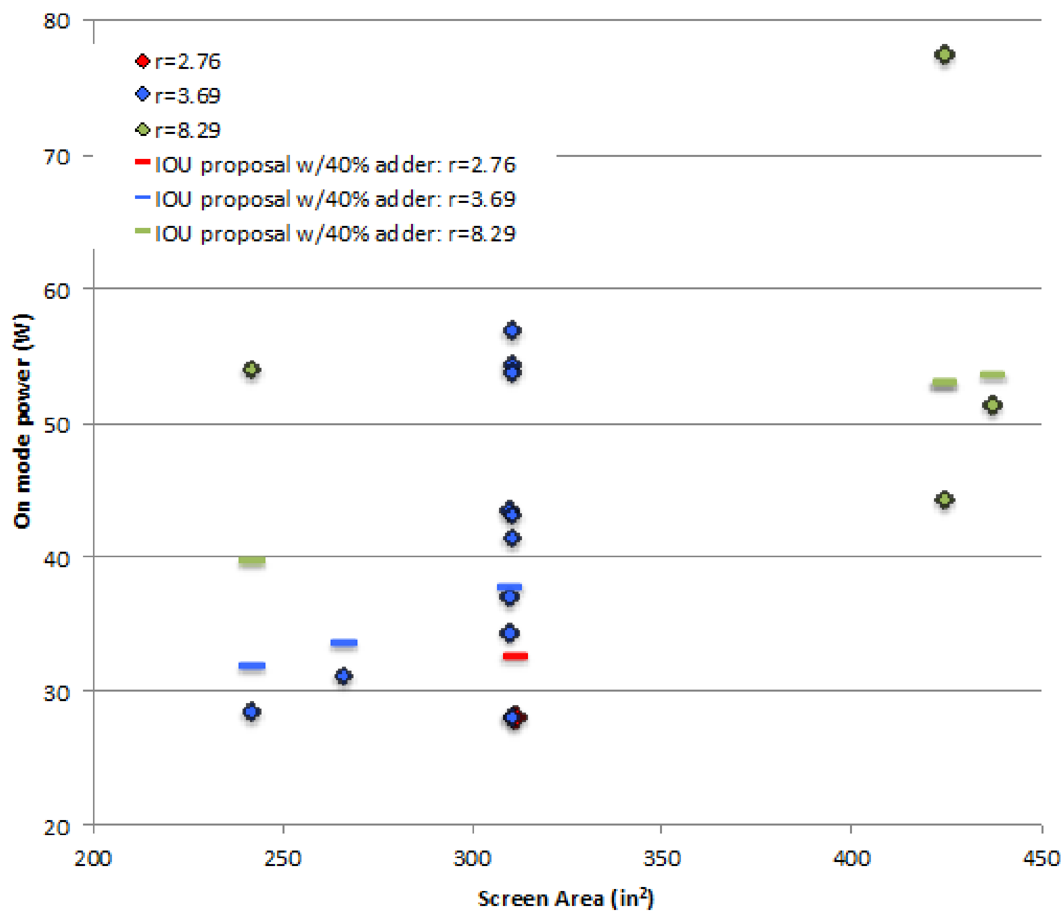
The CASE Team has previously outlined a path to compliance without an adder for Type II EPDs that use colored LEDs to produce their broad color gamut (CA IOUs 2015b). In this scenario, high efficacy LEDs, quantum dot film, and a LCD panel with typical color filters replace the low efficiency colored LEDs and LCD panel with more saturated color filters. 3M estimates that displays produced with these updates can be up to 50 percent more efficient than current models with colored LEDs.[6] Although concrete cost information is not available, the CASE Team estimates that the improvements are cost-effective. The increased cost for quantum dot film could be offset,

[6]http://solutions.3m.com/3MContentRetrievalAPI/BlobServlet?lmd=1383547134000&locale=en_US&assetType=MMM_Image&assetId=1361748701374&blobAttribute=ImageFile

at least in part, by using standard rather than specialized color filters and blue rather than colored LEDs.

Because a technically feasible path to compliance exists, CEC should phase out the proposed power adders for Type II EPDs 2 years after Title 20 Standards take effect. This approach to sunset the power allowance also accounts for the fact that LED technology will continue to make significant improvements in the near future with respect to quality and efficiency.

Figure 4.1 On Mode power of Type II EPDs by Area and Resolution: 2.76 MP (red diamonds, n=1), 3.69 MP (blue diamonds, n=11), and 8.29 MP (green diamonds, n=4). Dashes show the IOUs' proposed maximum On Mode power for the area and resolution of the models shown.



The CASE Team believes enhanced performance displays have characteristics that are becoming more common in mainstream computer monitors, such as high resolution and accurate color reproduction. Therefore we are supportive of CEC includes them in the scope of this rulemaking. Initially the CASE Team conducted assessments of EPDs based on earlier datasets obtained from ENERGY STAR, through the specification development process and the QPL. Through our model-by-model review of the datasets, a number of models listed as EPDs did not meet the specifications. Based on a recent review of models from the QPL, 70 models were EPDs. Table 4.2 summarizes the number of EPD models that would be able to meet the On Mode levels proposed by CEC with and without any additional power adders listed in Table 10 of the updated staff report (CEC 2016a).

Table 4.2 EPD Model Analysis

EPD Type	QPL Models	Pass On Mode Proposal without Adder	Pass On Mode Proposal with CEC Proposed Adders (10% sRGB; 50% AdobeRGB)
sRGB	49	11	21
Adobe RGB	21	0	8
Total	70		

5 Test Procedure

5.1 Test Brightness Level As-Shipped

The CASE Team at this time continues to recommend On Mode testing for monitors without adjusting luminance or other settings from their default settings. Since most users likely do not adjust brightness settings from "out of the box" settings, this method is likely to be more representative of real world power usage than by calibrating the screen brightness to a certain level. By testing default settings, the State of California will be able to accurately measure monitor energy usage that is more reflective of real-world conditions.

Industry representatives recommend the test procedure as adopted by the ENERGY STAR displays specification. The ENERGY STAR test procedure requires that display screen brightness be calibrated to 200 candelas per meter squared (cd/m^2) for On Mode testing and the default brightness can be set at any level. In our testing, the CASE Team found screen brightness values in default mode as-shipped to be significantly higher than 200 cd/m^2. This in turn has a significant impact on the backlight unit (BLU) power. Since most users likely do not adjust brightness settings from "out of the box" settings, this method is likely to be not representative of real world power usage.

In the updated staff report, CEC proposes to align the test procedure with ENERGY STAR. The IOUs would support this provision only with the additional requirement proposed by CEC to limit the displays being shipped excessively bright by restricting the default screen luminance to be no brighter than 200 cd/m^2 as-shipped.

5.2 Automatic Brightness Control (ABC)

In earlier comments, the CASE Team outlined a method designed to credit displays with ABC by incorporating ABC test data into the On Mode power (CA IOUs 2014). The CEC proposal uses the ENERGY STAR test method, which measures On Mode power of displays at 200 cd/m^2, whether they have ABC or not. The CASE Team suggested calculating On Mode power for displays with ABC enabled by default using the ENERGY STAR required power tests at 10 lux (since updated to 12 lux in the new test method) and 300 lux. These power measurements would be weighted by an assumed usage, so that that On Mode power is:

$$P_{on} = W_{300}P_{300} + W_{12}P_{12},$$

where P_{300} and P_{12} are the power measured at room illuminance of 300 lux and 12 lux, respectively, and W_{300} and W_{12} are the percent of monitors used in bright and dark settings, respectively. We assumed that most monitors are used in bright office settings, and a small fraction of them are used for gaming or watching video in dimmer settings. Thus we proposed weighting the 300 lux and 12 lux measurements by 80 percent and 20 percent.

These were initial suggestions based on the CASE Team's understanding of ABC in televisions, in which viewing conditions have been well-studied. Given the lack of data on how often monitors are used in bright and dim environments, it is difficult to understand the energy savings potential of this feature for monitors. The CASE Team recommends that if ABC is to be accommodated in this rulemaking to incentivize this potentially energy saving feature, CEC and its stakeholders should further discuss viewing conditions and sensor technology to determine appropriate *monitor-specific* room illuminance levels for testing.

6 Cost-Effectiveness

6.1 Support Design Life Estimate

We support CEC's estimate of 6.6 years as the design life for computer monitors. Based on a study from a group at Lawrence Berkeley National Laboratory (Park 2013) and correspondence with industry experts, the CASE Team understands that the business markets monitor replacement cycles can be up to 6 years. We also understand residential products likely have longer lifetimes since they are used relatively less and consumers tend to replace a monitor only when it breaks or when there is a substantial improvement in technology. The CASE Team estimates the lifetime of a residential monitor to be 7 years, which reflects the high end of the range noted in the LBNL study. The installed base-weighted average across both sectors would be **6.6 years**.

6.2 Support CEC Calculations

We support CEC's estimates on the life-cycle cost and net benefits of the proposed standards for computer monitors. In both the CASE Report and subsequently submitted responses, the CASE Team has docketed updated estimates that closely align with CEC's assumed inputs and calculations (CA IOUs 2013; CA IOUs 2015b).

7 Definitions and Scope

The CASE Team recommends that CEC base its modal and product type definitions on those in the ENERGY STAR specifications (EPA 2013, 2015b). Specifically, definitions should be adopted on product types, visual characteristics, additional functions and features, product family, representative model, and power source. The CASE Team has presents an initial draft of these definitions in Appendix A of this letter. As the next step to finalizing these definitions, the CEC, including its technical and legal staff, and its stakeholders should together review and modify the language so that the definitions are technically and legally sound and reflect industry practices and terminology.

The CASE Team continues to recommend that the scope of the Title 20 regulations include products that are in scope with ENERGY STAR and potentially exempt products that are out of scope with ENERGY STAR. The products that are exempted in ENERGY STAR include (EPA 2015a):

- Electronic displays with an integrated TV tuner (these products are already be covered under the Title 20 television regulations).
- Electronic billboards and scoreboards.
- Displays with integrated or replaceable batteries designed to support primary operation without ac mains or external dc power, or device mobility (e.g., electronic readers, battery powered digital picture frames).
- Products that must meet Food and Drug Administration specifications for medical devices.

If there are other categories of electronic displays that should be excluded, the CASE Team would like to work with the CEC and its stakeholders to use objective market data to help inform decision on how the regulations should treat other specialty products, like professional display monitors, and outdoor signage displays.

8 Signage Displays

8.1 Clarification of Existing Coverage

We support CEC's clarification in the updated staff report that signage displays have been covered under the current Title 20 TV regulations. As the CASE Team has previously cited, based on guidance provided by the CEC to the Consumer Electronics Association (CEA) in a letter dated March 29, 2010, electronic displays that do not contain tuners are subject to the television regulations. At least one industry stakeholder has stated they understood that professional signage (i.e., signage displays) were already covered under the television regulations (Panasonic 2011). The manufacturer stated that they were designing and registering applicable products to adhere to these existing regulations. We believe that updating the definitions as proposed in this report will increase compliance dramatically. Currently, however, we believe there is a limited market share of models that comply with the current Title 20 regulations.

The CASE Team recommends CEC <u>remove</u> the effective date of January 1, 2018 noted in Chapter 15 of the updated staff report. As we have stated previously, and CEC has supported, the *current* television On Mode standards *have applied* to signage displays since the television regulations first took effect on January 1, 2011.

8.2 Cover all Screen Sizes

As we extensively outlined in Section 3 of our response to CEC standards proposal for displays (CA IOUs 2015), we strongly urge the CEC to apply current regulations to all screen sizes of signage displays, including currently unregulated models greater than 1400 inches-squared (in-sq). Given 1) a significant percentage of the signage display market is greater than 1400 in-sq (14 percent of 2017 shipments and 30 percent of energy use) and 2) the testing and analysis the CASE Team has docketed showing the cost-effectiveness, CEC should use this rulemaking as an opportunity to realize significant energy savings for signage displays larger than 1400 in-sq.

8.3 Update on Mode levels in This Docket

Also outlined in Section 3 of our response to CEC standards proposal for displays (CA IOUs 2015), an On Mode power limit more stringent than what CEC is clarifying in the updated staff report is cost-effective and technically feasible. We continue to recommend an On Mode equation for signage displays, outlined in Table 8.1, that accounts for luminance and screen area and aligns with the approach proposed by ENERGY STAR in the development of the Version 7 specification. Because of the broad range of applications for signage displays that require various levels of brightness to account for the relative brightness of the ambient conditions, from dimly lit conference rooms to public displays that may receive direct sunlight, we recommend that the CEC consider including screen luminance in any On Mode equation for signage displays. These conclusions were based on extensive testing and analysis conducted by the CASE Team and docketed with CEC.

Table 8.1 Maximum Power Requirements– Signage Displays All Screen Areas

Screen Size (area A in inches squared)	On Mode (W)
$A < 1400$ **and** $A \geq 1400$	$(4.5 \times 10^{-5} \times l \times A) + 70 \times \tanh(0.001 \times (A - 200)) + 20$

Where

A = Viewable screen area (square inches);

l = Maximum measured luminance in candelas per square meter

8.4 Displays Used as Televisions

Given the vast majority of users that receive television content through 1) television equipment already containing a tuner (e.g., a set-top box) or 2) internet programming, an integrated tuner in a television is only needed for watching programs on over-the-air broadcasts using an external antenna. The CASE Team has been made aware of at least one major manufacturer with several series of tuner-free displays intended to be used as a television and display television programming. The manufacturer's research indicates that less than 10 percent of TV viewers receive over-the-air broadcasts (Vizio 2016).

Based on a ruling by the Federal Communication Commission (FCC), as of March 1, 2007, new televisions must include a built-in digital tuner that can receive and decode ATSC terrestrial digital transmissions. Since the tuner-free displays cannot be called televisions, they should be considered signage displays. Until CEC updates the television regulations, which we support addressing as soon as this rulemaking is completed, CEC should consider this equipment as signage displays from a regulatory perspective and subject to the current Title 20 Standards for equipment less than 1400 in-sq.

9 References

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Appendix A Preliminary Definitions

A) Product Types:

1) Electronic Display (Display): A product with a display screen and associated electronics, often encased in a single housing, that as its primary function produces visual information from (1) a computer, workstation, or server via one or more inputs (e.g., VGA, DVI, HDMI, DisplayPort, IEEE 1394, USB), (2) external storage (e.g., USB flash drive, memory card), or (3) a network connection.

a) Monitor: An Electronic Display intended for one person to view in a desk based environment.

i) Enhanced Performance Display: A computer monitor that has all of the following features and functionalities:

(a) A contrast ratio of at least 60:1 measured at a horizontal viewing angle of at least

85°, with or without a screen cover glass;

(b) A native resolution greater than or equal to 2.3 megapixels (MP); and,

(c) A color gamut size of at least sRGB as defined by IEC619662-1. Shifts in color space are allowable as long as 99% or more of defined sRGB colors are supported.

b) Signage Display: An Electronic Display intended for multiple people to view in non desk based environments, such as retail or department stores, restaurants, museums, hotels, outdoor venues, airports, conference rooms or classrooms. For the purposes of this specification, a Display shall be classified as a Signage Display if it meets two or more criteria listed below:

(1) Diagonal screen size is greater than 30 inches;
(2) Maximum Reported Luminance is greater than 400 candelas per square meter;
(3) Pixel density is less than or equal to 5,000 pixels per square inch; or
(4) Ships without a mounting stand.

B) Operational Modes:

1) On Mode: The mode in which the Display has been activated, and is providing the primary function.

2) Sleep Mode: A low-power mode in which the Display provides one or more non-primary protective functions or continuous functions. Sleep Mode may serve the following functions: facilitate the activation of On Mode via remote switch, Touch Technology, internal sensor, or timer; provide information or status displays including clocks; support sensor-based functions; or maintain a network presence.

3) Off Mode: The mode where the Display is connected to a power source, produces no visual information, and cannot be switched into any other mode with the remote control unit, an internal signal, or an external signal.

Note: The Display may only exit this mode by direct user actuation of an integrated power switch or control. Some products may not have an Off Mode.

C) Visual Characteristics:

1) Ambient Light Conditions: The combination of light illuminances in the environment surrounding a Display, such as a living room or an office.

2) Automatic Brightness Control (ABC): The self-acting mechanism that controls the brightness of a Display as a function of Ambient Light Conditions. ABC functionality must be enabled to control the brightness of a Display.

3) Color Gamut: Color gamut area shall be reported as a percentage of the CIE LUV 1976 *u*' *v*' color space and calculated per Section 5.18 Gamut Area of the Information Display Measurements Standard Version 1.03. Any gamut support in non-visible/invisible color areas is not to be counted. The gamut's size must be expressed as a percentage of area of the visible CIE LUV color space only.

4) Luminance: The photometric measure of the luminous intensity per unit area of light travelling in a given direction, expressed in candelas per square meter (cd/m2).

a) As-shipped Luminance: The luminance of the Display at the factory default preset setting the manufacturer selects for normal home or applicable market use.

5) Native Vertical Resolution**:** The number of physical lines along the vertical axis of the Display within the visible area of the Display. A Display with a screen resolution of 1920 x 1080 (horizontal x vertical) would have a Native Vertical Resolution of 1080.

6) Screen Area: The visible area of the Display that produces images. Screen Area is calculated by multiplying the viewable image width by the viewable image height. For curved screens, measure the width and height along the arc of the Display.

D) Additional Functions and Features:

1) Bridge Connection: A physical connection between two hub controllers (i.e., USB, FireWire). Bridge Connections allow for expansion of ports typically for the purpose of relocating the ports to a more convenient location or increasing the number of available ports.

2) Full Network Connectivity: The ability of the Display to maintain network presence while in Sleep Mode. Presence of the Display, its network services, and its applications, is maintained even if some components of the Display are powered down. The Display can elect to change power states based on receipt of network data from remote network devices, but should otherwise stay in Sleep Mode absent a demand for services from a remote network device. Full Network Connectivity is not limited to a specific set of protocols. Also referred to as "network proxy" functionality and described in the Ecma-393 standard.

3) Occupancy Sensor: A device used to detect human presence in front of or in the area surrounding a Display. An Occupancy Sensor is typically used to switch a Display between On Mode and Sleep Mode.

4) Touch Technology: Enables the user to interact with a product by touching areas on the Display screen.

5) Plug-in Module: A modular plugin device that provides one or more of the following functions without the explicit purpose of providing general computing function:

a) Display images, mirror remote content streamed to it, or otherwise render content on the screen from local or remote sources; or

b) Process touch signals.

Note: Modules providing any other additional input options are not considered Plug-in Modules for the purposes of this specification.

E) Product Family: A group of product models that (1) are made by the same manufacturer, (2) share the same Screen Area, Resolution, and Maximum Reported Luminance, and (3) are of a common basic screen design. Models within a Product Family may differ from each other according to one or more characteristics or features. For Displays, acceptable variations within a Product Family include:

1) External housing;

2) Number and types of interfaces;

3) Number and types of data, network, or peripheral ports; and

4) Processing and memory capability.

F) Representative Model: The product configuration that is tested for ENERGY STAR certification and is intended to be marketed and labeled as ENERGY STAR.

G) Power Source

1) External Power Supply (EPS): An external power supply circuit that is used to convert household electric current into dc current or lower-voltage ac current to operate a consumer product.

2) Standard dc: A method for transmitting dc power defined by a well-known technology standard, enabling plug-and-play interoperability. Common examples are USB and Power-over-Ethernet. Usually Standard dc includes both power and communications over the same cable, but as with the 380 V dc standard, that is not required.