



ENERGY STAR® Program Requirements Product Specification for Displays

Eligibility Criteria Draft 2 Version 8.0

1 Following is the Draft 2 Version 8.0 ENERGY STAR product specification for Displays. A product shall
2 meet all of the identified criteria if it is to earn the ENERGY STAR.

3 **1 DEFINITIONS**

4 A) Product Types:

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

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

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

17 (1) Diagonal screen size is greater than 30 inches;

18 (2) Maximum Reported Luminance is greater than 400 candelas per square meter;

19 (3) Pixel density is less than or equal to 5,000 pixels per square inch;

20 (4) Ships without a mounting stand designed to support the display on a desktop; or

21 (5) Designed to be operated by an external data controller or remote management
22 system.

23 c) Tiled Display System: An array of individual Displays or panels tiled together
24 contiguously and supported by single external controller and single external power
25 supply to produce a single larger image.

26 d) Maximum Tiled Configuration: At Tiled Display System with the maximum number of
27 panels supported by the power supply and controller.

28 Note: Typical Maximum Tiled Configurations include a 2 x 2 configuration (four
29 display panels). In this example, the minimum configuration would include a single
30 panel operating with the power supply and controller rated for a total of four panels.
31 For the purposes of the ENERGY STAR test, only the Maximum Tiled Configuration
32 is considered.

33 **Note:** Stakeholders commented that there are several larger format models marketed as computer
34 monitors that meet the definition of Signage Display. Monitors are increasingly becoming brighter (over
35 400 candelas per square meter) with the addition of HDR capability and other high performance features.
36 To better differentiate between displays and signage , EPA proposes to require that Signage Displays
37 meet three instead of two of the listed criterion and has additionally added a fifth criterion related to
38 remote management. EPA has found one example of a large format monitor/display with mounting stand
39 that is intended for more than one viewer in a conference room setting and welcomes any additional
40 stakeholder feedback on how to distinguish Computer Monitors from Signage Displays.

41 In response to Draft 1, EPA received feedback to create a specific product subcategory for tiled displays
42 with On Mode power requirements similar to comparably sized single panel signage displays. In Draft 2,
43 EPA is proposing the definition of Tiled Display System and Maximum Tiled Configuration. EPA welcome
44 stakeholder feedback on this proposal.

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46 B) Operational Modes:

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

49 2) Sleep Mode: A low-power mode in which the Display provides one or more non-primary
50 protective functions or continuous functions.

51 Note: Sleep Mode may serve the following functions: facilitate the activation of On Mode via
52 remote switch, Touch Technology, internal sensor, or timer; provide information or status
53 displays including clocks; support sensor-based functions; or maintain a network presence.

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

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

59 C) Displays Settings and Menus

60 1) Default Picture Setting: The preset picture setting in the model's as-shipped default state. If
61 the Display has a Forced Menu, it is the preset picture setting that the Display enters
62 immediately after selecting the mode tested according the ENERGY STAR test method.

63 2) Forced Menu: A series of menus which require the selection of initial settings before
64 allowing the user to utilize primary functions. Within these menus contains an option to
65 choose the viewing environment between the "standard" picture setting and another picture
66 setting not tested in the ENERGY STAR test method.

67 Note: In the case that no standard setting or equivalent exists, the default setting
68 recommended by the manufacturer is considered "standard" for the purposes of this
69 specification. "Standard" can apply to alternative terminology.

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Note: Similar to the ENERGY STAR televisions specification, EPA is proposing definitions for Preset Picture Setting and Default Picture Setting to refer to the default as-shipped Display mode that is tested by ENERGY STAR and meets the specification requirements.

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The existing ENERGY STAR test method specifies procedures for testing models with a Forced Menu. EPA is including a formal definition of Forced Menu adopting language from the Version 8 ENERGY STAR Televisions specification and televisions Federal test procedure 10 CFR 430, Subpart B, Appendix H, Section 2.5. EPA notes that there are currently 31 displays in the ENERGY STAR dataset that report the presence of a forced menu and possibly more models that do not report this feature because it was not prior defined in the specification.

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D) Visual Characteristics:

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

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

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Note: ABC functionality must be enabled to control the brightness of a Display.

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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.

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Note: 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.

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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/m^2).

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a) Maximum Reported Luminance: The maximum luminance the Display may attain at an On Mode preset setting, and as specified by the manufacturer, for example, in the user manual.

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b) Maximum Measured Luminance: The maximum measured luminance the Display may attain by manually configuring its controls, such as brightness and contrast.

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

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5) Total Native Resolution: Resolution expressed as total pixel count in megapixels calculated as the product of physical lines along the vertical and horizontal axes of the Display within the visible area of the Display.

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Note: A Display with a screen resolution of 1920 x 1080 (horizontal x vertical) would have a Total Native Resolution of 2.07 megapixels (MP).

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Note: In Draft 2, EPA is replacing the definition for Vertical Resolution with a definition for Total Native Resolution. This definition is used to calculate the resolution that is applied to energy requirements in this specification.

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6) Screen Area: The visible area of the Display that produces images.

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Note: 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.

113 E) Additional Functions and Features:

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- 115 1) Bridge Connection: A physical connection between two hub controllers (i.e., USB, FireWire).

116 Note: Bridge Connections allow for expansion of ports typically for the purpose of relocating
117 the ports to a more convenient location or increasing the number of available ports.

- 118 2) Full Network Connectivity: The ability of the Display to maintain network presence while in
119 Sleep Mode. Presence of the Display, its network services, and its applications, is
120 maintained even if some components of the Display are powered down. The Display can
121 elect to change power states based on receipt of network data from remote network devices,
122 but should otherwise stay in Sleep Mode absent a demand for services from a remote
123 network device.

124 Note: Full Network Connectivity is not limited to a specific set of protocols. Also referred to
125 as “network proxy” functionality and described in the Ecma-393 standard.

- 126 3) Occupancy Sensor: A device used to detect human presence in front of or in the area
127 surrounding a Display.

128 Note: An Occupancy Sensor is typically used to switch a Display between On Mode and
129 Sleep Mode by detecting human presence or a combination of human presence and a
130 signaling device such as Bluetooth device.

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

- 133 5) Plug-in Module: A modular plugin device that provides one or more of the following functions
134 without the explicit purpose of providing general computing function intended for a broad
135 range of home and office applications:

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

138 b) Process touch signals.

139 Note: Modules providing any other additional input options are not considered Plug-in
140 Modules for the purposes of this specification. Modules typically meet the Open Pluggable
141 Specification (OPS).

- 142 6) Embedded Module: A non-modular processor or computing system embedded in the
143 Display that provides one or more of the following functions without the explicit purpose of
144 providing general computing function intended for a broad range of home and office
145 applications:

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

148 b) Process touch signals.

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150 **Note:** In response to Version 8 Draft 1 specification, stakeholders commented that Signage Displays with
151 plug-in modules offer computing functions and could overlap with the Computers specification scope.
152 Stakeholder further noted that instead of a plug-in, removable module, displays could contain an
153 embedded processor that provides computing functions and can replace the host computer where the
154 content is, and instead deliver the content from the network directly to the device. EPA views these
155 processors and modules as similar to Smart TVs that have replaced Set-top Boxes. EPA does not believe
156 these types of displays meet the definition of a Computer because they are not intended for a broad
157 range of home and office applications including running a variety of non-proprietary software or tasks
158 including design, word processing, or gaming.

159 In Draft 2, EPA is proposing a revised definition for Plug-In Module to include language that explicitly
160 excludes computing function “intended for a broad range of home and office applications.” EPA has also
161 included a new definition for embedded computing function that is intended to cover internal processors
162 for niche, display-oriented applications such as rendering content or running a proprietary software to
163 form a specific function like delivering interactive educational content.

164 Further, EPA will consider explicitly excluding displays with plug-in or embedded modules from future
165 revisions of the ENERGY STAR Computers specification. EPA welcomes general feedback on these
166 proposals as well as specific examples of displays that may have embedded modules meeting the
167 proposed definition.

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

- 174 1) External housing;
- 175 2) Number and types of interfaces;
- 176 3) Number and types of data, network, or peripheral ports; and
- 177 4) Processing and memory capability.

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

180 H) Power Source

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

184 2) Standard dc: A method for transmitting dc power defined by a well-known technology
185 standard, enabling plug-and-play interoperability.

186 Note: Common examples are USB and Power-over-Ethernet. Usually Standard dc includes
187 both power and communications over the same cable, but as with the 380 V dc standard,
188 that is not required.

189 2 SCOPE

190 2.1 Included Products

191 2.1.1 Products that meet the definition of a Display as specified herein and are powered directly from
192 ac mains, an External Power Supply, or Standard dc are eligible for ENERGY STAR certification,
193 with the exception of products listed in Section 2.2. Typical products that would be eligible for
194 certification under this specification include:

- 195 i. Monitors;
- 196 ii. Signage Displays;
- 197 iii. Signage Displays and Monitors with Plug-in Modules; and
- 198 iv. Signage Displays and Monitors with Embedded Modules.
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200 **Note:** Per the new proposed definition of Embedded Module, EPA has proposed language that explicitly
201 includes Displays with Embedded Modules in the scope of this specification.

202 **2.2 Excluded Products**

203 2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for
204 certification under this specification including Televisions and Computers (Thin Clients,
205 Slates/Tablets, Portable All-in-one Computers, Integrated Desktops). The list of specifications
206 currently in effect can be found at www.energystar.gov/products.

207 2.2.2 The following products are not eligible for certification under this specification:

- 208 i. Products with an integrated television tuner;
- 209 ii. Displays with integrated or replaceable batteries designed to support primary operation
210 without ac mains or external dc power, or device mobility (e.g., electronic readers, battery-
211 powered digital picture frames); and
- 212 iii. Products that must meet Food and Drug Administration specifications for medical devices
213 that prohibit power management capabilities and/or do not have a power state meeting the
214 definition of Sleep Mode.
- 215 v. Monitors with keyboard, video, and mouse (KVM) switch functionality;

216 **3 CERTIFICATION CRITERIA**

217 **3.1 Significant Digits and Rounding**

- 218 3.1.1 All calculations shall be carried out with directly measured (unrounded) values.
- 219 3.1.2 Unless otherwise specified, compliance with specification requirements shall be evaluated using
220 directly measured or calculated values without any benefit from rounding.
- 221 3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR
222 website shall be rounded to the nearest significant digit as expressed in the corresponding
223 specification requirements.

224 **3.2 General Requirements for Monitors and Signage Displays**

- 225 3.2.1 External Power Supplies (EPSs): Single- and Multiple-voltage EPSs shall meet the Level VI or
226 higher performance requirements under the International Efficiency Marking Protocol when tested
227 according to the Uniform Test Method for Measuring the Energy Consumption of External Power
228 Supplies, Appendix Z to 10 CFR Part 430.
- 229 i. Single- and Multiple-voltage EPSs shall include the Level VI or higher marking.
- 230 ii. Additional information on the Marking Protocol is available
231 at <http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0005-0218>.

232 3.2.2 General User Information: The product shall ship with consumer informational materials located in
233 either (1) the hard copy or electronic user manual, or (2) a package or box insert. These materials
234 shall include:

- 235 i. Information about the ENERGY STAR program,
- 236 ii. Information on the energy consumption implications of changes to default as-shipped
237 displays configuration and settings, and
- 238 iii. Notification that enabling certain optional features and functionalities (e.g., instant-on), may
239 increase energy consumption beyond the limits required for ENERGY STAR certification,
240 as applicable.

241 **Note:** In Draft 2, EPA is proposing general user information requirements that have been present for
242 some time in related ENERGY STAR specifications such as televisions and computers. EPA believes
243 consumers should be informed that there are several features and picture setting modes that the
244 consumer or installer could enable that may consume more energy than the default as-shipped ENERGY
245 STAR tested modes.

246 3.2.3 Forced Menu: Any product that includes a Forced Menu upon initial start-up shall upon selection
247 of any mode other than the “standard” as-tested by ENERGY STAR mode either (1) display a
248 second prompt requiring the user to confirm the choice of the other mode, or (2) display
249 information either with the ENERGY STAR mark or copy on the start-up menu that the “standard”
250 default ENERGY STAR tested mode is the setting in which the product qualifies for ENERGY
251 STAR.

252 **Note:** Similar to the requirement in the ENERGY STAR televisions specification, EPA is proposing that
253 the model indicate which mode meets ENERGY STAR requirements.

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255 3.2.4 Preset Picture Setting Menu: For any product where consumers have the option of selecting
256 different picture settings from a preset menu at any time:

- 257 i. The product shall identify on-screen Default Picture Setting under which the product
258 qualifies for the ENERGY STAR, if available. For example, the product may display an
259 electronic ENERGY STAR mark alongside the name or description of that Default Picture
260 Setting or display a message each time any setting other than the Default Picture Setting is
261 selected.
- 262 ii. The as-tested default mode should return to its original preset picture Settings whenever
263 the user selects the Default Picture Setting.

264 **Note:** EPA has incorporated and modified sections of the Preset Picture Setting requirements from the
265 Version 8 ENERGY STAR televisions specification finalized in February 2018. EPA intends for these
266 above picture setting requirements to better inform consumers about which mode meets ENERGY STAR
267 requirements and for users to easily return to the ENERGY STAR tested mode by selecting Default
268 Picture Setting. EPA welcomes stakeholder feedback on these proposals.

269 3.2.5 Sleep Mode Settings: If users can select and enable Sleep Mode functions from a display prompt
270 in On Mode or a settings menu other than a Forced Menu, and if these functions may alter power
271 draw (i.e. quick on) from the default as-shipped Sleep Mode in which the product qualifies for the
272 ENERGY STAR:

273 i. The product shall display on-screen information identifying the settings under which the
274 product qualifies for the ENERGY STAR. For example, such information may be indicated
275 by including an electronic ENERGY STAR mark alongside the name or description of the
276 default as-shipped settings or in the form of a message displayed each time any setting
277 other than a default as-shipped setting is selected.

278 ii. Products with a physical ENERGY STAR mark affixed to the front or top of the Display may
279 alternatively display on-screen information that enabling settings other than those under
280 which the product qualifies for the ENERGY STAR may change the energy consumption of
281 the product.

282 **Note:** EPA is aware that displays may have higher power Sleep Modes than the default as-tested mode.
283 Based on discussion with stakeholders, EPA learned that there is pressure on signage manufacturers to
284 produce low latency sleep modes that enable quick start. These products can have significantly more
285 consumptive sleep modes. EPA is proposing use of prompts or the ENERGY STAR mark to indicate
286 when default settings are changed.

287 3.2.6 Power Management:

288 i. Products shall offer at least one power management feature that is enabled by default, and
289 that can be used to automatically transition from On Mode to Sleep Mode either by a
290 connected host device or internally (e.g., support for VESA Display Power Management
291 Signaling (DPMS), enabled by default).

292 ii. Products that generate content for display from one or more internal sources shall have a
293 sensor or timer enabled by default to automatically engage Sleep or Off Mode.

294 iii. For products that have an internal default delay time after which the product transitions from
295 On Mode to Sleep Mode or Off Mode, the delay time shall be reported.

296 iv. Monitors shall automatically enter Sleep Mode or Off Mode within 5 minutes of being
297 disconnected from a host computer.

298 3.2.7 Signage Displays shall have a true power factor in On Mode of 0.7 or greater per Section 5.2. Fin
299 the ENERGY STAR Test Method.

300 3.3 Energy Requirements for Computer Monitors

301 3.3.1 The Total Energy Consumption (TEC) in kWh shall be calculated per Equation 1 based on
302 measured values.

303 Equation 1: Total Energy Consumption Calculation

$$304 E_{TEC} = 8.76 \times (0.35 \times P_{ON} + 0.65 \times P_{SLEEP})$$

305 Where:

- 306 ■ E_{TEC} is the Total Energy Consumption calculation in kWh;
- 307 ■ P_{ON} is Measured On Mode Power in watts
- 308 ■ P_{SLEEP} is Measured Sleep Mode Power in watts; and
- 309 ■ The result shall be rounded to the nearest tenth of a kWh for reporting.
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312 3.3.2 The Maximum TEC (E_{TEC_MAX}) in kWh for Monitors shall be calculated per Equation 2.

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Equation 2: Calculation of Maximum TEC (E_{TEC_MAX}) for Monitors in kWh

$$E_{TEC_MAX} = (4.20 * R) + (0.122 * A) + 8.00$$

Where:

- R is the Total Native Resolution in megapixels
- A is the Screen Area in inches squared

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Note: In Draft 1, stakeholders suggested EPA to revisit resolution allowance, area coefficients, and intercept value in the TEC calculation. In response to stakeholder comments, EPA has made a slight revision to the coefficients and intercept values for the Maximum TEC equation in Draft 2. EPA proposes increasing the resolution allowance to 4.2 kWh per megapixel from 3.99 kWh per megapixel in Draft 1, slightly decreasing the area coefficient to 0.122 kWh per square inch from 0.123 kWh per square inch in Draft 1, and common intercept of 8.0 kWh for all screen sizes. EPA has applied a continuous line to provide more balanced requirements across size bins and avoid issues with models that straddle bins. EPA welcomes feedback on this proposal.

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In the Draft 2 dataset provided to stakeholders, EPA has identified models that are unique in terms of Tested Model number with a label in the far right column. Under the ENERGY STAR certification process, Partners may submit the same tested model data more than once to represent either different features (i.e. bezel color) that do not affect energy consumption or different brand names and model numbers for retail and marketing purposes. EPA removes models from its analysis that may be repetitive to avoid skewing the results. EPA has clarified this analysis further by referring specifically to 'unique' models that represent a unique tested model number.

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3.3.3 For all Monitors, Calculated TEC (E_{TEC}) in kWh shall be less than or equal the calculation of Maximum TEC (E_{TEC_MAX}) with the applicable allowances and adjustments (applied at most once) per Equation 3.

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Equation 3: Total Energy Consumption Requirement for Monitors

$$E_{TEC} \leq (E_{TEC_MAX} + E_{EP} + E_{ABC} + E_N + E_T + E_C) \times eff_{AC_DC}$$

Where:

- E_{TEC} is TEC in kWh calculated per Equation 1;
- E_{TEC_MAX} is the Maximum TEC requirement in kWh calculated per Equation 2;
- E_{EP} is the enhanced performance display allowance in kWh per Section 3.3.4;
- E_{ABC} is the Automatic Brightness Control allowance in kWh per Equation 6;
- E_N is the Full Network Connectivity allowance in kWh per Table 1;
- E_T is the Touch Technology allowance in kWh per Equation 7;
- E_C is the curved Display allowance in kWh per Equation 8; and
- eff_{AC_DC} is the standard adjustment for ac-dc power conversion losses that occur at the device powering the Display, and is 1.0 for Ac-powered Displays and 0.85 for Displays with Standard dc.

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3.3.4 For Monitors meeting the enhanced performance display (EPD) requirements below, the energy allowance in Equation 4 shall be applied to the Total Energy Consumption requirement in Equation 3:

- 356 i. Contrast ratio of at least 60:1 measured at a horizontal viewing angle of at least 85° from the
 357 perpendicular on a flat screen and at least 83° from the perpendicular on a curved screen,
 358 with or without a screen cover glass;
- 359 ii. A native resolution greater than or equal to 3.6 megapixels (MP); and
- 360 iii. Color Gamut greater than or equal to 32.9% of CIE LUV.

361 **Equation 4: Calculation of Energy Allowance for Enhanced Performance Displays**

362
$$E_{EP} = 0.14 \times G$$

363 *Where:*

- 365 ▪ *E_{EP} is the enhanced performance display energy allowance in kWh*
- 366 ▪ *G is Color Gamut expressed as a percentage of CIE LUV*

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368 Note: A model supporting greater than 99% of the sRGB color space translates to 32.9% of CIE LUV
 369 and a model supporting greater than 99% of Adobe RGB translates to 38.4% of CIE LUV.

370 **Note:** In response to Draft 1, stakeholders suggested EPA develop a continuous function to apply to an
 371 energy allowance for the variable Color Gamut instead of applying two separate discrete allowances.
 372 EPA reviewed the dataset and analyzed a select group of models with the percentage Color Gamut
 373 reported correctly. EPA found that many models did not have Color Gamut accurately reported to CIE
 374 LUV space and it was therefore unable to assess the full set of models. EPA found no significant
 375 relationship between Color Gamut and power for models with Total Native Resolution below 3.6
 376 megapixels. Further a substantial amount of models below 3.6 megapixels are able to meet the Draft 2
 377 proposed energy requirements without an additional allowance.

378 EPA is, therefore, proposing to raise the minimum Total Native Resolution requirement from 2.6 to 3.6
 379 megapixels for models to access the enhanced performance display allowance. Further, in Draft 2, EPA
 380 is proposing to apply an enhanced performance allowance based on a continuous function of color
 381 gamut. EPA welcomes feedback on this proposal.

382 EPA proposes maintaining the viewing angle contrast requirement as it is present in enhanced performing
 383 displays dedicated to niche applications as compared to more mainstream models that may offer higher
 384 color coverage but poor off-angle viewing.

385 EPA did not receive model specific data indicating the monitors marketed for gaming functions demand
 386 more power in On Mode. However, through a web search of a subset of models, EPA did identify seven
 387 models marketed for gaming, of which three models meet the proposed Draft 2 criteria. Further, EPA
 388 received no feedback on how to define gaming monitors. As such, the Agency has not proposed an
 389 allowance for gaming in the Draft 2 specification. One stakeholder did comment that gaming monitors use
 390 “double the logic power” and “reduce transmittance,” however, no model level data was provided to
 391 support these statements.

392 EPA received stakeholder comments regarding HDR functionality. The existing ENERGY STAR displays
 393 test method does not have procedure in place to assess displaying native or upscaled HDR content and
 394 would require a substantial revision and review process. Prior to the launch of the Version 9 specification
 395 development, EPA and DOE will continue to monitor the current development of HDR test procedures led
 396 by other organizations including CLASP and consider a possible future revision to the ENERGY STAR
 397 test method. EPA and stakeholders have also considered the issue of HDR under the recent Version 8
 398 specification development process for TVs completed in February 2018. In the Version 8 televisions
 399 specification, EPA has included a data reporting requirement for partners to report power consumption of
 400 the TV when HDR upscaling function is enabled. These data should help inform how HDR upscaling may
 401 affect power consumption of Monitors and Signage Displays and shall be considered in the Version 9
 402 specification.

403 To date, TVs with HDR capability have not required additional power allowances or consideration to meet
404 the ENERGY STAR specification power requirements and EPA has received no specific model data for
405 Monitors indicating that HDR capability leads to more power demand under the ENERGY STAR test
406 procedures. Further, EPA continues to welcome market data that indicates how prevalent HDR content
407 viewing is among Monitors in the field.

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409 3.3.5 For monitors with Automatic Brightness Control (ABC) enabled by default, an energy allowance
410 (E_{ABC}), as calculated per Equation 6, shall be added to E_{TEC_MAX} in Equation 3, if the On Mode
411 power reduction (R_{ABC}), as calculated per Equation 5, is greater than or equal to 20%.

412 **Equation 5: Calculation of On Mode Reduction with ABC Enabled by Default**

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$$R_{ABC} = 100\% \times \left(\frac{P_{300} - P_{12}}{P_{300}} \right)$$

414 *Where:*

- 415 ▪ R_{ABC} is the On Mode percent power reduction due to ABC;
 - 416 ▪ P_{300} is the On Mode power in watts, as measured at an ambient light level of 300 lux in Section 6.4 of
417 the Test Method; and
 - 418 ▪ P_{12} is the On Mode power in watts, as measured at an ambient light level of 12 lux in Section 6.4 of
419 the Test Method.
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421 **Equation 6: Monitors ABC Energy Allowance (E_{ABC}) for Monitors**

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$$E_{ABC} = 0.05 \times E_{TEC_MAX}$$

423 *Where:*

- 424 ▪ E_{ABC} is the energy allowance for Automatic Brightness Control in kWh; and
 - 425 ▪ E_{TEC_MAX} is the Maximum TEC in kWh, per Equation 2.
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427 3.3.6 Products with Full Network Connectivity confirmed in Section 6.7 of the ENERGY STAR Test
428 Method shall apply the allowance specified in Table 1.

429 **Table 1: Full Network Connectivity Energy Allowance (E_N) for Monitors**

E_N (kWh)
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430 **Note:** EPA is proposing to remove the Occupancy Sensor allowance for Computer Monitors as there are
431 no data indicating that the presence of such feature will draw significantly more power.

432 3.3.7 Products tested with Touch Technology active in On Mode shall apply the allowance specified in
433 Equation 7.

434 **Equation 7: Energy Allowance for Touch Technology (E_T) for Monitors**

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$$E_T = 0.15 \times E_{TEC_MAX}$$

436 *Where:*

- 437 ▪ E_T is the energy allowance for Touch Technology in kWh; and
- 438 ▪ E_{TEC_MAX} is the Maximum TEC in kWh, per Equation 2.

439 **Note:** In Draft 2, EPA proposes a revision to the energy allowance for monitors with touch technology
440 from 20% in Draft 1 to 15% percent of E_{TEC_MAX} . A 15% allowance allows 22% of the models with touch
441 enabled by default to meet the energy requirements with another several models within 2% of the
442 requirements.

443 **Equation 8: Monitors Curved Display Energy Allowance (E_C) for Monitors**

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$$E_C = 0.05 \times E_{TEC_MAX}$$

445 *Where:*

- 446 ▪ E_C is the energy allowance for curved Displays in kWh; and
- 447 ▪ E_{TEC_MAX} is the Maximum TEC in kWh, per Equation 2 **Error! Reference source not found.**
- 448

449 **Note:** In response to Draft 1, one stakeholder provided panel data indicating that curved Monitors
450 consume more power relative to their flat counterparts. EPA identified four curved Monitors in the existing
451 ENERGY STAR dataset. The four models did not meet the Draft 2 proposed energy requirements without
452 an allowance. In Draft 2, EPA is proposing an allowance of 5% for curved displays based on which results
453 in one out of the EPA dataset four curved models meeting the proposed Draft 2 criteria. EPA welcomes
454 stakeholder feedback on this proposal and requests test data submission for curved models that are not
455 currently ENERGY STAR certified.

456 **3.4 Tiled Display Systems**

457 3.4.1 Tiled Display Systems shall meet the Signage Display On Mode criteria for the total screen area
458 of the Maximum Tiled Configuration.

459 Note: The total Screen Area of 4 x 4 Tiled Displays System of individual 42-inch diagonal screen
460 size (height 23.3 inches and length 41.5 inches) displays is calculated as (2 x 23.3") x (2 x 41.5")
461 equal to 3867.8 square inches. The Tiled Display System shall meet the On Mode criteria for a
462 3,867.8 square inch Signage Display.
463

464 **Note:** EPA is proposing to assess the total combined screen area of a Tiled Display System as it is
465 primarily intended to display images equivalent to the total area. EPA welcomes feedback on this
466 proposal as any additional data for these systems in both On Mode and Sleep Mode.

467

468 **3.5 On Mode Requirements for Signage Displays**

469 **Note:** While EPA did not propose any changes to the On Mode requirements for Signage in Draft 1, the
470 Agency received feedback that the On Mode power limit equation was relatively more stringent for
471 displays over 65 diagonal inches compared to the relatively lenient criteria for smaller models. In Draft 2,
472 EPA has revised the limit to recognize top models across varying sizes, luminance, and resolution. The
473 revised hyperbolic tangent equation has an asymptote of 135 W compared to 125 W in Draft 1 for On
474 Mode Power minus the luminance allowance. EPA welcomes stakeholder feedback on this proposal.

475

476 3.5.1 The Maximum On Mode Power (P_{ON_MAX}) in watts shall be calculated per Equation 9.

477 **Equation 9: Calculation of Maximum On Mode Power (P_{ON_MAX}) in Watts for Signage Displays**

478

$$P_{ON_MAX} = (4.0 \times 10^{-5} \times \ell \times A) + 120 \times \tanh(0.0005 \times (A - 140.0) + 0.03) + 20$$

480

481

Where:

482

483

484

485

486

- P_{ON_MAX} is the Maximum on Mode Power, in watts;
- A is the Screen Area in square inches;
- ℓ is the Maximum Measured Luminance of the Display in candelas per square meter, as measured in Section 6.2 of the test method; and
- The result shall be rounded to the nearest tenth of a watt for reporting.

487

488 **Equation 10: On Mode Power Requirement for Signage Displays**

489

$$P_{ON} \leq P_{ON_MAX} + P_{ABC}$$

490

491

Where:

492

493

494

495

- P_{ON} is On Mode Power in watts, as measured in Section 6.3 or 6.4 of the Test Method;
- P_{ON_MAX} is the Maximum On Mode Power in watts, per Equation 9; and
- P_{ABC} is the On Mode power allowance for ABC in watts, per Equation 11.

496 3.5.2 For Signage Displays with ABC enabled by default, a power allowance (P_{ABC}), as calculated per
497 Equation 11, shall be added to P_{ON_MAX} , as calculated per Equation 10, if the On Mode power
498 reduction (R_{ABC}), as calculated per Equation 5, is greater than or equal to 20 percent.

499 **Equation 11: Calculation of On Mode Power Allowance for Signage Displays with ABC Enabled by
500 Default**

501

$$P_{ABC} = 0.05 \times P_{ON_MAX}$$

502

Where:

503

504

505

- P_{ABC} is the Measured On Mode Power allowance for ABC in watts; and
- P_{ON_MAX} is the Maximum On Mode Power requirement in watts.

506 **3.6 Sleep Mode Requirements for Signage Displays**

507 3.6.1 Measured Sleep Mode Power (P_{SLEEP}) in watts shall be less than or equal the sum of the
508 Maximum Sleep Mode Power Requirement (P_{SLEEP_MAX}) and any allowances (applied at most
509 once) per Equation 12.

510

Equation 12: Sleep Mode Power Requirement for Signage Displays

511

$$P_{SLEEP} \leq P_{SLEEP_MAX} + P_N + P_{OS} + P_T$$

512

513

Where:

514

- P_{SLEEP} is Measured Sleep Mode Power in watts;
- P_{SLEEP_MAX} is the Maximum Sleep Mode Power requirement in watts per Table 2;
- P_N is the Full Network Connectivity allowance in watts per Table 3;
- P_{OS} is the Occupancy Sensor allowance in watts per Table 4; and
- P_T is the Touch allowance in watts per Table 4.

515

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Table 2: Maximum Sleep Mode Power Requirement (P_{SLEEP_MAX}) for Signage Displays

P_{SLEEP_MAX} (watts)
0.5

521

522

3.6.2 Products with Full Network Connectivity confirmed in Section 6.7 of the ENERGY STAR Test Method shall apply the allowance specified in Table 3.

523

524

Table 3: Full Network Connectivity Allowance for Signage Displays

P_N (watts)
3.0

525

526

3.6.3 Products tested with an Occupancy Sensor or Touch Technology active in Sleep Mode shall apply the allowances specified in Table 4.

527

528

Table 4: Additional Functions Sleep Mode Power Allowance for Signage Displays

Type	Screen Size (in)	Allowance (watts)
Occupancy Sensor P_{OS}	All	0.3
Touch Functionality P_T <i>(applicable only to Signage Displays where screen size is greater than 30 inches)</i>	≤ 30	0.0
	> 30	1.5

529

3.7 Off Mode Requirements for all Displays

530

3.7.1 A product need not have an Off Mode to be eligible for certification. For products that do offer Off Mode, measured Off Mode power (P_{OFF}) shall be less than or equal to the Maximum Off Mode Power Requirement (P_{OFF_MAX}) in Table 5.

531

532

533

Table 5: Maximum Off Mode Power Requirement (P_{OFF_MAX})

P_{OFF_MAX} (watts)
0.5

534

535 **3.8 Luminescence Reporting Requirements**

536 3.8.1 Maximum Reported and Maximum Measured Luminescence shall be reported for all products; As-
537 Shipped Luminescence shall be reported for all products except those with ABC enabled by default.

538
539 Note: Products intended for sale in the US market are subject to minimum toxicity and recyclability
540 requirements. Please see ENERGY STAR® Program Requirements for Displays: Partner Commitments
541 for details.

542 **4 TEST REQUIREMENTS**

543 **4.1 Test Methods**

544 4.1.1 Test methods identified in Table 6 shall be used to determine certification for ENERGY STAR.

Table 6: Test Methods for ENERGY STAR Certification

Product Type	Test Method
All Product Types and Screen Sizes	ENERGY STAR Test Method for Determining Display Energy – Rev. August-2018
Enhanced Performance Displays	International Committee for Display Metrology (ICDM) Information Display Measurements Standard – Version 1.03
Displays Claiming Full Network Connectivity	CEA-2037-A, Determination of Television Set Power Consumption

546

547 **4.2 Number of Units Required for Testing**

548 4.2.1 One unit of a Representative Model, as defined in Section 1, shall be selected for testing.

549 4.2.2 For certification of a Product Family, the product configuration that represents the worst-case
550 power demand for each product category within the Product Family shall be considered the
551 Representative Model.

552 **4.3 International Market Qualification**

553 4.3.1 Products shall be tested for qualification at the relevant input voltage/frequency combination for
554 each market in which they will be sold and promoted as ENERGY STAR.

555 **5 USER INTERFACE**

556 5.1.1 Manufacturers are encouraged to design products in accordance with the user interface standard,
557 IEEE P1621: Standard for User Interface Elements in Power Control of Electronic Devices
558 Employed in Office/Consumer Environments. For details, see <http://energy.lbl.gov/controls/>.

559 **6 EFFECTIVE DATE**

560 6.1.1 Effective Date: The Version 8 ENERGY STAR Display specification shall take effect on **TBD**. To
561 qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect
562 on its date of manufacture. The date of manufacture is specific to each unit and is the date on
563 which a unit is considered to be completely assembled.

564 **Note:** EPA intends to finalize the Version 8.0 Displays specification by the end of 2018.

565 6.1.2 Future Specification Revisions: EPA reserves the right to change this specification should
566 technological and/or market changes affect its usefulness to consumers, industry, or the
567 environment. In keeping with current policy, revisions to the specification are arrived at through
568 stakeholder discussions. In the event of a specification revision, please note ENERGY STAR
569 certification is not automatically granted for the life of a model.

570 **7 CONSIDERATIONS FOR FUTURE REVISIONS**

571

572 7.1.1 Standby-Active, High Mode: Similar to future revisions of the ENERGY STAR Televisions
573 specification, EPA and DOE are interested in learning more about Standby-Active, High Mode or
574 Displays with Sleep Modes that demand higher power draw because they actively running
575 components to reduce latency from Sleep to On Mode, download software updates, or process
576 sensor data. This issue is particularly pertinent with interactive displays that either have a remote
577 or touch screen where the use expects Display to display content without delay. EPA anticipates
578 exploring this issue and potential power limits and duty cycle requirements in the next
579 specification revision.

580 7.1.2 HDR: Similar to future revisions of the ENERGY STAR Televisions specification, EPA will monitor
581 the market to assess the extent to which opportunities exist to improve the energy efficiency of
582 the HDR upscaling features

583 7.1.3 Revisions to Test Content: As displays technologies continue to evolve, DOE and EPA support
584 external stakeholder efforts to revise test content (i.e. test clips) to better account for how
585 products perform under more realistic consumer viewing conditions, especially with regard to
586 UHD (4K) Content and Native HDR Content.