



ENERGY STAR® Program Requirements Product Specification for Displays

Eligibility Criteria Final Draft Version 8.0

1 Following is the Final Draft 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 criteria 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 7,000 pixels per square inch;

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

21 (5) Contains RJ45 or RS232 physical ports.

22 **Note:** In response to the Draft 2 proposal that signage displays meet three instead of two of the above
23 criteria, stakeholders suggested the pixel density maximum be increased from 5,000 to 7,000 pixels per
24 square inch to accommodate the trend towards higher resolution signage displays. EPA agrees with the
25 suggestion and has updated criterion (3) accordingly.

26 Additionally, stakeholders requested clarification on criterion (5) regarding the capability of remote
27 management or the presence of an external data controller. In response, EPA has specified that models
28 shall contain RJ45 or RS232 physical ports to meet this criterion as these may commonly be used in
29 remote management systems.

30 c) Tiled Display System: A testable configuration of Signage Displays in which multiple
31 Signage Displays are tiled together contiguously and supported by one or more
32 modular external controllers and one or more modular external power supplies to
33 produce a single larger image.

34 (1) Maximum Tiled Configuration: A Tiled Display System configured with the
35 maximum number of Signage Display panels supported by the same set of
36 external support modules (e.g., power supplies, controllers, etc.) that are needed
37 to support a configuration with two panels.

38 **Note:** In response to stakeholder requests for clarification, EPA is revising the proposed definitions of
39 Tiled Display System and Maximum Tiled Configuration. Further below, EPA is also proposing to modify
40 Section 4.2, Number of Units Required for Testing, to specify that Tiled Display Systems shall be tested in
41 the Maximum Tiled Configuration.

42 B) Operational Modes:

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

45 3) Sleep Mode: A low-power mode in which the Display provides one or more non-primary
46 protective functions or continuous functions.

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

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

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

55 C) Displays Settings and Menu

56 5) Preset Picture Setting: A preprogrammed factory setting obtained from the Display menu
57 with pre-determined picture parameters such as brightness, contrast, color, sharpness, etc.

58 6) Default Picture Setting: The Preset Picture Setting tested and recognized according to the
59 ENERGY STAR test method. The Default Picture Setting is typically the Preset Picture
60 Setting in the model's as-shipped default state. If the Display has a Forced Menu, the
61 Default Picture Setting is the Preset Picture Setting identified according to the ENERGY
62 STAR test method, usually the setting labeled "Standard" or "Home."

63 7) Forced Menu: A series of menus which require the selection of initial settings before
64 allowing the user to utilize primary functions. These menus may contain an option to select
65 between the Default Picture Setting and other picture settings not tested in the ENERGY
66 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 the Default Picture Setting for the
69 purposes of this specification.

70 **Note:** EPA has made minor clarification to the above note to reference the Default Picture Setting as
71 defined above.

72 D) Visual Characteristics:

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

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

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

78 10) Color Gamut: The range of color supported within the CIE LUV 1976 $u' v'$ color space and
79 calculated per Section 5.18 Gamut Area of the Information Display Measurements Standard
80 Version 1.03.

81 Note: Any gamut support in non-visible/invisible color areas is not to be counted. The gamut
82 must be expressed as a percentage from 1% to 100% to the nearest 0.1% of the area of the
83 visible CIE LUV color space only.

84 11) High Dynamic Range (HDR): The ability to display images with greater range of contrast and
85 color than what is considered standard dynamic range.

86 **Note:** EPA is adding the definition of High Dynamic Range (HDR) adapted from the well-accepted
87 definition by the Video Electronics Standards Association (VESA).

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

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

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

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

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

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

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

103 Note: Screen Area is calculated by multiplying the viewable image width by the viewable
104 image height. For curved screens, measure the width and height along the arc of the
105 Display.

106 E) Additional Functions and Features:

107 15) Bridge Connection: A physical connection between two hub controllers (e.g. USB, FireWire).

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

110 16) Full Network Connectivity: The ability of the Display to maintain network presence while in
111 Sleep Mode. Presence of the Display, its network services, and its applications, is
112 maintained even if some components of the Display are powered down. The Display can
113 elect to change power states based on receipt of network data from remote network devices,
114 but should otherwise stay in Sleep Mode absent a demand for services from a remote
115 network device.

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

118 17) Occupancy Sensor: A device used to detect human presence in front of or in the area
119 surrounding a Display.

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

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

125 19) Plug-in Module: A modular plugin device for Signage Displays with compute functionality
126 that provides one or more of the following functions:

127 a) Display remote content streamed to it, such as images or screen mirroring, or
128 otherwise render content on the screen from local or remote sources; or

129 b) Process touch signals.

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

133 20) Embedded Module: A non-modular processor or computing system embedded in a Signage
134 Display that provides one or more of the following functions:

135 a) Display remote content streamed to it, such as images or screen mirroring, or
136 otherwise render content on the screen from local or remote sources; or

137 b) Process touch signals.

138 **Note:** In response to the new proposed definition of Embedded Module for Signage Displays in Draft 2,
139 one stakeholder recommended that the phrase “without the explicit purpose of providing general
140 computing function” be omitted from the Embedded Module and Plug-in Module definitions because of
141 the ambiguity regarding capabilities of compute cards present in these modules and interpreting the
142 meaning of general computing function. EPA has removed the clause restricting these modules from
143 having general computing function. To reduce overlap with Integrated Desktop Computers in the
144 ENERGY STAR Computers specification, EPA has specified in the definition that the Embedded Module
145 and Plug-in Modules are for Signage Displays (not Computer Monitors).

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

151 1) External housing;

152 2) Number and types of interfaces;

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

154 4) Processing and memory capability.

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

157 H) Power Sources:

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

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

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

166 **2 SCOPE**

167 **2.1 Included Products**

168 2.1.1 Products that meet the definition of a Display as specified herein and are powered directly from
169 ac mains, an External Power Supply, or Standard dc are eligible for ENERGY STAR certification,
170 with the exception of products listed in Section 2.2. Typical products that would be eligible for
171 certification under this specification include:

- 172 i. Monitors;
- 173 ii. Signage Displays;
- 174 iii. Signage Displays with Plug-in Modules;
- 175 iv. Signage Displays with Embedded Modules; and
- 176 v. Signage Displays in a Tiled Display System configuration.

177 **Note:** Per the requested refinements to the definition of Plug-in Module, Embedded Module, and Tiled
178 Display System, EPA has amended the language here to explicitly include Signage Displays with Plug-in
179 and Embedded Modules and Signage Displays in a Tiled Display System configuration in the scope of
180 this specification. The inclusion of these products was proposed implicitly by defining criteria for their
181 certification in Draft 2 in response to stakeholder requests. Only favorable responses were received
182 regarding this expansion in scope, so EPA does not foresee any concern with explicitly including these
183 products.

184 **2.2 Excluded Products**

185 2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for
186 certification under this specification including Televisions and Computers (Thin Clients,
187 Slates/Tablets, Portable All-in-one Computers, and Integrated Desktops). The list of
188 specifications currently in effect can be found at www.energystar.gov/products.

189 2.2.2 The following products are not eligible for certification under this specification:

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

198 **3 CERTIFICATION CRITERIA**

199 **3.1 Significant Digits and Rounding**

200 3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

201 3.1.2 Unless otherwise specified, compliance with specification requirements shall be evaluated using
202 directly measured or calculated values without any benefit from rounding.

203 3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR
204 website shall be rounded to the nearest significant digit as expressed in the corresponding
205 specification requirements.

206 **3.2 General Requirements for Monitors and Signage Displays**

207 3.2.1 External Power Supplies (EPSs): Single- and Multiple-voltage EPSs shall meet the Level VI or
208 higher performance requirements under the International Efficiency Marking Protocol when tested
209 according to the Uniform Test Method for Measuring the Energy Consumption of External Power
210 Supplies, Appendix Z to 10 CFR Part 430.

211 i. Single- and Multiple-voltage EPSs shall include the Level VI or higher marking.

212 ii. Additional information on the Marking Protocol is available
213 at <http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0005-0218>.

214 3.2.2 General User Information: The product shall ship with consumer informational materials located in
215 either (1) the hard copy or electronic user manual, or (2) a package or box insert. These materials
216 shall include:

217 a) Information about the ENERGY STAR program,

218 b) Information on the energy consumption implications of changes to default as-shipped
219 displays configuration and settings, and

220 c) Notification that enabling certain optional features and functionalities (e.g., instant-on), may
221 increase energy consumption beyond the limits required for ENERGY STAR certification,
222 as applicable.

223 3.2.3 Forced Menu: Any product that includes a Forced Menu upon initial start-up shall upon selection
224 of any mode other than the Default Picture Setting as identified and tested by the ENERGY STAR
225 test procedure either (1) display a second prompt requiring the user to confirm the choice of the
226 other mode, or (2) display information either with the ENERGY STAR mark or copy on the start-
227 up menu that the Default Picture Setting is the setting in which the product qualifies for ENERGY
228 STAR.

229 **Note:** To clarify this section, EPA now refers to the defined term Default Picture Setting.

230 3.2.4 Preset Picture Setting Menu: For any product where consumers have the option of selecting
231 different picture settings from a preset menu at any time:

232 a) The product shall identify on-screen the Default Picture Setting under which the product
233 qualifies for the ENERGY STAR, if available. For example, the product may display an
234 electronic ENERGY STAR mark alongside the name or description of that Default Picture
235 Setting or display a message each time any setting other than the Default Picture Setting is
236 selected.

237 b) The product shall return to the identified Default Picture Setting, including all energy saving
238 features enabled by default, whenever the user selects that Preset Picture Setting.

239 **Note:** To clarify expectations for Preset Picture Setting, EPA has replaced 'should' with 'shall' in the
240 above requirement and made minor language revisions to the requirement, 'the product shall return to the
241 identified Default Picture Setting, including all energy saving features enabled by default, whenever the
242 user selects that Preset Picture Setting.'

243 3.2.5 Sleep Mode Settings: If users can select and enable Sleep Mode functions from a display prompt
244 in On Mode or a settings menu other than a Forced Menu, and if these functions may alter power
245 draw (i.e. quick start) from the default as-shipped Sleep Mode in which the product qualifies for
246 the ENERGY STAR:

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

252 b) Products with a physical ENERGY STAR mark affixed to the front or top of the Display may
 253 alternatively display on-screen information that enabling settings other than those under
 254 which the product qualifies for the ENERGY STAR may change the energy consumption of
 255 the product.

256 3.2.6 Power Management:

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

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

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

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

267 3.2.7 Signage Displays shall have a true power factor in On Mode of 0.7 or greater per Section 5.2.F in
 268 the ENERGY STAR Test Method.

269 **3.3 Energy Requirements for Computer Monitors**

270 3.3.1 The Total Energy Consumption (TEC) in kWh shall be calculated per Equation 1 based on
 271 measured values.

272 **Equation 1: Total Energy Consumption Calculation**

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

273 Where:

- 274 ■ E_{TEC} is the Total Energy Consumption calculation in kWh;
- 275 ■ P_{ON} is Measured On Mode Power in watts
- 276 ■ P_{SLEEP} is Measured Sleep Mode Power in watts; and
- 277 ■ The result shall be rounded to the nearest tenth of a kWh for reporting.

278 3.3.2 The Maximum TEC (E_{TEC_MAX}) in kWh for Monitors shall be calculated per Table 1.

282 **Table 1: Calculation of Maximum TEC (E_{TEC_MAX}) for Monitors in kWh**

Area (in ²)	E_{TEC} Max (kWh)
Where: A = Viewable screen area in in ² r = Screen resolution in megapixels (MP) The result shall be rounded to the nearest tenth of a kWh for reporting.	
A < 190	$(4.00 \times r) + (0.172 \times A) + 1.50$
$190 \leq A < 210$	$(4.00 \times r) + (0.020 \times A) + 30.4$
$210 \leq A < 315$	$(4.00 \times r) + (0.091 \times A) + 15.4$
A ≥ 315	$(4.00 \times r) + (0.182 \times A) - 13.2$

283

284 **Note:** In response to Draft 2, EPA received comments requesting less stringent criteria for models with
 285 screen areas over 300 square inches. The equation for E_{TEC} MAX proposed in Draft 2 was a single linear
 286 function of area and resolution. Per closer review of the data, EPA recognizes that separate functions
 287 could better balance requirements for monitors of different sizes; at 13%, the pass rate for monitors with
 288 diagonal screen sizes over 30 inches was significantly lower than the overall pass rate of 27%. Based on
 289 stakeholder feedback, EPA is thus proposing revised E_{TEC} MAX requirements for monitors with different
 290 E_{TEC} MAX equations based on four size bins: Screen Area less than 190 square inches, 190 to 210
 291 square inches, 210 to 315 square inches, and greater than or equal to 315 square inches. To avoid
 292 issues with models that straddle size bins, the E_{TEC} MAX equation for each size bin is continuous with the
 293 next bin. The revised Final Draft requirements for monitors, including E_{TEC} MAX and allowances, result in
 294 balanced dataset pass rates of 32%, 29%, 32%, and 33% for monitors with Screen Area less than 190
 295 square inches, 190 to 210 square inches, 210 to 315 square inches, and greater than or equal to 315
 296 square inches, respectively. To account for changes in the area coefficient, intercepts, and feature
 297 allowances, EPA has revised the resolution allowance of 4.2 kWh per megapixel to 4.0 kWh per
 298 megapixel.

299 Through two drafts, numerous stakeholder meetings, and careful consideration of all comments and data,
 300 this final draft specification balances recognizing energy savings while also supporting the features that
 301 consumers seek. Approximately 30% of monitors in a variety of size bins from a wide selection of brand
 302 owners meet the final draft levels. EPA did receive an additional request to ease the TEC requirements
 303 for monitors. EPA evaluated this request and found that accommodating it would result in more than 50%
 304 of available models meeting the eased levels. In the interest of recognizing leadership products, EPA has
 305 not made this requested change.

306 3.3.3 For all Monitors, Calculated TEC (E_{TEC}) in kWh shall be less than or equal the calculation of
 307 Maximum TEC (E_{TEC_MAX}) with the applicable allowances and adjustments (applied at most once)
 308 per Equation 2.

309 **Equation 2: Total Energy Consumption Requirement for Monitors**

310
$$E_{TEC} \leq (E_{TEC_MAX} + E_{EP} + E_{ABC} + E_N + E_T + E_C + E_{H600} + E_{H1000} + E_{USB}) \times eff_{AC_DC}$$

311 Where:

- 312
- 313 ■ E_{TEC} is TEC in kWh calculated per Equation 1;
- 314 ■ E_{TEC_MAX} is the Maximum TEC requirement in kWh calculated per Table 1;
- 315 ■ E_{EP} is the enhanced performance display allowance in kWh per Section 3.3.4;
- 316 ■ E_{ABC} is the Automatic Brightness Control allowance in kWh per Equation 5;
- 317 ■ E_N is the Full Network Connectivity allowance in kWh per Table 2;
- 318 ■ E_T is the Touch Technology allowance in kWh per Equation 6;
- 319 ■ E_C is the curved Display allowance in kWh per Equation 7;
- 320 ■ E_{H600} is the HDR 600 Display allowance in kWh per Table 3;
- 321 ■ E_{H1000} is the HDR 1000 Display allowance in kWh per Table 3;
- 322 ■ E_{USB} is the allowance for Displays with USB-C functionality per Table 4; and
- 323 ■ eff_{AC_DC} is the standard adjustment for ac-dc power conversion losses that occur at the device
 324 powering the Display, and is 1.0 for Ac-powered Displays and 0.85 for Displays with Standard dc.

325 3.3.4 For Monitors meeting the enhanced performance display (EPD) requirements below, the energy
 326 allowance in Equation 3 shall be applied to the Total Energy Consumption requirement in
 327 Equation 2:

- 328 i. Contrast ratio of at least 60:1 measured at a horizontal viewing angle of at least 85° from the
 329 perpendicular on a flat screen and at least 83° from the perpendicular on a curved screen,
 330 with or without a screen cover glass;
- 331 ii. A native resolution greater than or equal to 2.3 megapixels (MP); and
- 332 iii. Color Gamut greater than or equal to 32.9% of CIE LUV.

333 **Equation 3: Calculation of Energy Allowance for Enhanced Performance Displays**

334
$$E_{EP} = \left(\left(1.70 \times \frac{G}{100\%} \right) - 0.52 \right) * E_{TEC_MAX}$$

335
336 *Where:*

- 337 ▪ E_{EP} is the enhanced performance display energy allowance in kWh
- 338 ▪ G is Color Gamut expressed as a percentage of CIE LUV from 1.0% to 100.0%, reported to the
- 339 nearest 0.1%
- 340 ▪ E_{TEC_MAX} is the Maximum TEC requirement in kWh calculated per Equation 2

341
342 Note: A model supporting greater than 99% of the sRGB color space translates to 32.9% of CIE LUV
343 and a model supporting greater than 99% of Adobe RGB translates to 38.4% of CIE LUV.

344 **Note:** In response to Draft 2, stakeholders suggested that the EPD allowance, in addition to being a
345 continuous function of Color Gamut, should be implemented as a percentage of the Maximum TEC
346 requirement so as to also account for the impact of screen size on power demand. EPA agreed with this
347 recommendation and has included an EPD allowance that computes a percentage of Maximum TEC by a
348 linear function of the Color Gamut.

349 EPA received a number of suggestions regarding the equivalent allowances for models supporting sRGB
350 and Adobe RGB color coverage, respectively. Ultimately, EPA based the Final Draft EPD allowance
351 equation on balancing pass rates among models meeting the two performance levels. The ENERGY
352 STAR dataset pass rate for eligible enhanced performance displays is 32% for both Color Gamut
353 between 32.9% and 38.4% and Color Gamut 38.4% or higher, which is comparable to the overall pass
354 rate for monitors of 31%. The Final Draft equation results in an allowance of 4% of E_{TEC_MAX} for
355 models covering 32.9% of CIE LUV and 13% of E_{TEC_MAX} for models covering 38.4% of CIE LUV.
356 Models in the market covering the highest percentage of the CIE LUV color space receive an allowance
357 of approximately 33% of E_{TEC_MAX} .

358 Per closer review of the data, EPA agrees that WUXGA (MP=2.3) resolution is still a premium segment of
359 the market and indicates need for the EPD allowance. Therefore, EPA has reverted to the original
360 resolution requirement that models have a minimum of 2.3 MP down from 3.6 MP proposed in Draft 2 to
361 be eligible for the EPD allowance.

362 3.3.5 For monitors with Automatic Brightness Control (ABC) enabled by default, an energy allowance
363 (E_{ABC}), as calculated per Equation 5, shall be added to E_{TEC_MAX} in Equation 2, if the On Mode
364 power reduction (R_{ABC}), as calculated per Equation 4, is greater than or equal to 20%.

365 **Equation 4: Calculation of On Mode Reduction with ABC Enabled by Default**

366
$$R_{ABC} = 100\% \times \left(\frac{P_{300} - P_{12}}{P_{300}} \right)$$

367 *Where:*

- 368 ▪ R_{ABC} is the On Mode percent power reduction due to ABC;
- 369 ▪ P_{300} is the On Mode power in watts, as measured at an ambient light level of 300 lux in Section 6.4 of
- 370 the Test Method; and
- 371 ▪ P_{12} is the On Mode power in watts, as measured at an ambient light level of 12 lux in Section 6.4 of
- 372 the Test Method.

373 **Equation 5: ABC Energy Allowance (E_{ABC}) for Monitors**

374
$$E_{ABC} = 0.05 \times E_{TEC_MAX}$$

375 *Where:*

- 376 ▪ E_{ABC} is the energy allowance for Automatic Brightness Control in kWh; and
- 377 ▪ E_{TEC_MAX} is the Maximum TEC in kWh, per Table 1.

378 3.3.6 Products with Full Network Connectivity confirmed in Section 6.7 of the ENERGY STAR Test
 379 Method shall apply the allowance specified in Table 2.

380 **Table 2: Full Network Connectivity Energy Allowance (E_N) for Monitors**

E_N (kWh)
2.9

381 3.3.7 Products tested with Touch Technology active in On Mode shall apply the allowance specified in
 382 Equation 6.

383 **Equation 6: Energy Allowance for Touch Technology (E_T) for Monitors**

$$E_T = 0.17 \times E_{TEC_MAX}$$

385 *Where:*

- 386 ▪ E_T is the energy allowance for Touch Technology in kWh; and
- 387 ▪ E_{TEC_MAX} is the Maximum TEC in kWh, per Table 1.

388 **Note:** Per review of the data and stakeholder comments, EPA has included a Touch Technology
 389 allowance of 17% of TEC, up from 15% of TEC in Draft 2, which results in 7 of the 21 models with Touch
 390 Technology meeting the Final Draft criteria.

391 3.3.8 Products tested with curved Displays shall apply the allowance specified in Equation 7.

392 **Equation 7: Monitors Curved Display Energy Allowance (E_C) for Monitors**

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

394 *Where:*

- 395 ▪ E_C is the energy allowance for curved Displays in kWh; and
- 396 ▪ E_{TEC_MAX} is the Maximum TEC in kWh, per Table 1.

397 **Note:** EPA has considered stakeholder feedback and revised the curved display allowance from 5% in
 398 Draft 2 to 15% in the Final Draft to account for increased on mode power requirements inherent to curved
 399 screen technology while encouraging the most energy efficient implementations of this technology.

400 3.3.9 Monitors that meet either the following DisplayHDR 600 or DisplayHDR 1000 White Luminance
 401 Criteria specified in Table 2-1: DisplayHDR Performance Tier Summary of the Video Electronics
 402 Standards Association (VESA) High-performance Monitor and Display Compliance Test
 403 Specification (DisplayHDR CTS) Version 1.0 shall apply the allowance specified in Table 3.

- 404 a) 10% Center Patch Minimum Requirement (cd/m²);
- 405 b) Full-screen Flash Minimum Requirement (cd/m²); and
- 406 c) Full-screen Long-duration Minimum Requirement (cd/m²).

407 **Table 3: HDR 600 and HDR 1000 Energy Allowances for Monitors**

VESA DisplayHDR Certification	Allowance (kWh)
HDR 600 (E_{H600})	$0.05^* E_{TEC_MAX}$
HDR 1000 (E_{H1000})	$0.10^* E_{TEC_MAX}$

408 *Where:*

- 409 ▪ E_{H600} and E_{H1000} are the allowances for models meeting the DisplayHDR CTS tiers 600 and 1000
 410 respectively; and
- 411 ▪ E_{TEC_MAX} is the Maximum TEC per Table 1.

412 **Note:** In response to stakeholder requests for an allowance for monitors with High Dynamic Range (HDR)
413 capability, the final draft includes allowances for models that meet white luminance tier requirements for
414 DisplayHDR 600 and DisplayHDR 1000 outlined in VESA’s DisplayHDR CTS v1.0 specification. These
415 allowances are intended to account for increased power needed to support the capability to display higher
416 peak brightness of models supporting HDR as opposed to standard dynamic range. EPA proposes that
417 these allowances be applied regardless of whether HDR upscaling is enabled in the default, as-shipped
418 settings to account for modest systematic increases attributable to a display supporting HDR. By setting
419 modest 5% and 10% allowances, EPA seeks to only recognize HDR monitors that scale down power,
420 peak brightness and processing functions in a content-based manner such that the monitor is saving
421 power when displaying images for applications such as web browsing and word processing, which are the
422 uses best accounted for by the ENERGY STAR Test Method.

423
424 EPA found that four out of ten models in the dataset either certified to VESA DisplayHDR 400 or
425 marketed as HDR but not certified to the VESA specification met the proposed criteria without an
426 allowance. Thus, models not meeting DisplayHDR 600 or higher performance are not eligible for the HDR
427 allowance. EPA identified three HDR 600 models with diagonal screen size of 31 to 32 inches from two
428 different brands, none of which were able to meet the proposed ENERGY STAR Final Draft criteria
429 without an allowance. EPA also identified a 27-inch HDR 600 model that was able to meet the proposed
430 Final Draft criteria without an allowance. Given the limited number of models with HDR 600, EPA has
431 added a modest 5% of E_{TEC} MAX allowance for HDR 600 and scaling that allowance up to 10% for higher
432 performing HDR 1000 models. There is one HDR 1000 model in the ENERGY STAR dataset with
433 diagonal screen size of 43 inches that meets the Final Draft criteria without the allowance and EPA is
434 aware of two other non-ENERGY STAR certified models that meet HDR 1000.

435 The existing ENERGY STAR displays test method does not have a procedure in place to assess
436 displaying native or upscaled HDR content and would require a substantial revision and review process to
437 incorporate such procedures. Prior to the launch of the Version 9 specification development, EPA and
438 DOE will continue to monitor the current development of HDR test procedures led by other organizations
439 including CLASP and consider a possible future revision to the ENERGY STAR test method. Until such a
440 change is made, EPA encourages energy-efficient implementation of HDR as tested per the existing
441 methods.

442 3.3.10 Products with USB Type C interface compatibility shall apply the allowance specified in Table 4.

443 **Table 4: Allowance for Monitors with USB Type C Compatibility**

E_{USB} (kWh)
0.7

444 *Where:*

- 445 E_{USB} is the allowance for models with USB Type C compatibility.

446 **Note:** In response to stakeholder feedback, EPA reviewed the latest ENERGY STAR certified model data
447 and identified 56 monitors with USB-C ports. Without an allowance the pass rate for models with USB-C
448 is 23%. Therefore, EPA added a modest allowance of 0.7 kWh to TEC Max for models with USB-C to
449 account for additional background power demand of USB-C yet encourage energy-efficient
450 implementations of USB-C when the port is not fully being utilized.

451 **3.4 Signage Displays Tested in a Tiled Display System Configuration**

452 3.4.1 Signage Displays marketed, shipped, and tested in a Tiled Display System configuration shall
453 meet the Signage Display On Mode and Sleep Mode criteria as calculated per Equation 9 and
454 Equation 11, in which the Screen Area used for all such calculations shall be the total screen area
455 of the Maximum Tiled Configuration.

456 Note: The total Screen Area of a Tiled Display System with a Maximum Tiled Configuration of 2x2
457 individual 47.6-inch diagonal Signage Displays (height 23.3 inches and length 41.5 inches) is
458 calculated as (2 x 23.3") x (2 x 41.5") equal to 3867.8 square inches. The Tiled Display System
459 shall meet the On Mode criteria for a 3,867.8 square inch Signage Display.

460 **Note:** In response to stakeholder feedback, EPA has made minor revisions to this section to clarify that
461 Tiled Display Systems shall meet both the On Mode and Sleep Mode criteria for Signage Displays
462 calculated based on the total screen area of the Maximum Tiled Configuration.

463 **3.5 On Mode Requirements for Signage Displays**

464 3.5.1 The Maximum On Mode Power (P_{ON_MAX}) in watts shall be calculated per Equation 8.

465 **Equation 8: Calculation of Maximum On Mode Power (P_{ON_MAX}) in Watts for Signage Displays**

466
$$P_{ON_MAX} = (4.0 \times 10^{-5} \times \ell \times A) + 120 \times \tanh(0.0005 \times (A - 140.0) + 0.03) + 20$$

467 Where:

- 468 ▪ P_{ON_MAX} is the Maximum on Mode Power, in watts;
- 469 ▪ A is the Screen Area in square inches;
- 470 ▪ ℓ is the Maximum Measured Luminance of the Display in candelas per square meter, as measured in
- 471 Section 6.2 of the test method; and
- 472 ▪ The result shall be rounded to the nearest tenth of a watt for reporting.
- 473

474 **Equation 9: On Mode Power Requirement for Signage Displays**

475
$$P_{ON} \leq P_{ON_MAX} + P_{ABC} + P_{Module}$$

476 Where:

- 477 ▪ P_{ON} is On Mode Power in watts, as measured in Section 6.3 or 6.4 of the Test Method;
- 478 ▪ P_{ON_MAX} is the Maximum On Mode Power in watts, per Equation 8; and
- 479 ▪ P_{ABC} is the On Mode power allowance for ABC in watts, per Equation 10; and
- 480 ▪ P_{Module} is the On Mode power allowance for Signage Displays with Embedded or Plug-In Modules as
- 481 specified in Table 5.
- 482

483 3.5.2 For Signage Displays with ABC enabled by default, a power allowance (P_{ABC}), as calculated per
484 Equation 10, shall be added to P_{ON_MAX} , as calculated per Equation 9, if the On Mode power
485 reduction (R_{ABC}), as calculated per Equation 4, is greater than or equal to 20 percent.

486 **Equation 10: Calculation of On Mode Power Allowance for Signage Displays with ABC Enabled by**
487 **Default**

488
$$P_{ABC} = 0.05 \times P_{ON_MAX}$$

489 Where:

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

492 3.5.3 For Signage Displays with an Embedded Module, a power allowance (P_{Module}) determined by
493 Table 5 shall be added to P_{ON_MAX} , as calculated per Equation 9.

494 **Table 5: On Mode Power Allowance for Signage Displays with an Embedded Module**

P_{Module} (W)
2.5

495 Where:
 496

- P_{Module} is the Measured On Mode Power allowance for Embedded Modules in Watts.

497 **Note:** In response to Draft 2, one stakeholder requested EPA to provide an allowance for compute power
 498 if the signage display has a Plug-in Module or Embedded Module though no specific allowance amount
 499 was suggested given these types of models have either not yet entered the market or have not been
 500 tested per the ENERGY STAR test method. EPA analyzed the ENERGY STAR televisions dataset for
 501 televisions with Thin Client Capability, the ability of the TV to receive, decrypt, and display encrypted
 502 content provided by a Multichannel Video Programming Distributor (MVPD) over the Local Area Network.
 503 These "Smart TVs" are the most similar product to signage displays with embedded processors and
 504 computation capability. On average, UHD TVs with a thin client draw 2.7 W more in On Mode than UHD
 505 TVs without Thin Client controlling for screen area.

506 Based on these data, EPA included an adder of 2.5 W in On Mode for signage displays manufactured
 507 with Embedded Modules to encourage the adoption of the most energy-efficient designs and hardware.
 508 EPA is not proposing to apply this allowance to Signage Displays shipped and tested with Plug-In
 509 Modules as these types of signage displays have been eligible for ENERGY STAR Version 7 and there is
 510 thus far no data or examples of models demanding higher power.

511 **3.6 Sleep Mode Requirements for Signage Displays**

512 3.6.1 Measured Sleep Mode Power (P_{SLEEP}) in watts shall be less than or equal the sum of the
 513 Maximum Sleep Mode Power Requirement (P_{SLEEP_MAX}) and any allowances (applied at most
 514 once) per Equation 11.

515 **Equation 11: Sleep Mode Power Requirement for Signage Displays**

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

- 517 Where:
- 518 ▪ P_{SLEEP} is Measured Sleep Mode Power in watts;
 - 519 ▪ P_{SLEEP_MAX} is the Maximum Sleep Mode Power requirement in watts per Table 6;
 - 520 ▪ P_N is the Full Network Connectivity allowance in watts per Table 7;
 - 521 ▪ P_{OS} is the Occupancy Sensor allowance in watts per Table 8; and
 - 522 ▪ P_T is the Touch allowance in watts per Table 8.

524 **Table 6: Maximum Sleep Mode Power Requirement (P_{SLEEP_MAX}) for Signage Displays**

P_{SLEEP_MAX} (watts)
0.5

525

526 3.6.2 Products with Full Network Connectivity confirmed in Section 6.7 of the ENERGY STAR Test
527 Method shall apply the allowance specified in Table 7.

528 **Table 7: Full Network Connectivity Allowance for Signage Displays**

P_N (watts)
3.0

529

530 3.6.3 Products tested with an Occupancy Sensor or Touch Technology active in Sleep Mode shall
531 apply the allowances specified in Table 8.

532 **Table 8: 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

533 **3.7 Off Mode Requirements for all Displays**

534 3.7.1 A product need not have an Off Mode to be eligible for certification. For products that do offer Off
535 Mode, measured Off Mode power (P_{OFF}) shall be less than or equal to the Maximum Off Mode
536 Power Requirement (P_{OFF_MAX}) in Table 9.

537 **Table 9: Maximum Off Mode Power Requirement (P_{OFF_MAX})**

P_{OFF_MAX} (watts)
0.5

538

539 **3.8 Luminance and Total Native Resolution Reporting Requirements**

540 3.8.1 Maximum Reported, Maximum Measured Luminance, and Total Native Resolution shall be
541 reported for all products; As-Shipped Luminance shall be reported for all products except those
542 with ABC enabled by default.

543 a) Testing for the above measurements shall be conducted for the individual Signage Display
544 of a Tiled Display System.

545 **Note:** EPA has clarified testing procedures that apply to the individual Signage Display model for the
546 Tiled Displays Systems.

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

550 4 TEST REQUIREMENTS

551 4.1 Test Methods

552 4.1.1 Test methods identified in Table 10 shall be used to determine certification for ENERGY STAR.

553 **Table 10: 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. January-2019
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
Displays Claiming High Dynamic Range (HDR)	VESA High-performance Monitor and Display Compliance Test Specification (DisplayHDR CTS) Version 1.0

554

555 4.2 Number of Units Required for Testing

556 4.2.1 One unit of a Representative Model, as defined in Section 1, shall be selected for testing.

557 i. For Tiled Display Systems, the Maximum Tiled Configuration, as defined in Section 1,
558 shall be used for testing.

559 **Note:** EPA is clarifying the number of Signage Displays and support components to be used for the
560 testing of Tiled Display Systems by referencing the Maximum Tiled Configuration, as defined in Section 1.

561 4.3 International Market Qualification

562 4.3.1 Products shall be tested for qualification at the relevant input voltage/frequency combination for
563 each market in which they will be sold and promoted as ENERGY STAR.

564 5 USER INTERFACE

565 5.1.1 Manufacturers are encouraged to design products in accordance with the user interface standard,
566 IEEE P1621: Standard for User Interface Elements in Power Control of Electronic Devices
567 Employed in Office/Consumer Environments. For details, see <http://energy.lbl.gov/controls/>.

568 6 EFFECTIVE DATE

569 6.1.1 Effective Date: The Version 8 ENERGY STAR Display specification shall take effect on **January**
570 **28, 2020**. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR
571 specification in effect on its date of manufacture. The date of manufacture is specific to each unit
572 and is the date on which a unit is considered to be completely assembled.

573 6.1.2 Future Specification Revisions: EPA reserves the right to change this specification should
574 technological and/or market changes affect its usefulness to consumers, industry, or the
575 environment. In keeping with current policy, revisions to the specification are arrived at through
576 stakeholder discussions. In the event of a specification revision, please note ENERGY STAR
577 certification is not automatically granted for the life of a model.

578 **7 CONSIDERATIONS FOR FUTURE REVISIONS**

579 7.1.1 Standby-Active, High Mode: Similar to future revisions of the ENERGY STAR Televisions
580 specification, EPA and the U.S. Department of Energy (DOE) are interested in learning more
581 about Standby-Active, High Mode or Displays with Sleep Modes that demand higher power draw
582 because they are actively running components to reduce latency from Sleep to On Mode,
583 download software updates, or process sensor data. This issue is particularly pertinent with
584 interactive displays that either have a remote or touch screen where the user expects the Display
585 to display content without delay. EPA anticipates exploring this issue and potential power limits
586 and duty cycle requirements in the next specification revision.

587 7.1.2 Revisions to Test Content: As displays technologies continue to evolve, DOE and EPA support
588 external stakeholder efforts to revise test content (i.e. test clips) to better account for how
589 products perform under more realistic consumer viewing conditions, especially with regard to
590 UHD (4K) content and native HDR content.