



ENERGY STAR® Program Requirements Product Specification for Residential Water Heaters

Eligibility Criteria Draft 1 Version 5.0

1 Following is the **Version 5.0** product specification for ENERGY STAR certified water heaters. A product
2 shall meet all of the identified criteria if it is to earn the ENERGY STAR.

3
4 **1) Definitions:** Below are the definitions of the relevant terms in this document.

- 5
6 A. Residential Water Heater (Consumer Water Heater): A product that utilizes gas, electricity, or
7 solar thermal energy to heat potable water for use outside the heater upon demand, including:
8
9 a. Storage type units designed to heat and store water at a thermostatically-controlled
10 temperature, including: gas-fired storage (gas storage-type) water heaters with a
11 nameplate input of 75,000 Btu per hour or less, containing more than one gallon of water
12 per 4,000 Btu per hour of input; heat pump type units with a maximum current rating of 24
13 amperes at an input voltage 250 volts or less, including all ancillary equipment such as
14 fans, storage tanks, pumps, or controls necessary for the device to perform its function.¹
15
16 b. Instantaneous type units heat water, but contain no more than one gallon of water per
17 4,000 Btu per hour of input with an input capacity less than or equal to 200,000 Btu per
18 hour for gas-fired instantaneous.¹
19
20 c. Gas-fired storage residential-duty commercial water heaters include gas-fired storage
21 water heaters that are designed to deliver hot water at a temperature less than or equal
22 to 180°F, with an input rate greater than 75,000 Btu per hour and not exceeding 105,000
23 Btu per hour, containing more than one gallon of water per 4,000 Btu per hour of input,
24 and storage volume less than or equal to 120 gallons. For models requiring electricity, a
25 single-phase external power supply is used.²
26
27 d. Solar water heaters include a collector and storage tank, and use the sun's energy to
28 heat water using one of the five basic types of solar water heating systems:
29
30 i. forced circulation (includes both direct and indirect systems),
31 ii. integrated collector and storage,
32 iii. thermosiphon,
33 iv. self-pumped, or
34 v. photovoltaic (PV).
35
36 e. Integrated heat pump water heaters are residential water heaters where the compressor,
37 evaporator, condenser, and storage tank are integrated into the same unit.
38
39 f. Split-System heat pump water heaters are residential water heaters where the
40 compressor, evaporator, and/or condenser are separated from a storage tank that is
41 specified by the manufacturer and rated as a single system.

¹ Adapted from 10 CFR Part 430, Subpart A §430.2 *Definitions*; in case of any inconsistencies, definitions in the CFR are authoritative.

² Adapted from 10 CFR Part 431, Subpart G §431.102 *Definitions*; in case of any inconsistencies, definitions in the CFR are authoritative.

- 42 g. Add-on Heat Pump Units are air to water heat pumps designed for use with a storage-
43 type water heater or a storage tank that is not specified or supplied by the manufacturer.
44
- 45 B. Uniform Energy Factor³: Uniform Energy Factor (UEF) is the measure of water heater overall
46 efficiency.
47
- 48 C. Solar Uniform Energy Factor: Solar Uniform Energy Factor (SUEF) refers to the energy delivered
49 by the total system divided by the electrical or gas energy put into the system.
50
- 51 D. First-Hour Rating³: The First-Hour Rating (FHR) is an estimate of the maximum volume of “hot”
52 water that a storage-type water heater can supply within an hour that begins with the water heater
53 fully heated (i.e., with all thermostats satisfied). It is a function of both the storage volume and the
54 recovery rate.
55
- 56 E. Maximum GPM Rating³: Maximum GPM is the maximum gallons per minute of hot water that can
57 be supplied by an instantaneous water heater while maintaining a nominal temperature rise of 67
58 °F (37.3 °C) during steady-state operation.
59
- 60 F. Manufacturer Limited Warranty: Manufacturer limited warranty is an assurance by the
61 manufacturer to the consumer that the water heater, including purchased system equipment and
62 components, are guaranteed to work for a defined period of time.
63
- 64 G. Basic Model: All units of a given type of covered product (or class thereof) manufactured by one
65 manufacturer and which have the same primary energy source and, which have essentially
66 identical electrical, physical, or functional (or hydraulic) characteristics that affect energy
67 consumption, energy efficiency, water consumption or water efficiency.³ Further, all individual
68 models within a basic model have the same certified rating based on the applicable sampling
69 criteria per U.S. Department of Energy’s (DOE) regulations in Part 429⁴, and this rating must be
70 used for all manufacturer literature, the qualified product list and certification of compliance to
71 DOE standards.
72
- 73 H. Lower Compressor Cut-off Temperature: The temperature below which a heat pump water
74 heater’s compressor will no longer operate, such that the unit will only work as a conventional
75 electric resistance water heater.
76
- 77 I. Combination Space-Heating and Water-Heating Appliance: Appliance that provides both space
78 conditioning (boiler) and hot water heating with one appliance or energy source. The combination
79 appliance circulates hot water from the water heater through a heat exchanger in the air handler.
80 A blower will move the heated air through a standard duct system. In the summer, an air
81 conditioner is connected to the exchanger and the system functions similarly, with cool air being
82 pushed through the ductwork.
83

84 2) Scope:

- 85 A. Included Products: Only products that meet the definition of a Residential Water Heater, as
86 specified herein, are eligible for ENERGY STAR certification with exception of those products
87 listed in Section 2B.
88
- 89 B. Excluded Products:
90
- 91 a. Electric resistance water heaters,
92 b. Add-on heat pump units,

³ 10 CFR Part 430, Subpart B, Appendix E

⁴ 10 CFR Part 429, Subpart B

- 93 c. Products intended only for commercial applications,
- 94 d. Combination space-heating and water-heating appliances.

95
96 **3) Certification Criteria:**

97 A. Product Performance Requirements for Electric Water Heaters:

98 **Table 1: Criteria for Certified Electric Water Heaters**

| Criteria | | ENERGY STAR Requirements |
|---|--|--|
| Uniform Energy Factor | Integrated HPWH | UEF ≥ 3.30 |
| | Integrated HPWH, 120 Volt / 15 Amp Circuit | UEF ≥ 2.20 |
| | Split-system HPWH | UEF ≥ 2.20 |
| First-Hour Rating | | FHR ≥ 45 gallons per hour |
| Warranty | | Warranty ≥ 6 years on sealed system |
| Safety | | UL 174 and UL 1995 or UL 60335-2-40 |
| Lower Compressor Cut-Off Temperature (Reporting Requirement Only) | | Report ambient temperature below which the compressor cuts off and electric resistance only operation begins |

99
100 B. Product Performance Requirements for Gas-Fired Water Heaters:

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102 a. Gas-Fired Storage Water Heaters:

103 **Table 2: Criteria for Certified Gas-Fired Storage Water Heaters**

| Criteria | ENERGY STAR Requirements |
|-----------------------|--|
| Uniform Energy Factor | UEF ≥ 1.00 |
| First-Hour Rating | FHR ≥ 51 gallons per hour |
| Warranty | Warranty ≥ 6 years on system (including parts) |
| Safety | ANSI Z21.10.1/CSA 4.1 |

104
105 **Note:** Consistent with the Biden Administration’s commitment to decarbonization, EPA is proposing more
106 stringent criteria for gas-fired storage water heaters, while allowing them to remain in scope as familiarity
107 with electric alternatives grows. The proposed gas-fired storage water heater level could be met with
108 developments in technologies like gas heat pump water heaters. EPA was unable to determine a cost-
109 effective level that provides meaningful differentiation for units on the market.
110

111 The proposed criteria will increase the annual energy savings that EPA and utility partners can claim to
112 80 therms (\$81) per year for gas-fired water heaters 55 gallons or less and to 46 therms (\$46) per year

113 for gas-fired water heaters greater than 55 gallons. We have not estimated payback; since there are
 114 currently no products on the market meeting these criteria, the cost is unclear. If all gas storage water
 115 heaters sold in the US met these requirements, the national savings would grow to over 4,875 million
 116 therms, or over 25 MMT CO₂e. Savings are based on a comparison of the ENERGY STAR requirements
 117 to the federal minimum standard for typical tank sizes of 40 and 65 gallons.

118
 119 EPA welcomes comments on the proposed criteria, particularly on appropriate safety standards and any
 120 such practical barriers to products entering the market.

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122 b. Gas-Fired Instantaneous Water Heaters:

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Table 3: Criteria for Certified Gas-Fired Instantaneous Water Heaters

| Criteria | ENERGY STAR Requirements |
|----------------------------|--|
| Uniform Energy Factor | UEF ≥ 0.95 |
| Maximum Gallons Per Minute | Max GPM ≥ 2.8 over a 67°F rise |
| Warranty | Warranty ≥ 6 years on heat exchanger and ≥ 5 years on parts |
| Safety | ANSI Z21.10.3/CSA 4.3 |

125

126 **Note:** EPA is proposing more stringent criteria for gas-fired instantaneous water heaters as noted above
 127 to recognize differentiation within the market. The proposed criteria will recognize about 15% of products
 128 available on the market.

129

130 The proposed criteria will increase the annual energy savings that EPA and utility partners can claim to
 131 31 therms (\$31) per year. This will improve the payback compared the that of the previous specification.
 132 If all gas instantaneous water heaters sold met these criteria, EPA estimates that the national savings
 133 would grow to over 225 million therms, or over 1.2 MMT CO₂e.

134

135 EPA welcomes comments on the proposed criteria.

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137 c. Gas-Fired Storage Residential-duty Commercial Water Heaters:

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Table 4: Criteria for Certified Gas-Fired Storage Residential-duty Commercial Water Heaters

| Criteria | ENERGY STAR Requirements |
|-----------------------|------------------------------|
| Uniform Energy Factor | UEF ≥ 1.00 |
| Warranty | Warranty ≥ 6 years on system |
| Safety | ANSI Z21.10.3/CSA 4.3 |

140

141 **Note:** Similar to storage water heaters, EPA is proposing more stringent criteria for gas-fired storage
 142 residential-duty commercial water heaters. EPA was unable to determine a cost-effective level that
 143 provides meaningful differentiation for units on the market. Recognizing the Biden Administration's
 144 commitment to decarbonization, EPA has proposed a level that gas-fired storage residential-duty

145 commercial water heaters could meet with future developments in technologies like gas heat pumps
 146 water heaters allowing for gas storage products to remain within scope.
 147
 148 The proposed criteria will increase the annual energy savings that EPA and utility partners can claim to
 149 112 therms (\$114) per year. EPA welcomes comments on the proposed criteria.
 150

151 C. Product Performance Requirements for Solar Water Heaters:

152 **Table 5: Criteria for Certified Solar Water Heaters**

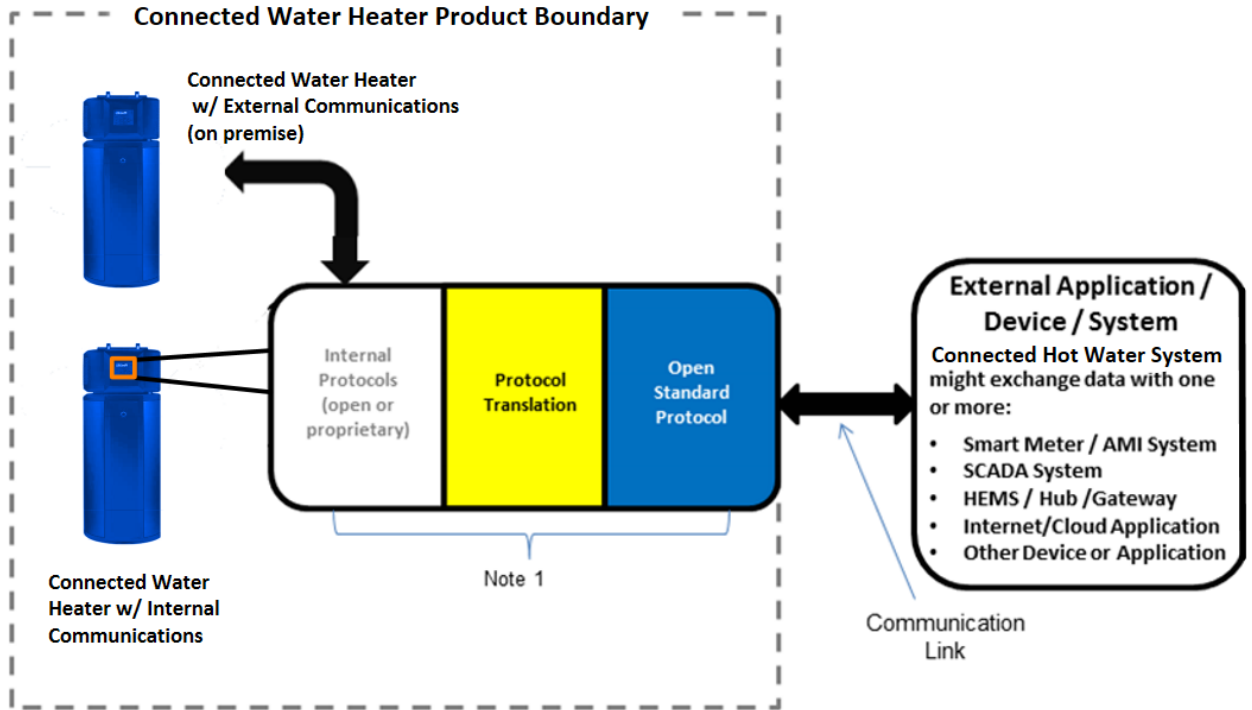
| Criteria | ENERGY STAR Requirements |
|-----------------------------|--|
| Solar Uniform Energy Factor | SUEF ≥ 3.00 for electric backup SUEF ≥ 1.80 for gas backup |
| Warranty | Warranty ≥ 10 years on collector, ≥ 6 years sealed system, ≥ 2 years on controls, ≥ 1 year on parts |

154 **4) Connected Product Criteria – Optional:**

155 This section presents connected criteria for ENERGY STAR certified water heaters. Compliance with
 156 Section 4 criteria is optional. ENERGY STAR certified water heaters that comply with all Section 4 criteria
 157 will be identified on the ENERGY STAR website as having ‘Connected’ functionality. As for all ENERGY
 158 STAR products, these criteria define products which provide a combination of additional user functionality
 159 and grid services, as appropriate for the product type.
 160
 161

162 A. Definitions

- 163 a. Communication Link: As shown in Figure 1, the mechanism for bi-directional data
 164 transfers between the Connected Water Heater Product and one or more external
 165 applications, devices or systems.
- 166 b. Connected Water Heater Product (CWHP): As shown in Figure 1, includes the ENERGY
 167 STAR certified water heater, integrated or separate communications hardware, and
 168 additional hardware and software required to enable connected functionality.
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Figure 1: Connected Water Heater Product (CWHP)

175 **Note 1:** Communication device(s), link(s) and/or processing that enables Open Standards-based
176 communication between the CWHP and external application / device / system(s). These
177 elements, either individually or together, could be within the water heater/controller, and/or an
178 external communication module, a hub/gateway, or in the Internet/cloud.

- 179
180 c. Consumer Authorized Third Party: Any entity for which the consumer has provided
181 explicit permission to access the CWHP connected functionality, in whole or in part, via a
182 Communication Link. *Example: A consumer may allow a Home Energy Management*
183 *System (HEMS) or a Demand Response Management System (DRMS) access to the*
184 *CWHP connected functionality.*
185
186 d. Demand Response (DR): Changes in electric or gas usage by end-use customers from
187 their normal consumption patterns in response to changes in the price of electricity or gas
188 over time, or to incentive payments designed to induce lower electricity or gas use at
189 times of high wholesale market prices or when system reliability is jeopardized⁵.
190
191 e. Demand Response Management System (DRMS): The system operated by a consumer
192 authorized program administrator, such as the utility or third party, which dispatches
193 signals with DR instructions and/or price signals to the CWHP products and receives
194 messages from the CWHP product.
195
196 f. Interface Specification: A document or collection of documents that contains detailed
197 technical information to facilitate access to relevant data and product capabilities over a
198 communications interface.
199

⁵ Modified to apply to gas as well, based on Federal Energy Regulatory Commission, <https://www.ferc.gov/electric/industry-activity/demand-response/national-assessment-and-action-plan-demand-response>

- 200 g. Load Management Entity: Consumer authorized DRMS, home energy management
201 system, or the like.
202
- 203 h. Open Standards: Communication with entities outside the CWHP that use, for all
204 communication layers, standards:
205
- 206 • included in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards,⁶ and/or
 - 207
 - 208 • included in the NIST Smart Grid Framework Tables 4.1 and 4.2, and/or
 - 209
 - 210 • adopted by the American National Standards Institute (ANSI) or another well-
 - 211 established international standards organization such as the International Organization
 - 212 for Standardization (ISO), International Electrotechnical Commission (IEC), International
 - 213 Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE)
 - 214 or Internet Engineering Task Force (IETF).⁶
 - 215
- 216 i. On-Premises: Refers to a function that relies only on equipment present at the physical
217 installed location of the ENERGY STAR certified device/equipment.
218
- 219 j. Load Shift: A load shift operation moves energy that would have been used by a device
220 within a time interval under normal operating conditions, to occur outside that time
221 interval. Load shifting can be performed by a combination of load up and curtailment
222 requests.
223

224 B. Communications
225

- 226 a. The CWHP Communication Link, in Figure 1, shall use Open Standards for all
227 communication layers to enable functions listed in Sections 4B) and 4C).
228
- 229 b. An Interface Control Document (ICD), Application Programming Interface (API), or other
230 documentation shall be made available to interested parties that, at minimum, allows
231 access to the functions listed in Sections 4B) and 4C).
232

233 C. Remote Management and Consumer Feedback
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235 The CWHP shall provide the following functionality:
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237 a. **Remote Management:**

238 The product shall be capable of receiving and responding to consumer authorized remote
239 requests (not including third-party remote management which may be made available
240 solely at the discretion of the manufacturer), via a communication link, similar to
241 consumer controllable functions on the product.

- 242 i. Higher energy mode settings shall be temporary: If a remote management signal
243 puts the CWHP into a mode that uses more energy than the mode selected
244 locally, the product shall revert to the locally set mode within 72 hours if no
245 additional user input is received.
246

247 b. **User Alerts:**

248 The CWHP shall be capable of providing at least two types of messages relevant to
249 optimizing its energy consumption, either:

- 250 i. On the product (e.g. water heater and/or controller), and/or

⁶ <https://sepapower.org/knowledge/catalog-of-standards/>

251 ii. Transmitted to consumers and consumer authorized third parties via a
252 communication link. This link can include open standards protocols used for
253 Demand Response or could use a secondary communication link.

254
255 *For example, messages relevant to energy consumption for water heaters might address*
256 *a fault condition, a reminder to descale heating elements, heat pump refrigerant charge,*
257 *or a report of energy consumption that is outside the product's normal range*

258
259 c. **Energy Reporting:**

260 The product shall be capable of transmitting measured or estimated instantaneous power
261 draw in current conditions via a communication link to a Load Management Entity and
262 other consumer authorized devices, services, or applications. Products compliant with the
263 Demand Response criteria in Section 4C) meet this criterion through energy reporting
264 there.

265
266 D. Demand Response (DR)

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268 Gas-fired Instantaneous Water Heaters are exempt from this functionality and may be recognized
269 as connected without meeting the criteria in this subsection. Solar water heaters are anticipated
270 to only respond to demand response signals while using grid power.

271
272 a. **DR Communications Protocols:**

273 The CWHP shall meet the communication and equipment performance standards for
274 CTA-2045 or OpenADR 2.0b (Virtual End Node), or both.

275
276 b. **Override:**

277 The product shall provide an easily accessible means for consumers to override demand
278 response events during the event or ahead of time for a scheduled event, except for Grid
279 Emergency/Off Mode events. When the event is overridden, the CPWH shall return to
280 normal operation as set by the customer. Temporary overrides shall be limited to a
281 duration up to 72 hours without additional user input; after this time, the CPWH will return
282 to its previous operating mode.

283
284 c. **Loss of connectivity:**

285 A 'loss of connectivity' event is defined as 15 minutes without connection. The CWHP
286 shall respond as follows:

- 287 i. If a 'loss of connectivity' event occurs while processing a DR event with a set
288 duration or end time, product may complete DR event as planned, returning to
289 normal operation as set by the customer afterwards, or if over-ridden.
290 ii. If a 'loss of connectivity' event occurs while processing a DR event without a set
291 duration or end time, product will resume normal operation within 30 minutes.
292 iii. If the CWHP is capable of storing and operating with a time of use schedule, the
293 unit may continue operating on that schedule during a 'loss of connectivity' event.

294
295 d. **Minimum Load Shift:**

296 CWHP shall be capable of load shifting either:

- 297 i. Basic Load Shift: 0.5 kWh or more via a combination of Basic Load Up and
298 General Curtailment responses defined in 4)D.f. under the conditions defined in
299 the ENERGY STAR Test Procedure for Water Heater Demand Response, or

300 ii. Advanced Load Shift: 1.0 kWh or more via a combination of Advanced Load Up
301 and General Curtailment responses defined in section 4)D.f. under the conditions
302 as defined in the ENERGY STAR Test Procedure for Water Heater Demand
303 Response.

304 Manufacturers shall report which load shift test was used for each model.

305
306

e. **DR Information and Messaging:**

307 The CWHP shall support the following upstream messaging from the device when
308 available and may support the additional (optional) messaging capabilities. Support for
309 these messaging signals is implemented via the open standards protocol used in the
310 product. The required mapping for these events is described in *Appendix B*. While the
311 required or optional functionality may vary based on product type and either protocol may
312 be used, the messaging must be communicated via the specified protocol command
313 within this appendix.

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315 Data provided by below messaging functions shall be calculated from product state no
316 older than 60 seconds from request.

317

318 Required Messaging I/O

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- 320 • **Device Type** – Electric Resistance / Gas-fired Storage / Heat Pump.
- 321 • **Operational State** – Information on product running state, DR conditions
322 operating on product, opt in/out state, and fault conditions. The following states
323 will be able to be reported, as applicable to the chosen DR protocol:
 - 324 ○ **Idle Normal** – Water heater is not heating but is in a normal mode of
325 operation.
 - 326 ○ **Running Normal** – Water heater is in a Normal Operating Mode and the
327 water heater is presently heating (heat pump compressor or any heating
328 elements are energized).
 - 329 ○ **Running Curtailed Grid** – Water heater is running in a grid service
330 mode of operation and the water heater is presently heating (heat pump
331 compressor or any heating elements are energized).
 - 332 ○ **Running Heightened Grid** – Water heater is processing a load up
333 request and water is being heated.
 - 334 ○ **Idle Grid** – Water heater is in a grid service operational mode and the
335 water heater is not heating water.
 - 336 ○ **Water Heater Error** – Device is malfunctioning. Recommended use:
337 Failure of heat pump or element.
 - 338 ○ **Idle Heightened** – Water heater is processing a Load Up request and
339 water is not being heated.
 - 340 ○ **Idle Opted Out** – Water heater is overridden has no/insignificant energy
341 consumption.
 - 342 ○ **Running, Opted Out** – Water heater is overridden and is consuming
343 energy.
- 344 • **Current Available Energy Storage Capacity** – The amount of grid energy that
345 the end device can take now (kWh or therms). It is recognized that under some
346 extraordinary circumstances, the Current Available Energy Storage could exceed
347 the Total. For example, if a water heater temperature has fallen well below the
348 normal minimum regulation range.⁷
- 349 • **Power/Demand (Instantaneous)** – Measured or estimated power consumption
350 in current conditions (kW, Btu/hr, or therms).
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⁷ CTA-2045-A

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Optional Messaging I/O:

- **Energy Use** – Measured or estimated cumulative energy use of product (kWh or Btu, therms).
- **Current Total Energy Storage Capacity** – The total amount of grid energy storage that the end device represents. For example, the energy capacity of a water heater would be the total amount of energy (kWh or therms) supplied to move the tank from its minimum operating temperature (e.g. what it would allow itself to drop to during a curtailment event) to its maximum operating temperature (e.g. what it could run up to when asked to “Load Up” before shutting off).⁷

f. **Error! Bookmark not defined.DR Requests and Responses:**

The CWHP shall also support the required DR operational modes listed below and may support additional open standard defined DR signals. Support for these requests is implemented via the open standards protocol used in the product. The required mapping for these events is described in *Appendix B*. While the required or optional functionality may vary based on product type and either protocol may be used, the messaging must be communicated via the specified protocol command within this appendix.

Required Operational Mode Functionality:

| Required Operational Mode Functionality | | | |
|---|---------------------------------|--|--|
| Operational Mode Request | Required for which products | Expected use and consumer impact | Response |
| General Curtailment (Shed/Light Shed) | All product types | Daily, several hours long; minimal impact | Avoids using energy that the device otherwise would have used under normal operating conditions, up to allowing the stored thermal energy in the tank to reduce moderately. For Heat Pump Water Heaters with resistive elements, the water heater shall avoid use of electric resistance elements during and immediately after the event unless user needs cannot be met. ¹ |
| Emergency Curtailment (Critical Curtailment/Deep Shed)) | Electric storage and Solar ERWH | Daily, less than 1 hour; may be some consumer impact | Avoids using energy that the device otherwise would have used under normal operating conditions, up to allowing the stored thermal energy in the tank to deplete to a very low level, less than that for a General Curtailment request. For Heat Pump Water Heaters with resistive elements, this request would result in heat pump only operation during the request period. ¹ |
| Grid Emergency (Off Mode/Full Shed) | Electric storage and Solar ERWH | Annually or less; consumer impact may be significant | Immediately, stop using energy for water heating when safe to do so. ¹ |

| Required Operational Mode Functionality | | | |
|---|--|----------------------------------|--|
| Operational Mode Request | Required for which products | Expected use and consumer impact | Response |
| Load Up: Basic or Advanced | Basic: All product types Advanced: Optional | Daily, several hours long | Use and/or store additional thermal energy that device otherwise would not have used/stored under normal operation. Allows the stored thermal energy to increase, within safety parameters as determined by the manufacturer up to user set point for Basic Load Up. For Advanced Load Up, the device may exceed user set point. ² For heat pump water heaters with resistive heating elements, the use of the elements should be avoided as much as possible to satisfy this request. ¹ |
| Return to Normal Operation | All product types | Daily | In the event an ongoing event is canceled for any reason, the product shall return to normal operation. ¹ |

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1. For all commands both immediate events and events scheduled in advance will be supported.
2. **Advanced Load Up** response is anticipated to be used on installations with a mixing valve, and is anticipated to require a user action to enable this request for the first time.

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Optional Operational Mode Functionality:

| Optional Operational Mode Functionality | | |
|---|-----------------------------|---|
| Operational Mode Request | Required for which products | Response |
| Set Point Adjustment | Optional | Adjusts product thermostat set point up or down if safe to do so. |
| Relative Price Signal(s) | Optional | Communicates information to endpoint on current energy cost and upcoming changes, to allow consumer configuration of when grid energy should be used and when it should be curtailed if possible. |

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381 E. Additional Information for Consumers

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- a. If additional modules, devices, services, and/or supporting infrastructure are required in order to activate the CWHP's communications capabilities, installation instructions and a list of these requirements shall be made available at the point of purchase and prominently displayed in the product literature. It is also suggested that information be provided on the product packaging and on the product. These instructions shall provide specific information on what must be done to activate these capabilities (e.g. a product package or product label might briefly state, "This product has Wi-Fi capability and requires Internet connectivity and a wireless router to enable interconnection with external devices, systems or applications.").

5) Test Requirements:

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- A. One of the following sampling plans shall be used to test energy performance for qualification to ENERGY STAR:

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- a. A single unit is selected, obtained, and tested. The measured performance of this unit and of each subsequent unit manufactured must be equal to or better than the ENERGY STAR specification requirements. Results of the tested unit may be used to certify additional individual model variations within a basic model as long as the definition for basic model provided in Section 1, above, is met; or

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- b. Units are selected for testing and results are calculated according to the sampling requirements defined in 10 CFR Part 429, Subpart B §429.17. The certified rating must be equal to or better than the ENERGY STAR specification requirements. Results of the tested unit may be used to certify additional variations within a basic model as long as the definition for basic model provided in Section 1, above, is met. Further, all individual models within a basic model must have the same certified rating based on the applicable sampling criteria. This rating must be used for all manufacturer literature, the qualified products list, and certification of compliance to DOE standards.

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- B. When testing residential water heaters, the following test methods shall be used to determine ENERGY STAR certification:

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Table 6: Test Methods for ENERGY STAR Certification

| Applicable Products | ENERGY STAR Requirement | Test Method Reference |
|---|--------------------------------------|--|
| Gas and Electric products (not including gas-fired storage residential-duty commercial water heaters); FHR is applicable to storage products and Maximum GPM is applicable to instantaneous products. | Uniform Energy Factor (UEF) | 10 CFR Part 430, Subpart B, Appendix E* |
| | First Hour Rating (FHR) | |
| | Maximum GPM Rating | |
| Gas-fired Storage Residential-duty Commercial products | Uniform Energy Factor (UEF) | 10 CFR Part 430, Subpart B, Appendix E* |
| Whole-home solar units | Solar Universal Energy Factor (SUEF) | ICC 900/SRCC 300-2020 Solar Thermal System Standard, Appendix A: Solar Uniform Energy Factor Procedure for Solar Water Heating Systems |
| Connected Products | Demand Response | Test Method to Validate Demand Response |

* Includes any applicable guidance that DOE has issued regarding the testing of these products (See <http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1>).

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C. Compliance with Connected Criteria

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- a. Aside from demand response functionality, compliance with connected criteria, as specified in Section 4), shall be through examination of product and/or product documentation.

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D. Significant Digits and Rounding:

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- a. All calculations shall be carried out with actual measured (unrounded) values. Only the final result of a calculation shall be rounded.
- b. Unless otherwise noted in this section, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.
- c. Reporting on the ENERGY STAR website shall be performed using calculation results or measured values that are rounded to the nearest unit in the last right-hand digit as specified in the corresponding specification requirement below.

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6) Effective Date:

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The ENERGY STAR Version 5.0 Residential Water Heaters specification shall take effect on **TBD**. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

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Note: The effective date of Version 5.0 will be approximately 9 months after it is finalized. EPA currently expects an effective date in 2023. Version 4.0 will be effective January 2, 2022, so some units will need to be recertified twice in quick succession, though one of those will be purely administrative, as the criteria for each product type will only change once. EPA urges certification bodies to keep the process as easy as possible.

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446 **7) Future Specification Revisions:**

447 EPA reserves the right to change the specification should technological and/or market changes affect
448 its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to
449 the specification are arrived at through industry discussions. In the event of a specification revision,
450 please note that the ENERGY STAR certification is not automatically granted for the life of a product
451 model.

452 A. The Federal minimum efficiency standards are based on the unit volume, reflecting the
453 influence of design elements on efficiency. However, since ENERGY STAR levels are not,
454 comparison between them is challenging. EPA may consider restructuring this specification
455 to include similar metrics that are dependent on volume and categorized further by draw
456 pattern. This may include a distinct level for low draw pattern units in the future.

457 B. EPA is also in discussion with the Northwest Energy Efficiency Alliance on their Advanced
458 Water Heating Specification and with the Advanced Water Heating Initiative as they expand
459 to national action, seeking to harmonize specifications as much as possible in the future.
460 This may include adding reporting or performance requirements similar to those in the other
461 specifications.

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463 **Note:** Appendix A in the Version 4.0 specification contained criteria in terms of EF and TE, as a courtesy
 464 for the specification to be used by Natural Resources Canada for products sold only in Canada. As this is
 465 no longer necessary, the entire appendix has been removed, meaning that all products certified to
 466 Version 5 must use UEF or SUEF. The remaining appendices have been re-numbered.

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468 **Appendix A – Demand Response Message Mapping**

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Table 7: Normative DR Message Mapping

| Category | Subtype | Demand Response Messaging | Response Result | ANSI/CTA (2045-A) | OpenADR (2.0b) |
|--------------------------------|--------------------------|---------------------------------------|---|--|---|
| Basic Signals | Curtailment | General Curtailment | Reduce load (moderate) | Shed ⁸ | oadrDistributeEvent: SIMPLE level 1. ⁹ |
| | | Emergency Curtailment | Reduce load (major) | Critical Peak Event ⁸ | oadrDistributeEvent: SIMPLE level 2. ⁹ |
| | | Grid Emergency | Turn off (if possible) | Grid Emergency ⁸ | oadrDistributeEvent: SIMPLE level 3. ⁹ |
| | Load Up | Load Up | Use more energy (if possible) | Load Up ⁸ | oadrDistributeEvent: NEAR / FAR flag. CHARGE STATE, LOAD_DISPATCH. ⁹ |
| | Run Normal | Return to Normal Operation | Return to defaults | End Shed / Run Normal ⁸ | oadrDistributeEvent: CANCELLED. ⁹ |
| Advanced Signals | Device State | Set Point Adjustment | Adjust water setpoint (if possible) | Get / Set SetPoint ¹⁰ [Section 9.1.6] | oadrDistributeEvent: LOAD_CONTROL. ⁹ |
| | Real Time / Device Logic | Real Time System Load | Use / do not use energy when appropriate (follow programming) | Request for Power Level ¹⁰ [Section 8.2.1] | |
| | | Utility Peak Load Price Signal | | Present Relative Price ¹⁰ , [Section 9.1.3] | oadrDistributeEvent: ELECTRICITY_PRICE ⁹ |
| | | Excess Capacity(DER) | | Grid Guidance ⁸ | |
| Device Properties & Enrollment | Opt Out | Consumer Override | Skip response to event within opt out | Customer Override Message, in response to Operational State Query or load reduction request ⁸ | oadrCreateOpt: device sends upstream opt message ¹¹ |
| | Dev. Info | Device Information | Indicates all mandatory product information | Info Request ¹⁰ [Section 9.1.1] | Ei:eiTargetType (endDeviceAsset) |

⁸ CTA-2045-A: Table 8-2

⁹ Section 8.1, OpenADR 2.0b EiEvent Service; Figures 4 & 5, EiEvent Patterns; Section 8.2.2, OpenADR 2.0b Signal Definitions; Table 1, Signals

¹⁰ CTA-2045-A: Table 9-2

¹¹ Section 8.5, OpenADR 2.0b EiOpt Service; Figure 17, Interaction Diagram: Create Opt

| | | | | | |
|----------------------|----------|--|--|--|---|
| | Status | State Reporting Requirements | Provide state information to requestor | Operational State Query ⁸ [Section 8.2.4] (see Table 8) | EiReport. oadrPayloadResource Status (see Table 8 and 9) |
| | Hardware | Hardware Requirements | Design of product & comms. | DC or AC Form Factor ¹² | |
| Device Energy | Energy | Power (Instantaneous) | Demand of product (W) | GetCommodity Read, code 0 | oadrPayloadResource Status: energyReal |
| | | Energy (Cumulative) | Energy used by product (kWh) | GetCommodity Read, code 0 | oadrPayloadResource Status: energyReal |
| | Storage | Current Energy Storage Capacity | Available energy storage (Wh) | GetCommodity Read, Code 7 | oadrPayloadResource Status: oadrCapacity: oadrCurrent |
| | | Total Energy Storage Capacity | Energy storage under ideal conditions (Wh) | GetCommodity Read, Code 6 | oadrPayloadResource Status: oadrCapacity: oadrNormal |

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Table 8: Operational State Codes

| Op State Code | Name |
|---------------|-------------------------|
| 0 | Idle Normal |
| 1 | Running Normal |
| 2 | Running Curtailed Grid |
| 3 | Running Heightened Grid |
| 4 | Idle Grid |
| 5 | Water Heater Error |
| 6 | Idle Heightened |
| 11 | Idle, Opted Out |
| 12 | Running, Opted Out |

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Table 9: OpenADR 2.0b Operational State Reporting¹³

| OpenADR 2.0b EiReport Service | | | |
|--------------------------------------|------------------|----------------------------------|--------------|
| REQ | Report Name | x-CTA2045_Status | |
| M1.1 | Report Structure | Status | Interval |
| | rID | OperationalState | 1-min |
| | Report Type | Reading | |
| | Reading Type | Direct Read | |
| | Units | customUnit | |
| ANSI/CTA-2045-A Message | | | |
| Message | | Operational State Query Response | |
| Element Mapped to rID | | Opcode 2 of Basic 0x13 | |

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¹² CTA-2045-A, Appendix A & Appendix B

¹³ Electric Power Research Institute, Communication Protocol Mapping Guide 1.0, OpenADR 2.0 to ANSI/CTA-2045-A, Table 2-3 Measurement and Reporting Mapping Requirements

476 **Appendix B (Informational) – Demand Response Use cases**

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a. Peak Load Reduction: Curtailment and Emergency Curtailment

- i. Includes protocols for both advance notice and scheduled peak shed (reduction), and emergency curtailment programs.
- ii. Utility implementation may vary regionally but would be accessed via the open standards application layer specification for **General Curtailment**, **Emergency Curtailment**, and **Off Mode** in the relevant standard. See *Informational Appendix B* for messaging examples in common protocols.
- iii. Implementation could include downward adjustment of set points via application layer **Set Point Adjustment**. No requirements set on this parameter.

b. Spinning Reserves: Short Term Curtailment and (Simple) Load Up

- iv. Includes protocols for short term curtailment and load up. Utility implementation may vary regionally but would be accessed via the open standards application layer specification for **General Curtailment** and **Load Up** in the relevant standard. See *Informational Appendix B* for messaging examples in common protocols.
- v. Implementation could include application layer **Set Point Adjustment** downward. No requirements set on this parameter.

c. Thermal Storage

- vi. Includes routines which can incorporate tank stratification strategies and set point adjustment up to on-site maximum allowed tank temperature during load up (ramp) event. This storage is then used to reduce energy usage during a targeted future time period.
- vii. Utility implementation may vary regionally but would be accessed via the open standards application layer specification for **Set Point Adjustment** and **Load Up** in the relevant standard. See *Informational Appendix B* for messaging examples in common protocols.
- viii. Manufacturer strategies may include analysis of **Utility Peak Load Price Signal** and **Excess (DER) Capacity** signals to assist in identifying times where Thermal Storage should be initiated by the product.

Note: Impact of thermal storage strategies varies by tank capacity and installation circumstances.

d. Fast Response: Frequency Balancing

- ix. Fast response routines, where <10 second response intervals are used to frequency balance sections of an operator's grid, are still under active development. Additional research and more widespread adoption would be necessary prior to including this protocol in the standard DR suite for CWHP's.
- x. Utility implementation would require communication with the CWHP, providing **Real Time System Load** signals to the application layer of the product.

Note: Fast response operational modes require relay technology capable of a large number of switching cycles, which typically require upgraded contactor terminals.