



# ENERGY STAR® Program Requirements Product Specification for Residential Water Heaters

## Eligibility Criteria Version 3.3 Draft 1

Following is the **Version 3.3** product specification for ENERGY STAR certified water heaters. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

**Note:** Products may be certified using the Uniform Energy Factor (UEF) metric and current Uniform Test Method for Measuring the Energy Consumption of Water Heaters.<sup>1</sup> Criteria that are specific to UEF for electric and gas-fired water heaters are outlined in Appendix A of this document.

**1) Definitions:** Below are the definitions of the relevant terms in this document. See Appendix A, Section 1 for definitions relevant to UEF.

- A. Residential Water Heater (Consumer Water Heater): A product that utilizes gas, electricity, or solar thermal energy to heat potable water for use outside the heater upon demand, including:
- a. Storage type units designed to heat and store water at a thermostatically-controlled temperature of less than 180 °F, including: gas storage water heaters with a nominal input of 75,000 British thermal units (Btu) per hour or less and having a rated storage capacity of not less than 20 gallons nor more than 100 gallons; electric heat pump type units with a maximum current rating of 24 amperes at an input voltage 250 volts or less, and, if the tank is supplied, having a manufacturer's rated storage capacity of 120 gallons or less.<sup>2</sup>
  - b. Instantaneous (or "tankless") type units which initiate heating based on sensing water flow and deliver water at a controlled temperature of less than 180 °F, heat water, but contain no more than one gallon of water per 4,000 Btu per hour of input with an input capacity greater than 50,000 Btu per hour but less than 200,000 Btu per hour.<sup>3,4</sup>
  - c. Solar water heaters include a collector and storage tank, and use the sun's energy to heat water using one of the five basic types of solar water heating systems:
    - i. forced circulation (includes both direct and indirect systems),
    - ii. integrated collector and storage,
    - iii. thermosiphon,
    - iv. self-pumped, or
    - v. photovoltaic (PV).
  - d. Add-on Heat Pump Units are air to water heat pumps designed for use with a storage-type water heater or a storage tank that is not specified or supplied by the manufacturer.
  - e. Light Duty EPACT covered gas water heaters heat and store water at a thermostatically-controlled temperature, with an input rate >75,000 Btu per hour and ≤100,000 Btu per hour, and storage volume between 20 and 100 gallons.

<sup>1</sup> 10 CFR Part 430, Subpart B, Appendix E

<sup>2</sup> 10 CFR Part 430, Subpart B, Appendix E. Revised as of January 1, 2014.

<sup>3</sup> 10 CFR Part 430, Subpart B, Appendix E. Revised as of January 1, 2014.

<sup>4</sup> 10 CFR Part 430, Subpart A, § 430.2 Definitions. Revised as of January 1, 2014.

- 45 B. Energy Factor<sup>5</sup>: Energy Factor (EF), a measure of water heater overall efficiency, is the ratio of  
46 useful energy output from the water heater to the total amount of energy delivered to the water  
47 heater.  
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- 49 C. Solar Energy Factor: Solar Energy Factor (SEF) refers to the energy delivered by the total system  
50 divided by the electrical or gas energy put into the system.  
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- 52 D. Thermal Efficiency<sup>6</sup>: Thermal efficiency (TE) is the ratio of the heat transferred to the water  
53 flowing through the water heater to the amount of energy consumed by the water heater.  
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- 55 E. Standby Loss<sup>7</sup>: Standby Loss (SL) means the average hourly energy required to maintain the  
56 stored water temperature.  
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- 58 F. First-Hour Rating<sup>8</sup>: The First-Hour Rating (FHR) is an estimate of the maximum volume of hot  
59 water in gallons that a storage water heater can supply within an hour that begins with the water  
60 heater fully heated.  
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- 62 G. Gallons per Minute<sup>9</sup>: Gallons per Minute (“GPM”) is the amount of gallons per minute of hot water  
63 that can be supplied by an instantaneous water heater while maintaining a nominal temperature  
64 rise of 77°F during steady state operation.  
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- 66 H. Manufacturer Limited Warranty: Manufacturer limited warranty is an assurance by the  
67 manufacturer to the consumer that the water heater, including purchased system equipment and  
68 components, are guaranteed to work for a defined period of time.  
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- 70 I. Basic Model: All units of a given type of covered product (or class thereof) manufactured by one  
71 manufacturer and which have the same primary energy source and, which have essentially  
72 identical electrical, physical, or functional (or hydraulic) characteristics that affect energy  
73 consumption, energy efficiency, water consumption or water efficiency.<sup>10</sup> Further, all individual  
74 models within a basic model have the same certified rating based on the applicable sampling  
75 criteria per U.S. Department of Energy’s (DOE) regulations in Part 429<sup>11</sup>, and this rating must be  
76 used for all manufacturer literature, the qualified product list and certification of compliance to  
77 DOE standards.  
78
- 79 J. Lower Compressor Cut-off Temperature: The temperature below which a heat pump water  
80 heater’s compressor will no longer operate, such that the unit will only work as a conventional  
81 electric resistance water heater.
- 82 K. Combination Space-Heating and Water-Heating Appliance: Appliance that provides both space  
83 conditioning (boiler) and hot water heating with one appliance or energy source. The combination  
84 appliance circulates hot water from the water heater through a heat exchanger in the air handler.  
85 A blower will move the heated air through a standard duct system. In the summer, an air  
86 conditioner is connected to the exchanger and the system functions similarly, with cool air being  
87 pushed through the ductwork.  
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<sup>5</sup> Based on definition in 10 CFR Part 430, Subpart B, Appendix E. Revised as of January 1, 2014.

<sup>6</sup> 10 CFR Part 431, Subpart G. Revised as of January 1, 2014.

<sup>7</sup> 10 CFR Part 431, Subpart G. Revised as of January 1, 2014.

<sup>8</sup> 10 CFR Part 430, Subpart B, Appendix E. Revised as of January 1, 2014.

<sup>9</sup> 10 CFR Part 430, Subpart B, Appendix E. Revised as of January 1, 2014.

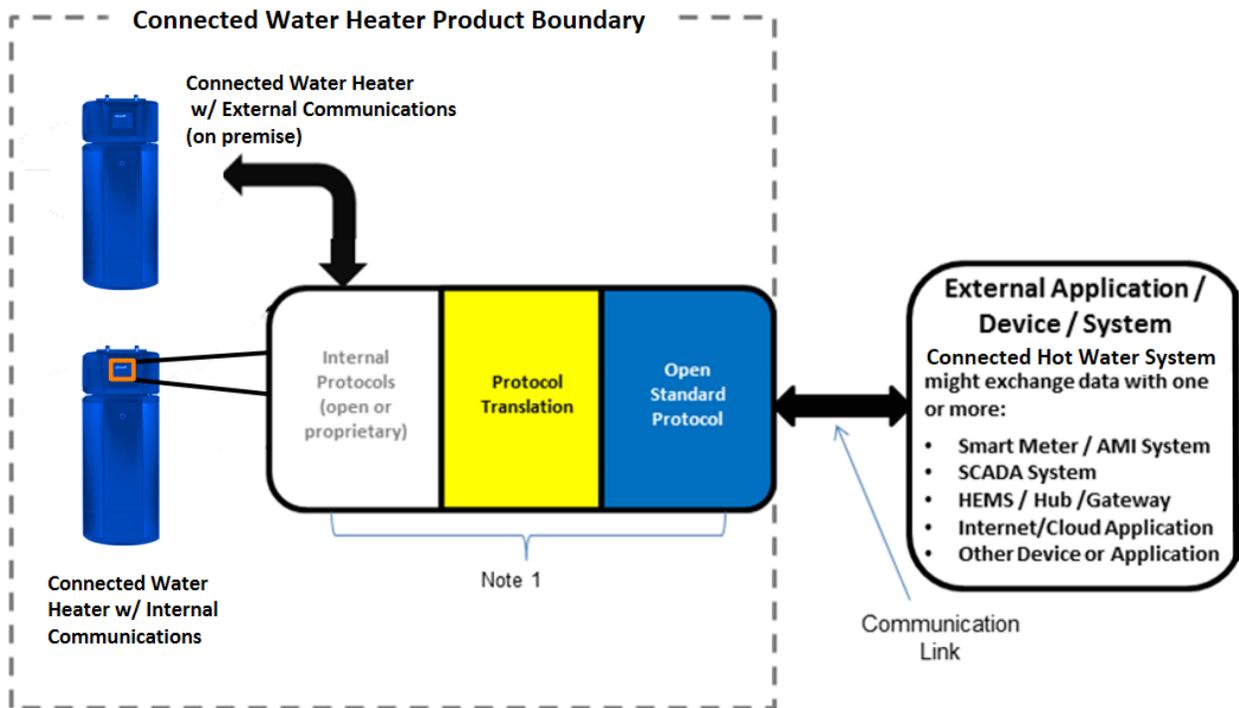
<sup>10</sup> 10 CFR Part 430, Subpart B, Appendix E

<sup>11</sup> 10 CFR Part 429, Subpart B

89 L. Communication Link: As shown in Figure 1, the mechanism for bi-directional data transfers  
90 between the Connected Water Heater Product and one or more external applications, devices or  
91 systems.

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93 M. Connected Water Heater Product (CWHP): As shown in Figure 1, includes the ENERGY STAR  
94 certified water heater, integrated or separate communications hardware, and additional hardware  
95 and software required to enable connected functionality.

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97 **Note:** Communication device(s), link(s) and/or processing that enables Open Standards-based  
98 communication between the CWHP and external application / device / system(s). These  
99 elements, either individually or together, could be within the water heater/controller, and/or an  
100 external communication module, a hub/gateway, or in the Internet/cloud.  
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102  
103 **Figure 1: Connected Water Heater Product (CWHP)**

104 N. Consumer Authorized Third Party: Any entity for which the consumer has provided explicit  
105 permission to access the CWHP connected functionality, in whole or in part, via a Communication  
106 Link.

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108 O. Demand Response (DR): Changes in electric or gas usage by end-use customers from their  
109 normal consumption patterns in response to changes in the price of electricity or gas over time, or  
110 to incentive payments designed to induce lower electricity or gas use at times of high wholesale  
111 market prices or when system reliability is jeopardized<sup>12</sup>.

112  
113 P. Demand Response Management System (DRMS): The system operated by a consumer  
114 authorized program administrator, such as the utility or third party, which dispatches signals with  
115 DR instructions and/or price signals to the CWHP products and receives messages from the  
116 CWHP product.  
117

<sup>12</sup> Modified to apply to gas as well, based on Federal Energy Regulatory Commission, <https://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp>

- 118 Q. Interface Specification: A document or collection of documents that contains detailed technical  
119 information to facilitate access to relevant data and product capabilities over a communications  
120 interface.  
121
- 122 R. Load Management Entity: Consumer authorized DRMS, home energy management system, or  
123 the like.  
124
- 125 S. Open Standards: Communication with entities outside the CWHP that use, for all communication  
126 layers, standards:  
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- 128 • included in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards,<sup>13</sup> and/or
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  - 130 • included in the NIST Smart Grid Framework Tables 4.1 and 4.2, and/or
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  - 132 • adopted by the American National Standards Institute (ANSI) or another well-established  
133 international standards organization such as the International Organization for Standardization  
134 (ISO), International Electrotechnical Commission (IEC), International Telecommunication Union  
135 (ITU), Institute of Electrical and Electronics Engineers (IEEE) or Internet Engineering Task Force  
136 (IETF).<sup>13</sup>  
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- 138 T. Premises: Land and the improvements on it.  
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140 **Note:** EPA is proposing to add the above definitions (L-T) and Figure 1 to describe connected water  
141 heater products. These largely parallel similar material in other ENERGY STAR specifications with  
142 connected criteria.

143 **2) Scope:**

- 144 A. Included Products: Only products that meet the definition of a Residential Water Heater, as  
145 specified herein, are eligible for ENERGY STAR certification with exception of those products  
146 listed in Section 2B.  
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- 148 B. Excluded Products:  
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- 150 a. Electric resistance water heaters,
  - 151 b. Add-on heat pump units,
  - 152 c. Products intended only for commercial applications,
  - 153 d. Combination space-heating and water-heating appliances.

<sup>13</sup> [http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PMO#Catalog\\_of\\_Standards\\_Processes](http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PMO#Catalog_of_Standards_Processes)

154 **3) Certification Criteria:**  
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156 **Note:** Products may be certified using the Uniform Energy Factor (UEF) metric and current Uniform Test  
 157 Method for Measuring the Energy Consumption of Water Heaters.<sup>14</sup> See Appendix A, Section 2 for  
 158 Product Performance Requirements for water heaters certifying using UEF.

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

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 169 B. Product Performance Requirements for Electric Water Heaters:  
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**Table 1: Criteria for Certified Electric Water Heaters**

Criteria		ENERGY STAR Requirements
Energy Factor	≤ 55 gallons	EF ≥ 2.00
	> 55 gallons	EF ≥ 2.20
First-Hour Rating		FHR ≥ 50 gallons per hour
Warranty		Warranty ≥ 6 years on sealed system
Safety		UL 174 and UL1995
Lower Compressor Cut-off Temperature (Reporting Requirement Only)		Report ambient temperature below which the compressor cuts off and electric resistance only operation begins

172 C. Product Performance Requirements for Gas Water Heaters:  
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- 174 a. Gas Storage Water Heaters:  
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**Table 2: Criteria for Certified Gas Storage Water Heaters**

Criteria		ENERGY STAR Requirements
Energy Factor	≤ 55 gallons	EF ≥ 0.67
	> 55 gallons	EF ≥ 0.77
First-Hour Rating		FHR ≥ 67 gallons per hour
Warranty		Warranty ≥ 6 years on system (including parts)
Safety		ANSI Z21.10.1/CSA 4.1

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<sup>14</sup> 10 CFR Part 430, Subpart B, Appendix E

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b. Gas Instantaneous Water Heaters:

**Table 3: Criteria for Certified Gas Instantaneous Water Heaters**

Criteria	ENERGY STAR Requirements
Energy Factor	EF $\geq$ 0.90
Gallons Per Minute	GPM $\geq$ 2.5 over a 77°F rise
Warranty	Warranty $\geq$ 6 years on heat exchanger and $\geq$ 5 years on parts
Safety	ANSI Z21.10.3/CSA 4.3

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c. Light Duty EPACT covered Gas Water Heaters:

**Table 4: Criteria for Certified Light Duty EPACT covered Gas Water Heaters**

Criteria	ENERGY STAR Requirements
Thermal Efficiency	TE $\geq$ 0.90
Standby Loss	Standby loss $\leq$ 1889 Btu/h $\times$ (TE-0.73)
Warranty	Warranty $\geq$ 6 years on system
Safety	ANSI Z21.10.3/CSA 4.3

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D. Product Performance Requirements for Solar Water Heaters:

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

Criteria	ENERGY STAR Requirements
Solar Energy Factor	SEF $\geq$ 1.8 for electric backup SEF $\geq$ 1.2 for gas backup
Warranty	Warranty $\geq$ 10 years on collector, $\geq$ 6 years sealed system, $\geq$ 2 years on controls, $\geq$ 1 year on parts

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

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

198  
199 A. Communications

- 200  
201 a. The CWHP Communication Link, in Figure 1, shall use Open Standards for all  
202 communication layers to enable functions listed in Sections 4B) and 4C).  
203 b. An Interface Control Document (ICD), Application Programming Interface (API), or other  
204 documentation shall be made available to interested parties that, at minimum, allows  
205 access to the functions listed in Sections 4B) and 4C).

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207 B. Remote Management and Consumer Feedback

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209 The CWHP shall provide the following functionality:

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211 a. **Remote Management:** The product shall be capable of receiving and responding to  
212 consumer authorized remote requests (not including third-party remote management  
213 which may be made available solely at the discretion of the manufacturer), via a  
214 communication link, similar to consumer controllable functions on the product.  
215 i. Higher energy mode settings shall be temporary: If a remote management signal  
216 puts the CWHP into a mode that uses more energy than the mode selected  
217 locally, the product shall revert to the locally set mode within 72 hours if no  
218 additional user input is received.  
219  
220 b. **User Alerts:**  
221 The CWHP shall be capable of providing at least two types of messages relevant to  
222 optimizing its energy consumption, either:  
223 i. On the product (e.g. water heater and/or controller), and/or  
224 ii. Transmitted to consumers and consumer authorized third parties via a  
225 communication link. This link can include open standards protocols used for  
226 Demand Response or could use a secondary communication link.

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

231  
232 c. **Energy Reporting**

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

238 **Note:** EPA is proposing basic user feedback and remote management be made available to consumers,  
239 typical of those appearing in connected criteria for other ENERGY STAR product types. At the March 10,  
240 2019 meeting, EPA came to understand that for some manufacturers, these criteria could only be met by  
241 adding a second communications pathway independent of that used for demand response. On the other  
242 hand, these criteria are relevant to all water heater types, not just storage. EPA looks forward to  
243 continuing this discussion.

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C. Demand Response (DR)

Gas Instantaneous Water Heaters are exempt from this functionality and may be recognized as connected without meeting the criteria in this subsection.

a. **DR Communications Protocols**

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

b. **Override:** The product shall provide an easily accessible means for consumers to override demand response events during the event or ahead of time for a scheduled event, except for Grid Emergency/Off Mode events. When the event is overridden, the CPWH shall return to its previous operating mode.

c. **Loss of connectivity:** If a product is equipped with a stored schedule (e.g. to accommodate Time of Use rates) and remote / DR operations cause the CWHP to operate outside these stored conditions, a loss of network connectivity and/or signal will cause the CWHP to revert to the stored schedule as soon as it is safe to do so. If the product is not equipped with a stored schedule, product shall continue with DR events which are planned or in progress when connectivity is lost.

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**Note:** EPA proposes requiring either CTA 2045 or OpenADR 2.0 compliance for the CWHP, to encourage national compatibility of demand response infrastructure and product communication hardware. According to our discussions with manufacturers and our understanding of related specifications for water heaters and related products, this represents the consensus state of the industry. However, EPA recognizes the hardware and software implications for this requirement would preclude some communication and network strategies in CWHP and is requesting stakeholder feedback on this requirement.

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d. **DR Information and Messaging**

The CWHP shall support the following upstream messaging from the device when available and may support the additional (optional) messaging capabilities. Support for these messaging signals is implemented via the open standards protocol used in the product. Implementation details are described in *Appendix B*.

Required Messaging I/O

- **Device Type** – Electric Resistance / Gas Storage / Heat Pump.
- **Operational State** – Information on product running state, DR conditions operating on product, opt in/out state, and fault conditions. The following states will be able to be reported, as applicable to the chosen DR protocol:
  - **Idle Normal** – Water heater is not heating but is in a normal mode of operation.
  - **Running Normal** – Water heater is in a Normal Operating Mode and the water heater is presently heating (heat pump compressor or any heating elements are energized).
  - **Running Curtailed Grid** – Water heater is running in a grid service mode of operation and the water heater is presently heating (heat pump compressor or any heating elements are energized).
  - **Running Heightened Grid** – Water heater is processing a Load Up

- 296 request and water is being heated.
- 297 ○ **Idle Grid** – Water heater is in a grid service operational mode and the
- 298 water heater is not heating water.
- 299 ○ **SGD Error** – Device is malfunctioning. Recommended use: Failure of
- 300 heat pump or element.
- 301 ○ **Idle Heightened** – Water heater is processing a Load Up request and
- 302 water is not being heated.
- 303 ○ **Cycling On** – Cycling type of grid service event is in effect and water is
- 304 being heated (i.e. cycled on).
- 305 ○ **Cycling Off** – Cycling type of grid service event is in effect and water is
- 306 NOT being heated (i.e. cycled off).
- 307 ○ **Idle Opted Out** – Water heater is overridden has no/insignificant energy
- 308 consumption.
- 309 ○ **Running, Opted Out** – Water heater is overridden and is consuming
- 310 significant energy.
- 311 • **Current Available Energy Storage Capacity** – Energy capacity available for
- 312 load up in product under current conditions (kWh or Btu).
- 313 • **Power/Demand (Instantaneous)** – Measured or estimated power consumption
- 314 in current conditions (kW or Btu/hr).

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316 Optional Messaging I/O:

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- 318 • **Energy Use** – Measured or estimated cumulative energy use of product (kWh or
- 319 Btu).
- 320 • **Current Total Energy Storage Capacity** – Energy storage capacity available in
- 321 product under current conditions (kWh or Btu), understood to be over and above
- 322 the hot water stored to provide user service at the moment.

323 **Note:** Gas instantaneous water heaters are not good targets for load shifting, and as such DR criteria are  
324 not required for these products to be recognized as connected.

325 EPA proposes to require multiple messages, including information on current demand and current energy  
326 storage capacity, due to the high planning value of this information in DR applications. EPA also proposes  
327 requiring the use and implementation of the device type and operational state information, as most of this  
328 information would be expected to be available in a majority of best practices field applications. EPA is  
329 requesting stakeholder feedback on these messaging requirements.

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331 **e. DR Requests and Responses**

332 The CWHP shall also support the required DR operational modes listed below and may  
333 support additional open standard defined DR signals.

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335 Required Operational Mode Functionality:

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- 337 • **General Curtailment (Shed)** – Reduce energy consumption throughout the
- 338 duration of the request, allowing the stored thermal energy in the tank to reduce
- 339 moderately. For Heat Pump Water Heaters with resistive elements, on recovery,
- 340 elements should not be used to return the stored thermal energy to its normal
- 341 operating level. This request could be made multiple times per day, so consumer
- 342 comfort level should be maintained at a high level throughout the duration of the
- 343 request. Both immediate events and events scheduled in advance will be
- 344 supported.
- 345 • **Emergency Curtailment (Critical Curtailment)** – Reduces energy consumption
- 346 of the product with high urgency and high energy usage restrictions throughout
- 347 the duration of the event, allowing the stored thermal energy in the tank to a very

348 low level, less than that for a **general curtailment (shed)** request. This request  
349 would occur less frequently than **general curtailment (shed)**, therefore  
350 consumer comfort may be maintained at a lower level throughout the duration of  
351 the request. Both immediate events and events scheduled in advance will be  
352 supported. Support for this request is optional for gas storage, light duty EPACT,  
353 and residential duty commercial water heaters.

- 354 • **Grid Emergency (Off Mode)** – Immediately, stop using energy for water heating  
355 when safe to do so. The only time this request should be made is to avoid  
356 outages, so that frequency should be one request every year or less. Both  
357 immediate events and events scheduled in advance will be supported. This  
358 mode is optional for gas storage, light duty EPACT, and residential duty  
359 commercial water heaters.
- 360 • **Load Up** – Increase energy consumption, allowing the stored thermal energy to  
361 increase, within safety parameters as determined by the manufacturer. For heat  
362 pump water heaters with resistive heating elements, the use of the elements  
363 should be avoided as much as possible to satisfy this request. This request could  
364 occur at the same frequency as **general and critical curtailment** requests. Both  
365 immediate events and events scheduled in advance will be supported.
- 366 • **Return to Normal Operation** – In the event an ongoing event is canceled for  
367 any reason, the product shall return to normal operation. Both immediate events  
368 and events scheduled in advance will be supported.

369  
370 Optional Operational Mode Functionality:

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- 372 • **Set Point Adjustment** – Adjusts product thermostat set point up or down if safe  
373 to do so.
- 374 • **Relative Price Signal(s)** – Communicates information to endpoint on current  
375 energy cost and upcoming changes, to allow consumer configuration of when  
376 grid energy should be used and when it should be curtailed if possible.

377 **Note:** EPA proposes requiring multiple standard operational modes, which would be able to support a  
378 wide variety of DR applications including thermal storage, peak shaving/load shifting, and critical  
379 curtailment. In recognition that gas DR programs are less well developed, some modes are optional for  
380 gas products. EPA is requesting stakeholder feedback on required DR functionality. Since EPA is not  
381 requiring Grid Emergency/Off Mode requests to be overridden, we are keenly interested to make sure  
382 they are not overused. If we are notified that utilities are overusing these requests, we will alter the  
383 specification to allow over rides in these cases. If they are used once a year or less, we do not expect the  
384 lack of override to be a problem for consumers.

385 Optional mode functionality is anticipated to support advanced / adaptive DR programs, and is centered  
386 on Pricing Signals, which would work in tandem with onboard CWHP controllers + logic to provide  
387 additional control and responsiveness in DR applications. EPA is requesting stakeholder feedback on this  
388 approach, and if additional optional operational mode functionality should be noted.

389 D. Additional Information for Consumers

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**5) Test Requirements:**

**Note:** See Appendix A, Section 3 for Test Methods for water heaters certifying using UEF.

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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 units; FHR only for storage units, GPM only for instantaneous units.	Energy Factor	10 CFR Part 430, Subpart B, Appendix E* Revised as of January 1, 2014**
	First-Hour Rating (FHR)	
	Gallons per minute (GPM)	
Light Duty EPACT covered gas water heaters	Thermal Efficiency	10 CFR Part 431, Subpart G Revised as of January 1, 2014**
	Standby Loss	
Whole-home solar units	Solar Energy Factor	SRCC – OG-300: Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems
Connected Products	Demand Response	<i>Evaluation of Demand Response in Connected Water Heaters (in development)</i>

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

427  
 428 **Note on recovery efficiency:** Guidance includes that for thermostatically-controlled water heaters  
 429 that do not initiate and complete a recovery cycle prior to the start of the second draw of the simulated-  
 430 use test, the recovery efficiency shall be determined as specified in Section 11.2 of ASHRAE 118.2.  
 431

432 \*\*Refer to the 10 CFR parts 200 to 499 edition revised as of January 1, 2014. An abbreviated version  
 433 of this reference, titled “*Historical Water Heaters Test Method*” can be found on the ENERGY STAR  
 434 Water Heaters for [Partners webpage](#).  
 435

436 C. Compliance with Connected Criteria

- 437
- 438 a. Aside from demand response functionality, compliance with connected criteria, as
- 439 specified in Section 4), shall be through examination of product and/or product
- 440 documentation.

441 **Note:** EPA is adding a reference to the corresponding testing requirements for connected products. EPA  
 442 is proposing to verify connected functionality (Non-DR) via product spec sheet examination. A test  
 443 procedure: *Evaluation of Demand Response in Connected Water Heaters* is forthcoming in development  
 444 by DOE during this revision. EPA encourages stakeholder participation in this test procedure  
 445 development process, including at the DOE in-person kickoff meeting on May 21, 2019 (details below).

446 **Location:**  
 447 Navigant Consulting, Inc.  
 448 1200 19<sup>th</sup> St NW, Suite 700  
 449 Washington DC, 20036  
 450 Conference Room 7A  
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452 **Time:** May 21, 2019. 9:00AM to 5:00PM (Eastern)  
 453

454 Please RSVP to [WaterHeaters@energystar.gov](mailto:WaterHeaters@energystar.gov) and indicate if you plan to attend in person. Participation  
 455 in the meeting can be done in person, online, or over the phone. Further meeting details will be provided  
 456 through email.  
 457

458 **6) Effective Date:**  
459 The ENERGY STAR Residential Water Heaters specification shall take effect on **April 16, 2015**. To  
460 qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on  
461 the model's date of manufacture. The date of manufacture is specific to each unit and is the date on  
462 which a unit is considered to be completely assembled.

463  
464 **7) Future Specification Revisions:**  
465 EPA reserves the right to change the specification should technological and/or market changes affect  
466 its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to  
467 the specification are arrived at through industry discussions. In the event of a specification revision,  
468 please note that the ENERGY STAR certification is not automatically granted for the life of a product  
469 model. EPA is planning to further investigate the following topics in future revisions:

470  
471 A. Several factors will lead to significant change to the mix of products available on the market in the  
472 next few years. First, the impact of the newest federal standards has been delayed by confusion  
473 around test method and metric. Second, the new test method allows different types of products to  
474 move into the market. Third, all products will eventually have UEF test data available, and  
475 consumers may use this measure to more easily compare different types of water heaters. Taking  
476 these factors into consideration, EPA expects the market will be in a position to begin a revision  
477 in the 2019 or 2020 timeframe.

478  
479 B. For some time, DOE has had minimum efficiency standard equations that rely largely on some  
480 measure of capacity while EPA has had single levels. This continues to be true now. EPA has not  
481 examined this practice for this version but will reconsider it for future revisions.

482  
483 C. The service delivered by gas-fired storage and gas-fired instantaneous water heaters is similar  
484 enough that consumers, particularly those working with new construction, actively consider which  
485 type of water heater to purchase. Therefore, it may be appropriate for EPA to set a single level for  
486 all gas-fired water heaters. EPA has not done so in the past because market dynamics and test  
487 method peculiarities have prevented this course of action. EPA will re-examine this possibility for  
488 the next revision.

## Appendix A – Eligibility Requirements in terms of Uniform Energy Factor

Appendix A contains the definitions, product performance criteria, and test requirements applicable to water heaters certifying using UEF, which, by appearing in Appendix A, supersede those in the rest of the specification. Aside from those appearing in Appendix A, all definitions, criteria, and test requirements in the specification above apply to water heaters certified via UEF.

### 1) **Definitions:** Below are the definitions relevant to the UEF test method.

- A. **Residential Water Heater (Consumer Water Heater):** A product that utilizes gas, electricity, or solar thermal energy to heat potable water for use outside the heater upon demand, including:
  - a. Storage type units designed to heat and store water at a thermostatically-controlled temperature, including: gas-fired storage water heaters with a nameplate input of 75,000 Btu per hour or less, containing more than one gallon of water per 4,000 Btu per hour of input; electric heat pump type units with a maximum current rating of 24 amperes at an input voltage 250 volts or less.<sup>15</sup>
  - b. Instantaneous type units heat water, but contain no more than one gallon of water per 4,000 Btu per hour of input with an input capacity less than or equal to 200,000 Btu per hour for gas-fired instantaneous.<sup>16</sup>
  - c. Gas-fired storage residential-duty commercial water heaters include gas-fired storage water heaters that are designed to deliver hot water at a temperature less than or equal to 180°F, with an input rate greater than 75,000 Btu per hour and not exceeding 105,000 Btu per hour, containing more than one gallon of water per 4,000 Btu per hour of input, and storage volume less than or equal to 120 gallons. For models requiring electricity, a single-phase external power supply is used.<sup>17</sup>
- B. **Uniform Energy Factor<sup>18</sup>:** Uniform Energy Factor (UEF) is the measure of water heater overall efficiency.
- C. **First-Hour Rating<sup>19</sup>:** The First-Hour Rating (FHR) is an estimate of the maximum volume of “hot” water that a storage-type water heater can supply within an hour that begins with the water heater fully heated (i.e., with all thermostats satisfied). It is a function of both the storage volume and the recovery rate.
- D. **Maximum GPM Rating<sup>20</sup>:** Maximum GPM is the maximum gallons per minute of hot water that can be supplied by an instantaneous water heater while maintaining a nominal temperature rise of 67 °F (37.3 °C) during steady-state operation.

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<sup>15</sup> Adapted from 10 CFR Part 430, Subpart A §430.2 *Definitions*

<sup>16</sup> Adapted from 10 CFR Part 430, Subpart A §430.2 *Definitions*

<sup>17</sup> Adapted from 10 CFR Part 431, Subpart G §431.102 *Definitions*

<sup>18</sup> 10 CFR Part 430, Subpart B, Appendix E

<sup>19</sup> 10 CFR Part 430, Subpart B, Appendix E

<sup>20</sup> 10 CFR Part 430, Subpart B, Appendix E

**2) Product Performance Requirements:**

**Note:** Below are the product performance requirements for water heaters certifying using UEF.

A. Product Performance Requirements for Electric Water Heaters:

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

Criteria		ENERGY STAR Requirements
Uniform Energy Factor	≤ 55 gallons	UEF ≥ 2.00
	> 55 gallons	UEF ≥ 2.20
First-Hour Rating		FHR ≥ 45 gallons per hour
Warranty		Warranty ≥ 6 years on sealed system
Safety		UL 174 and UL 1995
Lower Compressor Cut-Off Temperature (Reporting Requirement Only)		Report ambient temperature below which the compressor cuts off and electric resistance only operation begins

B. Product Performance Requirements for Gas-fired Water Heaters:

a. Gas-fired Storage Water Heaters:

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

Criteria		ENERGY STAR Requirements
Uniform Energy Factor	≤ 55 gallons	Medium Draw Pattern UEF ≥ 0.64 High Draw Pattern UEF ≥ 0.68
	> 55 gallons	Medium Draw Pattern UEF ≥ 0.78 High Draw Pattern UEF ≥ 0.80
First-Hour Rating		FHR ≥ 67 gallons per hour
Warranty		Warranty ≥ 6 years on system (including parts)
Safety		ANSI Z21.10.1/CSA 4.1

b. Gas-fired Instantaneous Water Heaters:

**Table 3: Criteria for Certified Gas-fired Instantaneous Water Heaters**

Criteria	ENERGY STAR Requirements
Uniform Energy Factor	UEF $\geq$ 0.87
Maximum Gallons Per Minute	Max GPM $\geq$ 2.9 over a 67°F rise
Warranty	Warranty $\geq$ 6 years on heat exchanger and $\geq$ 5 years on parts
Safety	ANSI Z21.10.3/CSA 4.3

c. Gas-fired Storage Residential-duty Commercial Water Heaters:

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

Criteria	ENERGY STAR Requirements
Uniform Energy Factor	UEF $\geq$ 0.80
Warranty	Warranty $\geq$ 6 years on system
Safety	ANSI Z21.10.3/CSA 4.3

**3) Test Methods:**

**Note:** Below are the test methods for water heaters certifying using UEF.

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

**Table 5: 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 431, Subpart G

Appendix B (Informational) – Demand Response Messaging

Category	Sub-type	Demand Response Messaging	Response Result	CTA (2045-A)	OpenADR (2.0b)
Basic Signals	Curtailment	<b>General Curtailment</b>	Reduce load (moderate)	Shed <sup>21</sup>	oadrDistributeEvent: SIMPLE level 1. <sup>22</sup>
		<b>Emergency Curtailment</b>	Reduce load (major)	Critical Peak Event <sup>21</sup>	oadrDistributeEvent: SIMPLE level 2. <sup>22</sup>
		<b>Off Mode</b>	Turn off (if possible)	Grid Emergency <sup>21</sup>	oadrDistributeEvent: SIMPLE level 3. <sup>22</sup>
	Load Up	<b>Load Up</b>	Use more energy (if possible)	Pending Event Warning and Pending Event Type <sup>21</sup> . Autonomous Cycling (9.1.8)	oadrDistributeEvent: NEAR / FAR flag. CHARGE STATE, LOAD_DISPATCH.
	Run Normal	<b>Return to Normal Operation</b>	Return to defaults	End Shed / Run Normal <sup>21</sup>	oadrDistributeEvent: CANCELLED. <sup>22</sup>
Advanced Signals	Device State (in event)	<b>Set Point Adjustment</b>	Adjust water setpoint (if possible)	Get / Set SetPoint (9.1.6)	oadrDistributeEvent: LOAD_CONTROL. <sup>22</sup>
	Real Time / Device Logic	<b>Real Time System Load</b>	Use / do not use energy when appropriate (follow programming)	Request for Power Level [8.2.1]	
		<b>Utility Peak Load Price Signal</b>		Present Relative Price <sup>21</sup> , 9.1.3	oadrDistributeEvent: ELECTRICITY_PRICE <sup>22</sup> .
		<b>Excess Capacity (DER)</b>		Grid Guidance <sup>21</sup>	
Device Properties & Enrollment	Opt Out	<b>Consumer Override</b>	Skip response to event within opt out time window	Customer Override Message. Sent each time device is queried while opt out is active <sup>21</sup>	oadrCreateOpt: device sends upstream opt message. <sup>23</sup>
	Dev. Info	<b>Device Information</b>	Indicates product type (e.g. HPWH)	Device Information Request	Ei:eiTargetType (endDeviceAsset)
	Status	<b>State Reporting Requirements</b>	Provide state information to requestor	Operational State Monitoring (8.2.4)	EiReport. oadrPayloadResource Status

<sup>21</sup> CTA Reference {CTA 2045-A: Table 8-2}

<sup>22</sup> ADR Reference {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 }

<sup>23</sup> ADR Reference { Section 8.5, OpenADR 2.0b EiOpt Service; Figure 17, Interaction Diagram: Create Opt}

	Hard-ware	Hardware Requirements	[Design of product & comms.]	Timing Parameters (Table 4-4)	
Device Energy	Energy	<b>Power (Instantaneous)</b>	Demand of product (W)	GetCommodity Read, code 0	oadrPayloadResource Status: energyReal
		<b>Energy (Cumulative)</b>	Energy used by product (kWh)	GetCommodity Read, code 0	oadrPayloadResource Status: energyReal
	Storage	<b>Current Energy Storage Capacity</b>	Available energy storage (kWh)	GetCommodity Read, Code 7	oadrPayloadResource Status: oadrCapacity: oadrCurrent
		<b>Total Energy Storage Capacity</b>	Energy storage under ideal conditions (kWh)	GetCommodity Read, Code 6	oadrPayloadResource Status: oadrCapacity: oadrNormal

**Note:** EPA is developing the above informational appendix on DR messaging under common protocols to improve the specificity of DR method definitions in section 4D, and assist with the interoperability and implementation of DR strategies for connected water heaters. EPA is requesting feedback on this appendix, and encourages stakeholders to engage in a dialogue with EPA to further develop this resource.

## Appendix C (Informational) – Demand Response Operational Modes

### 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. No limitations in this specification are applied to tank sizing regarding the support of this functionality.

**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.