REPI-90-21

# IECC®: SECTION 202 (New), R403.5.4 (New), ANSI Chapter 06 (New)

# Proponents:

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**2021 International Energy Conservation Code**

# Add new definitions as follows:

~~C202 GRID-INTEGRATED CONTROL.~~

~~An automatic control that can receive, automatically respond to demand response requests from and send information back to a utility, electrical system operator, or third-party demand response program provider.~~

DEMAND RESPONSE SIGNAL. A signal that indicates a price or a request to modify electricity consumption for a limited time period.

DEMAND RESPONSIVE CONTROL. A control capable of receiving and automatically responding to a demand response signal.

# Add new text as follows:

**R403.5.4~~Grid-integrated~~ Demand responsive water heating.** Electric storage water heaters with a ~~storage tank capacity between 37 (140 L) and 120 gallons (454 L)~~ a rated water storage volume of 40 gallons (150L) to 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with *~~grid-integrated~~ demand responsive controls* ~~that comply with ANSI/CTA-2045-B Level 2~~ in accordance with Table R403.5.4 or another equivalent *approved* standard.

**Exceptions:**

# Water heaters that deliver water at a temperature of 180°F (82°C) or greater

# Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code

# Water heaters that use 3-phase electric power

**Table R403.5.4**

**Demand Responsive Controls for Water Heating**

|  |  |  |
| --- | --- | --- |
| **Equipment Type** | **Controls** | |
| Before 7/1/2025 | On or after 7/1/2025 |
| Electric storage water heaters | ANSI/CTA-2045-B Level 1 and also capable of initiating water heating to meet the temperature set point in response to a *demand response signal*. | ANSI/CTA-2045-B Level 2, except “Price Stream Communication” functionality as defined in the standard. |

*Revise table as follows:*

**Table R405.2**

**Requirements for TOTAL BUILDING PERFORMANCE**

|  |  |
| --- | --- |
| **SECTION** | **TITLE** |
| Mechanical | |
| R403.5 except Section R403.5.2 | Service hot water systems |
| ~~R403.5.1~~ | ~~Heated water circulation and temperature maintenance systems~~ |
| ~~R403.5.3~~ | ~~Drain water heat recovery units~~ |

*Revise table as follows:*

**Table R406.2**

**Requirements for Energy Rating Index**

|  |  |
| --- | --- |
| **SECTION** | **TITLE** |
| Mechanical | |
| R403.5 except Section R403.5.2 | Service hot water systems |
| ~~R403.5.1~~ | ~~Heated water circulation and temperature maintenance systems~~ |
| ~~R403.5.3~~ | ~~Drain water heat recovery units~~ |

# *Add new standard(s) as follows:*

|  |  |  |
| --- | --- | --- |
| **ASME** | ASME  Two Park Avenue  New York, NY 10016-5990  (800) 843-2763; <https://www.asme.org> |  |
| **CTA** | Consumer Technology Association  1919 S. Eads Street  Arlington, VA 22202 |  |
| Standard  reference  number | Title | Referenced  in code  section number |
| ANSI/CTA-2045-B | Modular Communications Interface for Energy Management . . . . . . . | . . . . . . . R403.5.4 |
| ASME BPVC | Boiler and Pressure Vessel Code | . . . . . . . R403.5.4 |

# Reason for revision

# Minor edit from SEHPCAC review.

# Reason for revision

# This revision is the result of a collaboration/negotiation between AHRI and NBI. It makes these key revisions:

# It replaces definitions for “grid integrated control” with “demand responsive control.” The market is moving to a more robust implementation of demand response, but has not yet settled on a terminology. This change utilizes a known term, “demand response,” until such time as the market settles on a new term that can be defined in code. These definitions are used in Title 24, which is leading the market for demand responsive control requirements.

# The range of storage tank sizes subject to the requirement been aligned with water heaters on which manufacturers are installing controls that comply with these requirements.

# An effective date of 7/1/2025 has been added based on the availability of these controls on the market. Before that date, water heaters will be required to meet requirements that can be met by equipment on the market today. After that date, water heaters will be required to meet requirements that can be met by equipment that manufacturers have committed to having available on the market by that date.

# The proposal uses a table format as that is the precedent for having “on or after” requirements in the IECC.

# Reason Statement:

With increasing penetrations of intermittent renewable energy, volatile wholesale power prices, and subsequent growth in dynamic rates/demand response programs, grid-interactive end uses present an opportunity to help homes manage their bills, participate in programs, and support efficient grid operations. Water heaters can provide many services to the grid, including generation, transmission, and distribution capacity, energy arbitrage, and ancillary services. In their assessment of the National Potential for Load Flexibility, Brattle estimated that across all measures these services could provide as much as $15 billion per year in value to the electric system.

As electricity systems transform to include more variable wind and solar energy, demand flexibility becomes increasingly critical to both grid operation and further transformation. Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates - a current and accelerating trend. Water heaters offer an unparalleled opportunity for load shifting: tanks full of hot water are inherently energy storage devices. Including the controls necessary to take advantage of this opportunity is relatively simple and affordable in new construction. Compared to other energy storage technologies such as batteries, smart, grid-integrated water heater controls can deliver substantial dispatchable (that is, reliable to the grid operator) energy flexibility. The controls specified by ANSI/CTA-2045-B ensure negligible risk of occupant disruption (that is, the hot water will not run out). Water heaters provide a particularly attractive option as they have inherent thermal storage that allows energy consumption to be shifted with little to no impact to the end user. This capability has been demonstrated in several contexts, most recently through regional demonstrations conducted by EPRI and BPA.

In their Grid-interactive and Efficient Buildings (GEBs) Roadmap, the US Department of Energy estimates that approximately 15 GW of additional load flexibility is expected to be added to the system under reference case assumptions. Combined with energy efficiency, this is expected to provide $13 billion/year of peak demand savings to the power system and its customers. Through a comprehensive literature review and interviewing dozens of national experts, the USDOE team found that one of the biggest barriers was the lack of interoperability. A key tool to solve this problem is building codes, which can help to ensure that interoperable devices and controls are installed at the time of construction. USDOE cited explicitly the use of codes and standards as one of its recommended pathways to enable greater adoption of GEBs technologies.

It is important to include the requirement for two-way communication (specifically, communication from the behind-the-meter control module back to the utility, grid operator, or other third party entity) because this communication ensures that the controls capability can be fully deployed when needed. With legacy demand response systems, a signal is sent out but the ability to track and quantify the impacts of that signal is effectively nonexistent. This one-way communication paradigm is a key reason that the "firmness" or reliability of many flexibility-related demand side management strategies, particularly demand response, is often considered to be very low.

However, a two-way communication paradigm enables much more reliable impact tracking. Buildings whose controls include two-way communication capability, that is, those with grid-interactive controls as defined here, will be better able to participate in the demand response programs of the future, and their owners will have improved financial prospects through enhanced ability to participate in potentially lucrative utility demand response programs.

ANSI/CTA-2045-B standardizes the socket, and communications protocol, for electric water heaters so they can communicate with the grid, and with demand response signal providers. In addition, 2045-B adds control and communications requirements for mixing valves in water heaters, which enable them to provide greater storage capacity to support increased load shifting while eliminating scalding risk.

Versions of this standard are included in codes or other requirements in California, Oregon, and Washington and are referenced explicitly by ENERGY STAR.

# Bibliography:

Brattle, The National Potential for Load Flexibility (2019) https://brattlefiles.blob.core.windows.net/files/16639\_national\_potential\_for\_load\_flexibility\_-\_final.pdf

BPA, CTA-2045 Water Heater Demonstration Report (2018) https://[www.bpa.gov/EE/Technology/demand-](http://www.bpa.gov/EE/Technology/demand-) response/Documents/Demand%20Response%20-%20FINAL%20REPORT%20110918.pdf

EPRI, CEA-2045 Field Demonstrations Project Description (2014) https://[www.epri.com/research/products/000000003002004009](http://www.epri.com/research/products/000000003002004009)

USDOE, A National Roadmap for Grid-Interactive Efficient Buildings (2021) https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf

Washington State Revised Code of Washington, Title 19, Chapter 19.260, Section 19.260.080, available at https://app.leg.wa.gov/RCW/default.aspx?cite=19.260.080

Oregon Department of Energy, Energy Efficiency Standards Rulemaking https://[www.oregon.gov/energy/Get-Involved/Pages/EE-](http://www.oregon.gov/energy/Get-Involved/Pages/EE-) Standards-Rulemaking.aspx

U.S. EPA Energy Star Program, Connected Criteria for ENERGY STAR Products, https://[www.energystar.gov/products/spec/connected\_criteria\_energy\_star\_products\_pd](http://www.energystar.gov/products/spec/connected_criteria_energy_star_products_pd)

# Cost Impact:

The code change proposal will increase the cost of construction.

To enable grid-interactive controls, there are two sources of costs: the incremental cost to ensure that equipment is interoperable with CTA-2045-B and the cost of the control module installed in that device. The incremental manufacturing cost is in the range of a few dollars, and negligible at higher volumes. The current incremental cost to include a CTA-2045-B compliant control module ranges from about $60 (direct current, hard-wired connection) to $160 (alternating current, wireless cellular connection); this is expected to decline as manufacturing lines are brought up to larger scale (source: Advanced Water Heating Initiative). The major determinant of cost if the chosen radio pathway as chipset costs vary considerably between different frequencies/standards.

In the BPA report, manufacturers stated a range of $2-$30 for regional deployment, but noted that there would be economies of scale for a national rollout. The main cost was development of firmware/hardware to accommodate the standard, but these costs have

already been incurred to meet codes/standards in OR, WA, and CA. REPI-90-21