CEPI-99-21 (Clean version)

# IECC®: SECTION 202 (New), C403.4.1.6 (New)

**Proponents:**

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Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services

(bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org);

Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office

(kim.burke@state.co.us); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Matt Tidwell, representing Portland

General Electric (matthew.tidwell@pgn.com); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Amber Wood,

representing ACEEE (awood@aceee.org)

**2021 International Energy Conservation Code**

# Add new definition as follows:

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:

# Add new text as follows:C403.4.1.6 Demand Responsive Controls.All thermostatic controls shall be provided with demand responsive controls capable of the following:

# Automatically increasing the zone operating cooling set point by a minimum of 4°F (2.2°C)

# Automatically decreasing the zone operating heating set point by a minimum of 4°F (2.2°C)

Demand responsive controls shall comply with the following:

1. All demand responsive controls shall comply with no less than one of the following:
	1. A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification, or
	2. Certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b Virtual End Node by automatically implementing the control functions requested by the Virtual End Node for the equipment it controls, or
	3. Comply with IEC 62746-10-1, an international standard for the open automated demand response system interface between the smart appliance, system, or energy management system and the controlling entity, such as a utility or service provider, or
	4. Comply with the communication protocol required by a controlling entity, such as a utility or service provider, to participate in an automated demand response program.
	5. Comply with the physical configuration and communication protocol required by CTA 2045-A.
2. All demand responsive controls shall be capable of communicating to the VEN using one or more of the following: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring any other bi-directional communication pathway.
3. When communications are disabled or unavailable, all demand responsive controls shall continue to perform all other control functions provided by the control.

**Exception:** Health care; assisted living facilities; data centers; mission critical spaces; industrial and process spaces; and buildings with energy management systems that meet the intent of this section.

**Variable capacity HVAC less than 5 tons:** Variable capacity HVAC systems may alternately comply with AHRI 1380.

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

Chapter 6 Referenced Standards New

CTA

Consumer Technology Association Technology & Standards Department

1919 S Eads Street

Arlington, VA 22202

ANSI/CTA-2045-B – 2018: Modular Communications Interface for Energy Management

IEC

IEC Regional Centre for North America

446 Main Street 16th Floor

Worcester, MA 01608

IEC 62746-10-1 - 2018 Systems interface between customer energy management system and the power management system - Part 10-1: Open automated demand response

OpenADR

OpenADR Alliance

111 Deerwood Road

Suite 200

San Ramon, CA 94583

OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources

# Reason for revision

# This revision is the result of a collaboration/negotiation between NBI, DOE, and AHRI. This proposal is being revised to align closely with REPI-70, which defines requirements for demand responsive thermostats in residential applications.

# 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 requirement to include ramp-up and ramp-down logic to prevent building peak demand from exceeding that without the demand response implementation has been removed because currently available thermostats that are otherwise compliant with the requirements in this proposal generally do not include this capability and therefore including this requirement risks substantially increasing costs for compliance.

# It includes requirements that demand responsive controls shall comply with accepted industry-standard communications signals and protocols, including flexibility to allow controls to use one of several currently-available options. These requirements align with California’s Title 24 energy code as well as proposal REPI-70.

# Reason Statement:

Grid-integrated controls for thermostats are added based on language from California Title 24 and ASHRAE Standard 189.1. Any

thermostat listed as “Title 24 compliant” would meet this requirement. The controls allow for dialing back heating and cooling, as well

as to accept additional heating or cooling when renewable energy generation is high or energy prices are low, and both ramp up and

down requirements in relationship to the utility/grid operator/third party aggregator signal to prevent rebound issues on the grid after

the signal is released.

In health care and assisted living facilities, thermostat setpoints can impact more than just thermal comfort, and temperature can be

part of the health care being provided. To ensure that this requirement cannot have an adverse impact on those services, these

facilities have been exempted from this requirement.

HVAC system control, often through thermostats, has been at the center of demand response (DR) programs for decades. DR

programs continue to rely deeply on thermostat control strategies, but the need for such controls is fast growing. 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.

Today’s demand response programs typically set event (call) durations between 15 minutes and 4 hours. The preconditioning

strategies (cooling set point reduction / heating set point increase) and temporary setback strategies (cooling set point increase /

heating set point reduction) will enable substantial HVAC system energy savings over this time frame. In many cases, in a building compliant with this code, tenants are unlikely to even notice a change in their thermal comfort. The inclusion of preconditioning helps

ensure that the building is able to reduce electrical demand by adjusting HVAC setpoints while minimizing the risk of tenant disruption:

in many cases the event will end before the higher cooling (or lower heating) set point is reached in the space.

Based on modeling by LBNL (foundational modeling supporting the May 2021 DOE Grid-integrated Efficient Buildings Roadmap),

thermostat controls configured to deliver preconditioning and/or space temperature adjustments can reduce building peak demand by

roughly 10% in many cases.

**Bibliography:**

A National Roadmap for Grid-Interactive Efficient Buildings, U.S. Department of Energy, 17 May

2021, https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf.

Final CASE Report: Upgradeable Setback Thermostats, California Statewide Codes and Standards Enhancement (CASE) Program,

October 2011, https://title24stakeholders.com/wp-content/uploads/2020/01/2013\_CASE-Report\_Upgradeable-Setback-

Thermostats.pdf

SupplyHouse. “T3700 - Venstar T3700 - Explorer T3700 Residential Digital Thermostat (2 Heat, 1

Cool).” SupplyHouse.com, www.supplyhouse.com/Venstar-T3700-Explorer-T3700-Residential-Digital-Thermostat-2-Heat-1-

Cool. SupplyHouse. “T1010 - Venstar T1010 –Single Day Programmable Digital

Thermostat” SupplyHouse.com, https://www.supplyhouse.com/Venstar-T1010-Venstar-T1010-Single-Day-Programmable-Digital-

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Home Depot. “Honeywell Home 5-1-1 Day Programmable Thermostat” https://www.homedepot.com/p/Honeywell-Home-5-1-1-Day-Programmable-Thermostat-with-Digital-Backlit-Display-RTH2410B/203539465?ITC=AUC-63044-23-12070

2017 Tier III TRM Characterizations, Advanced

Thermostat https://publicservice.vermont.gov/sites/dps/files/documents/2017%20Tier%20III%20TRM%20Characterizations.pdf.

**Cost Impact:**

The code change proposal will increase the cost of construction.

For larger commercial buildings with building management systems, it is not common to install a thermostat without demand response capabilities. Therefore, there is no incremental equipment cost associated with this measure for those building types. However, there could be soft costs to ensure those demand responsive controls function properly with the building management system. Conversations with industry experts indicate these soft costs can be around $0.25/s.f. for a medium office building. The primary cost drivers in thermostats are not the grid-integration controls but rather other features. Therefore, incremental costs vary. An entry-level grid-integrated thermostat currently available from a national retailer costs about $70, while the same retailer lists a similar non-grid- integrated programmable unit for just over $35, indicating an incremental cost of about $35. This cost has dropped in the last five years. A 2017 study out of Vermont cited incremental costs for smart thermostats in new construction at roughly $150 – a decrease in incremental costs of $115 over just 4 years.

However, smart thermostats (i.e., those with grid-integrated controls) are very common in new construction and represent a growing share of the retrofit market. All major smart thermostat brands already include grid-integration controls that comply with this requirement, so there is generally no incremental cost to include these controls assuming a smart thermostat is installed either based on customer preference or efficiency requirements.

Multifamily buildings and smaller commercial buildings that install direct-attached thermostats, demand responsive thermostats (which were estimated in a 2011 study to cost $68 more than a programmable thermostat) were found to be extremely cost effective. It was estimated that installing demand responsive thermostats in a 10,000 s.f. office building resulted in 83kWh to 274 kWh of electricity savings and between 0.19 to 1.97kW in demand savings in Climate Zones 2-4. Every dollar spent on demand responsive thermostats yielded between $1.20 to $7 in operating cost savings over a 15-year period for office buildings. In the 10 years since, equipment prices have decrease and incremental costs are estimated to be only $40 making this measure even more cost effective than estimated previously for buildings without building management systems. This measure will not only result in cost savings for consumers but will also result in other significant societal benefits. According to DOE’s report, “A National Roadmap for Grid-Interactive Efficient Buildings,” every watt in peak demand savings was found to create 17 cents in annual electric grid system value. This value included energy savings, capacity savings, transmission deferral and ancillary services. A 10,000 square foot office building with a demand responsive thermostat which is estimated to reduce peak demand savings between 0.26 to 1.09kW would result in $44 to $334 in annual electric grid system value. Demand responsive thermostats which allow grid operators to reduce demand on the grid during the times when the carbon intensity of the electric grid is high also results in reduced carbon emissions generating additional significant societal benefits.

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**2021 International Energy Conservation Code**

# Add new definition 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:

# Add new text as follows:C403.4.1.6 Demand Responsive~~Grid-Integrated~~ Controls.All thermostatic controls shall be provided with demand responsive~~grid-integrated~~ controls capable of the following:

# Automatically increasing the zone operating cooling set point by a minimum of 4°F (2.2°C)

# Automatically decreasing the zone operating heating set point by a minimum of 4°F (2.2°C)

# ~~Automatically decreasing the zone operating cooling set point by a minimum of 2°F (1.1°C)~~

# ~~Automatically increasing the zone operation heating set point by a minimum of 2°F (1.1°C)~~

# ~~Both ramp-up and ramp-down logic to prevent the building peak demand from exceeding that expected without the DRimplementation.~~

# ~~The thermostatic controls shall be capable of performing all other functions provided by the control when the grid-integrated controls are not available. Systems with direct digital control of individual zones reporting to a central control panel shall becapable of remotely complying.~~

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Cool. SupplyHouse. “T1010 - Venstar T1010 –Single Day Programmable Digital

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