Residential Demand Response

Modify the 2021 International Energy Conservation Code as follows:

Add new definition as follows:

DEMAND-RESPONSIVE CONTROL. An automatic control that can receive and automatically modify building electric load in response to requests from a utility, electrical system operator, or third-party.

Revise as follows:

R403.1.1 Programmable thermostat.
The thermostat controlling the primary heating or cooling system of the *dwelling unit* shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day and different days of the week. This thermostat shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures of not less than 55°F (13°C) to not greater than 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F (21°C) and a cooling temperature setpoint of not less than 78°F (26°C). The thermostat shall be provided with Demand-Responsive Control capable of increasing the cooling setpoint by no less than 4 °F (2.2 °C) and decreasing the heating setpoint by no less than 4 °F (2.2 °C) in response to a DR request.

Demand responsive controls shall comply with all of the following:

1. All demand responsive controls shall be either:
   a. 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
   b. 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
   c. Comply with IEC 62726-10-1, 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
   d. 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.
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.

Add new text as follows:

R403.5.4 Demand-responsive water heating..
All electric storage water heaters with a storage tank capacity greater than 20 gallons (76 L) shall be provided with demand-responsive controls that comply with CTA-2045 or another demand-responsive control approved by the Authority Having Jurisdiction.

Add new standard(s) as follows:

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
C403.5.4

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
C403.1.1

OpenADR
OpenADR Alliance
111 Deerwood Road
Suite 200
San Ramon, CA 94583
OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources
C403.1.1

Reason:

As buildings account for over 70% of U.S. electricity use, effectively managing their loads can greatly facilitate the transition towards a clean, reliable grid. Grid-interactive efficient buildings (GEBs) combine efficiency and demand flexibility with smart technologies and communication to provide occupant comfort and productivity while serving the grid as a distributed energy resource (DER). In turn, GEBs can play a key role in ensuring access to an affordable, reliable, sustainable and modern U.S. electric power system. Their national adoption could provide $100-200 billion in U.S. electric power system cost savings over the next two decades. The associated reduction in CO_2 emissions is estimated at 6% per year by 2030.[1]

Building codes represent standard design practice in the construction industry and continually evolve to include advanced technologies and innovative practices. Historically, national model energy codes establish minimum efficiency requirements for new construction.[2] Expanding codes to support GEB capabilities is a pivotal step towards realizing demand flexibility in support of a clean grid by addressing capabilities to improve interoperability between smart building systems, the grid, and renewable energy resources. Realizing GEBs requires buildings with automated demand response (DR) capabilities that enable standardized control, subject to explicit consumer consent, of energy smart appliances on an electricity network. This is achieved through communication between appliances and a controlling entity that is in communication with the consumer participants.

Energy codes can support DR communication standardization and advance the deployment of flexible load technologies such as smart home energy management systems, energy storage, behind-the-meter generation, and electric vehicles (EVs). Incorporating automated demand response capabilities in energy codes provides many benefits to consumers and society. Specifically, it matches intermittent renewable energy sources to building electric loads, decreases peak load on the electric grid, allows buildings to respond to utility price signals, supports electrical n etwork reliability and market growth of products and processes aligned with clean economic growth.

The incorporation of DR into the model residential energy codes was considered for the 2021 International Energy Conservation Code (IECC) code development cycle. The scope of this proposal includes two strategies for DR in residential buildings: 1) smart thermostats with demand-responsive control and 2) electric water heating incorporating demand-responsive controls and communication.

[1] DOE (U.S. Department of Energy). 2021. *A National Roadmap for Grid-Interactive Efficient Buildings*. Washington DC. Accessed on June 9, 2021 at https://gebroadmap.lbl.gov/

[2] Whileadvanced codes can be considered model codes, in this document, the term “model energy code” refers to the current published version of the International Energy Conservation Code-Residential and ASHRAE Standard 90.1, as those documents are referenced by Energy Conservation and Production Act as modified by the Energy Policy Act of 1992 as the minimum requirements for states adopting energy codes. https://www.govinfo.gov/content/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap81-subchapII.pdf.

[3] https://www.iccsafe.org/building-safety-journal/bsj-technical/code-development-a-process-of-evolution-and-improvement/

Cost Impact:

The code change proposal will increase the cost of construction.

The costs associated with installing residential DR control strategies highlighted in this technical brief are discussed below. The installed costs for smart thermostats and electric water heaters with DR control are modest and depend on the design of the home.

The cost of a standard programmable thermostat required in the 2021 IECC ranges from $20 to $100 based on costs at local home improvement stores. A smart thermostat can range from $120 to $400 based on brand, model, and level of sophistication. The cost to install a programmable or smart thermostat ranges from $112 to $255, with the national average cost of $175. Thus, the incremental cost of upgrading from a standard programmable thermostat to a smart thermostat with DR controls is anywhere between $100 and $300.

Electric resistance water heaters supplied with CTA-2045 communication have been manufactured but are not widely available. HPWHs have taken over the energy efficiency segment of the water heater market, and brands at local home improvement stores include the CTA-2045 communication ports. The average cost for a 50-gallon electric resistance heater is $400, while the average cost for a 50-gallon HPWH is $1,300 at local home improvement stores (Salcido et al. 2021). The incremental cost of $900 plus additional condensate removal equipment of $75 results in a total cost differential of $975. Therefore, for buildings already including HPWHs in the original design, the incremental increase in cost is $0. If the building specified an electric resistance water heater, the most straightforward way to implement the CTA-2045 communication for DR control is to switch to an HPWH with an incremental cost of $975.

While DR control functionality will reduce costs to utilities as well as electric costs to consumers, it is difficult to estimate or calculate the actual cost savings. DR will present cost-saving opportunities for buildings as more homeowners take advantage of time-of-use or real-time pricing controls as they become more widely available. Adding DR controls in model energy codes can help homeowners have the capability of participating in DR programs with alternative utility pricing structures whether they exist now or in the future. When DR requirements are part of the model energy code, it will not require homeowners or buildings to participate in any DR programs but will guarantee that residential buildings are capable of participating in DR programs

Bibliography:

Salcido V, Y Chen, B Taube, E Franconi, and M Rosenberg. 2021. *Demand Response in Residential Energy Code.* Pacific Northwest National Laboratory, Richland, Washington. PNNL-31994