# Emerging Codes and Standards for Grid-Interactive Buildings

January 2021

## Acknowledgment

This report reflects the invaluable contributions of multiple individuals. We recognize the report's lead authors, Darren Port, NEEP Manager Codes and Standards, and David Lis, NEEP Director Technology Solutions.

Several NEEP staff served critical roles in developing the report, including Carolyn Sarno Goldthwaite, Senior Director of Buildings and Community Solutions, and Sammi Lor, Buildings and Community Solutions Intern.

Formatting and edits were provided by NEEP's Strategic Marketing & Communications - Director of Partner Engagement Lisa Cascio and Digital Marketing Senior Associate Victoria Salvatore.

NEEP would like to recognize and thank reviewers Lauran Urbanek, NRDC, Andrew deLaski, ASAP, and Chris Corcoran, NYSERDA.

State rulemaking section reviewers include Blake Shelide, Oregon Department of Energy; Haile Bucaneg, California Energy Commission; Pierre duVair, California Energy Commission; Bruce Helft, California Energy Commission and Brittany Wager, Department of Commerce Washington State.

## About NEEP

NEEP was founded in 1996 as a non-profit whose mission is to serve the Northeast and Mid-Atlantic to accelerate regional collaboration to promote advanced energy efficiency and related solutions in homes, buildings, industry, and communities. Our vision is that the region's homes, buildings, and communities are transformed into efficient, affordable, low-carbon resilient places to live, work, and play.

**Disclaimer:** NEEP verified the data used for this brief to the best of our ability. This paper reflects the NEEP staff's opinion and judgments and does not necessarily reflect those of NEEP Board members, NEEP Sponsors, or project participants and funders.

## Contents

Introduction....3
State Efforts to Require Grid-interactive Capabilities in Appliances....4
Washington....4
Oregon....5
California....5
Proposals to Incorporate Grid-interactive Requirements into Building Codes....7
California's Title 24....7
National Mode Code activity....8
Status of Rrelated Grid-interactive Initiatives....9
U.S. Department of Energy's Grid-interactive Efficient Buildings....9
U.S. Environmental Protection Agency's ENERGY STAR Connected Products....11
History of Building Energy Codes and Efficiency Appliance Standards in Northeast/Mid-Atlantic States....12
Considerations for Regional Stakeholders....13
Conclusion....13

## Introduction

Buildings throughout the United States (U.S.) are responsible for roughly 40 percent of national greenhouse gas emissions, and as such, buildings are a critical component of economy-wide decarbonization. To help offset emissions from buildings and other sectors like transportation and manufacturing, most states in the NEEP region have goals to reduce emissions by 75-80 percent by 2050. According to NEEP's 2018 Northeast Strategic Electrification Action Plan, building decarbonization relies on a few key pathways, including energy efficiency, electrification, and enhanced building-to-grid integration.[1] These strategies also depend on the dramatic increase of renewably-generated electricity. States across the Northeast and Mid-Atlantic are exploring how to more broadly advance decarbonization pathways to achieve the deep emission reduction targets that most have set.

As regions across the nation move towards increasing deployment of these solutions, there is a growing recognition that "connected" or grid-interactive equipment in buildings is a critical component of these decarbonization strategies. Homes and buildings must become more flexible and interact with the grid to meet both grid and customer needs.

Emerging opportunities to help drive greater adoption of grid-interactive appliances and buildings involves appliance regulation and building energy codes. Several western states are beginning to adopt building energy codes and appliance standards, requiring grid-interactive functionality for appliances, homes, and buildings more generally.

This brief explores these codes and standards activities to inform the Northeast and Mid-Atlantic region's potential use. As regional stakeholders consider policy and programs to assist the proliferation of grid-interactive appliances and buildings, we examine how long-standing models of building energy codes and standards may be replicated or leveraged for purposes of driving grid-interactive homes and buildings.

We will explore:

- How leading states are using building and appliance regulation to increase the adoption of grid-interactive appliances, homes, and buildings;
- State motivation;
- Related initiatives involving grid-interactive appliances and buildings;
- History of building energy codes and appliance efficiency standards in the Northeast and Mid-Atlantic states;
- Critical considerations for regional stakeholders exploring grid-interactive building codes and appliance regulations.

[1] Northeast Strategic Electrification Action Plan; https://neep.org/reports/strategic-electrification-action-plan

## State Efforts to Require Grid-Interactive Capabilities in Appliances

Washington, Oregon, and California are leading the country in state-led efforts to require grid-interactive functionalities in specific product categories. Electric storage water heaters, which include heat pump water heaters, are emerging as the lead appliance category for grid-interactive requirements. There is currently no indication from the U.S Department of Energy (U.S. DOE) that it considers creating national grid-interactive requirements for any appliance or equipment categories.

### ANSI/CTA-2045-A Standard

The ANSI/CTA-2045-A standard specifies a modular communication interface (MCI), a physical port and communication protocol, to facilitate communications with residential devices for applications such as energy management. This interface is comparable in concept to a USB socket specifically designed for appliances. The interface provides a standard port and communication protocol for energy management devices to be attached to, and communicate with, the specific end use appliance.

***ANSI/CTA2045-B is now under development at CTA***

### *Washington*

Washington House Bill 1444 promulgates electric and water efficiency standards for home and commercial appliances and products. The legislation requires that electric storage water heaters sold in the state be grid-ready, which will allow utilities to reduce the load on the electric grid during peak demand periods to maintain electricity reliability as the state transitions to renewable energy sources.[2]

More specifically, Washington House Bill 1444 states: "An electric storage water heater, if manufactured on or after January 1, 2022, may not be installed, sold, or offered for sale, lease, or rent in the state unless it complies with the following design requirement: (a) The product must have a modular demand response communications port compliant with: (i) The March 2018 version of the ANSI/CTA–2045-A communication interface standard, or equivalent and (ii) the March 2018 version of the ANSI/CTA-2045-A application layer requirements."[3] Washington's design requirement will be the first in the nation. Heat pump water heater implementation began on January 1, 2021.

Washington's Department of Commerce, the agency responsible for implementing the requirement, highlighted several motivating factors of the design requirement:[4]

- Behavioral and technical data from the Bonneville Power Authority's (BPA) water heater pilot[5] in the Pacific Northwest supports the inclusion of design requirements into 2019 legislation;
- Technology supports the electric grid of the future by enabling utility programs to manage water heating loads;
- The Clean Energy Transformation Act supports flexible grid as the state adds more renewables towards the state 100 percent clean energy standard;

[2] https://www.sierraclub.org/washington/blog/2019/04/bill-for-brighter-future-appliance-efficiency-standards-pass-legislature
[3] http://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/Session%20Laws/House/1444-S2.SL.pdf?q=20200611070408

[4] Washington Department of Commerce Presentation; "Grid-Ready Water Heaters in Washington State 19.260 RCW and 194-24 WAC" 1.22.2019 ; https://www.naseo.org/Data/Sites/1/vorpahl-naseo-geb-grid-water-heater-webinar-07-24-2020.pdf
[5] CTA-2045 Water Heater Demonstration Report

- Commerce supports modular, open standards that are both good for consumers and allow for innovation.

## Oregon

Governor Brown's Executive Order 20-04 tasks the Oregon Department of Energy (ODOE) with efficiency standards rulemaking, including appliance standards. The 2020 Energy Efficiency Standards Rulemaking[6] includes integrating demand response-enabled technologies in electric water heating equipment to have a communication port that operates in compliance with CTA-2045 (or equivalent open-source modular interface standard). These new and updated standards intend to promote consumer energy conservation, reduce greenhouse gas emissions, and provide alignment with Washington and California markets. The rulemaking process and public comment session was completed in the summer of 2020 and the rules become effective September 1, 2021. The standard for grid-connected electric water heaters will apply to equipment manufactured on or after January 1, 2022. There will also be legislation introduced in Oregon's 2021 session to conform statute to ODOE's recent rulemaking.

Washington and Oregon both reference Bonneville Power Authority's CTA-2045 Water Heater Demonstration Report and Scaled Deployment and Demonstration of Demand Response using Water Heaters with CTA 2045 Technology Brief as key resources to clarify the opportunity associated with gird-interactive water heaters. The report includes highlights of the business case (in the aggregate of Washington and Oregon):

- Creation of a 301MW peaking plant equivalent by 2039;
- Long-term net present value (total resource) of $106 million, double this if evaluated at a direct load control level;
- Benefit-cost ratio of 1.74 compared to a simple peaking generation plant (2.45 as direct load control);
- 340 to 800 MWh of battery storage equivalence depending on time of day and year.

## California

Senate Bill 49 (S.B. 49, Skinner, Chapter 697, Statutes of 2019), known as The Clean Power, Smart Power Bill, became effective on January 1, 2020 and requires the California Energy Commission (CEC) to encourage grid-interactive appliance development.

The Clean Power, Smart Power Bill directs the Energy Commission to:

- Adopt, by regulation, and periodically update, standards for appliances to facilitate the deployment of flexible demand technologies, and would require that those standards be cost-effective and prioritize appliances with specified attributes;
- Consult with the Public Utilities Commission and load-serving entities to better align the flexible demand appliance standards with demand response programs administered by the state and load-serving entities and to incentivize flexible demand appliances;
- Establish an administrative enforcement process to enforce the flexible demand appliance standards with an administrative, civil penalty not to exceed $2,500 for each violation, or to refer a violation to the Attorney General for enforcement action in a court;

[6] https://www.oregon.gov/energy/Get-Involved/Pages/EE-Standards-Rulemaking.aspx

- On or before January 1, 2021, and as necessary thereafter, to include as part of each integrated energy policy report a description of any actions it has taken relating to flexible demand appliance standards and the standards' cost to consumers.[7]

In response to the legislation, the CEC opened the Load Management rulemaking (Docket #19-OIR-01) in October 2019 to increase efficiency and demand flexibility in California's electricity grid. More recently, California opened a Flexible Demand Appliance Standards rulemaking (Docket #20-FDAS-01) in October 2020. From the order:

> "Senate Bill 49 authorizes the California Energy Commission (CEC or Commission) to adopt regulations establishing standards and labeling requirements for appliances that promote flexible demand technologies, which can schedule, shift, or curtail electric demand of appliances, to reduce the greenhouse gases emitted in electricity generation. Cal. Pub. Res. Code section 25402(f)(1). This is separate and distinct from the Commission's traditional authority to prescribe energy efficiency standards and labeling requirements "for minimum levels of operating efficiency" of appliances to reduce their energy consumption. Cal. Pub. Res. Code section 25402(c)(1)(A).
>
> SB 49 directs the CEC to establish standards and labeling requirements "to facilitate the deployment of flexible demand technologies" for appliances. Cal. Pub. Res. Code section 25402(f)(1). These standards and labeling requirements encompass technical measures taken by energy customers, third parties, load-serving entities, or a grid balancing authority (with customers' consent) "that will enable appliance operations to be scheduled, shifted, or curtailed to reduce emissions of greenhouse gases associated with energy generation." Id.; Cal. Pub. Res. Code section 25402(f)(7)(A).
>
> The regulations the CEC adopts must be feasible, cost-effective, and adopted in consideration of a list of priorities and factors the bill delineates (e.g., cost, benefits to consumers, alignment of energy demand and supply, rates, or other grid requirements). Cal. Pub. Res. Code section 25402(f)(3) and (5). Starting on January 1, 2021, the CEC must describe any actions it has taken pursuant to S.B. 49 in its Integrated Energy Policy Report (IEPR). Cal. Pub. Res. Code section 25402(f)(6)."

The CEC also published a staff paper, Introduction to Flexible Demand Appliance Standards. "This staff paper introduces the statutory requirements for flexible demand appliance standards within the context of a broader statewide energy policy framework that enables progress toward a 100 percent clean electricity supply. Flexible demand appliance standards will promote technologies to schedule, shift, and curtail appliance operations to support grid reliability, benefit consumers, and reduce greenhouse gas emissions associated with electricity generation. While a small number of other flexible demand appliance initiatives do exist internationally, to date, no federal or state regulations have mandated the robust, flexible demand appliance standards consistent with those envisioned by S.B. 49."

On December 14, 2020, the California Energy Commission (CEC) hosted a remote-access workshop to receive public input on the approach to developing flexible demand appliance standards.

[7] https://openstates.org/ca/bills/20192020/SB49/

## Proposals to Incorporate Grid-interactive Requirements into Building Codes

### *California's Title 24*

To date, only California's 2019 Building Energy Efficiency Standards (Title 24) addresses distributed energy resources that promote electric load flexibility and responsiveness.

The 2019 Building Energy Efficiency Standards[8] contain a section (110.12) titled "Mandatory Requirements for Demand Management". Below is a short description of each of the four subsections. Additional details can be found in the standard.

- Demand responsive controls: General communication requirements for all demand-responsive controls and demand-responsive control thermostats, including communication specifications and communication pathways.
- Demand Responsive Zonal HVAC Controls: Nonresidential HVAC systems with DDC to the zone level demand shed requirements for non-critical zones.
- Demand Responsive Lighting Controls: Specifications for when demand-responsive lighting controls are required for nonresidential lighting systems and requirements for reducing lighting power in response to demand response signals
- Demand Responsive Electronic Message Center Control: Specifications for when demand-responsive controls are required for electronic message centers and requirements for reducing lighting power in response to demand response signals.

Title 24 also contains the following definition*: DEMAND FLEXIBILITY MEASURE is a measure that reduces TDV (time dependent value) energy consumption using communication and control technology to shift electricity use across hours of the day to decrease energy use on-peak or increase energy use offpeak, including but not limited to battery storage, or HVAC or water heating load shifting.*

Qualification requirements for heat pump water heater demand management systems (Appendix JA13)[9] were recently added for the 2019 Building Energy Efficiency Standards. These requirements apply to heat pump water heater systems used for demand flexibility compliance credits. Compliance options allow for alternative approaches for complying with energy efficiency standards. Demand flexibility credits will affect solar electric generation and demand flexibility design rating, which along with the energy efficiency design rating, is used to determine the building's energy design rating.

**2022 Title 24 Development Cycle**

California's 2022 Building Energy Efficiency Standards (Energy Code) will improve upon the 2019 energy code for new construction of, and additions and alterations to, residential and nonresidential buildings. Proposed

[8] https://ww2.energy.ca.gov/2018publications/CEC-400-2018-020/CEC-400-2018-020-CMF.pdf
[9] https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment/ja13

standards will be adopted in 2021 with an effective date of January 1, 2023. The California Energy Commission (CEC) updates the standards every three years.

To support the 2022 revisions to the energy code, investor-owned utilities (IUO's) and publicly-owned utilities are conducting Codes and Standards Enhancement (CASE) initiatives and programs. These initiatives address potential changes to the energy code that show promise, based on utility research results and incentive program success. The initiatives document potential energy savings, cost implications, and specific approaches. The CASE Initiative presents recommendations to support the California Energy Commission's efforts to update the California Energy Code (Title 24, Part 6) to include new requirements or upgrade existing requirements for various technologies.

The statewide CASE team refers to demand management as the ongoing or day-to-day holistic practice of using building controls to operate equipment to optimize electric demand, measured in kilowatts (kW). DR is thus a component of demand management, referring to the additional adjustments to equipment a customer takes when notified by the utility. CASE reports have been developed for grid integration in both the single-family and non-residential sectors. See below:

Codes and Standards Enhancement (CASE) Initiative 2022 California Energy Code Single Family Grid Integration Report
Single-family targeted applications include batteries, heat pump water heater (HPWH) load shifting, heating, ventilation, and air conditioning (HVAC) load shifting, and home energy management systems (HEMS). These proposed sub measures were developed as compliance options for the residential sector and differ from mandatory or prescriptive requirements.

Codes and Standards Enhancement (CASE) Initiative 2022 California Energy Code Nonresidential Grid Integration
The nonresidential grid integration measure focuses on updating existing requirements to better align with current demand management and demand response marketplaces. The measures include new time-dependent valuation of energy prices, demand-responsive lighting equipment and labor prices, available communication protocols, additional thermal energy storage (TES) systems aside from chilled water storage, and commercial heat pump water heaters (HPWHs). Bringing the requirements in line with current practices would help ensure that newly constructed non-residential buildings are positively contributing to grid stability, which is critical as California aims to achieve its renewable portfolio goals and building zero net energy goals.

In addition to CASE proposals, the Commission is also considering potential additions of photovoltaic and battery system requirements that would specify photovoltaic system capacities and battery storage system rated energy capacities and rated power capacities for certain building types.

## *National Mode Code Activity*

A review of ASHRAE Standard 90.1-2016 and 2019 (Franconi et al. 2020) determined that there are requirements specified for active controls for HVAC, lighting, power, service water heating, and elevators. However, direct or indirect automated controls of these technologies and equipment initiated by a grid signal are still to be addressed.

A disconnect between the cost-effectiveness assessment methodology used by ASHRAE (minimum efficiency) in consideration of inclusion of new provisions into standards and the variables in cost savings inherent in demand-responsive is a substantial barrier to time variance efficiency measures being integrated into code. However, the Francosi paper states that the time of use energy rates is in the ASHRAE 90.1-2022 work plan.

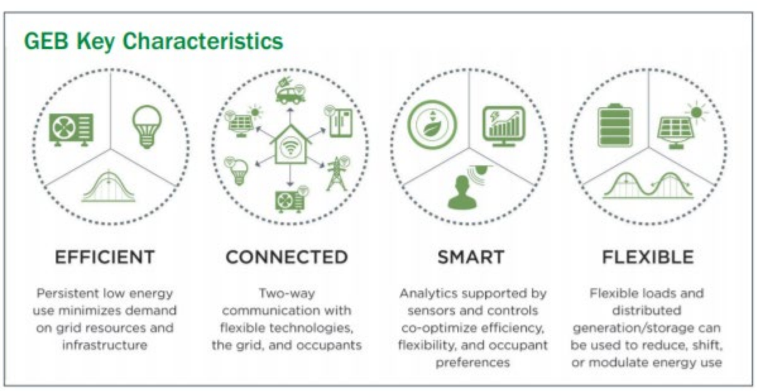
Another emerging opportunity for building codes is the potential incorporation of electrification measures into model codes. However, there are hurdles, such as federal preemption and whether electrification measures belong in the energy code or the electrical code. For example, a proposal for inclusion into the 2021 International Energy Conservation Code would have required electrical outlets to be installed in areas where gas appliances are connected to allow for future transition from gas to electric appliances. The proposal was not seen to save energy so proponents were directed to seek inclusion in the national electrical code proposal. Other proposals to require electric vehicle charging for residential and commercial buildings were also removed from the 2021 code.

The next opportunity to engage in the national model code development process will be in January of 2022. Building energy codes advocates have the next year to develop strategies and build necessary partnerships to ensure passage of code provisions elevating grid-interactive functionality, in conjunction with energy efficiency and electrification.

## Status of Related Grid-Interactive Initiatives

### *U.S. Department of Energy's Grid-Interactive Efficient Buildings*

Grid-interactive efficient buildings (GEBs) are buildings with an integrated combination of energy efficiency, energy storage, renewable energy, and load flexibility technologies facilitated by unidirectional sensors, smart technologies, and controls. In 2019, the U.S. Department of Energy launched its Grid-Interactive Efficient Buildings (GEBs) Initiative to make buildings more flexible regarding the quantity and timing of energy use.[10] This flexibility can help cost-effectively address several grid challenges, from growth in peak demand to higher variable renewable energy generation levels to increasing electrification of transportation and other loads.[11]




Graphic: https://www.energy.gov/sites/prod/files/2019/04/f62/bto-geb-factsheet-41119.pdf

[10] https://www.energy.gov/eere/buildings/grid-interactive-efficient-buildings
[11] DOE's GEBs report https://www.energy.gov/sites/prod/files/2020/04/f74/bto-see-action-GEBs-intro-20200415.pdf

By 2030, according to one estimate, the United States will have nearly 200 gigawatts (GW) of cost-effective load flexibility potential, equal to 20 percent of estimated U.S. peak load. That is three times the existing demand response capability, with savings for consumers from avoiding utility system costs estimated at $15 billion annually.[12]

Today, parallel distributed energy resources (DERs)—including energy efficiency, demand response, solar PV, EVs, and battery storage—are typically assessed, scheduled, employed, and administered independently. GEBs is the integration and continuous optimization of DERs to benefit building owners, occupants, and the grid. Buildings first optimize their energy consumption and peak demand from high-performance design or retrofit, insulative walls, windows, efficient appliances, and equipment. Additionally, buildings intergrated grid connected sensors- and controls send and receive signals required to respond to time-dependent grid needs. The combination of a high-performance building envelope, equipment, and two-way communication via controls and sensors offers building energy load flexibility that can be shaped and optimized across behind-the-meter generation, electric vehicles, and energy storage.

**Benefits of Grid-interactive Efficient Buildings:**

**General**

- Increases grid and building resilience
- Reduces needed fossil fuels
- Reduces greenhouse gas (GHG) emissions
- Reduces energy cost

**Building Owners**

- Reduces energy and demand charge
- Offers ability to sell electricity back to the grid
- Allows participation in utility demand response programs
- Offers ability to purchase electricity at reduced or wholesale rates

**Utilities**

- Shifts demand to times when ample cleaner, more affordable power is available
- Provides more balanced load demand, lowering costs for procurement of power
- Avoids investment in new transmission, distribution, and generation
- Assists with curtailing renewable energy during times when it is overproduced
- Offers more efficient overall grid operation

**NBI GridOptimal Buildings Initiative**

The New Buildings Institute (NBI), in partnership with the U.S. Green Building Council (USGBC), is leading a national coalition committed to better integrating buildings into utility grid management strategies. This project, called the GridOptimal™ Buildings Initiative, will develop metrics by which building features and operating characteristics that support more effective grid operation and decarbonization can be measured and quantified. By supporting the adoption of GridOptimal building features, utilities will be able to tap into a new resource to support grid operation while supporting energy efficiency and carbon emission reductions.

For more information see this fact sheet.

[12] Hledik, R., A. Faruqui, T. Lee, and J. Higham. 2019. The Brattle Group. "The National Potential for Load Flexibility: Value and Market Potential Through 2030." https://brattlefiles.blob.core.windows.net/files/16639_national_potential_for_load_flexibility_-_final.pdf.

## *U.S. Environmental Protection Agency's ENERGY STAR Connected Products*

The EPA has maintained "connected" criteria, generally optional, through ENERGY STAR specifications for several products since 2011. These criteria seek to identify products that provide energy reporting, consumer amenity, and grid services through connection to other systems inside and outside the home. The EPA follows common principles in considering connected criteria, but the specifics for each product type depend on considerations specific to its technologies and markets.[13]

ENERGY STAR connected criteria are available for the following product categories

| | |
|---|---|
| Smart Thermostats | Light Fixtures |
| Room Air Conditioners | Dishwashers |
| Refrigerators | Pool Pumps |
| Freezers | Electric Vehicle Supply Equipment |
| Clothes Washers | Ceiling Fans |
| Clothes Dryers | Commercial Ice Machines |
| Light Bulbs | |

ENERGY STAR certified products with connected functionality are designed to encourage interoperability and offer features like low energy use, energy use reporting, and consumer ownership of all data. Some products, such as appliances and smart thermostats, also offer the features below:

- Ability to communicate with local utilities through a demand response program (with customer permission), enabling support of a smarter, cleaner electricity system
- Ability to allow utility control (with customer permission) of specific functions (e.g., shifting refrigerator defrost time to the middle of the night when energy demand is low)
- Ultimate consumer control over products, including ability to override utility requests

The EPA understands there can be security risks associated with connected products and systems. It will continue to follow industry-standard developments, and to the extent that acceptable security standards arise, may point to them in ENERGY STAR specifications as appropriate.

According to ENERGY STAR's Connected Criteria for Large Load Products Discussion Guide (February 2019)[14], "In the past several years, the landscape of home automation and the need for flexible loads has changed, placing increasing value on flexible and controllable loads and the tools needed to achieve them. Given these developments, EPA is advancing our strategy on connected criteria to serve the evolving market and expanding coverage to linchpin products".

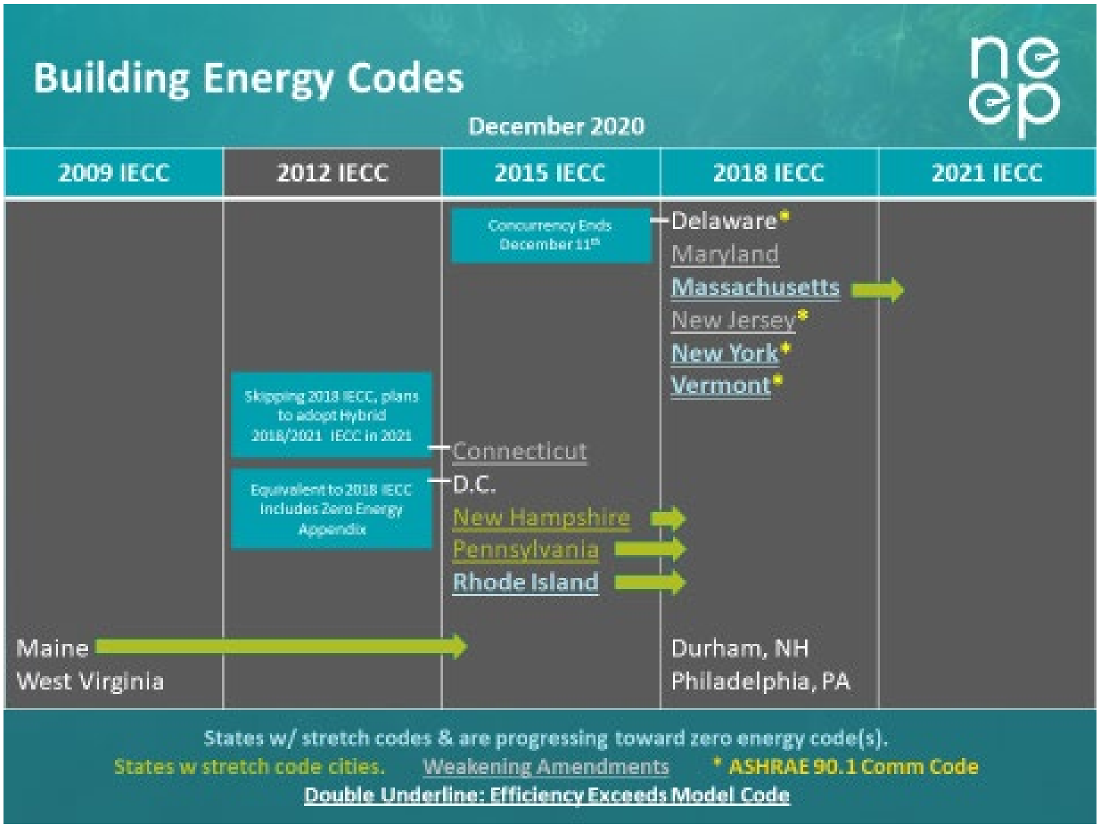
[13] https://www.energystar.gov/products/smart_home_tips/about_products_connected_functionality_0
[14] https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Connected%20Criteria%20for%20Large%20Load%20Products%20Discussion%20Guide.pdf

The EPA identified a small set of products that have an immense potential to support this evolved grid landscape. Those are water heaters, central air conditioners and air source heat pumps (CAC/ASHP), pool pumps, and electric vehicle supply equipment (EVSE).

- Water heaters and pool pumps have considerable flexibility when they use energy before it starts affecting user service.
- Water heaters and EVSE act as energy storage, as do CAC and ASHP to a much lesser extent.
- CAC and ASHP energy use are highly peak coincident, meaning they present a great opportunity to limit demand, particularly in critical shortages.
- Lastly, all of these products impose large loads, compared to other standard residential equipment

## History of Building Energy Codes and Efficiency Appliance standards in Northeast/Mid-Atlantic states

The NEEP region has consistently been at the forefront of state building code and appliance standards adoption. Several states (MA, MD) have legislative mandates requiring adoption of the latest code within one year of publication. Similarly, other states such as Maine have mandates requiring the state not to be more than one code cycle behind the national codes. Eleven of 13 NEEP states have adopted one of the lastest two model codes (2015 IECC or 2018 IECC). Maine and West Virginia are on the 2009 IECC. Massachusettes was the first state in the country to adopt a statewide stretch code. Five other states (NY, MD, RI, DC, VT) have stretch codes while Maine and Connecticut are developing them. DC has adopted a zero energy appendix for commercial buildings that will become the base code by 2030. Three states (VT, NY, and MA) are on track to have zero energy base codes by 2030, and several other states (RI, DE, CT) have roadmaps to zero energy codes.




The Northeast has also been integral in advancing state appliance standards. Since 2005, nine states across the Northeast and Mid-Atlantic region (CT, DC, MA MD, NH, NJ, NY, RI, VT) have adopted standards for various appliances and lighting. In December of 2020, DC became the most recent to passnew standards, and became first in the country to adopt state standards for air purifiers. In 2021, it is expected that several states will pass updated appliance standards bills. The highest likelihood of new adoption appears in NJ, MA, CT, NY, MD, RI, and ME

## Considerations for Regional Stakeholders

According to several states outside of the region, grid-interactive buildings are crucial to achieving building sector and electricity generation decarbonization. Frameworks established by federal and state energy efficiency standards for appliances/equipment and building energy codes (including "stretch" codes) for homes and buildings, provide replicable models that stakeholders in the Northeast and Mid-Atlantic should explore for implementing grid-interactive requirements. The Northeast and Mid-Atlantic region has a strong history in adopting building energy codes and appliance efficiency standards on which to build.

Below are several considerations for regional stakeholders, including state energy offices, public utility commissions, program administrators, and grid planners and operators as they weigh strategies to drive the accelerated adoption of grid interactive appliances, homes, and buildings through buildings energy codes and appliance standards.

- Key grid service objectives for grid-interactive appliances and buildings can be state/region-specific (i.e., summer or winter peak management, grid infrastructure cost savings, renewable electricity integration, resiliency, etc.). It is recommended that consumer and utility analyses are conducted at the state or regional grid level to prioritize specific appliances or building components for grid-interactive functionality and requirements. Studies might look at technical and regulatory feasibility and projected economic, environmental, and reliability impacts.
- Alignment with existing state grid-interactive codes and standards helps overall market development for various product and building component functionalities. Stakeholders are encouraged to leverage codes and standards established by other states when appropriate. Stakeholders should also consider leveraging industry-recognized “open standards” in regulation for appliances and equipment that enhance connectivity and interoperability.
- Consider grid interactive codes and standards within a broader package of policy and program measures to increase Grid-interactive appliances and buildings' adoption. To fully realize the benefits of grid-interactive homes and buildings, utility rates, incentive structures, and programs must be in place to enable and promote grid-interactive functionalities.
- When contemplating requirements, stakeholders should consider the energy use associated with providing grid-interactive functionalities.
- Stakeholders should consider proposals for grid-interactive equipment as part of the next model code cycle for both the 2024 IECC and ASHRAE 2022 code cycle. Interested stakeholders can engage codes-setting bodies to develop and refine future grid-interactive proposals
- Stakeholders should consider grid-interactive and electrification provisions in base code adoption or stretch codes at the state level.

## Conclusion

The nation is witnessing the evolution of a modern decarbonized grid, including smart, grid-interactive appliances and equipment and distributed energy resources. Grid modernization coupled with new and emerging electrification policy, codes, and standards have enormous potential to continue to propel buildings towards grid-interactivity and electrification.

Water heaters alone, literally tens of millions of water heaters in buildings throughout the country, represent immense demand-side management potential. The considerations laid out in the paper will assist a variety of stakeholders – from power generators to power end-users – to operate buildings in a more efficient, safer, resilient, and lower emissions manner. More efficient buildings will translate into affordability both for building operators and for building tennants or owners. In addition to grid reliability and saving consumers money, grid-interactive buildings will assist states in reducing emissions and meeting their emissions reduction targets

The challenge ahead is in adopting and implementing the policies, codes, and standards noted within the paper and prioritizing the research development and manufacturing of grid-connected capable equipment. The market transformation has begun in Oregon, California, and Washington. We are beginning to see and hear of conversations starting in other states, including in the NEEP region, towards the inclusion of grid-inactive equipment and anticipate seeing provisions included in appliance standards legislation in the coming years.

One unexplored topic in this paper is that of consumer interest in allowing their appliances and equipment to engage with utility demand flexibility programs. Consumer behavior and acceptance of new paradigms is often a hurdle to market transformation. Education and incentives will be needed at the start. Hopefully, in time, we will think of participation in demand flexibility programs as a cost saving opportunity with little-to-no impact on convenience.

NEEP facilitates several regional initiatives, including initiatives specific to appliance standards, building energy codes, and smart energy homes and buildings. Working groups within these initiatives can provide platforms for continued learning around promoting grid-interactive functionality, including regulation. Regional stakeholders are encouraged to engage regional partners through these groups. A future with broad-scale deployment and participation of grid-interactive homes and buildings will depend on regional cross-learning and partnerships.