Strategic Electrification and Energy Codes

November 2020

Table of Contents

Acknowledgements

This brief reflects the invaluable contributions of multiple individuals.

We would like to recognize the brief's lead author, Kai Palmer-Dunning. Several NEEP staff served key roles in the development of the brief including Carolyn Sarno-Goldthwaite, Darren Port, and Moses Riley. Formatting and edits were provided by Lisa Cascio, Director of Partner Engagement, and Victoria Salvatore, Marketing Associate.

NEEP would like to recognize and thank Jim Meyers and the team at Southwest Energy Efficiency Project (SWEEP) for their participation in reviewing this brief and providing input into the creation of this document.

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.

Introduction

As states create and implement long-term climate goals, they must directly address decarbonization for the building sector to reduce carbon emissions from construction and operation. **Decarbonization** is a holistic approach to achieving greenhouse gas reductions and energy savings across all sectors and industries like transportation, manufacturing, and buildings. Building decarbonization can most effectively be addressed through the implementation of updated **energy codes** and stretch or reach codes that help reduce energy consumption, create healthier indoor environments, achieve savings, and reduce carbon emissions beyond base code minimums. Updated energy codes and stretch codes promote building decarbonization by focusing on **energy efficiency, renewable energy, and strategic electrification**.

While energy-efficient construction supplemented by a combination of on-site and off-site renewables can help buildings and homes achieve zero energy, strategic electrification goes a step further by electrifying equipment and appliances that would typically run on fossil fuels, such as gas heaters, ovens, boilers, and gas dryers. In addition to electrifying building systems, strategic electrification incorporates distributed energy resources like renewable energy storage and microgrids. This encourages distributed energy production so that energy doesn't come from a centralized source, making the grid more resilient to stresses and capable of meeting varying load demands. Strategic electrification takes advantage of high-efficiency systems and appliances, like heat pumps and high-efficiency electric appliances, to reduce consumer-end energy and carbon emissions. When coupled with the overall energy efficiency of the building or home, the renewable energy demand can be reduced, making its procurement more affordable for owners.

Energy codes can address these strategies by setting requirements for electrifying buildings and homes, prohibiting fossil-fuel-powered systems and appliances, and promoting on-site electrification infrastructure like battery storage or electric vehicle charging, which further promote decarbonization.

This brief will address the current national and regional energy code landscape as a means towards home and building decarbonization. The intersection of codes and strategic electrification is a focus that can assist states in their decarbonization goals. Including strategic electrification language in codes is the first step in ensuring that codes stay at the forefront as an essential decarbonization strategy.

Shifting the Code Conversation to Carbon

For a long time, energy codes have dealt solely with the energy use of buildings and homes. As model energy codes like the International Energy Conservation Code (IECC) and the ASHRAE 90.1 standard have been updated, they created energy efficiency improvements and lowered energy consumption for buildings and homes. Codes have allowed buildings and homes to significantly reduce operating costs and improve their long-term viability as energy assets to decarbonizing the built environment.

Carbon Reduction through Strategic Electrification

Focusing solely on reducing energy use, however, only addresses one part of building decarbonization. Buildings and homes in the United States account for **33 percent of annual carbon emissions**. To truly decarbonize the building sector, buildings must somehow account for the **operational carbon** they produce. This accounting begins with removing on-site carbon-producing systems through strategic electrification. Energy-efficient, all-electric systems like air source heat pumps (ASHPs) and variable refrigerant flow (VRF) systems provide heating/cooling solutions that can replace less efficient, carbon-intensive space conditioning systems. NEEP has published helpful resources on both ASHPs and VRF systems that provide a comprehensive overview of the technology and best practices for driving rapid market adoption in the region.

Operational Carbon

Carbon emissions produced through the ongoing operations of a building, which are produced from electricity and heating systems powered by fossil fuels.

Many states have renewable portfolio standards (RPS) to gradually transition their grids to renewable energy. This is a crucial step in ensuring that the energy being supplied to buildings is carbon-free. However, it is also just as important that buildings and homes eliminate operational carbon produced on-site.

Intelligent controls that are flexible and adapt to user energy habits and home energy management systems paired with buildings systems can respond to demand in real-time and further improve efficiency. Systems that address domestic hot water have proven to be an ongoing obstacle to thoroughly electrifying buildings. However, as heat pumps and VRF technology have vastly improved over the last decade, other solutions like solar water heaters and heat pump water heaters are also helping to electrify domestic hot water heaters.

Combustion-Free Requirements

Nationally, some jurisdictions have begun looking at combustion-free requirements for new construction. In California, six municipalities including, Berkeley, CA, implemented natural-gas infrastructure prohibitions on new construction. Many cities and towns in the state (including Berkeley) have also passed stretch codes that mandate all-electric heating and sometimes cooking appliances in new construction.

However, local efforts in Massachusetts have shifted the spotlight to the energy code and its feasibility to regulate fossil fuel consumption by buildings and homes. The Town of Brookline passed a local ordinance prohibiting natural gas hookups in new construction (with certain exceptions). While the state attorney general later denied this ordinance due to conflicts with the building and plumbing code, it did raise questions around what role codes should play in mitigating the effects of climate change through building decarbonization.

“

If indeed, model energy codes are minimum standards for buildings' safety and energy use, then addressing the safety risks associated with carbon emissions should be within the purview of energy codes.

”

Code Adoption, Stretch Codes, and Electrification Opportunities in Code

In the NEEP region, all but one of the 13 states (West Virginia) has updated to at least the 2015 version of the IECC. States like Massachusetts and New York are looking ahead to the upcoming IECC 2021, which is poised to take major steps forward in energy efficiency. On the other hand, some states have adopted weakened versions of the 2015 or 2018 IECC, while others consider skipping the next code cycle altogether.

While it is crucial for states to consistently adopt the most current version(s) of the IECC, states can also take a leadership role by promulgating a stretch code option that local municipalities can adopt voluntarily. Many municipalities within the NEEP region have done so; Massachusetts, Rhode Island, Maine, and New Jersey are all considering stretch codes or stretch code updates that could include language around electrification.

Regional Code Adoption Landscape

State	Current Base Energy Code	Next Planned Adoption
Maine	IECC 2015* *Still using 2009. 2015 IECC approved but awaiting ratification by the attorney general and commissioner.	
Vermont	IECC 2018	
New Hampshire	IECC 2015	Reviewing IECC 2018 for adoption
Massachusetts	IECC 2018	IECC 2021 on January 1, 2022
Rhode Island	IECC 2015	Reviewing IECC 2018 for adoption
Connecticut	IECC 2015	Reviewing IECC 2018, planning to skip IECC 2021
New York	IECC 2018	
New Jersey	IECC 2018	
Washington, DC	IECC 2015	
Maryland	IECC 2018* *Weakening amendments on both res. & comm. side	
Pennsylvania	IECC 2015	Reviewing IECC 2018 for adoption in 2021

Delaware	IECC 2018	
West Virginia	IECC 2009	Exploring 2015 IECC for adoption, likely not before 2022

Source: NEEP Code Tracker

Stretch Codes in the Region

Stretch codes are a great pathway for buildings and homes to go beyond the minimum standards set by model energy codes. Six states/jurisdictions (Vermont, Massachusetts, Rhode Island, New York, Maryland, and Washington, D.C.) have stretch codes. These stretch codes take a variety of approaches. New York uses a "percent better than base" approach, while Massachusetts uses this approach for commercial buildings and Energy Rating Index (ERI) compliance for residential. Vermont's point-based stretch code system offers multiple compliance paths, including using the ERI. Maryland uses the 2015 International Green Construction Code (IgCC) for state-owned or funded buildings as its stretch code and allows that municipalities can adopt it. Washington DC adopted Appendix Z for commercial buildings, the first zero-energy stretch code in the region.

DC Stretch Code- Appendix Z

Appendix Z builds upon the provisions of IECC 2015 by setting minimum thresholds consistent with Passive House standards for thermal energy performance and airtightness. By doing so, Appendix Z ensures buildings achieve a low energy use intensity (EUI) that can be supplemented by renewables. The stretch code sets requirements for on-site and off-site renewables and addresses certain provisions for electrification by prohibiting the use of on-site combustion for thermal energy to buildings.

States can take many different approaches for stretch codes; there is no one-size-fits-all approach for a stretch code. Stretch codes should be designed to meet the state's current needs based on what can feasibly be achieved beyond the base code. Stretch codes should also create a pathway for continued energy efficiency and electrification improvements for buildings and homes.

State	Current Stretch Code	Next Planned Adoption	Electrification Req.
Maine	N/A	Drafting first stretch code for 2021 adoption	N/A
Vermont	Section R407(2020)	Three-year adoption cycle	"EV Ready" requirement
Massachusetts	CMR 780 Chapter 115 AA (2020)	Reviewing zero energy stretch codes for 2022 adoption	*a zero energy stretch code will likely include some electrification provisions
New York	NYStretch Energy Code-2020	Three-year adoption cycle	• Energy Recovery Ventilation System requirement • "EV Capable" requirement
Rhode Island	Residential Stretch Code (DOE ZERH) Commercial Stretch Code (amended IgCC 2015)	Considering updated stretch code* *current standards are voluntary and unenforceable at the municipal or state level	N/A

Maryland	Maryland IgCC 2015 Supplement	N/A	N/A
Washington, DC	Appendix Z	Appendix Z planned to become base code within two code cycles	Combustion-free heating system requirement

Source: NEEP Code Tracker

IECC 2021, Opportunities and Setbacks

IECC 2021 is the first model code in the last two cycles to see significant increases in energy efficiency; projections put average energy efficiency gains in the 10-12 percent range for both residential and commercial buildings. This is a much bigger increase than from IECC 2015 to 2018 (**see figure 1**).

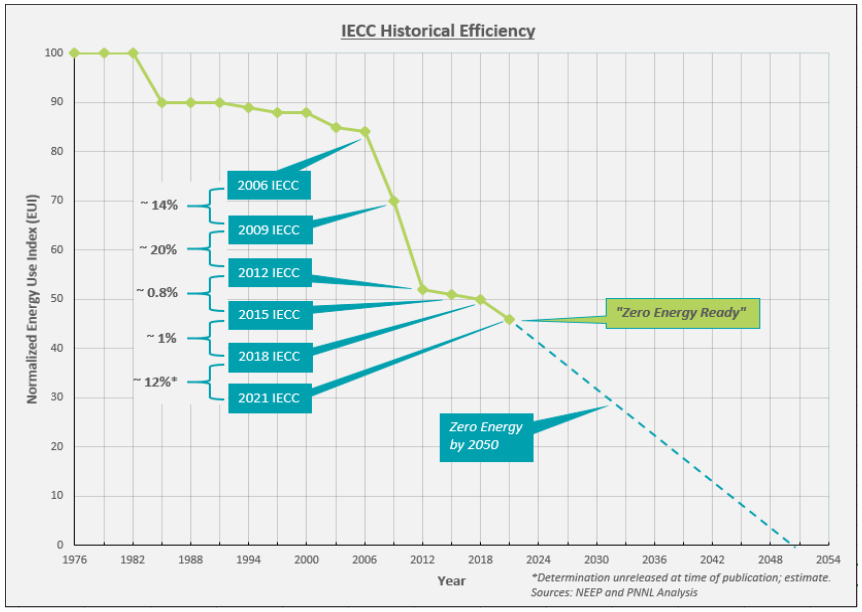

Figure 1: IECC Historical Average EUI, NEEP

The energy efficiency gains of IECC are due to improvements in building envelope requirements, HVAC systems, lighting, and power. For instance, HVAC ventilation is now required to be leakage tested and ventilation fan efficacy increased to meet current Energy Star standards for residential construction. For commercial construction, equipment is required to meet efficiency standards contained in ASHRAE 90.1-2019, and energy recovery ventilation is required for all non-transient dwelling units greater than 500 sq. ft. New Building Institute (NBI) provides an overview of these improvements and others on its IECC 2021 Base Code webpage.

IECC 2021 is also the first model code to include zero energy appendices for commercial and residential new construction. These appendices can be adopted as model stretch codes for states and local jurisdictions. The Zero Code by Architecture 2030, the zero-energy appendix for commercial new construction, provides a performance path based on ASHRAE 90.1 (Appendix G) to determine how much renewable energy a commercial building would need to achieve zero energy, but doesn't require additional energy efficiency above base levels. The Zero Energy Appendix by New Building Institute (NBI) for residential new construction uses an Energy Rating Index (ERI) compliance path based on the U.S. Department of Energy's Zero Energy Ready Homes (DOE ZERH) program to guide residential construction towards zero energy. Both appendices can be adopted "as is" or amended to require higher levels of energy efficiency, promote strategic electrification, and meet local renewable energy requirements.

While IECC 2021 is set to make many important strides forward for energy efficiency, some of the electrification proposals were dropped and did not make it into the final version of the code that was initially approved by ICC governmental officials. For instance, the Electric Vehicle Ready proposal didn't make it into the final code, which would have required EV-ready and -capable parking spots in commercial new construction. An electrification-ready proposal was also removed that would have required that electrical outlets be placed near gas and oil-powered appliances to anticipate future electrification in residential buildings. Unfortunately, the ICC board ruled that these proposals went beyond the scope of the IECC following appeals from the home builder lobby and other industry lobbyists. However, there are still opportunities for states to amend IECC 2021 for their state code and include similar electrification provisions.

Electrification in Codes

Energy codes play an important role in strategic electrification because codes can set aggressive energy efficiency targets that support strategic electrification. Energy codes can directly require "clean heating," that HVAC systems be combustion-free, or that buildings be constructed with electric infrastructure and are "electrification ready" to anticipate future all-electric infrastructure.

Codes can also take a more indirect approach by requiring a minimum heat pump capacity for buildings over a specific size or establishing an aggressive coefficient of performance (CoP), which is a ratio that measures the heating/cooling performance of a system based on the work required to run the system. The higher the CoP, the more efficient a system will be required, meaning that energy efficiency technology like heat pumps would be used instead of fossil fuel-powered systems.

While the energy efficiency and electrification improvements to IECC 2021 are an important step for national model codes, states and jurisdictions have already taken steps to address electrification within their state and municipal building codes. In 2020, a new California building energy code requires all new single-family homes and low-rise apartment buildings to install solar panels or provide access to community solar that meets all the building's electricity needs. The code also encourages the installation of energy storage, such as residential battery storage. Electrification in water heating is also addressed within the code by requiring that 60% of the energy required for service water heating in state buildings be provided by on-site solar or energy recovery. It also sets minimum energy efficiency standards for service water heating systems in buildings and homes.

In addition to the state building energy code, municipalities in California have implemented local codes that require electrification by prohibiting on-site combustion. Over 35 cities in California have implemented stretch codes or "reach codes" that promote or require all-electric (or prewiring for electrification) for new construction.

While California has set the standard for addressing electrification in code, other states/jurisdictions in NEEP's region like Massachusetts, New York, and the District of Columbia are looking at using stretch codes to drive electrification.

Utilities

To optimize strategic electrification through energy codes, engagement with utilities and state utility commissions are critical. Since utilities manage the pipes and fossil fuel infrastructure used in homes and buildings to control temperature, hot water, and cooking, they must be involved in decarbonization efforts. Many utilities already promulgate energy efficiency initiatives to their customers through rebates and incentives for all-electric systems and appliances, like the Mass Save Program in Massachusetts or EnergizeCT in Connecticut.

Additionally, due to the prevalence of ongoing gas leaks and tragic incidents like the Merrimack Valley Gas Explosion in 2018, many utility customers are starting to question the safety of natural gas as a fuel source and a major culprit of carbon emissions. Utilities have the opportunity to work in conjunction with code boards to address the connection between energy codes and strategic electrification.

Exemplar: Burlington Electric Department (Burlington, VT)

In Burlington, Vermont, the city is working with the local utility, Burlington Electric Department (BED), to implement a citywide vision of reaching net-zero by 2030. The Burlington Electric Department 2020–21 Strategic Direction outlines innovative utility strategies to accomplish this. These strategies include:

- Advance district energy, microgrid projects, and customer- or community-based renewable energy production;
- Improve automated demand response capability and implement appropriate end-use technologies to manage loads;
- Provide clean and affordable transportation fuel through renewable electricity, and invest in and encourage the use of the necessary infrastructure to serve customers across all modes of transportation, including electric bikes, electric vehicles, and electric transit buses;
- Launch electrification programs for cooking, additional lawn equipment, and snow removal;
- Maintain and invest in quality facilities and use them to pilot and showcase new technologies that advance Net Zero Energy.

By targeting strategies to electrify buildings, homes, and other infrastructure, BED can proactively promote electrification in anticipation of a Vermont building code or stretch code that requires electrification provisions like all-electric buildings or minimum heat pump capacity. Working in conjunction with the city, BED is a leading example of how utilities can prepare utility customers and building owners for electrification as codes move to implement requirements.

Appliance Standards

Appliance and equipment efficiency standards are one of the most impactful energy-saving policies. Appliance standards keep energy-inefficient, low-quality products out of marketplaces to ensure all products reach minimum energy and water efficiency levels. The performance floor that appliance standards raise results in the "phase-out" of wasteful technologies so that they don't make it into buildings and homes during construction. Strong appliance standards ensure that building technology keeps pace with continued improvements to the energy efficiency of codes and that energy-efficient electrical products are used instead of less efficient products powered by fossil fuels.

Grid-Interactive Efficient Buildings

Grid-interactive Efficient Buildings (GEBs) are buildings with a holistic and well-optimized blend of energy efficiency, energy storage, renewable energy, and load flexibility technologies enabled through smart controls.

Their responsiveness to the grid allows them to reduce energy and emissions and be more adaptive to real-time changes in energy demand on the grid. Smart controls and energy management systems work to track and mitigate the plug load of appliances.

Improved appliance standards and grid-interactivity requirements through code are great way for buildings and homes to drive electrification and overall decarbonization.

For more info: Grid-Interactive Efficient Buildings (GEBs)

Conclusion

As states continue to implement decarbonization strategies for their buildings, strategic electrification will become more important, especially within codes. Every non-electrified building or home constructed today will have to be retrofitted in the future to be interconnected with grids that are moving towards 100 percent carbon-free renewable energy for most states in the NEEP region. Incorporating strategic electrification and electrification readiness into national model codes, state building codes, and stretch codes will help prepare the building sector and mitigate future costs like expensive retrofits.

Recommendations

NEEP recommends that states consider IECC 2021 for the significant energy efficiency gains and adopt electrification amendments from the IECC 2021 proposals for EV-Ready/Capable (CE217-19, Part I & II) and electrification-ready (RE126, RE107-19, RE147-19) infrastructure that were not included in the final version. States should also consider legislation and work with utilities to increase demand responsiveness in buildings and other GEBs strategies like "smart" and grid-connected appliances and energy management systems that are connected to the grid. This includes states taking a leadership role in adopting strategic electrification roadmaps that layout these various pathways for achieving success and building partnerships with utilities, local organizations, and other states to offer programming, incentives, and support resources ahead of future code adoptions. States should also begin forming strategic partnerships and building awareness around the next version of the IECC. There will be opportunities for states and municipal officials to push the envelope and make strides forward in not only achieving another sizable jump in efficiency but also electrification for IECC 2024. Working with ASHRAE and creating more programs and incentives for electrification will be instrumental to the evolution of codes and standards as well.

Codes should also address the differences between electrification for residential and commercial new construction. Commercial codes should include minimum heat pump capacity and variable refrigerant flow (VRF) system requirements for buildings above a certain size. Residential codes must include electrification-ready provisions that allow homeowners to easily transition to electric appliances and mitigate the out-of-pocket costs of retrofits.

Finally, acknowledging that new construction only makes up a percentage of buildings, codes must better address strategic electrification in existing buildings. Existing building codes should ensure that when buildings undergo additions, alterations, extensive repairs, or changes in occupancy that they incorporate "electrification-ready" improvements. This is important as states and municipalities like New York City implement building performance standards (BPS) to ensure that buildings increase energy performance over time. Existing building codes that include electrification provisions can help make the performance improvements from policies like BPS less cost-prohibitive for building owners.

Resources

2020 NEEP Code Adoption Toolkit.