Pathway to Net-Zero-Energy and -Carbon Residential Building Codes

Steven Nadel and Skye Gruen, American Council for an Energy-Efficient Economy

ABSTRACT

States and cities seeking to progress from ensuring that new homes meet current model energy codes to ensuring that new homes achieve net-zero-energy or net-zero-carbon performance face significant technical, market, and implementation challenges. Six states plus several nonprofit organizations recently collaborated in the Next Generation Codes Coalition to develop a series of new model residential energy codes designed to support this transition. The three codes—Step One: Efficient Homes, Step Two: Advanced, and Step Three: Net-Zero—build on the 2024 International Energy Conservation Code's residential provisions while introducing extensive amendments to its envelope, HVAC equipment, lighting, electrification, renewable energy, and compliance requirements. The codes are progressively more stringent, providing a phased pathway toward net-zero. All three codes are being published in 2026.

This paper describes the coalition's code development process, the structure and technical content of the codes, and preliminary analyses of the code's energy, emissions, and cost impacts. Our preliminary analysis indicates energy savings of about 22%, 34%, and 100% below typical current codes (100% is net for the year). For each code, we find that the energy savings are sufficient to approximately offset the increased mortgage payments needed to finance the energy upgrades. More broadly, this paper describes how the Next Generation Codes Coalition demonstrates a state-led approach to residential energy code development that can complement national model code processes and advance code performance beyond current baselines.

Introduction

Building energy codes have steadily improved in stringency for the past 20 years, as shown in Figure 1. Commercial codes have improved more than residential codes, and this difference is likely to increase: ASHRAE, the sponsor of the leading U.S. model commercial code, has established a goal for ASHRAE 90.1 to achieve net zero energy and carbon by the 2031 edition (ASHRAE 2022). In contrast, recent changes to the development and scope of the International Energy Conservation Code (IECC), the leading U.S. model residential code, have created uncertainty regarding future pathways for advancing residential energy efficiency and decarbonization.[1]

[1] The International Code Council has published a revised Scope and Intent for the 2030 IECC that introduces two separate codes—a Base IECC and an additive IECCX. It appears that decarbonization, electrification, and greenhouse-gas-related provisions are consigned to the IECCX. In addition, there is a newly created cost-effectiveness framework based on simple payback rather than life-cycle costs (ICC 2026).

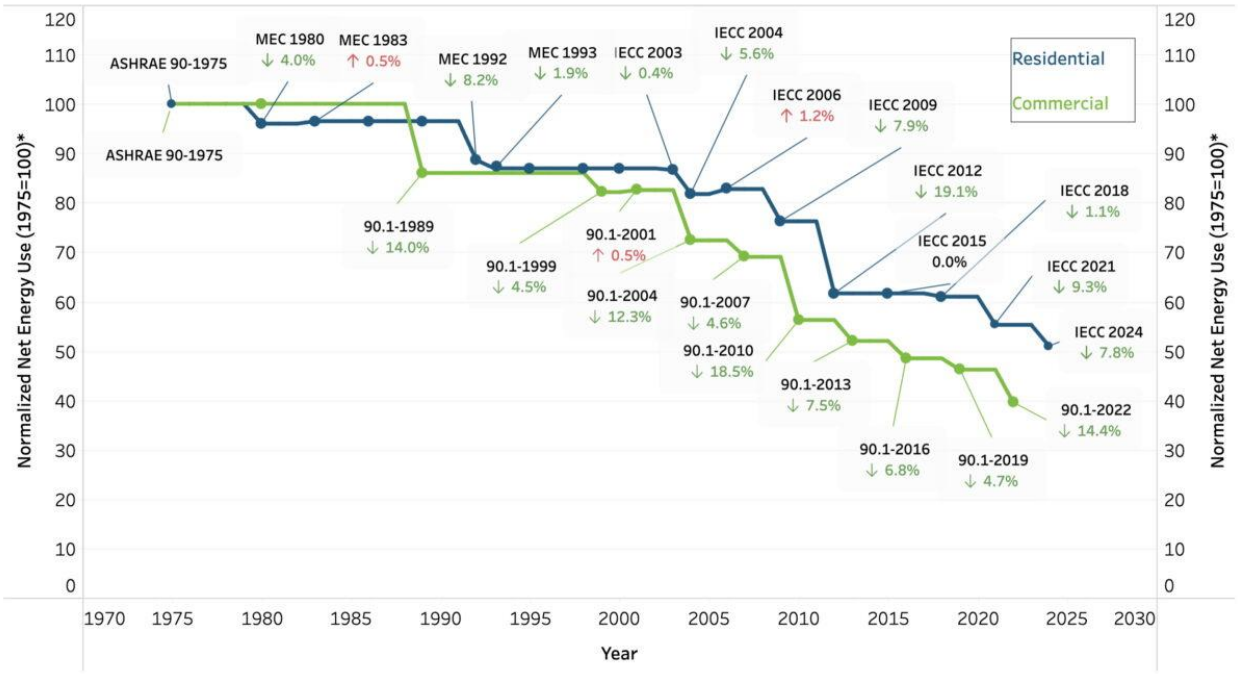

Figure 1. Average energy use of buildings just meeting model energy codes for residential and commercial buildings. Model codes in 1975 are calibrated to 100 on the y-axis, with newer codes gradually reducing energy use on average. Source: DOE 2025.

At the same time, many states and cities have established energy, affordability, and climate goals that will require continued improvement in residential building performance, potentially at a faster pace than can be achieved through national model codes. While voluntary programs, stretch codes, voluntary appendices, and local policies have established standards for higher levels of efficiency, there has been no broadly applicable code-based framework for helping jurisdictions transition from current model energy codes toward annual net-zero-energy and -carbon performance in new homes.

The Next Generation Codes Coalition was formed to address this need. Participating states collaborated to develop a common set of advanced model residential codes that jurisdictions can adopt, modify, and build upon. Together, the three codes—Step One: Efficient Homes, Step Two: Advanced, and Step Three: Net-Zero—provide a code-based pathway from the 2024 IECC, the model residential code used by most U.S. states, toward annual net-zero-energy and -carbon performance. The codes are designed to significantly reduce energy use and emissions in new homes through progressively more stringent requirements for building envelopes, HVAC systems, water heating, electrification readiness, renewable energy, and building performance.

The Next Generation Codes Coalition

The coalition is led by the American Council for an Energy-Efficient Economy (ACEEE) and comprises the states of California, Colorado, Maryland, Massachusetts, New York, and Washington, along with the City of Seattle, Enterprise Community Partners, the National Association of State Energy Officials, and the New Buildings Institute. Additional participation was provided by Delaware, the District of Columbia, NORESCo, and technical experts involved

in the development of the 2027 IECC. The work is supported by grants from the U.S. Department of Energy and several foundations and states.

The coalition organized its work through three committees focused on each of the codes. Participating states served as the primary decision-makers throughout code development, ensuring that proposed requirements reflected practical considerations related to adoption, implementation, and enforcement. The committees drew on participants' experience developing and implementing advanced energy and stretch codes, including the Massachusetts Stretch and Specialized Codes, the New York Stretch Code, the Colorado Model Low Energy and Carbon Code, California's Title 24, and the Washington State Energy Code. Committee decisions were made through consensus or near-consensus. Proposed amendments lacking broad support were removed from consideration.

Draft codes were circulated to stakeholders active in energy code development. Public review included more than 25 organizations and generated over 200 comments and recommendations. The coalition reviewed these comments through a series of committee meetings and refined the codes based on this feedback.

The Efficient Homes code was published in April 2026, and the Advanced and Net-Zero codes are due to be published in summer 2026. To support adoption and implementation, the Efficient Homes and Advanced codes are available as amendment packages to the 2024 IECC, as redline versions showing additions and deletions relative to the 2024 IECC, and as clean code documents. ACEEE obtained a license from the International Code Council (ICC) permitting the distribution of versions containing ICC-copyrighted material, allowing jurisdictions to evaluate and adopt the coalition codes within the broader IECC framework.

A Three-Step Pathway to Net Zero

The 2024 version of IECC was used as the foundation for all three codes because it is the most recently published edition available for use in the project (ICC 2024). Rather than developing a single advanced code, the coalition created a three-step framework intended to support jurisdictions at different stages of residential code advancement. Efficient Homes provides the most accessible step and is based largely on the U.S. Department of Energy's (DOE's) Zero Energy Ready Homes program (since renamed Efficient New Homes). The second step, Advanced, builds on the first step to achieve substantially greater energy savings through enhanced provisions informed by leading state codes and key elements of the Passive House standard. Net-Zero adds renewable energy, storage, and embodied carbon provisions to achieve annual net-zero energy, net-zero carbon, or both, allowing adopting jurisdictions to decide which objective to emphasize.

Compliance Pathways

All three coalition codes retain multiple compliance pathways to provide flexibility for different project types and enforcement needs. These pathways include prescriptive compliance, performance compliance based on Energy Rating Index (ERI), as well as a new Passive House certification option. A prescriptive Tropical Climate Region option is available for qualifying locations. The availability and structure of these pathways differ by code, as shown in Table 1.

The coalition retained the ERI-based performance pathway in the IECC but removed the Simulated Building Performance path included in the 2024 IECC. This decision was based on concerns that the Simulated Building Performance methodology allows broader tradeoffs among

efficiency measures and can be more difficult to enforce consistently. In the Advanced and Net-Zero codes, the ERI pathway is supplemented by optional pathways that combine ERI with CO_2e Index that allows projects to demonstrate compliance using both energy performance and/or modeled operational greenhouse gas emissions.

Table 1. Compliance pathways available in the coalition codes

Compliance pathway	Efficient Homes	Advanced	Net-Zero
Prescriptive path	Available	Available, subject to size and system limitations	Not available
ERI performance path	Available	Available	Available
ERI + CO_2e performance path	Not available	Available	Choice of ERI or CO_2e
Passive House building certification option	Available	Available	Available
Tropical Climate Region prescriptive option	Available for qualifying locations	Available for qualifying locations	Not available

Relationship to Leading State Codes

As noted earlier, all three codes, particularly the Advanced code, incorporate innovations from several leading state and city codes. Envelope and thermal performance requirements draw on multiple sources; for example, some reduced U-values for warmer climates come from California's Title 24, and the thermal bridging mitigation provisions in Advanced's prescriptive path are based on New York State's Stretch Code. Revised performance pathways, including the combined ERI + CO_2e approach and Passive House compliance path, are modeled off of the Massachusetts Stretch and Specialized Codes. Renewable-ready and electric-ready provisions were informed by Massachusetts and Colorado, while Seattle contributed details for restrictions on electric resistance heating. Alternative approaches to meeting on-site renewable energy requirements—such as embodied carbon reductions or an option to pay into a fund supporting on-site solar installations for low-income housing—draw on Massachusetts's and Seattle's codes.

Increasing Stringency

Table 2 summarizes major differences between the three code tiers, highlighting areas of increasing stringency. The Efficient Homes code establishes the first step of amendments, which are based largely on DOE's Zero Energy Ready program; Advanced further strengthens efficiency requirements across major building systems; Net-Zero shifts to a performance-based framework that incorporates renewable energy, energy storage, electric vehicle charging, and embodied carbon provisions.

Table 2. Comparison of key amendments in the Next Generation Code steps

Step 1: Efficient Homes	Step 2: Advanced	Step 3: Net-Zero
Community benefits: • Achieves energy efficiency and cost savings above the 2024 IECC for residents • Results in better quality and more comfortable homes • Advances communities toward their climate goals • Promotes a skilled and advanced local design and construction workforce	Community benefits: • Aligns new construction with long-term efficiency and decarbonization roadmaps • Further lowers energy use and operating costs by pushing efficiency and minimizing loads • Smaller and less expensive future solar and energy storage due to reduced loads • Improved comfort and resilience • Greater long-term protection from energy price volatility	Community benefits: • Requires maximum level of energy efficiency and carbon reduction to comply, aligning code with community goals • On-site solar and batteries increase resilience by providing homeowners with power during utility outages • Distributed generation and storage contribute to power grid stability, reducing likelihood of service disruptions
Significant amendments: • Deletes Simulated Building Performance Compliance Path, making the ERI Path the only remaining performance pathway • Adds new Passive House Building Certification Option • Increases performance requirements for fenestration, doors, floors, and crawlspaces • Improves mitigation of air leakage and thermal bridging • Boosts performance of HVAC systems through efficiency, right-sizing, and balanced ventilation. Less efficient equipment can still be used, but additional	Significant amendments in addition to those in Efficient Homes: • Promotes Passive House and ERI compliance by limiting prescriptive compliance for large buildings and requiring additional efficiency credits for all projects, with further credits required for projects that install non-heat pump or lower-efficiency HVAC and water-heating equipment • Further amends insulation and fenestration requirements to maximize building envelope performance • Reduces air leakage to minimize infiltration and exfiltration through building envelope.	Significant amendments: • Removes prescriptive compliance path; establishes performance requirements with mandatory provisions based on Advanced requirements not captured in modeling processes • Uses Home Energy Rating System index (HERS; a higher-quality ERI) or carbon index (CO_2e) to evaluate compliance for all-electric buildings and requires use of CO_2e index for mixed-fuel buildings • Incorporates embodied carbon considerations, low GWP products, or whole-building life-cycle assessment

energy use must be offset with additional energy efficiency credits. • Locates ductwork within conditioned space, with exceptions, and strengthens duct insulation requirements • Supports efficient water heating through equipment performance, demand management, and compact and better insulated distribution systems • Strengthens lighting efficacy and controls • Future-proofs homes for cost-efficient upgrades to HVAC, water heating, and cooking appliances, electric vehicle charging access, and solar systems	• Mitigates heat loss through above-grade wall assemblies with additional thermal bridge mitigation strategies not required by Efficient Homes • Promotes use of highly efficient heat pumps for HVAC and water heating • Requires balanced mechanical ventilation with heat or energy recovery (ERV/HRV) in Climate Zones 4–8, extending the Efficient Homes requirement to cover 4A and 4B • Addresses efficient pool and spa heating • Adds an optional combined ERI and carbon index metric to the ERI path • Offers several new additional efficiency measures for earning credits, such as energy-efficient appliances and embodied carbon reduction	• Requires installation of solar panels, or purchase of renewable energy credits (several specific options are provided) to help meet performance requirements • Incorporates electric battery energy storage systems • Requires charging infrastructure for electric vehicles

Key Features and Design Approach of the Coalition Codes

While Table 2 summarizes the major differences in stringency across the three code tiers, the following sections describe how the coalition structured the pathway to get from the 2024 IECC to annual net-zero-energy and -carbon performance. The discussion begins with the progression of prescriptive requirements from Efficient Homes to Advanced, followed by the performance compliance pathways and the Net-Zero framework.

Prescriptive progression from Efficient Homes to Advanced. The Advanced code builds upon the Efficient Homes (EH) code, retaining most EH requirements while adding or modifying measures to achieve higher energy performance. The following sections describe how the prescriptive compliance path evolves across key building systems and other major code requirements.

Envelope and air leakage. The coalition codes progressively strengthen building envelope requirements as a primary strategy for reducing heating and cooling loads.

EH aligns with the envelope requirements of the DOE Zero Energy Ready and ENERGY STAR New Homes programs, requiring more stringent insulation and window performance than

the 2024 IECC in many climate zones as well as more stringent air leakage limits. EH also establishes a thermal envelope backstop by requiring compliance with the envelope UA provision in the prescriptive path in either the 2021 or 2024 IECC. This provision permits tradeoffs within envelope components, but it prohibits tradeoffs between envelope and other measures such as HVAC equipment or renewable energy systems.

The Advanced code further increases envelope performance through lower U-factors and additional thermal bridge mitigation requirements. Depending on climate zone and building type, prescriptive envelope performance exceeds that of the 2024 IECC by approximately 5–15%. The Advanced code also reduces allowable air leakage rates by roughly 10% relative to EH and by 35–50% relative to the 2024 IECC.

HVAC systems. The coalition codes establish increasing levels of performance for space-conditioning systems while emphasizing high-efficiency equipment and improved indoor air quality. EH adopts the equipment efficiency requirements of the ENERGY STAR program, while Advanced further increases efficiency thresholds for heating and cooling equipment, strongly encouraging the use of electric or gas heat pumps. Alternative compliance pathways are available for EH and Advanced projects installing lower-efficiency equipment through the performance path or by achieving additional energy efficiency credits. The required credits are structured to offset the additional energy use of the lower-efficiency equipment.

To support future electrification, buildings that do not install heat pumps for space-conditioning must be heat-pump ready, with electrical infrastructure provided to facilitate future equipment replacement. Electric resistance is prohibited in Climate Zones 2 through 8 except for limited applications.

The codes also emphasize efficient air distribution and ventilation systems. All heating and cooling distribution ducts and air-handling equipment must be located within the conditioned space, with minimal exceptions. Balanced mechanical ventilation with heat or energy recovery (ERV/HRV) is required under EH in Climate Zones 4C and 5 through 8; Advanced expands this requirement to include Climate Zones 4A and 4B and increases the minimum sensible energy recovery (SRE) requirements for smaller systems. Additionally, all homes and dwelling units must comply with the indoor air quality requirements of EPA Indoor AirPLUS in all three codes.

Water heating. The coalition codes progressively strengthen both hot water distribution system performance and water-heating equipment efficiency. Relative to the 2024 IECC, EH adds enhanced water heater efficiency requirements based on the ENERGY STAR program, as well as requirements for grid-integrated water heating, increased pipe insulation, compact water distribution systems, advanced demand-controlled recirculation controls, and low-flow fixtures. These provisions are intended to reduce both water-heating energy consumption and water waste while adding the ability of water-heating systems to respond to grid conditions.

The Advanced code retains most of these distribution requirements while increasing minimum efficiency thresholds for water-heating equipment. One- and two-family dwellings and townhouses are prescriptively required to install heat pump water heaters (although these can be offset by earning additional energy-saving credits). Multifamily buildings must meet elevated minimum efficiency levels for both unitary and central water heating systems that strongly encourage the use of heat pumps.

Alternative compliance pathways remain available under both codes for projects installing lower-efficiency equipment through the performance path or additional energy

efficiency credits; however, as with space-conditioning equipment, the required credits are structured to offset the additional energy use associated with lower-efficiency equipment.

Lighting, electrification readiness, and renewable energy. The coalition codes include provisions intended to reduce lighting energy consumption, support future electrification, and prepare buildings for renewable energy and electric vehicle adoption. Relative to the 2024 IECC, both EH and Advanced strengthen lighting requirements by requiring near-universal installation of high-efficacy lighting with only minimal exceptions. Automatic lighting controls are also expanded in multifamily common areas and building exterior spaces.

Both EH and Advanced emphasize electrification readiness. Buildings that install fossil-fuel-fired space-heating, water-heating, or cooking equipment must include electrical infrastructure to facilitate future conversion to electric alternatives. These requirements are intended to reduce the cost and complexity of future electrification.

Buildings must also meet PV-ready requirements and install EV-charging infrastructure (e.g., conduit, wires, and circuit breakers) to support future electric vehicle charging. The Advanced code further strengthens EV-readiness requirements by requiring electrical service capacity sufficient to support Level 2 charging for at least one parking space per dwelling unit, or for all parking spaces provided, whichever is less.

Additional energy efficiency credits. Both EH and Advanced retain aspects of the additional energy efficiency credit framework included in 2024 IECC but modify it to align with the requirements of each code. Because many measures that qualify for credits under the 2024 IECC become mandatory in EH and Advanced, the list of available credits is updated and the credits made more stringent in some cases.

Under Advanced, all projects must achieve at least 10 efficiency credits, consistent with the requirements of the 2024 IECC. Additional credits are required for homes larger than 4,000 square feet and for projects that install heating, cooling, or water-heating equipment with efficiencies below the code's prescriptive requirements. The code reduces the size threshold from 5,000 square feet in the 2024 IECC to 4,000 square feet to discourage excessive energy use associated with very large homes.

EH uses a similar framework but eliminates the baseline requirement for all projects to achieve 10 credits. Credits are required only for homes larger than 4,000 square feet and for projects that install lower-efficiency equipment. This approach reflects the fact that many measures that would earn credits under the 2024 IECC become mandatory under EH.

In both codes, the additional energy efficiency credit framework serves two functions: encouraging the adoption of advanced efficiency measures and offsetting the additional energy associated with larger homes and equipment that does not meet the codes' prescriptive efficiency levels.

Performance compliance in Efficient Homes and Advanced. Both EH and Advanced include performance-based compliance pathways using the ERI.[2] The EH code establishes a maximum ERI of 42 for homes that use fossil fuels for any end-use, 45 for all-electric homes, and 48 for homes with qualifying on-site solar systems. Different ERI targets are used to reduce compliance advantages associated with mixed-fuel homes under the ERI methodology and to better align overall performance outcomes across fuel types. As a result, mixed-fuel buildings are assigned a lower ERI target, while all-electric homes and homes with on-site solar are permitted somewhat higher ERI values.

Advanced further reduces the allowable ERI values to 35 for mixed-fuel homes, 38 for all-electric homes, and 41 for homes with qualifying on-site solar systems. These lower targets reflect the substantially higher efficiency requirements of this tier. The Advanced code also introduces an optional combined ERI + CO_2e performance pathway that evaluates both energy performance and modeled operational greenhouse gas emissions. Under this combined approach, projects must comply with both an ERI target and a CO_2e index target, providing a mechanism for incorporating emissions considerations directly into performance-based compliance. For homes that meet both ERI and CO_2e, the required index values are slightly higher since both indexes must be met.

Net-Zero performance framework. The Net-Zero code moves to a performance-only code, eliminating the prescriptive compliance path. Mandatory provisions from the Advanced code that are not captured by the ERI and CO_2e modeling methodologies are carried forward into the Net-Zero code to ensure they remain enforceable. Compliance is determined using two performance evaluations that must both be met. First, the dwelling must achieve the maximum HERS or CO_2e Index without considering on-site solar, ensuring that the building itself is highly efficient (HERS is a type of ERI with specific certification and quality control requirement; its use is required for Net-Zero). Second, after meeting this first requirement, the project must install sufficient on-site solar to reduce the applicable index to zero. Where adequate on-site solar is not feasible, the code allows limited alternative compliance options to reduce any remaining shortfall between the calculated index and zero. Performance targets are summarized in Table 3. The maximum indices without on-site solar are the same as the Advanced performance path.

Table 3. Maximum performance index values under the Net-Zero code

Compliance path	Maximum index without on-site solar		Maximum index with on-site solar
	Mixed fuel	All-electric	
HERS index	NA	38	0
CO2e index	41	41	0

Notes: For the Net-Zero code, the HERS index is required. HERS is a form of ERI, but with specific certification and quality control procedures. Homes using fossil fuels must use the CO_2e Index.

[2] ERI targets were established based on modeling of homes complying with the prescriptive requirements of each code tier, with additional adjustments to account for fuel type and qualifying on-site solar systems.

In addition to the performance targets, the Net-Zero code includes several new or expanded mandatory provisions not included in the Advanced code that support long-term decarbonization, including energy storage, electric vehicle charging, and embodied carbon requirements. These additional provisions are described below.

Energy Storage: For homes with on-site solar, the code requires 2 kilowatt-hours (kWh) of storage capacity per kW of installed solar capacity. This improves resilience, supports the electric grid, and increases the value of on-site renewable generation.

Electric Vehicle Charging: Expands the EV charging requirements from the Advanced code by increasing the amount of required EV charging infrastructure. Requirements vary by parking configuration, with separate requirements for private, assigned, and unassigned parking. This ensures that new residential developments are better prepared to support widespread electric vehicle adoption.

Embodied Carbon: The code provides four options for achieving moderate reductions in embodied carbon relative to common new construction; one of these options must be chosen. The four options are (1) a table of prescriptive options of which builders must pick two; (2) requirements for carbon emissions per unit volume for concrete and insulation, with the specified values 25% below average materials; (3) conduct a carbon life-cycle assessment with maximum embodied carbon emissions per square foot of conditioned floor below a specified ceiling; or (4) meet specified building reuse requirements. While the ERI and CO2e Index primarily address operational performance, these embodied carbon requirements reduce emissions associated with the production of major building materials.

For projects that cannot install sufficient on-site solar to achieve an ERI or CO_2e Index of zero, the code also establishes limited alternative compliance options. These options are available only after a project has maximized its on-site solar installation potential. In these cases, projects may address the remaining shortfall through one or more of the following approaches:

- Contract for renewable energy from a qualifying community renewable energy facility sufficient to address the remaining shortfall. “Community” means located within the same county, an adjacent county, or within 60 miles of the building site.
- Contribute to a low-income household solar fund designated by the adopting jurisdiction. Contributions must equal at least $5 per watt of the remaining solar generation shortfall.
- Projects may earn 5 HERS or CO2e points by exceeding the mandatory embodied carbon requirements. Compliance is demonstrated through one of three options: (1) meeting more items on the prescriptive checklist than is mandated, (2) conducting a whole-building life-cycle assessment, or (3) meeting a specified emissions ceiling per unit volume for concrete and insulation that is tighter than the mandatory requirements.

Feasibility and Market Readiness

Although the coalition codes establish performance levels that exceed current model energy codes, they are not based on untested concepts. Each tier draws on existing programs,

standards, and real-world experience that demonstrate the technical feasibility of these performance levels. Over 100,000 homes are already being built to performance levels comparable to the EH code, and several thousand have achieved performance levels approaching the Advanced code.

Preliminary analysis also suggests that the codes can be implemented with manageable cost impacts, and initial outreach demonstrates that the codes may be attractive to jurisdictions seeking pathways beyond the 2024 IECC.

Existing Market Experience

DOE Zero Energy Ready Homes and Efficient New Homes certifications now represent a meaningful share of the new construction market. From 2022 to 2024, a total of 61,053 homes were certified through the programs (Energy and Environmental Building Alliance 2025). In 2025, an additional 83,427 homes were certified, bringing the total to more than 140,000 homes. With 1.36 million housing starts in 2025 (NAHB 2026), Efficient New Homes certifications represented approximately 6% of annual housing production in 2025.

Though the market for homes achieving Advanced levels of performance is smaller, thousands of projects have already demonstrated the feasibility of comparable approaches. Phius is the closest analog to the Advanced code's performance levels, and Positive Energy (2026) reports over 3,300 certified housing units and roughly 4,000 additional projects in pre-certification status. Because the coalition's Advanced code has fewer requirements than the Phius standard, it is likely that higher numbers of homes have been built to Advanced levels of performance without pursuing formal certification.

Data on Net-Zero level homes are less readily available. The Energy and Environmental Building Alliance's "Inventory of Zero" identified 67,000 units in 2022, although this figure combines both zero-energy and zero-energy-ready homes and includes projects under construction. Despite these limitations, the inventory suggests the existence of a substantial market for very-high-performance and net-zero housing.

Preliminary Costs and Savings

Comprehensive cost-effectiveness analyses are currently underway and will provide a more rigorous assessment of construction costs and energy savings. Until those results are available, the discussion below is intended to provide an illustrative comparison of the three codes based on publicly available information and a number of simplifying assumptions. Details of this analysis are summarized in an appendix at the end of this paper. Results of this analysis are provided in Table 4. Two of the codes (EH and Net-Zero) offer modest reductions in annual carrying costs, while the Advanced code is approximately breakeven on net annual cost relative to a typical home (net cost of about $3 per month).

Table 4. Approximate typical annual cashflow of homes built to coalition codes

Code	Incremental cost	Additional annual mortgage payment	Energy savings	Annual energy bill savings	Net annual cost savings
Efficient homes	$ 5,000	$ 377	22%	$ 564	$ 187
Advanced	12,000	906	34%	868	(37)
Net-Zero	31,313	2,363	100%	2,518	155

Notes: Costs and percentage energy savings are discussed in the appendix. Base new home energy use for new homes constructed 2016-2020 as reported in EIA 2024b. Mortgage costs assume a 30-year mortgage at 6.36% (Freddie Mac 2026). Energy bill savings based on Feb. 2026 average residential electric rates of $0.1765 per kWh (EIA 2026a) and 2025 average residential natural gas rates of $1.53 per 100 cubic feet (EIA 2026b).

Adoption Potential and Implications for Future Residential Code Development

Initial outreach suggests that the coalition codes may fill an important gap between current model codes and long-term state and local energy and emissions goals. Because many leading states are currently focused on adoption of the 2024 IECC, it is unlikely that these codes will be considered for immediate adoption. However, several states with stretch codes and advanced energy policies have expressed interest in incorporating elements of the coalition codes into future updates.

The codes may also provide a framework for utility and state new construction programs and other efforts intended to support jurisdictions seeking pathways to go beyond statewide minimum requirements. The coalition plans to provide technical assistance to states and other jurisdictions over the next several years to support consideration of these code-based approaches in future development and adoption processes.

More broadly, the coalition's work offers several lessons for future residential code development:

- States can collaborate to develop advanced codes outside national model-code cycles.
- A tiered pathway may be more adoptable than a single leap to net-zero.
- Existing above-code programs and policies (DOE Efficient New Homes, Phius, state stretch codes) provide a foundation for future code development.
- Advanced residential codes can continue to evolve; this project demonstrates a mechanism for continued code advancement toward energy efficiency and affordability even if model-code development slows, fragments, or becomes less ambitious.

Conclusion

Residential energy codes have made substantial progress since 1980. The average energy use of homes built to modern codes is roughly half that of homes built under earlier model energy codes. Achieving further reductions in energy use, energy costs, and emissions will require continued, intentional advancement toward net-zero-energy or net-zero-carbon performance. The Next Generation Codes Coalition has developed a three-step framework to support that transition through a series of increasingly ambitious but technically feasible codes. Drawing on existing programs, leading state policies, and demonstrated market experience, the coalition codes represent a practical pathway for advancing residential building performance beyond current model codes. Critically, the potential impacts of this work demonstrate how states can play a more active role in shaping their energy codes to meet their needs by collaborating to develop and refine advanced energy code provisions that support their long-term energy, affordability, and emissions-reduction objectives.

References

ASHRAE. 2022. *ASHRAE Position Document on Building Decarbonization*. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers. www.ashrae.org/file%20library/about/ashrae_building_decarbonization_pd_2022.pdf.

DOE. 2025. "Estimated Model Energy Code Improvement." Building Energy Codes Program. Washington, DC: DOE. www.energycodes.gov/infographics.

_____. 2026a. "DOE Efficient New Homes Single Family National Program Requirements Version 2 (Rev. 3). Washington, DC: DOE. www.energy.gov/sites/default/files/2025-10/DOE%20Efficient%20New%20Homes%20Single%20Family%20Version%202%20%28Rev.%203%29%20National%20Program%20Requirements%20%281%29.pdf.

_____. 2026b. "Building Energy Codes Program, Status of State Energy Code Adoption, Residential Buildings." Washington, DC: DOE. www.energycodes.gov/state-portal.

_____. 2026c. "DOE Efficient New Homes DOE Efficient New Homes Program FAQs." Washington, DC: DOE. www.energy.gov/cmei/buildings/doe-efficient-new-homes-program-faqs . Visited June 18, 2026.

EIA [Energy Information Administration]. 2024a. "2020 RECS Survey Data, Housing Characteristics Tables." Washington, DC: EIA. www.eia.gov/consumption/residential/data/2020/#squarefootage.

_____. 2024b. "2020 RECS Survey Data, Consumption and Expenditure Tables." Washington, DC: EIA. www.eia.gov/consumption/residential/data/2020/index.php?view=consumption.

_____. 2026a. "Electricity Monthly Update, End Use: February 2026." Washington, DC: EIA. www.eia.gov/electricity/monthly/update/end-use.php.

_____. 2026b. "U.S. Price of Natural Gas Delivered to Residential Customers." (used 2025). Washington, DC: EIA. www.eia.gov/dnav/ng/hist/n3010us3a.htm.

Energy and Environmental Building Alliance. 2022. *Inventory of Zero in the US and Canada*. www.sips.org/documents/EEBA-Report-Inventory-of-Zero-in-the-US-and-Canada-2022.pdf.

_____. 2025. "Exponential Growth for the Zero Energy Ready Home Program." EEBA's High Performance Home Blog. www.eeba.org/exponential-growth-for-the-zero-energy-ready-home-program-1.

Energy Sage. 2024. "How Much Solar Power Can My Roof Generate? www.energysage.com/solar/how-much-solar-power-can-my-roof-generate/.

_____. 2026. "Solar panel cost in 2026: It may be lower than you think." April. www.energysage.com/local-data/solar-panel-cost/.

FRED [Federal Reserve Economic Data]. 2026. "Median Sales Price for New Houses Sold in the United States." Used March 2026. fred.stlouisfed.org/series/MSPNHSUS.

Freddie Mac. 2026. "Mortgage Rates" (as of May 14, 2026). Washington, DC: Federal Home Loan Mortgage Corp.. www.freddiemac.com/pmms.

ICC [International Code Council]. 2021. *2018 International Energy Conservation Code*. www.codes.iccsafe.org/content/IECC2018P5/chapter-4-re-residential-energy-efficiency#IECC2018P5_RE_Ch04_SecR406.

_____. 2024. *2024 International Energy Conservation Code*. www.codes.iccsafe.org/content/IECC2024P1.

_____. 2026. "2030 IECC®/IRC Chap. 11/IECC Expanded (IECCX), Scope & Intent, Public Comment Responses."

Lynch, E. 2025. "Cost of Constructing a Home-2024." www.nahb.org/-/media/NAHB/news-and-economics/docs/housing-economics-plus/special-studies/2025/special-study-cost-of-constructing-a-home-2024-january-2025.pdf?rev=00a42a1ce63b4a22a4dba9bda8af954b.

NAHB [National Association of Home Builders]. 2026. "Overall Housing Starts Inch Lower in 2025." www.nahb.org/news-and-economics/press-releases/2026/02/overall-housing-starts-inch-lower-in-2025.

Phius. 2024. "How Much Do PHIUS Buildings Cost." www.phius.org/sites/default/files/2024-02/Phius%20Multifamily%20Cost%20Data.pdf.

_____. Undated. "Zero Energy & PHIUS+ Certifications." www.phius.org/sites/default/files/2022-04/031220_Zero_Energy_PassiveHouseCrosswalk_PHIUS.pdf.

Positive Energy. 2026. "Phius Market Penetration in the U.S.: A Comparative Analysis with Typical Code-Built Houses." www.positiveenergy.pro/building-science-blog/2025/5/26/phius-market-penetration-in-the-us-a-comparative-analysis-with-typical-code-built-houses.

RESNET. 2021. “Demand for HERS® Ratings Grows by 24% in 2020.” www.resnet.us/articles/demand-for-hers-ratings-grows-by-24-in-2020/.

Ungar, L., and S. Nadel. 2025. “The 45L Tax Credit for New Energy-Efficient Homes Has Been Exceptionally Effective.” Washington, DC: ACEEE. www.aceee.org/sites/default/files/pdfs/the_45l_tax_credit_for_new_energy-efficient_homes_has_been_exceptionally_effective.pdf.

Appendix: Cost-Effectiveness Analysis Assumptions

Efficient Homes. The EH code generally requires an ERI of 45. We use as our base an ERI of 58, which was the average new home in 2020 that was rated by RESNET (RESNET 2021). This base is similar to the required ERI for homes using the ERI Path under the 2018 IECC (ICC 2021). The 2018 IECC is approximately the median residential code in the U.S. (DOE 2025b). An ERI of 45 reduces energy use approximately 22% relative to this base.[3] DOE (2026c) estimates the cost premium for a manufactured home under its Efficient New Homes program is less than $5,000. In 2025, homes certified under DOE’s Efficient New Homes program were eligible for a $5,000 federal tax credit and over 50,000 manufactured homes and over 30,000 single-family homes and multifamily apartments were certified, implying the tax credit was sufficient to cover builder costs.

Advanced. For Advanced, absent other data at present, we use data on Phius homes as a proxy. Our Advanced code just includes key items from Phius so it is likely that the costs of meeting Phius overestimate the costs of meeting this code. Data from Phius show examples of incremental costs of 1–4% and note that costs go down as designers and builders gain experience. As an approximate estimate, for our illustrative analysis we use a 3% cost premium and apply it to an average cost for a new home of $400,000,[4] for an incremental cost of $12,000. The Advanced code is based on an ERI of 38, which is 34% energy savings relative to our base home, as discussed in the prior section.

Net-Zero. For our Net-Zero analysis, we take the costs of the Advanced code and add the costs of a solar system to meet all energy use over the course of a year. We start with data on Phius home average energy use of 16.7 British thermal units (Btu) per square foot of floor area (from measured data on 18 projects; Phius undated), convert to kWh (3,412 Btu/kWh) and apply to an average-size of the newest homes and apartments of 1,996 sq. ft. from EIA (2024a). This yields an average home energy use of 9,769 kWh per year. We assume a typical solar system produces 1.3 kWh annually per watt of rated capacity (Energy Sage 2024), resulting in a 7.5 kWh system. At an average cost of $2.57 per watt (Energy Sage 2026), the system will cost $19,300. This analysis ignores interactions between the home and the utility grid. With net metering, some solar systems can make money. But if the price the utility pays for excess kWh is low, there will be additional costs from purchasing some power from the utility.

[3] (58-45)/58 = 22%.

[4] The Federal Reserve notes a median sales price of $387,000 for new homes in March 2026 (FRED 2026). The National Association of Home Builders estimates a new home construction cost of $428,000 (NAHB 2024). We use $400,000 as a round number between these two figures.