One Energy Code After Another: Barriers to Zero-Carbon New Construction

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ABSTRACT

As jurisdictions pursue building decarbonization through diverse policy mechanisms, strong and enforceable energy codes remain a cornerstone of efforts to ensure that new construction aligns with a zero-carbon future. This paper presents a study of the key impediments that threaten progress toward this alignment and the continued progress of codes. We classify these impediments into five categories: (1) Political Challenges, (2) Technical Feasibility, (3) Economic Landscape, (4) Code Development Methodology, or (5) Code Compliance. The challenges included in this paper were identified through a review of the development of multiple national model codes, state and local energy codes, state and local above-code standards, existing literature, stakeholder interviews, and the direct experience of the authors. Examples of challenges covered by this paper include political variation in the appetite for electrification mandates, rising electricity costs relative to fossil fuels, and the growing complexity of energy code structures and requirements. Other examples include tradeoffs among high-performance envelopes, zero-emissions mechanical equipment, and on-site energy generation and storage, as well as the practical ability of code officials to understand and enforce increasingly complex requirements. The paper reviews examples and the impact of each challenge as well as emerging strategies for policymakers to advance energy codes that keep new buildings on track toward a zero-carbon future.

Introduction

New construction represents one of the best opportunities to address building emissions from operation in a technically feasible and low-cost manner with impacts lasting on the order of multiple decades up to a century (Aktas and Bilec 2012). Over the lifetime of a building, building operation can result in 250% more GHG emissions than embodied emissions; this ratio closes as building energy codes improve operational performance and move towards lower emissions systems and technologies (WorldGBC 2019; Lewis et al. 2021).

Heating, cooling, water heating, lighting, and plug loads tend to be the building end uses that drive GHG emissions in new construction. Emissions tied to these end uses vary widely by building type, location, fuel use, and other efficiency indicators; in general, a substantial source of emissions in buildings is space heating use, followed by cooling and water heating, although plug loads make up more of newer buildings' emissions than older buildings (EIA 2018; EIA 2020). Heating, cooling, water heating, and lighting are the end uses most easily regulated in new construction, and energy codes are the key policy mechanism for regulating these. This paper focuses primarily on the past and future of energy code progress.

Fuel choice, particularly for heating and water heating, along with envelope insulation, air tightness, and mechanical design and efficiency, significantly affects lifecycle GHG impacts. Occupant behavior also influences performance but is difficult to regulate through codes and is constrained by building design, construction, and system capabilities.

Challenges to eliminating these emissions stem from political barriers at every level of government, an economic landscape that can discourage decarbonization, convoluted and lengthy code development processes, and workforce and compliance gaps. However, progress is being made through increasing economic viability of renewable energy, jurisdiction policies that complement energy codes, and more streamlined code and compliance processes. Eliminating emissions from new construction should be one of the more straightforward decarbonization opportunities, but key challenges remain on the path to zero-carbon new construction nationwide. This paper's scope covers residential and commercial buildings and end uses but not industrial process loads.

Methodology

To analyze current challenges and potential solutions facing zero-emissions codes and standards, this report combines a review of available literature on codes and standards implementation with first-hand experience contributing to and analyzing model, state, and local codes, drawing on:

1. Model codes including IECC, ASHRAE 90.1, ASHRAE 90.2, and ASHRAE 189.1; past, current, and future versions were reviewed.
2. State and local energy codes, including ECCCNYS, California Title 24 Part 6, NYStretch-Energy Code, Illinois Stretch Energy Code, and Fort Collins Energy Code.
3. State and local laws and policies, including mandates on local pollutants, fuel bans, distributed energy resources, and performance standards.
4. Federal appliance standards and energy policies.
5. DOE and EPA code resources and research.
6. Cost-effectiveness analysis and research for energy codes, including DOE methodology and cost-effectiveness reporting for the codes above.
7. Legal proceedings, analysis, and reporting on the codes and policies listed.

The authors used these sources and experience to highlight critical areas of decarbonization impedance at all levels of governance, then present relatively novel but well-vetted opportunities for addressing or avoiding these hurdles.

Results

Political Challenges

Codes and standards face political challenges at every level of government, which leads to slow adoption, inconsistent implementation, and unintended outcomes.

Influence of Executive Partisanship on National Lab Activities: Building efficiency is not mandated by federal law, but the federal government still strongly influences model code development and local adoption: DOE's national labs (PNNL and ORNL) provide critical support for developing the IECC and ASHRAE 90.1, support that administration changes can disrupt, creating an unstable landscape.

As energy codes have grown more complex, energy modeling, whether used to determine targets, performance factors, or optional energy credit values, has become an increasingly important part of code development. However, with over $200 million in recent funding cuts to PNNL, the timeline or ability to produce this modeling may be undercut (Wu and Smith 2026), and national lab staff participation in ASHRAE, historically robust, has been paused, adding further instability. During administrations that limit national lab resources, codes requiring less modeling and fewer development iterations, such as some performance-based codes, may help maintain progress toward carbon neutral codes.

Federal Preemption: A further constraint on model code improvement is federal preemption under the Energy Policy and Conservation Act (EPCA), which sets a nationwide floor of appliance efficiency standards and limits states and localities from directly requiring equipment to exceed those minimums or mandating a specific fuel source (10 C.F.R. § 431.26). The Department of Justice's willingness to enforce this limit against noncompliant state and local codes can also expand or contract with each administration's priorities, pushing jurisdictions toward indirect strategies, such as emissions thresholds, point-based compliance pathways, and zoning incentives, to advance decarbonization without triggering preemption. These approaches can work but add complexity and can limit the reach of new energy codes. To address preemption without an executive or legislative act, performance-based energy codes will encourage efficient electric equipment while still technically allowing any fuel type.

State and Local Resources, Opposition, and Conflicts: States typically hold primary authority for adopting energy codes but sometimes defer adoption and enforcement authority to local jurisdictions. Energy codes are one of the more politically popular mechanisms for building decarbonization at the state and local level, but support is highly split by partisanship (Dorsey-Palmateer et al. 2026). The resulting political negotiations mean many states either: (1) do not adopt the most recent code cycles, (2) adopt but do not adequately enforce them, or (3) adopt them with less stringent amendments.

At the local level, many of the same state- and federal-level challenges are compounded by resource constraints or barriers stemming from local laws, organizational structures, or socioeconomic factors. Meanwhile, jurisdictions with sufficient political consensus and resources have succeeded in advancing codes and local laws that improve energy efficiency, add requirements for decarbonization measures such as on-site renewable generation and storage or EV charging infrastructure, or effective gas bans, such as the City of Ithaca's energy code, a bespoke improvement over the state code that heavily encourages high-performance envelopes and heat pump installation (City of Ithaca 2023). However, some of these policies have resulted in legal cases, as with Berkeley's "gas ban" (California Restaurant Association v. City of Berkeley 2023). Other policies have caused conflicts when jurisdictions adopt an energy code that regulates a component already covered by local law, such as NYC's Local Laws 92/94 mandating rooftop solar or green roofs while some model codes consider a different mandated amount in the prescriptive path.

To address energy codes clashing with state and local priorities and resources, the focus should be on developing streamlined and flexible codes in collaboration with state and local governments. In practice this means model code bodies such as ICC and ASHRAE building modular, opt-in provisions for measures like on-site renewable generation and EV charging directly into the base code, rather than leaving states to draft one-off amendments each cycle, as New York and other states have had to do.

Economic Challenges

One reason for the political challenges is the popular notion that energy codes and decarbonization policies increase costs, as noted in a recent DOE press release about the 2024 IECC (DOE 2026). This is tied to debates over how codes are evaluated for costs. Costs associated with energy codes can stem from additional materials or better equipment, but also from lack of market availability or unfamiliarity with newer technologies, such as heat pump water heaters, and strategies, such as continuous insulation, among builders and installers. Fuel prices also significantly impact code cost-effectiveness but are hard to predict over a building's lifetime and can vary widely by region, building type, and time of use.

Code Cost Effectiveness: Model energy codes are unique among building codes in being required to demonstrate cost-effectiveness. Fire, structural, and life-safety codes are adopted without economic analysis; their justification is protecting building assets and occupants. Sprinkler systems and fire-rated egress stairs, for example, need not prove cost-effectiveness to be required. This does not mean life-safety requirements are immune to economic and political negotiation, but the expectation that a building must be safe is a given. Energy codes are treated differently: because energy is directly measurable in dollars, efficiency proposals are typically evaluated on simple payback or life-cycle cost and rejected if they miss that threshold, even when they deliver other benefits, such as improved resilience during extreme weather. These metrics generally capture only energy cost savings and first costs.

This framing excludes broader impacts. Energy use drives emissions, which drive health and climate costs. The COGfx (cognitive function) Study at Harvard links indoor air quality and ventilation to cognitive performance and productivity (MacNaughton et al. 2017); fossil fuel combustion drives outdoor air pollution costs estimated in the billions annually (Buonocore et al. 2021); climate change amplifies economic risks through extreme weather, infrastructure damage, and lost productivity (Bilal and Känzig 2024). Energy codes, then, are not just about utility savings; they are a health and life-safety measure with real economic implications.

Current cost-effectiveness methodologies for model code assessment do not account for these externalities, focusing instead on first costs and energy savings. Other codes are often adopted without a comparable cost-effectiveness requirement. PNNL's methodology includes appendix guidance on monetizing "advanced" benefit flows, such as avoided emissions, health impacts, and resilience impacts (Salcido et al. 2024), but these benefits are not yet incorporated into model code evaluation or by most states.

Energy codes are also scrutinized for cost during state and local adoption, sometimes regardless of demonstrated cost-effectiveness: California’s Assembly Bill 130 places a six-year moratorium on updating the residential building standards to limit upfront construction costs, despite previous energy codes showing net bill savings (Cal. Assembly Bill 130 2025). Home-price affordability concerns are often attributed to construction costs, though price increases are more closely tied to land costs and demand (Weinberg 2026). Energy codes also function as consumer protection: buyers generally cannot assess at purchase whether a building will be costly to operate, and energy codes reduce that risk.

A few states have taken it upon themselves to account for other benefit flows in their cost-effectiveness analyses, including New York State's energy code cost effectiveness criteria, which was updated in 2024 (NYSERDA 2024). Several states already incorporate expanded accounting on the utility side: Maryland and Connecticut have replaced their default cost-effectiveness test with a jurisdiction-specific test based on the National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources, which incorporates health, equity, and decarbonization goals alongside energy savings (Woolf et al. 2020; NEEP 2022). Model energy code methodology has not adopted an equivalent framework, but this precedent suggests one would be administratively feasible.

Costs and Market Readiness of High Efficiency Low Carbon Design: The actual cost to construct a well-insulated, all-electric building remains up for debate; studies vary widely on which costs are incremental, which are avoided, and what design changes are necessary. A New Buildings Institute study found an all-electric single-family home about $8,000 cheaper to build than a fossil-fuel baseline home when factoring in avoided gas infrastructure costs, while a Home Innovation Research Labs study commissioned by the National Association of Home Builders found a similar home $4,000 to $15,000 more expensive (NBI 2022; HIRL 2021). The perception of high costs for electrification, which can be driven by studies funded by trade groups such as NAHB with a singular focus on limiting regulation of homebuilding, can be just as detrimental to decarbonization as the reality of high costs. Organized campaigns emphasizing the cost and inconvenience of electrification, regardless of accuracy, have measurably shaped public and legislative opinion on building electrification policy (InfluenceMap 2025). There are, of course, real costs to consider: some advanced efficiency components carry cost step increases, such as double- to triple-pane window upgrades, until thin-triple products become mainstream, though these are sometimes offset by avoided mechanical equipment or gas infrastructure.

The cost of electricity relative to fossil fuels in many regions is another real economic challenge. Electricity costs are rising in many states due to growing data-center demand, transmission and distribution infrastructure costs, and increasingly frequent and severe natural disasters (Levinson 2025). Heat pumps are three to four times as efficient at converting distributed energy into heat as natural gas furnaces, but electricity can cost over four times more per unit of distributed energy than gas in many places (Wilson 2024). Electricity need not cost more than gas, but with fossil fuel still subsidized and renewable tax credits eroding under the current administration, this trend is unlikely to reverse soon. Current global conflict may shift fuel prices substantially, but the long-term impacts are not yet clear. This adds to the political challenge of adopting policies that encourage all-electric new construction.

Developing codes that provide flexibility and clearly affordable pathways to meet stringent requirements while finding ways to encourage utilities to reduce the real cost of electricity and, more specifically, the cost to run heat pumps will be critical to addressing economic challenges to decarbonization.

Code Development Process Challenges

The process of getting from building science theory to an enforceable building energy code has many stages, each with challenges related to competing interests and to the time and complexity of developing the codes.

Shifting Development Approach and Participants: Prior to the 2024 IECC cycle, the IECC had historically been developed using a “code” process, leaving the final determination of provisions to a governmental consensus body of public safety officials. Starting in 2024, the process shifted to a “standards” process, leaving the final decision up to consensus committees appointed by the ICC Board (ICC n.d.-a). However, appeals submitted to the ICC Appeals Board by natural gas industry groups after the code was finalized by the consensus committees sought to remove key decarbonization provisions; the appeals were approved and those provisions were moved to voluntary appendices (ICC 2024). This ability to undercut the consensus committee process introduced uncertainty about the value of participation, and changes to the 2027 IECC scope and intent made clear that decarbonization-only provisions would not be covered going forward (ICC n.d.-b). As the 2030 IECC cycle unfolds, decarbonization efforts may be split across two codes and/or relegated to a secondary code, IECCX, which would not carry the same adoption requirements at state or local levels (ICC 2025). These changes have created uncertainty and setbacks for states interested in adopting a code progressing toward zero-carbon new construction.

Naturally, stakeholder influence is a consistent factor in code development and adoption. Industry groups, trade associations, and advocacy organizations often prioritize competing objectives: affordability, speed of construction, or climate and resilience ambitions. A process that allows special interest groups to hold more power over the code's outcome than residents' representatives and technical experts is a barrier to a code designed for maximum occupant and societal benefit. Any code process with policies limiting special interest groups' ability to undercut it will help, alongside complementary state and local policies targeting specific decarbonization goals. The governmental-consensus process that governed the IECC prior to 2024 is one precedent: it kept the final vote with public officials rather than the industry groups proposing changes, although officials could still be pressured via special interest groups. A more explicit safeguard is ANSI's balance-of-interest rule, which governs standards like ASHRAE 90.1 and requires that no single interest category hold more than a third of a safety-related consensus body, or a majority of any other, with affiliations disclosed so the balance can be checked. Neither eliminates special interest influence, but both are likely more resistant to capture than a process where outcomes can simply be overturned on appeal by a board with no such requirement, as happened with the 2024 IECC electrification provisions.

Development Time Burden and Complexity: During state-level adoption, many states devote considerable resources to modifying model codes to align with the state's political and economic goals. Some jurisdictions prioritize specific efficiency goals, such as high insulation levels, or decarbonization goals, such as on-site renewable generation or EV charging. For example, New York State amended the 2024 IECC to align with its previous voluntary NYStretch code and the Climate Action Council’s Scoping Plan (NY DOS 2024), while Idaho adopted amendments weakening the 2021 IECC (Idaho DOPL n.d.). Beyond the time code officials, state agencies, and national labs spend on model code development, additional time goes to state-level modification, cost-effectiveness evaluation, and adoption, a lengthy, resource-intensive process that duplicates much of the effort already spent on the model code. This is not only time intensive; it is also a period of lost progress, since new construction continues and more emissions are locked in while deliberation runs past initial estimates.

The IECC, beginning with the 2024 edition, also added a section for additional energy credits, developed with support from efficiency advocates trying to improve code efficiency without running up against federal preemption or an overly inflexible prescriptive path. This is a menu of additional efficiency options with corresponding credit values, and buildings using the prescriptive path must meet a minimum credit total in addition to prescriptive requirements. Because enough non-mechanical credit options exist, the credits sections are also permitted to award credit for mechanical efficiency above federal minimum standards. Developing and verifying these credits requires far more energy modeling than earlier prescriptive-only cycles, and industry members have called the resulting menu harder to enforce than a single checklist or modeled performance path, since each option needs its own verification and integrating the system into rater and code-official workflows takes time (Ekotrope 2025). This makes credits sections a more fragile place to locate efficiency gains than the prescriptive path: several jurisdictions, including Pennsylvania, Utah, and Yuma, Arizona, removed the R408 credit section entirely at adoption (NAHB 2026). This suggests pushing improvements through a credits section carries more adoption risk than embedding them in the prescriptive path, where states are less likely to remove individual line items wholesale.

A more streamlined code could reduce this risk; once priorities and performance targets are set, a simpler code can shorten development time, reduce complexity, and lower the burden on local code officials responsible for enforcement.

Code Compliance Challenges

Once the code is in the hands of the officials who enforce it and the builders who must follow it, there are additional challenges related to workforce education, under-resourced staff, and tracking compliance requirements that fall outside typical code scopes.

Strained Code Officials: Every aspect of code development and adoption hinges on enforceability. Jurisdictions hold final enforcement power for the energy code and most related local laws, so local code officials ultimately ensure this progress plays out in new construction. However, code officials nationwide face steep barriers, including limited time and resources, aging staff, and lack of expertise in building energy science. In Tioga County, New York, for example, most code enforcement officers hold multiple part-time positions but spend more time on their duties than the job description indicates, and half the staff were two years from retirement (Riley 2020). An unpublished ICC gap analysis for a DOE grant found that resistance to change, interdepartmental alignment issues, and lack of training create friction in enforcing new tools and more complex codes. Additional resources and training for jurisdiction workforces, plus a more streamlined code and compliance process that integrates automation where feasible, can address this challenge.

Lack of Energy Code and Electrification Fluency: The impact of lagging compliance is measurable: a DOE meta-analysis of residential field studies across seven states found that lack of compliance with duct tightness, envelope tightness, lighting, and insulation requirements had the largest impact on lost savings. Targeted training, classroom, online, circuit riders, and mailers, improved compliance in most states across all measures, yielding annual energy cost savings of 6% to 80% in six of the seven states (Blanding et al. 2022). A parallel DOE study of 230 commercial office and retail buildings found HVAC and lighting controls to be the largest sources of lost savings, with 15% of annual energy costs recoverable through better compliance (Tyler, Huckett, and Hart 2023).

Another challenge is the balkanization created by jurisdictions adopting new and different energy codes and policies: for code officials, designers, and builders working across multiple jurisdictions, varying or conflicting codes and laws can lower compliance rates or increase permitting times (Medina, Berry, and Yamhure 2023).

Builders also have a knowledge gap around some electrification technologies and strategies. The perception of all-electric construction as challenging or premium often stems from limited experience installing heat pumps, especially in colder climates that typically rely on fossil fuel heating. Builders can also resist advanced strategies such as continuous insulation or balanced ventilation with heat recovery. Workforce training will be key to addressing these challenges, alongside marketing electrification as something that benefits occupants and reduces, rather than increases, design complexity.

Renewable Energy Procurement Issues: Zero-emissions code frameworks generally require all building energy to come from on- or off-site renewable sources, and may allow on-site combustion emissions to be offset through additional renewable procurement, retained via Renewable Energy Certificates (RECs) or Energy Attribution Credits (EACs) conveyed to the owner. These requirements create real implementation, enforcement, and compliance challenges. A building code can only regulate conditions at certificate-of-occupancy issuance, while zero-emissions performance is ongoing, and there is no way to guarantee an owner will not later resell the RECs or EACs tied to their procured energy. These requirements can also restrict procurement options, since common financing structures, such as power purchase agreements, leases, and community solar, do not typically convey REC or EAC ownership to the purchaser. This will ultimately require a top-down federal approach to procurement attribution; until then, strict treatment of how codes credit renewable energy will matter.

Opportunities for Progress

While the list of challenges for carbon neutral new construction is daunting, there are still opportunities for success due to political structures and motivation, economic factors, market readiness, co-benefits of high-performance buildings, and expected progress on code development.

Electrification Feasibility and Benefits: Despite some perceptions, all-electric new construction that reduces emissions is currently feasible in virtually all climates and building types and provides tangible benefits to builders and occupants alike. In new buildings, exterior envelopes can support efficient, lower-intensity heat pump usage, especially with variable-speed and/or cold-climate heat pumps. Electricity is also safer, removing combustible gases from living spaces, and induction cooking offers much better indoor air quality at comparable cook times. Costs and labor for installing slightly larger electrical infrastructure are often lower than for gas infrastructure, as reported in the NBI (2022) cost study cited above. Many groups are marketing electrification's benefits, but marketing alone will not close the knowledge gap among those who design, build, and permit buildings; workforce development that reaches builders, contractors, and code officials directly is the real opportunity here, with marketing playing a secondary, awareness-building role.

Low-Cost Renewables: Because the case for building electrification codes rests on electricity becoming cleaner over a building's lifetime, the faster and cheaper the grid decarbonizes, the stronger the emissions case for requiring all-electric new construction today. The federal government affects power generation by setting or removing emissions standards (EPA 2026), but economics remains the primary driver of generation additions and retirements: from 2011 to 2024, renewable generation doubled while fossil generation fell 8% (EIA n.d.). Jurisdictions have also found ways to lower the cost and friction of building renewables directly into new construction, independent of the code's technical requirements. SolarAPP+, a free instant-permitting platform developed by the National Laboratory of the Rockies (NLR) with DOE funding and industry and building-safety-community input, automates code-compliance review for standard residential rooftop PV and PV-plus-storage systems and issues permits immediately for passing projects. NLR found permitting-to-inspection timelines about 31% shorter under the platform, saving a median of 14.5 business days per project and tens of thousands of staff hours across participating jurisdictions (DOE 2024); Tucson's mayor reported permits that once took about a month were being issued the same day after adoption (RMI 2026), and by late 2023, more than 160 communities in 10 states had adopted the platform (DOE 2023a). This shows a substantial share of renewable-building "cost" is administrative rather than technical, a lever states and localities can pull without touching underlying code requirements. This complements code improvements directly: faster local grid decarbonization speeds code progress toward carbon neutrality, and if electricity prices fall as renewables scale, opposition to carbon-neutral codes may ease too.

Limiting New Gas Infrastructure: While jurisdictions are limited in mandating which heating and cooking fuels new construction can use, there are options for removing existing fossil fuel subsidies. Specifically, the "100-foot rule," which in some states provides ratepayer-subsidized free gas hookups to new buildings within 100 feet of a gas transmission line, can be repealed, changing the economics of installing natural gas in homes. Three states (CA, CO, and NY) have already repealed this rule, and more (at least MA, MD, WA, OR, and MN) are in the process of doing so (Earthjustice 2025).

Air Quality Regulation: Jurisdictions can also regulate air quality, which is affected differently by different heating and cooking fuel sources. Fossil fuel-fired furnaces and water heaters release

NO_x and SO_2, which can create $PM_{2.5}$ when released in the atmosphere, causing respiratory and cardiovascular issues; the Bay Area Air District in California recently adopted rules that will limit the sales of furnaces and water heaters that emit NO_x and SO_2, which will effectively require heat pumps to be used in both new construction and replacements of failing gas equipment (BAAQMD 2023).

Performance-Based Codes and Training: One outlet for improving codes without mandating fuel types or efficiencies is performance-based codes. Unlike prescriptive codes, which mandate specifics such as insulation levels or duct locations, performance codes let builders choose whatever design minimizes energy use or emissions, whether through more efficient mechanical equipment, all-electric construction, or otherwise, depending on the metric. Performance codes are common for commercial construction but have not previously been widely used residentially. The residential IECC has a Total Building Performance path and an Energy Rating Index path, but the prescriptive path remains primary for most builders (Karpman and Rosenberg 2021). ASHRAE 90.2, High-Performance Energy Design of Residential Buildings, is performance-based with no prescriptive path and includes mandatory backstops preventing excessive trade-offs between envelope, mechanical, and renewable energy efficiency (ASHRAE and IES 2024). It relies on the same Energy Rating Index metric as the IECC, calculated through ANSI/RESNET/ICC 301, and now also offers an alternative CO_2 Rating Index that evaluates performance based on GHG emissions, better aligning with carbon-neutral priorities (RESNET and ICC 2022). Though not yet adopted anywhere, ASHRAE 90.2 is ready for adoption and, like 90.1, undergoes constant maintenance. It will require training on building energy modeling but remains a promising option for jurisdictions with GHG goals.

Code Compliance Education and Tools: For builders, the energy code alone isn't sufficient education on better carbon-neutral practices, and builders often push back against changing practices. The most effective way to educate builders is to develop training sessions led by other builders and contractors already using all-electric and low-carbon construction practices; this helps build trust while showing proof of concept for what's in the energy code. NYSERDA, in collaboration with an all-electric homebuilder and one of this paper's authors, is currently developing a training course for New York builders on complying with the new energy code using all-electric construction strategies. Contractor-facing electrification guides such as Redwood Energy's Electrification Guide for Large Commercial Buildings, developed with input from builders already practicing all-electric construction, also help (Redwood Energy 2019). For code officials, compliance evaluation is growing more complex as code sections multiply, but the shift toward performance-based pathways brings tools allowing more streamlined, still-comprehensive compliance evaluation. Ensuring compliance with performance-based codes still requires deep understanding of building simulation results, but there may be more opportunities to automate and streamline the process. A research team led by ICC evaluated tools that could benefit building departments at different stages of digitization (ICC 2026).

Building Load Management Technologies and Programs: Building load management technologies address both technical and economic challenges. Already present in code, these systems help operators manage peak demand and cost, shift building use into low-emission generation periods, and offer grid operators flexibility that increases building- and grid-level resilience while opening funding streams for deployment. Realizing this potential requires utilities to provide price and emissions signals through robust demand response programs, which can reliably reduce peak demand and distribution infrastructure needs, provided utilities keep supporting efficient, managed all-electric homes with the right incentives to respond.

Full-Scope Cost Effectiveness Tests: Current cost effectiveness tests fail to capture the full-scope benefits of advanced energy codes, including demonstrated public health, resilience and occupant life-safety, and electricity grid benefits (DOE 2023b). Some are harder to monetize than others, but these are real benefits to owners, occupants, and the public that should factor into policy decisions. Methodology already exists to value these benefits: a multi-lab DOE effort (PNNL, NREL, and Lawrence Berkeley National Laboratory) developed a framework valuing the "passive survivability" of efficient envelopes during extreme heat or cold power outages, using metrics such as Standard Effective Temperature degree-hours, hazard risk, and excess mortality (PNNL 2023). The authors of this paper are building on this research and plan to incorporate it into code evaluations where possible. Other building codes are not subject to any cost-effectiveness tests, so if the energy code must achieve cost-effectiveness, it would at least be consistent to credit it with improvements to critical health and safety outcomes alongside annual energy savings.

Conclusions

The challenges facing zero-emissions codes for new construction vary from individual knowledge gaps to large institutional inertia. Current progress is under threat from shifting federal priorities, a perception that codes hurt affordability, growing code complexity and adoption time, and unfamiliarity with advanced decarbonization strategies among those enforcing codes. However, the end goal for eliminating emissions from new construction is well established, even if the path and pace of getting there remain contested: all-electric buildings with high-performance envelopes and access to carbon-free electricity. These buildings' benefits go beyond emissions reductions to include air quality and health improvements, comfort, and grid demand and resilience benefits, and must be included in the assessment of new proposed codes. Quantifying resilience benefits from energy codes and incorporating them into cost-effectiveness methodologies is an ongoing area of research by the authors of this report. Building all-electric and efficient from the outset also future-proofs buildings against policies like building performance standards or fossil fuel phase-outs that would otherwise require costly retrofits.

States and most jurisdictions can push energy codes further than the model codes, and should consider performance codes, which offer flexibility for efficient all-electric construction while building a network of energy raters that supports jobs and compliance. For jurisdictions that can't adopt more stringent energy codes, improving training and providing more resources for code officials is one of the most impactful strategies to improve building performance.

The opportunities detailed in this paper are only the tip of the spear toward a carbon-neutral buildings sector and economy. These strategies should be considered alongside, and can often complement, additional policies and programs targeting existing building decarbonization, such as building performance standards and upstream heat pump manufacturer incentives. Finally, ensuring universal access to these benefits, through policies targeting rental units, rural homes, and other under-resourced areas, will be critical to building support for carbon-neutral codes.

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AI-assisted Tools: Disclosures and Responsibility

AI-assisted tools used: ChatGPT, Claude.
Used for: initial translation from outline to full sentences for two to three concepts by one author (ChatGPT); rewording for clarity after second draft (Claude).
Extent: minor; no section developed with ChatGPT was left in without major revisions and review.
Human review: The authors reviewed and verified all content, calculations, and citations.