Energy Codes and Affordability

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Abstract

This paper explores the affordability impacts of energy codes in residential construction, focusing on how these codes affect home buyers, renters, and other stakeholders, and provides a better understanding to entities that have the authority to adopt energy codes, and anyone interested in learning how these codes affect affordability.

The analysis includes various metrics for cost-effectiveness—such as life cycle cost, cash flow, and simple payback—drawing on studies from Pacific Northwest National Laboratory (PNNL), US Department of Housing and Urban Development (HUD), and state-level energy programs. Key themes include the advantages of stretch codes, incentives to support code adoption, and the broader policy context that influences housing costs. Special emphasis is given to the impact on renters, highlighting how energy codes can reduce energy burdens for those who often face financial challenges in accessing efficient housing. The paper concludes by discussing future research opportunities to promote awareness and support for energy efficiency, ensuring that advanced energy codes help foster a more equitable housing market.

Checklist for Evaluating the Impacts of Energy Codes on Affordability

Any stakeholder involved in energy code updates, amendments, and the adoption process, such as government agencies at the state and local level (like building and code officials), technical experts, industry professionals (builders, designers, engineers), code development organizations, community representatives, and other stakeholders, can use this checklist to make informed decisions about the impacts of energy codes on affordability.

1. **Review Cost-Effectiveness Analysis:** Review PNNL published energy code cost-effectiveness analysis or reach out to PNNL for a state-specific cost-effectiveness analysis for any code amendments or stretch code provisions.
2. **Select the Appropriate Code Cycle:** If a cost-effectiveness analysis is done independently from PNNL, ensure that the baseline code used in analysis is the currently adopted code. Using the wrong code could artificially deflate or inflate energy savings.
3. **Choose the Best Metric:** When conducting cost-effectiveness analysis use metrics like life cycle costs (LCC) which account for long term costs and savings of energy codes.
4. **Evaluate Future Retrofit Costs:** Consider potential savings by installing efficient equipment and materials during new construction to avoid costly retrofits later.
5. **Assess Medical Cost Savings:** Recognize health benefits, including how improved indoor air quality and energy efficiency can lower health-related expenses.
6. **Analyze the Impact on Energy Bills for Renters:** Determine the impact of advanced energy codes on energy bills for renters. Lower energy bills promote equitable access to efficiency benefits.
7. **Examine Energy Burden Implications:** Evaluate how adopting energy codes can help reduce overall energy burdens by lowering energy costs for all households.
8. **Review Available Incentives:** Investigate federal, state, and utility incentives, such as tax credits or

utility rebates, that can help offset initial construction costs. This financial assistance programs should be incorporated into cost-effectiveness analysis.

9. **Consider HUD and USDA Requirements:** Consider HUD's requirement where all new single-family and low-rise multifamily housing financed through HUD and US Department of Agriculture (USDA) programs must adhere to the 2021 IECC.

Introduction

Energy codes play a critical role in improving the efficiency of residential and commercial buildings. They ensure that new construction meets minimum energy performance standards, which reduces energy consumption and provides long-term financial savings for renters and owners. However, builders and other stakeholders often question the affordability of energy codes. One common argument builders make against energy codes is that they significantly increase the upfront costs of constructing homes, making them less accessible to low-income buyers. This and similar arguments often rely on cost-effectiveness analysis with inflated cost estimates, use the most expensive compliance path, and assume higher profit margins, which create misleading analyses of transitions between much older codes and the current version. For example, moving from the 2012 International Energy Conservation Code (IECC) to the 2021 IECC can lead to greater cost impacts compared to moving from the 2018 version, which has fewer changes. In some cases, cost-effectiveness analyses for the 2021 IECC have used the 2012 code as the baseline, which is a significant jump with many more changes compared to using the 2018 version. However, most jurisdictions do not make such a large code jump. This highlights the importance of using the appropriate code versions in cost-effectiveness analysis to ensure accurate assessments of the costs involved in adopting energy codes.

This paper explores the cost implications of energy codes, focusing on new residential buildings and major renovations, to provide a clearer understanding to entities that have authority to adopt energy codes, and anyone interested in learning how these codes affect affordability.

Cost-Effectiveness Methodologies

When evaluating the cost-effectiveness of energy codes, it is essential to understand and rely on accurate and comprehensive metrics. The three most common metrics include life cycle costs, cash flow, and simple payback.[1]

Life Cycle Costs (LCC) reflect the total cost of owning a home over a 30-year period, incorporating both the incremental costs of more efficient construction and the long-term operational costs for energy bills. This metric incorporates savings from efficient construction practices that reduce utility bills. Code changes that result in a net LCC less than or equal to zero—where monetary benefits exceed costs—are deemed cost-

[1] United States Department of Energy (US DOE), Office of Energy Efficiency and Renewable Energy, Building Energy Codes Cost Analysis, Sep. 19, 2021. https://www.federalregister.gov/d/2011-23236.

effective. When LCC is less than zero, the metric is presented as “Life Cycle Costs Savings,” expressed as a positive value.

LCC accounts for various factors, including:

- ***Initial Costs:*** Expenses incurred during construction, such as materials and labor.
- ***Operating Costs:*** Ongoing expenses related to energy consumption and maintenance.
- ***Residual Value:*** The anticipated value of energy-efficient systems at the end of their useful life.

LCC is the primary metric utilized by the United States Department of Energy (DOE) to evaluate the cost-effectiveness of energy codes.[2] Its comprehensive nature allows stakeholders to understand the full economic impact of energy code adoption over time, making it a valuable tool for policymakers and builders.

Cash Flow Analysis evaluates the year-by-year financial impact of adopting energy codes by comparing the increased mortgage costs due to higher construction expenses with the energy savings generated from compliance with the codes. This metric is relevant because most homebuyers finance their homes through mortgages, which spread construction costs over a long period. The analysis typically assumes a 30-year fixed-rate mortgage, and for tax purposes, it considers that homebuyers will deduct the interest portion of their mortgage payments. It calculates when the annual energy savings exceed the additional mortgage costs, offering a practical view of the financial impact in the early years of homeownership.

While Cash Flow Analysis provides valuable insight into short-term affordability, it may not capture the full financial picture, as it does not include all long-term costs and benefits.

Simple Payback measures how long it will take for the savings from energy-efficient features to equal the initial investment. This metric serves as a straightforward measure of cost-effectiveness, defined as the number of years required for the sum of annual savings to match the initial investment costs. However, simple payback has several limitations. It fails to consider long-term savings that accrue over the lifespan of energy-efficient technologies. Furthermore, simple payback does not factor in the financing of initial costs through a mortgage, or the tax benefits associated with homeownership. It only considers first-year energy cost savings and initial construction costs, which can lead to an incomplete understanding of the financial benefits of energy efficiency.

While LCC, cash flow, and simple payback each have their merits, LCC is generally regarded as the most comprehensive metric. It encapsulates the total cost of ownership, allowing for a full assessment of both short-term and long-term financial impacts. Cash flow analysis offers valuable insights into immediate affordability, particularly for new homeowners who are concerned about their monthly budget. In contrast, simple payback serves as a useful introductory measure but lacks the depth required for thorough decision-making.

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[2] U.S. DOE, Office of Energy Efficiency and Renewable Energy, Methodology for Evaluating Energy Savings, Cost-Effectiveness and Societal Impacts of Residential Energy Code Changes, updated October 2024. https://www.energycodes.gov/sites/default/files/2024-10/residential_methodology_2024.pdf.

The Importance of Selecting the Appropriate Code Cycle

When comparing the cost-effectiveness of different code versions, it is important to consider the specific transitions a state is undergoing. It is crucial to conduct a cost-effectiveness analysis that compares the relevant code versions that the state is phasing out to the one it is adopting.

Table 1. ***PNNL determined national LCC savings, simple payback, and cash flow impacts by climate zone.***

Name of Report	Code Version Compared	Climate Zone	Life Cycle Cost Savings ($/dwelling unit)	Simple Payback Period (years)	Years to Cumulative Positive Cash Flow
National Cost-Effectiveness of the Residential Provisions of the 2021 IECC[3]	2021 IECC – 2018 IECC	1	3,536	4.8	1
		2	2,854	7.6	2
		3	2,829	8.6	3
		4	2,243	12.4	5
		5	1,034	16.7	10
		6	970	11.2	4
		7	3,783	9.6	3
		8	6,782	7.3	2
		National	**2,320**	**10.5**	**4**
National Cost-Effectiveness of the Residential Provisions of the 2018 IECC[4]	2018 IECC – 2015 IECC	1	405	0.0	1
		2	408	0.0	1
		3	532	2.8	1
		4	622	2.6	1
		5	633	1.9	1
		6	685	1.8	1
		7	832	1.5	1
		8	1,174	1.0	1
		National	**562**	**2.0**	**1**

[3] Pacific Northwest National Laboratory (PNNL), National Cost Effectiveness of the Residential Provisions of the 2021 IECC, June 2021. https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf.

[4] Pacific Northwest National Laboratory (PNNL), National Cost Effectiveness of the Residential Provisions of the 2018 IECC, April 2021. https://www.energycodes.gov/sites/default/files/2021-07/2018IECC_CE_Residential.pdf/

The results of this comprehensive analysis indicate that construction that complies with an updated energy code is cost-effective compared to older versions of the IECC across all climate zones. Although the simple payback period has increased when comparing an update from the 2015 to 2018 IECC with an update from the 2018 to 2021, this single data point does not account for the significant long-term benefits of adopting updated energy codes. In most climate zones, homeowners can expect to achieve net positive cash flows within the first five years.

This national analysis provides cost estimates based on climate zones. However, states can work with PNNL through the DOE Technical Assistance Network[5] to request customized cost-effectiveness analyses that reflect the specific energy code changes they intend to adopt. The timeframe for preparing these state-specific analyses varies depending on the complexity of the proposed code changes and the volume of requests.

One point raised by some builders is that any increase in construction costs, such as those associated with code updates, could exclude millions of Americans from qualifying for a mortgage. While Energy Efficient Mortgages (EEMs),[6] are one tool to help offset upfront costs by considering long-term energy savings, they are currently underutilized. Expanding EEMs alongside other approaches—such as targeted subsidies, rebates, tax incentives, and affordable financing options—can help mitigate the affordability impacts of energy-efficient homes. Creating greater awareness among builders and buyers about these financial tools is also critical for enhancing accessibility.

Analysis of 2021 IECC

PNNL and Other Cost-Effectiveness Analyses

Pacific Northwest National Laboratory (PNNL) has played a pivotal role in advancing the understanding of the cost-effectiveness of energy codes, particularly through comprehensive cost-effectiveness studies. PNNL's analyses provide a consistent and reliable basis for evaluating energy code impacts. PNNL's approach to determining cost-effectiveness utilizes a standardized methodology developed by DOE through a public Request for Information (76 FR 56413).[7] This robust methodology ensures that the findings are applicable across different types of residential construction, including single-family and multifamily homes. PNNL's analysis uses all three critical metrics: LCC, simple payback, and cash flow, allowing for a comprehensive assessment of the economic implications of energy codes. Furthermore, the analysis provides location-specific results to reflect conditions at state, climate zone, and national level.

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5 Find more at: DOE, Building Energy Codes, Technical Assistance Network. https://www.energycodes.gov/sites/default/files/2024-03/20240307_BECP_TANetwork.pdf.

6 U.S. Department of Housing and Urban Development (HUD), Energy Efficiency Morgage Programs. https://www.hud.gov/program_offices/housing/sfh/eem/energy-r.

7 Ibid.

States rely on PNNL's analyses as reliable sources of information on the cost impacts of energy codes. PNNL's latest cost-effectiveness analysis of the 2021 IECC compared to the 2018 IECC on a national level[8] includes the following outcomes:

- ***Average Life-Cycle Cost Savings:*** $2,320 per household over 30 years.
- ***Average Simple Payback Period:*** 10.5 years.
- ***Time to Positive Cash Flow:*** Four years.

These findings contradict claims from some industry groups, such as the National Association of Home Builders (NAHB), which estimated that the 2021 IECC would increase construction costs by between $6,548 and $9,301.[9] PNNL's analysis estimated the incremental costs at just $2,372—significantly lower than NAHB's projection. The PNNL analysis, based on the DOE methodology, utilizes a wider range of data sources (e.g., RS Means Residential Cost Data, national home hardware suppliers such as Lowe's, The Home Depot, and others)[10] to represent national building types and climate.

The DOE methodology prioritizes a comprehensive LCC analysis, considering both initial construction costs and long-term energy savings. The methodology used by NAHB and developed by Home Innovation Research Labs (formerly NAHB Research Center), places emphasis on the immediate impact of code changes on construction costs for builders and does not account for potential utility bill savings to the homeowner from the more energy-efficient home. This highlights the importance of carefully evaluating the assumptions and methodologies used in cost-effectiveness analyses. Differences in data sources, or the scope of the analyses, may contribute to different results.

PNNL acknowledges simple payback as a useful metric for gauging the time it takes for energy savings to match initial investments but does not consider it a primary indicator of cost-effectiveness. In contrast, NAHB uses simple payback as its main metric. While simple payback can provide a useful data point, it fails to account for long-term benefits, financing variables, and other economic factors such as changing fuel prices and maintenance costs. LCC, on the other hand, provides a comprehensive analysis of all costs and savings associated with an efficiency investment over a 30-year period. Although LCC uses a 30-year period to represent the average life of building systems, it's important to note that significant financial benefits of energy-efficient homes, such as lower utility bills and increased resale value, can be realized in shorter timeframes.

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8 Pacific Northwest National Laboratory (PNNL), National Cost Effectiveness of the Residential Provisions of the 2021 IECC, June 2021. https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf.

9 National Association of Home Builders (NAHB), 2021 IECC Residential Cost Effectiveness Analysis, June 2021. https://www.nahb.org/-/media/NAHB/advocacy/docs/top-priorities/codes/code-adoption/2021-iecc-cost-effectiveness-analysis-hirl.pdf.

10 U.S. DOE, Office of Energy Efficiency and Renewable Energy, Methodology for Evaluating Energy Savings, Cost-Effectiveness and Societal Impacts of Residential Energy Code Changes, updated October 2024. https://www.energycodes.gov/sites/default/files/2024-10/residential_methodology_2024.pdf.

HUD Analysis of Cost-Effectiveness

HUD requires the 2021 IECC for new construction of HUD- and USDA-financed housing.[11] HUD has conducted a cost-effectiveness analysis of the 2021 IECC compared to the 2009 IECC, focusing on how this code update impacts housing affordability. HUD's analysis reveals significant affordability benefits for borrowers and renters. Homes built to HUD's newly adopted standards, which are based on the 2021 IECC, are estimated to be 34.3 percent more efficient than HUD's previous requirements, which were based on the 2009 IECC.[12] Homebuyers can expect to save **approximately $960 on energy bills in the first year.** Although building to the newly adopted HUD standard increases down payment and closing costs by approximately $550, and **monthly mortgage payments by just over $35**, the savings on monthly energy bills offset these costs and result in net monthly savings of $45. The long-term benefits are substantial. Over a 30-year mortgage, homeowners can achieve net energy savings of **about $25,100**.[13]

When conducting this analysis, HUD updated DOE's construction cost estimates to reflect significant increases in supply chain costs experienced by the building industry from 2020 to 2023. This adaptability allowed HUD to provide a more accurate picture of current market conditions. HUD acknowledged that some third-party analyses reported differing construction costs. These discrepancies stem from variations in the prototype homes used and the assumptions made about builder profit margins and material costs. Despite these differences, HUD remains confident in the LCC approach employed in the DOE's analysis, citing the alignment in energy and cost savings across multiple reports.

Stretch Code Cost-Effectiveness Analysis

Stretch codes are advanced energy codes designed to achieve greater energy savings than the baseline energy code adopted at the state level. These codes can address additional aspects such as operational emissions, renewables, electrification, embodied carbon, and building material impacts, and can offer additional energy savings and environmental benefits. Several cost-effectiveness analyses, including those by the Massachusetts Department of Energy Resources (MA DOER), New York State Energy Research and Development Authority (NYSERDA), and PNNL, have demonstrated the affordability and long-term savings associated with these codes.

While adoption data alone may not fully prove the economic feasibility of stretch codes, the widespread adoption and implementation of stretch codes across these states suggest a strong finding of public benefits. Specifically, the Massachusetts Base Energy Code has been adopted by 50 cities and towns, the Stretch Energy Code by 254 cities and towns, and the Specialized Energy Code, which is more stringent than the Stretch

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[11] U.S. Department of Housing and Urban Development, Adoption of Energy Efficiency Standards for New Construction of HUD- and USDA-Financed Housing – Final Determination, Sep. 9, 2024. https://www.hud.gov/program_offices/comm_planning/environment_energy/mes_notice#:~:text=On%20April%2026%2C%202024%2C%20HUD,Update%206%2F28%2F2024.

[12] U.S. Department of Housing and Urban Development, Minimum Energy Standards, FAQ. https://www.hud.gov/program_offices/comm_planning/environment_energy/mes_notice/faqs#:~:text=Homes%20built%20to%20HUD's%20newly,IECC%20and%20ASHRAE%2090.1%2D2007.

[13] Ibid.

Energy Code, by 47 cities and towns. This broad adoption indicates that many jurisdictions are committed to higher efficiency standards as both achievable and beneficial, supporting the finding that voluntary stretch codes can be cost-effective and practical in achieving greater energy efficiency.[14]

Massachusetts Stretch Code Cost-Effectiveness Analysis

The Massachusetts Stretch Code mandates significantly higher energy efficiency standards compared to the base code by requiring stricter building envelope insulation, more efficient heating and cooling systems, and often better window performance. The stretch code encourages a building design that uses considerably less energy than what the base code would allow for new construction and major renovations.[15]

DOER has commissioned studies to analyze the change in construction costs related to building to the Massachusetts Stretch Code for several sizes and types of residences. While the Stretch Code allows for use of either fully electric or mixed fuel pathways, these studies generally indicate that construction and operating costs are lower when a project is fully electrified by using heat pumps, as shown in Table 2 below.[16] It is important to note that the cost analysis includes tax credits and Mass Save incentives[17] available to builders and homeowners at the time of the report. These tax credits and incentives help make homes that are compliant with the Massachusetts Stretch Code standards and are heated and cooled with heat pumps less expensive to build and operate than those heated with natural gas built under the base code.

Table 2. ***Costs and (savings) for residential construction under Massachusetts Stretch code (42 HERS) vs. base code (52 HERS)***

Costs and (savings) for residential construction under Stretch code (42 HERS) vs. base code (52 HERS)				
	Gas Heat		Electric Heat	
Size	**Builder costs (savings)**	**Resident annual costs (savings)**	**Builder costs (savings)**	**Resident annual costs (savings)**
4,000 sq. ft.	$3,184	($302)	($20,062)	($548)
2,100 sq. ft.	$7,907	$496	($28,597)	($1,053)
Townhouse	$62	($11)	($11,492)	($316)
Multi-family	$2,277	($14)	($15,690)	($683)

Source: DOER Stretch Energy and Municipal Opt-In Specialized Building Code Frequently Asked Questions

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[14] See more details at: Massachusetts Building Energy Code Adoption by Municipality as of 10.16.2024. https://www.mass.gov/doc/building-energy-code-adoption-by-municipality/download.

[15] The Massachusetts Specialized Opt-In Code is a further enhancement of the Stretch Code, meant to help Massachusetts achieve its greenhouse gas emission reductions set every five years from 2025 to 2050. This code offers three main compliance pathways for new construction, allowing builders to choose between zero energy, all electric, or mixed fuel pathways. See more at: Town of Westborough Massachusetts, MA Energy Codes, November 2024. https://www.town.westborough.ma.us/1226/MA-Energy-Codes.

[16] For more information on the residential cost studies, visit https://www.mass.gov/doc/residential-stretch-code-costs-and-benefits-case-studies/download.

[17] MassSave, New Home Construction. Available in September 2024. https://www.masssave.com/residential/programs-and-services/new-home-construction.

Stretch codes align with broader state and local incentives. In Massachusetts, new construction that meets more stringent requirements than the Massachusetts base code can receive rebates through programs like Mass Save, which further reduce upfront costs for builders and homeowners.[18]

New York Stretch Code (NYStretch) 2020 Cost-Effectiveness Analysis

The NYStretch-2020 Energy Code includes various elements designed to improve building energy efficiency, such as optimized hot water piping layouts, better duct placement, solar-ready provisions, and electric vehicle charging readiness. Given that NYStretch-2020 is 10–12 percent more efficient compared to the residential provisions of the 2020 Energy Conservation Construction Code of New York State (ECCC NYS),[19] building to this standard is expected to generate energy cost savings for buildings in jurisdictions that adopt it ranging from **16–24 percent**.[20]

The provisions have been evaluated through both a 10-year net present value (NPV) calculation and a 30-year LCC savings perspective for homeowners. The results show that the stretch code is cost-effective across single-family and most multifamily buildings. The **incremental cost** per **single-family home** under NYStretch is estimated at **$2,646**, with **annual energy cost savings of $357**, 30 years **LCC of $2,167 and a simple payback period of 7.4 years. For low-rise multifamily buildings**, the **incremental construction cost is $1,898**, with **annual energy cost savings of $189**, 30 years **LCC of $528** and a **payback period of approximately 10.1**.[21] The results confirm that the energy savings from NYStretch-2020 can help mitigate the incremental costs, ultimately supporting long-term housing affordability across various building types by reducing utility bills and making overall living costs more manageable for residents.

Illinois Stretch Code Cost-Effectiveness Analysis

The Illinois Stretch Code is an enhancement to the 2021 IECC, incorporating mandatory requirements for electric vehicle (EV) readiness, all-electric readiness, solar readiness, and demand response thermostats and water heaters.[22] Over a 30-year period, a homebuyer will save an estimated **$2,355 in life-cycle energy costs**, in addition to **$6,474 in avoided retrofit costs** for electrified technologies.[23] This results in total **estimated life-cycle cost savings of $8,829**. The stretch code's focus on future-proofing homes through

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[18] Find more information on incentives for all-electric new construction homes that exceed the Massachusetts Building Energy Code, visit https://www.masssave.com/residential/programs-and-services/new-home-construction/single-family.

[19] The New York State Energy Research and Development Authority (NYSERDA), NYStretch Energy Code–2020 Comparison to 2020 Energy Conservation Construction Code of NYS, https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/Fact-Sheets/NYStretch-Energy-Code-2020.pdf.

[20] The New York State Energy Research and Development Authority (NYSERDA), Energy Savings and Cost-Effectiveness Analysis of the 2020 NYStretch Energy Code Residential Provisions. P.S2, July 2022. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/Energy-Code-Training/22-22-NYStretch-2020-Res-Cost-analysis.pdf.

[21] Ibid.

[22] Illinois Stretch Energy Code (20 ILCS 3125/55).

[23] PNNL, Cost-Effectiveness Analysis of the Residential Provisions of the Illinois Stretch Energy Code Update, Jan. 2024. https://cdb.illinois.gov/content/dam/soi/en/web/cdb/business/codes/ecacouncil/stretch/docs/residential-stretch-code-cost-analysis-4-11-24.pdf.

readiness measures allows homeowners to avoid the high costs of retrofitting, which would be necessary if these technologies were installed after the home is already built.

While some may choose to stick with gas, transitioning to electric technologies offers significant financial savings and positions homeowners advantageously as energy systems evolve. By adopting these measures, homeowners can capitalize on lower energy bills and increased efficiency over time. When amortizing the upfront construction costs (referred to as first costs) and energy savings over the life of a typical 30-year mortgage, the analysis shows a **positive cash flow** within **an average of 6 years**. The **first costs** for implementing these measures range from **$3,400 to $5,100** for single-family homes and **$2,000 to $2,200** for low rise (three story) multifamily units.[24]

The analysis demonstrates that cumulative energy savings over time exceed the initial construction costs, offering a positive financial return for most homeowners in the first decade. The Illinois Stretch Code strikes a balance between higher upfront costs and long-term savings. Homeowners will not only benefit from lower energy bills but will also be able to integrate new energy technologies more cost-effectively.

Additional Long-Term Impacts

Energy codes and stretch codes offer not only immediate energy savings but also long-term economic and social benefits. Often these benefits are not accounted for in cost-effectiveness analysis.

Avoiding Retrofit Costs[25]

Electrification in buildings offers substantial benefits by promoting energy efficiency, reducing greenhouse gas emissions, and minimizing dependence on volatile fossil fuel costs. This transition provides long-term protection from rising gas costs, which are projected to increase by the early 2030s due to increasing pipeline maintenance and declining gas demand.[26] In a recent study, National Grid noted that as more affluent customers move to electric systems, low-income and disadvantaged communities remaining on gas will face even higher rates to cover maintenance, making early electrification a more equitable and cost-effective solution.[27] One of the most significant advantages of adopting the latest energy codes and/or stretch codes is the potential to avoid costly retrofits in the future.

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[24] Ibid.

[25] Also referred to as "Future Proofing"- actively anticipating future needs and technologies to design or modify something with long-term adaptability in mind.

[26] Walsh Michael, ZeroCarbonMA, New construction future of gas in Massachusetts, Feb. 8, 2024. https://static1.squarespace.com/static/62e94d16a77e1e191eafe-4ae/t/65c509b847ec46459341d78d/1707411896890/New+Construction+and+the+Future+of+Gas+in+MA+-+2.7.24.pdf.

[27] National Grid, National Grid New York Climate Leadership and Community Protection Act Study, Report for Brooklyn Union Gas Company (KEDNY), KeySpan East Gas Corporation (KEDLI), and Niagara Mohawk Power Corporation (NMPC), December 2022.

ZeroCarbonMA[28] examines the implications of electrifying new buildings compared to retrofitting existing ones. The study emphasizes that electrifying new buildings during construction is more beneficial than waiting to retrofit existing structures later. The study analyzes three types of future retrofits for a prototypical single-family home built in 2025. The study highlights that by 2040, most homeowners will need to invest in upgrading their heating systems, regardless of whether they use gas or electric heat. This analysis indicates that retrofitting to all-electric systems is significantly more expensive than building all-electric from the outset. Additionally, codes for new construction may apply to change-of-use or major renovation projects where existing structures are adapted to meet current energy standards. In these cases, retrofitting existing buildings to be all-electric could still be more cost-effective than waiting until later to make the transition.

Table 3. ***Cost estimates of several retrofit scenarios*****.**

2025 Construction	Gas			All Electric
Retrofit at end-of-life intervention	**Gas to Gas**	**Gas to Ductless Heat Pump**	**Gas to Ducted Heat Pump**	**Heat Pump Replacement**
Retrofit Steps	Replace high-efficiency gas furnace and central AC equipment	Install whole-home ductless electric air-source heat pumps	Install whole-home ducted electric air-source heat pumps, utilizing existing ducts	Replace existing heat pump system.
Estimated Costs	$8,592	$16,060	$17,098	$8,631

Source: ZeroCarbonMA study

As presented in Table 3, retrofitting existing buildings to accommodate energy-efficient technologies like efficient heat pumps is far more expensive than incorporating these technologies during initial construction. A recent study concluded that the cost of retrofitting electrical panels can exceed four times the cost of initial installations.[29] Specifically, the cost of **electrical modifications** for installing heat pump space- and water-heating equipment increases from $500 to $2,100, resulting in an **additional $1,600 for retrofitting**.[30] Furthermore, a PNNL study indicated that as many as 48 million households in the U.S. may require **panel upgrades** to fully electrify their homes, with **retrofit costs** ranging between **$1,000 to $5,000**. However, when electric panel upgrades are made during **initial construction**, the incremental cost is only **a few hundred dollars**.[31] This dramatic cost difference highlights the importance of **electric-ready provisions** in energy codes. Electric-ready provisions ensure that homes built with fossil fuel systems can easily transition to electric appliances in the future. These provisions are designed to protect homeowners from future retrofit costs.

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28 Walsh Michael, ZeroCarbonMA, New construction future of gas in Massachusetts, Feb. 8, 2024. New+Construction+and+the+Future+of+Gas+in+MA+-+2.7.24.pdf (squarespace.com).

29 Group14 Engineering, PBC, Electrification of Commercial and Residential Buildings, Nov. 2020. https://www.communityenergyinc.com/wp-content/uploads/Building-Electrification-Study-Group14-2020-11.09.pdf.

30 Ibid.

31 PNNL, Electric Readiness in Residential Energy Code, Technical Brief, Oct. 2021. https://www.energycodes.gov/sites/default/files/2021-10/TechBrief_Electric_Readiness_Oct2021.pdf.

Health and Resilience Impacts of Energy Codes

Advanced energy codes improve the energy efficiency and indoor air quality of homes and significantly reduce various health-related risks and associated costs. Studies have quantified the benefits associated with implementing energy-efficient measures. The Vermont Department of Health conducted a study on the health benefits of home weatherization in Vermont, which provides insights into health-associated savings related to the implementation of energy efficiency measures. The study concluded that weatherizing 2,000 low-income homes in Vermont would help prevent an estimated 223 emergency department visits, 13 hospitalizations, and 0.5 deaths associated with reduced health impacts caused by asthma, cold, and heat over a 10-year period. The estimated **10-year value of energy and health benefits** is at least **$24,757 per household**.[32]

While this study focused on improvements to existing buildings through weatherization programs, homes built to newer versions or advanced energy codes could achieve similar or even greater savings. These benefits come from implementing energy efficiency measures from the outset, enhancing both energy performance and health outcomes. The health benefits associated with improved indoor air quality and reduced thermal discomfort have significant economic implications. The Environmental Protection Agency (EPA) estimated that energy efficiency measures could prevent up to **3,600 premature deaths, 1,700 heart attacks**, and **90,000 asthma attacks** annually by 2030, highlighting the critical health benefits associated with improved building standards.[33] These health improvements could save the U.S. economy **up to $93 billion per year** in reduced medical costs and fewer lost workdays.[34]

Furthermore, investing in advanced energy codes enhances the resilience of homes against climate-related challenges. By improving energy efficiency, homes are better equipped to maintain comfortable indoor temperatures during extreme weather events, reducing vulnerability to heat waves and cold snaps. This resilience not only protects the health of residents but also reduces the strain on healthcare systems during crises. Resilient homes can also lead to significant cost savings beyond health expenditures. For example, energy-efficient buildings are more likely to remain habitable during extreme weather events and power outages, reducing the need for costly emergency repairs and temporary housing. Additionally, resilient infrastructure can help communities recover more quickly from disasters, minimizing the financial burden on local governments and taxpayers.

Investing in energy efficiency and resilience not only yields substantial health benefits but also contributes to long-term economic savings and community stability. These findings underscore the multifaceted advantages of energy codes, which promote healthier living conditions while bolstering resilience in the face of environmental challenges.

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[32] Vermont Department of Health, Health and Climate Change Co-Benefits of Home Weatherization in Vermont, Dec. 2018. https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_CH_WxHealthReport.pdf.

[33] U.S. Environmental Protection Agency (EPA), FACT SHEET: Clean Power Plan By The Numbers, https://archive.epa.gov/epa/cleanpowerplan/fact-sheet-clean-power-plan-numbers.html.

[34] Ogbemudia O.Nosa, Jeffery Okhuarobo, Ayodele Talabi, Matthew Ogieva, American Journal of Humanities and Social Sciences Research (AJHSSR), The relevance of energy efficient projects to the US economy, 2024, e-ISSN :2378-703X, V-08, I-09, pp-46-59.

Impact on Renters and Energy Burden

Energy codes play a crucial role in promoting housing affordability, especially for renters who often face unique challenges in the housing market. Energy codes benefit not just building owners but also renters, by reducing energy bills through more efficient buildings. This is true whether renters pay energy bills directly or if landlords include energy costs in rent, which affects the overall cost of renting. Rental properties tend to be less energy-efficient than owner-occupied homes, with studies indicating that rental units consume, on average, **15 percent more energy per square foot than similarly-sized owner-occupied homes**.[35] As a result, renters often incur higher energy bills compared to homeowners living in similarly sized properties. These energy inefficiencies have a substantial economic impact, with nearly one-third of U.S. **renters** experiencing high energy burdens—spending more than **six percent of their income on energy bills**.[36] According to the American Council for an Energy-Efficient Economy (ACEEE), one in four low-income households spends over 8**.3 percent of their income on energy bills**.[37] Such financial strains can make it difficult for renters and low-income households to manage essential living expenses, leading to further economic challenges.

The standard cost-effectiveness analysis for energy codes generally focuses on calculating energy savings, LCC, and simple payback periods using assumptions based on an average homeowner. However, this approach often fails to capture the unique circumstances of rental properties, particularly those in environmental justice communities. To ensure a more comprehensive and equitable evaluation, it is important to expand these analyses to include additional cost models, such as financing mechanisms for low-income rental properties, and incorporate non-energy benefits and equity-focused metrics. Moreover, a methodology should be developed that bases cost-effectiveness on income levels rather than using the average homeowner as the benchmark.[38]

Energy codes that require improved insulation, higher performing windows, advanced ventilation systems, and other efficiency measures can lead to lower energy consumption across all types of housing, including low-income and rental units. However, new construction projects, even those built to high-efficiency standards, can still face significant challenges if electricity costs are high, exacerbating the energy burden crisis. This highlights the need for policies that address both the energy efficiency of homes and the broader energy cost issues that renters and low-income households face.

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[35] American Council for an Energy-Efficient Economy (ACEEE), Energy Equity for Renters. https://www.aceee.org/energy-equity-for-renters#:~:text=Dramatically%20reducing%20greenhouse%20gas%20emissions,costs%2C%20and%20preserve%20affordable%20neighborhoods..

[36] Ibid.

[37] American Council for an Energy-Efficient Economy (ACEEE), Data Update: City Energy Burdens. Sep. 2024. https://www.aceee.org/sites/default/files/pdfs/data_update_-_city_energy_burdens_0.pdf.

[38] Bahareh van Boekhold, ILLUME Advising, Chitra Nambiar, Pacific Northwest National Laboratory, Emma Weaver, ILLUME Advising, Code and Communities: Opportunities to Incorporate Equity into Building Energy Codes, 2024. https://illumeadvising.com/files/10-0815_1216_000677-vanBoekhold.pdf.

Incentives, Policy Adjustments, and Market Dynamics

To make energy codes more affordable, it is important to understand the role of incentives and policy adjustments, as well as other factors that impact housing costs. This section discusses financial incentives and policy changes that can support the adoption of energy-efficient construction, while also highlighting broader market dynamics that influence home prices.

Incentives and Policy Adjustments can Support the Cost-Effectiveness of Energy Codes

Incentives enhance the cost-effectiveness of energy-efficient measures outlined in energy codes, making these upgrades even more affordable for builders and homeowners. By lowering initial costs, incentives encourage the adoption of energy codes and standards that exceed minimum requirements, resulting in long-term energy savings and environmental benefits. For example, builders can access incentives such as the $2,500 rebate for Energy Star-certified homes and the $5,000 rebate for homes meeting DOE Zero Energy Ready Home (ZERH) standards, both of which provide substantial support for energy-efficient construction.[39]

Although this paper does not provide an exhaustive list of incentives, it is recommended that states and jurisdictions collaborate with utilities and program administrators to develop and implement similar programs. Builders and homeowners are also encouraged to explore incentives available through sources like the Database of State Incentives for Renewables & Efficiency (DSIRE), which offers updated information on federal and state-level programs that can reduce the upfront costs of energy efficiency measures.

While incentives help offset some initial costs, a recent report from the Home Builders & Remodelers Association, with research from Wentworth Institute of Technology and Massachusetts Institute of Technology,[40] emphasizes the need for structural and policy changes to facilitate cost-effective, climate-smart housing solutions that align with advanced energy codes. Key solutions include[41]:

- ***Land Use and Zoning Adjustments:*** Many municipalities advocating for stricter energy codes still enforce large-lot, single-family zoning, which conflicts with affordability goals. Linking specialized stretch codes with updated land use policies—such as smaller lot sizes, higher density, and expanded multifamily zoning—could better support energy-efficient housing.
- ***Streamlined Permitting and Utility Connections:*** To reduce delays, waiving special permit requirements for net-zero multifamily projects and speeding up utility connections could enable more timely, cost-effective project completions.
- ***Restructured Financial Incentives:*** Simplifying the application process for climate-related incentives

39 Please note that incentives mentioned here do not constitute tax advice.

40 Wentworth Institute of Technology (WIT), Massachusetts Institute of Technology (MIT), and Home Builders & Remodelers Association of Massachusetts (HBRA-MA), Public Policy for Net Zero Homes and Affordability, June 23, 2023. https://hbrama.com/2023/06/hbrama-releases-landmark-study-on-net-zero-energy-code-and-housing-affordability/.

41 Ibid.

across agencies would make resources more accessible, encouraging broader adoption of energy-efficient building practices.

- ***Enhanced Technical Assistance and Workforce Training:*** Smaller builders often lack training for meeting net-zero standards. Expanding workforce training for energy-efficient construction techniques would support adaptation to evolving codes.
- ***Green Bank Financing:*** Establishing green banks could leverage public funding to attract private investment, reducing financial barriers for projects that meet new versions or advanced energy codes.
- ***Support for Low-Income Renters:*** As multifamily buildings shift to all-electric heating, additional energy assistance for renters could ensure that low-income renters are not disproportionately impacted by increased costs.
- ***Tax Incentives for Energy-Efficient Housing:*** Creating new tax classifications or exemptions for highly energy-efficient housing would provide stable, long-term incentives for producing both affordable and sustainable homes.
- ***Utility Support for Affordability:*** To further support affordable housing projects, utilities should explore specialized programs, such as tailored electricity rates, energy assistance for affordable housing projects or exempting affordable housing from covering the cost of grid upgrades, to mitigate cost pressures and enhance the financial viability of energy-efficient housing.

Factors Influencing Increased Home Costs

While energy efficiency measures aim to improve sustainability and reduce long-term expenses, they are not the primary driver behind the high costs of homes on the market. A variety of economic and market factors influence housing affordability, with energy codes representing only a small fraction of these costs. Although any added cost may be viewed as a burden, energy codes ultimately deliver long-term savings that help offset initial expenses and contribute to enhanced home affordability over time. Understanding these broader influences is essential for grasping the complexities of home pricing. Some of the main factors contributing to increased home costs include:

1. **Low Inventory:** The current housing market faces a significant shortage of available homes, driving competition among buyers.42 This scarcity leads to increased valuations, as more buyers compete for a limited number of properties, ultimately pushing prices higher.
2. **Income Disparities:** There is a stark contrast between median household incomes and those of new homebuyers, with the 2023 median U.S. household income at $80,61043 and average new homebuyers typically earning over $100,000.44 This disparity puts homeownership out of reach for

[42] National Public Radio (NPR), Housing experts say there just aren't enough homes in the U.S., Apr. 2024. https://www.npr.org/2024/04/23/1246623204/housing-experts-say-there-just-arent-enough-homes-in-the-u-s.

[43] U.S. Census Bureau, Income in the Unites States: 2023. https://www.census.gov/library/publications/2024/demo/p60-282.html.

[44] Investopedia, Typical Income To Buy Home Surged to $107,000 Last Year, Nov. 2023. https://www.investopedia.com/typical-income-to-buy-home-surged-to-usd107-000-last-year-8401169.

many, particularly those seeking affordable housing options. While it may seem reasonable to focus on lowering construction costs by eliminating energy efficiency measures, this approach overlooks the long-term benefits these codes provide. Though energy codes may add initial expenses, they ultimately lead to significant savings on utility bills, making homes more affordable over time and contributing to sustainable homeownership.

3. **Rising Interest Rates:** Interest rates have risen significantly over the past few years, impacting mortgage affordability and leading to increased monthly payments. This trend has made it more challenging for potential buyers to enter the market, contributing to a decline in home affordability. However, recent indications suggest that interest rates may be stabilizing and even decreasing slightly, though they may not return to the historically low levels seen over the past decade. Recognizing this shift is important, but the effects of elevated interest rates continue to pose challenges for many buyers.
4. **Home Size:** New homes in the U.S. have grown substantially over the decades, often exceeding 2,400 square feet on average,[45] compared to 2,080 square feet 30 years ago.[46] Over the past 42 years, the average new home has increased by more than 1,000 square feet, rising from 1,660 square feet in 1973.[47] Meanwhile, the average household size has declined from 3.01 persons per household in 1973 to a record low of 2.54 in 2015.[48] This contrast between growing home sizes and shrinking household sizes results in homes that are often larger than necessary for many families, further elevating prices and complicating affordability.
5. **Zoning Restrictions:** Local zoning laws can significantly limit the types and densities of housing that can be built, often prohibiting multifamily units in many areas. This restriction constrains the housing supply and drives up prices for single-family homes, which tend to be more expensive per dwelling unit.[49] However, increasing housing density can benefit both builders and the market. By allowing for more multifamily developments, builders can maximize their profits through economies of scale, while simultaneously providing more affordable housing options. This approach not only addresses the housing supply issue but also supports efforts to reduce overall housing costs.
6. **House Flipping:** The housing market has seen increased participation from investors and flippers who buy properties to renovate and sell at a profit. This practice reduces the number of affordable homes available, as properties that could be priced for first-time buyers are instead converted into higher-priced rentals or luxury homes.

Understanding these elements is crucial for policymakers and stakeholders aiming to address housing affordability and ensure that energy-efficient homes are accessible to a broader range of buyers.

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[45] Kevin Rose, Northwest Energy Efficiency Alliance, Energy Codes, Home Size, and Equity, 2024 ACEEE Summer Study on Energy Efficiency in Buildings. https://www.aceee.org/sites/default/files/proceedings/ssb24/assets/attachments/20240722163143718_e2313bbb-74b4-4dea-9fdc-b8c0c0b776d4.pdf.

[46] Newser Editors, Average Size of US Homes, Decade by Decade, May 2016. https://www.newser.com/story/225645/average-size-of-us-homes-decade-by-decade.html.

[47] American Enterprise Institute (AEI), New US Homes Today Are 1,000 Square Feet Larger Than in 1973 and Living Space per Person Has Nearly Doubled. https://www.aei.org/carpe-diem/new-us-homes-today-are-1000-square-feet-larger-than-in-1973-and-living-space-per-person-has-nearly-doubled/#:~:text=Living%20Space%20per%20Person.,average%20house%20size%20per%20person.

[48] Ibid.

[49] Ibid.

Conclusion

Energy codes play a vital role in enhancing the energy efficiency of residential and commercial buildings, leading to significant long-term savings and health benefits. While concerns about the upfront costs associated with these codes persist, analyses demonstrate that the long-term financial advantages outweigh initial investments. It is crucial, however, to recognize that for many potential homeowners, financing remains a significant barrier to entry. Without affordable financing options, the benefits of energy efficiency may be out of reach. Therefore, alongside robust energy codes, promoting accessible financing solutions is essential to ensure that all families can afford to buy homes and benefit from lower utility bills and improved indoor air quality. By addressing both the implementation of effective energy codes and the challenges of financing, we can work towards a more equitable housing market that supports better health outcomes and reduced overall cost burdens for homeowners.

It is essential to recognize that adopting these codes is not just an environmental imperative but also an economic necessity. Stakeholders—including policymakers, builders, and communities—should prioritize the integration of advanced energy codes to ensure that resilient, energy-efficient homes with lower operating costs are available for everyone. There is a need for effective communication strategies to educate diverse audiences, such as homeowners, renters, and community organizations, about the full costs of home buying, ownership, and the impacts of energy codes. This will help foster a more widespread understanding and acceptance of the benefits of energy efficiency. Furthermore, expanding research on financing tools and incentives will help create new solutions that make energy-efficient housing accessible to all.

Key Terms and Definitions

Advanced Energy Codes – States or jurisdictions may pass energy codes beyond the base ASHRAE and IECC model codes. These may be stretch codes but could also include the International Green Construction Code (IgCC), PassiveHouse, DOE Zero Energy Ready Home (ZERH, or other advanced standards aimed at enhancing efficiency and sustainability.

ASHRAE – The American Society of Heating, Refrigerating and Air-Conditioning Engineers is an international society of heating, refrigerating and air-conditioning professionals. ASHRAE has developed building design and energy efficiency standards and guidelines for new construction. ASHRAE's most recent standard with minimum requirements for energy-efficient design of most sites and buildings, except low-rise residential buildings is ASHRAE 90.1-2022.

Base Code – The energy code that all buildings in the state must follow. Base code is usually based on IECC and ASHRAE model codes and may be modified by states to better fit the concerns of their community. Base code requirements are used as the minimum standard for compliance.

Cash Flow Analysis – This metric evaluates the year-by-year financial impact of adopting energy codes by comparing the increased mortgage costs due to higher construction expenses with the energy savings generated from compliance with the codes, which offers a practical view of costs to homeowners. It helps to assess the short-term affordability of energy codes, especially for new homebuyers.

Cost-Effectiveness Analysis – Method of evaluation for energy-efficient technology upgrades that calculates energy savings, life cycle costs, and simple payback periods using assumptions based on an average homeowner. This analysis is critical for determining whether implementing a code will yield net economic benefits over time.

Department of Energy Technical Assistance Network (DOE TAN) – The DOE runs a TAN through the Building Energy Codes Program that helps states and local jurisdictions to support building energy code development, adoption, implementation, and enforcement. Assistance is facilitated by PNNL through the Regional Energy Efficiency Organizations.

Electrical Modifications – Changes in residential electric systems to accommodate or install energy-efficient electric equipment. Examples include electric panel upgrades, wiring installation, and heat pump installation. These modifications are often required for transitioning from fossil fuel-based systems to all-electric solutions.

Energy Codes – Building codes that set parameters around energy efficiency. They establish minimum requirements for reducing energy consumption and improving building performance.

Energy Burde – The percentage of household income spent on energy bills.

Energy Efficient Mortgages (EEMs) – A program through the Department of Housing and Urban Development that helps families save money on their utility bills by enabling them to finance energy-efficient improvements through their Federal Housing Authority-insured mortgage. An EEM can be used by borrowers to purchase or refinance a home that is already energy efficient, such as an ENERGY STAR certified home, or to finance energy efficient improvements to a new or existing home.

Energy Star-Certified Homes – Residential structures can become Energy Star-Certified through third-party inspections that verify a home meets Energy Star criteria, certifying that homes and apartments are designed and constructed to be more efficient, exceeding minimum energy code requirements by at least 10 percent.

Electrification Readiness – The process of preparing residential buildings to accommodate future electric technologies.

Green Bank Financing – A public or nonprofit entity that uses limited public funds to attract private investments into clean energy and energy efficiency projects.

HERS (Home Energy Rating System Index) – It is the nationally recognized system for inspecting and calculating a home's energy performance. A HERS rating is a number typically between 0-100 that represents a home's energy efficiency, with a score of 100 corresponding to the standard home based on the 2006 IECC and a score of 0 indicates a net-zero energy home, which produces as much energy as it consumes. A lower HERS score indicates a more energy-efficient home.

IECC (International Energy Conservation Code) – Part of the I-codes suite published by the International Codes Council. The IECC sets minimum standards for energy efficiency in residential and commercial buildings. The most recent version is the IECC 2024.

Incremental Cost – The cost of upgrading one residence from one model code year to another. This includes material, labor, and any additional systems required to meet updated code standards.

Life Cycle Costs – This metric reflects the total cost of owning a home over 30 years, incorporating both the initial construction costs and the long-term savings from reduced utility bills. This metric uses initial costs, operating costs, and residual value.

Mass Save Incentives – Programs offered in Massachusetts to promote energy efficiency, providing rebates and financial incentives for projects that meet stretch code requirements.

NPV (Net Present Value) – The difference between the present value of costs and savings for installing energy-efficient equipment over a period of time. NPV helps determine whether the energy savings outweigh the initial and ongoing costs.

Pacific Northwest National Laboratory (PNNL) – PNNL is a U.S. DOE Office of Science research facility that delivers research and solutions in the areas of environment, energy, health, fundamental science, and national security.

Stretch Codes – A stretch code is a more stringent energy code than a base energy code that can be adopted by local jurisdictions. Stretch codes are designed to increase energy efficiency, reduce emissions, and create healthier buildings. They can be adopted by states or jurisdictions, and can be based on the next version of a model code.

Simple Payback – This metric measures how long it will take for the savings from energy-efficient features to equal the initial investment. Simple payback does not consider long-term savings due to energy efficiency or factor in the initial costs of financing through a mortgage, or the tax benefits associated with homeownership.

ZERH (Zero Energy Ready Home) – A ZERH is a high-performance home that is so energy efficient that a renewable energy system could offset most or all the home's annual energy use. Each DOE ZERH meets rigorous efficiency and performance criteria found in the DOE ZERH National Program Requirements.