Consortium for Energy Efficiency℠

Residential New Construction Initiative

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Executive Summary

To date, there has been a patchwork of utility, state, and federal offerings aimed at increasing the efficiency of new homes beyond existing building codes. These programs have had varying success, but in general have had difficulty inducing many builders to climb the efficiency ladder towards zero net energy. This is in large part due to the variance in efficiency standards spanning the multiple jurisdictions that builders serve. However, recent developments in the residential new construction market have primed it for nationally coordinated programs that incentivize deep energy savings.

One such indicator is the increased adoption of the Home Energy Rating System (HERS), which is used for compliance in many voluntary efficiency programs for new homes and is similar to the system used for compliance with Section 45L tax incentives.[1] In 2016, roughly 35 percent of new homes received HERS ratings paid for by the builder; the average HERS rating for these homes was 61, which is more efficient than a house built to most local building codes.[2] Another indicator is the adoption of a new compliance path based on ratings, the Energy Rating Index (ERI), into the 2015 and subsequent 2018 International Energy Conservation Code (IECC).

The wide use of ratings and potential for beyond-code construction present a large opportunity for cost-effective savings and market transformation through increased national coordination. The *CEE℠ Residential New Construction Initiative* implements a tiered specification with performance-based levels that will help drive industry to adopt increasingly efficient new construction practices, support the development and adoption of future building codes that align with program goals, and promote increased stability in a traditionally fragmented market of energy efficiency targets.

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1 "Summary of Residential New Homes Programs in the United States and Canada," CEE, December 2016.

2 "Surge in New Homes Receiving HERS Ratings in First Half of 2016," RESNET, accessed December 6, 2017, http://www.resnet.us/blog/surge-in-new-homes-receiving-hers-ratings-in-first-half-of-2016/.

The Residential New Construction Initiative is designed to create a foundation from which members are able to work collaboratively to transform the landscape for newly built homes. CEE expects to achieve the following benefits and market influence through deployment of this Initiative:

- Grow the United States and Canadian markets for high efficiency systems, equipment, components, and products that contribute to new home performance through the creation of a tiered performance-based specification that is consistently promoted by voluntary programs
- Bolster the infrastructure of service providers, raters, trade ally networks, and contractors capable of designing and constructing high performing homes
- Complement and create strategic links with current platforms and federal voluntary programs, augmenting their impact in the market to drive greater uptake and hence increased total energy savings
- Support increased standardization of definitions, terminology, and building science practices across the United States and Canada to help unify disparate efforts and drive market transformation at scale
- Influence consumer awareness around the energy and non-energy benefits associated with high performing homes, thereby helping drive demand for adoption of efficient new construction projects
- Equip the financing, real estate, and appraisal industries with results that demonstrate the benefits of industry partnerships and investments in high performance homes

1 Residential New Construction Market

1.1 Market Overview

1.1.1 NEW CONSTRUCTION LANDSCAPE

According to Annual Energy Outlook (AEO) data supplied by the US Energy Information Administration (EIA), there were 115.2 million dwelling units in the United States as of 2010; this number is projected to grow to 140.6 million by 2030.[3]

Figure 1. **New Privately-Owned Housing Units Authorized Annually**[4]

Year	Number of Housing Units	% Change from Previous Year	Valuation (millions of dollars)	% Change from Previous Year
1991	948,800	N/A	$78,772,200	N/A
1992	1,094,900	15.4%	$95,539,000	21.3%
1993	1,199,100	9.5%	$106,801,000	11.8%
1994	1,333,700	11.2%	$120,429,800	12.8%
1995	1,332,500	-0.1%	$120,810,700	0.3%
1996	1,425,600	7.0%	$134,175,800	11.1%
1997	1,441,100	1.1%	$141,004,400	5.1%
1998	1,612,260	11.9%	$165,265,706	17.2%
1999	1,663,532	3.2%	$181,245,697	9.7%
2000	1,592,267	-4.3%	$185,743,681	2.5%
2001	1,636,676	2.8%	$196,247,625	5.7%
2002	1,747,678	6.8%	$219,188,679	11.7%
2003	1,889,214	8.1%	$249,693,105	13.9%
2004	2,070,077	9.6%	$292,413,689	17.1%
2005	2,155,316	4.1%	$329,254,469	12.6%
2006	1,838,903	-14.7%	$291,314,492	-11.5%
2007	1,398,415	-24.0%	$225,236,551	-22.7%
2008	905,359	-35.3%	$141,623,457	-37.1%
2009	582,963	-35.6%	$95,410,298	-32.6%
2010	604,610	3.7%	$101,943,061	6.8%
2011	624,061	3.2%	$105,268,541	3.3%
2012	829,658	32.9%	$140,425,307	33.4%
2013	990,822	19.4%	$177,655,914	26.5%
2014	1,052,100	6.2%	$191,531,180	7.8%
2015	1,182,642	12.4%	$219,132,700	14.4%
2016	1,206,642	2.0%	$230,671,802	5.3%

[3] ASHRAE: "*Final Report: ASHRAE and the Residential Construction Market*," Report of Presidential Ad Hoc Committee on the Residential Construction Market, June 2014, p. 9, https://www.ashrae.org/society-groups/committees/residential-building-committee-rbc.

[4] United States Census Bureau: Permits by United States and Regions (Excel spreadsheet), accessed November 2017, https://www.census.gov/construction/bps/uspermits.html.

A recent McGraw Hill Construction Market Forecast notes that single and multifamily housing projects accounted for about 45 percent of the value of all building construction projects started in the United States in 2014.[5] According to this report, both builders and remodelers stated that the market is increasingly recognizing the value of "green" homes and customers are willing to pay a premium for green features in a home. The study defined a green home as one that either complies with a "credible rating system" or "incorporates environmentally sensitive site planning; resource efficiency; energy and water efficiency; improved indoor air quality; and homeowner education."

An increasing number of homes are being constructed as "zero net energy" (ZNE) or "zero energy" buildings. Although varying distinctions and terminology are used to define this concept, the general principle is that net energy consumption is equivalent to zero. US DOE has developed the following common definition for a zero energy building: "An energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy."[6]

1.1.2 BUILDING CODES

Residential building energy codes are designed to ensure a minimum level of energy efficiency in new construction. Codes are most commonly adopted at the state level, but self-governing municipalities can choose to adopt and implement their own codes. In most states, local governments are in charge of implementing, inspecting, and enforcing the building code. Municipalities can provide training and education in code compliance for builders, inspectors, and other key stakeholders if they choose.

IECC: The International Energy Conservation Code (IECC) is a building code, developed and promulgated by the International Code Council (ICC), that can provide minimum design and construction standards pertaining to energy efficiency. Many states and municipalities in the United States have adopted various editions of the IECC (see Figure 2). The IECC is updated on a three-year cycle through a public hearing process.

There have been significant changes in the code over the past decade. The 2009 IECC compared to the 2006 IECC represents an average annual energy cost reduction of 10.8 percent, while the 2012 IECC compared to the 2006 IECC reduces the average energy cost by 32.1 percent.[7] The

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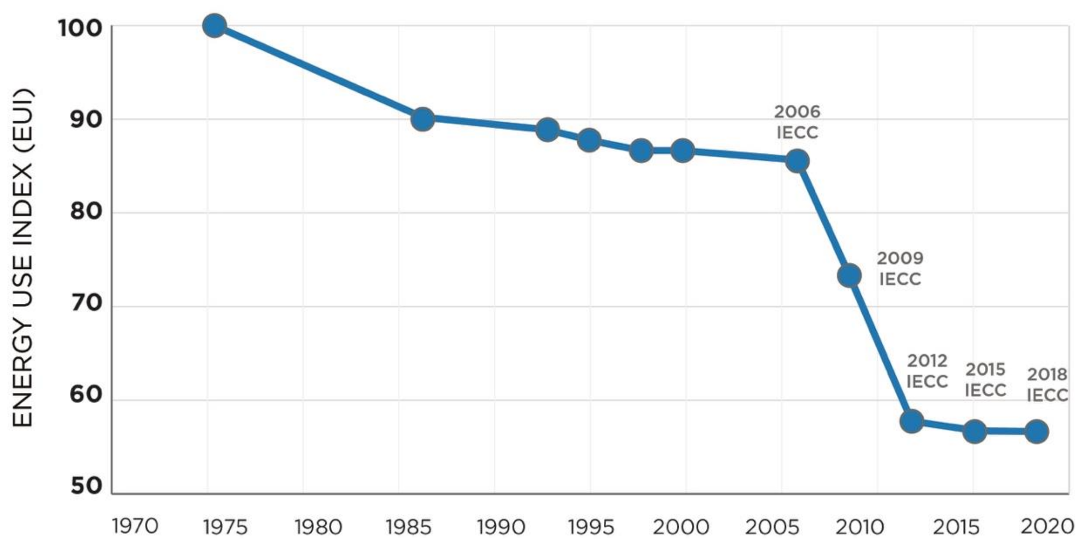
[5] "Green Homes Show Growth in a Recovering Market, According to New McGraw Hill Construction SmartMarket Report," McGraw Hill Construction (press release), Dodge Data & Analytics, June 5, 2014, https://www.construction.com/about-us/press/green-homes-show-growth-in-a-recovering-market-according-to-new-sm-report.asp.

[6] "A Common Definition for Zero Energy Buildings," US Department of Energy, September 2015, p. 4, https://energy.gov/sites/prod/files/2015/09/f26/A%20Common%20Definition%20for%20Zero%20Energy%20Buildings.pdf.

[7] *National Energy and Cost Savings for New Single and Multifamily Homes: A Comparison of the 2006, 2009, and 2012 Editions of the IECC*, US DOE Building Technologies Program, April 2012, p. 3, http://www.epa.illinois.gov/Assets/iepa/energy/natl-residential-cost-savings.pdf.

Pacific Northwest National Laboratory estimates that the total incremental cost of shifting from the 2009 IECC to the 2012 IECC ranges between about $1,500 and $2,800, with the sum varying depending on climate zone.[8] The 2015 and subsequent 2018 editions of the IECC adopt a compliance path based on the ratings determined by the Energy Rating Index (ERI). To conform with this path, a builder must meet the appropriate ERI target for a home's climate zone as well as complying with the minimum envelope requirements of the 2009 IECC. The 2018 code also accommodates the use of on-site power generation. Use of such measures determines the prescriptive envelope backstop. Additional details and background about the IECC are available in Appendix B.

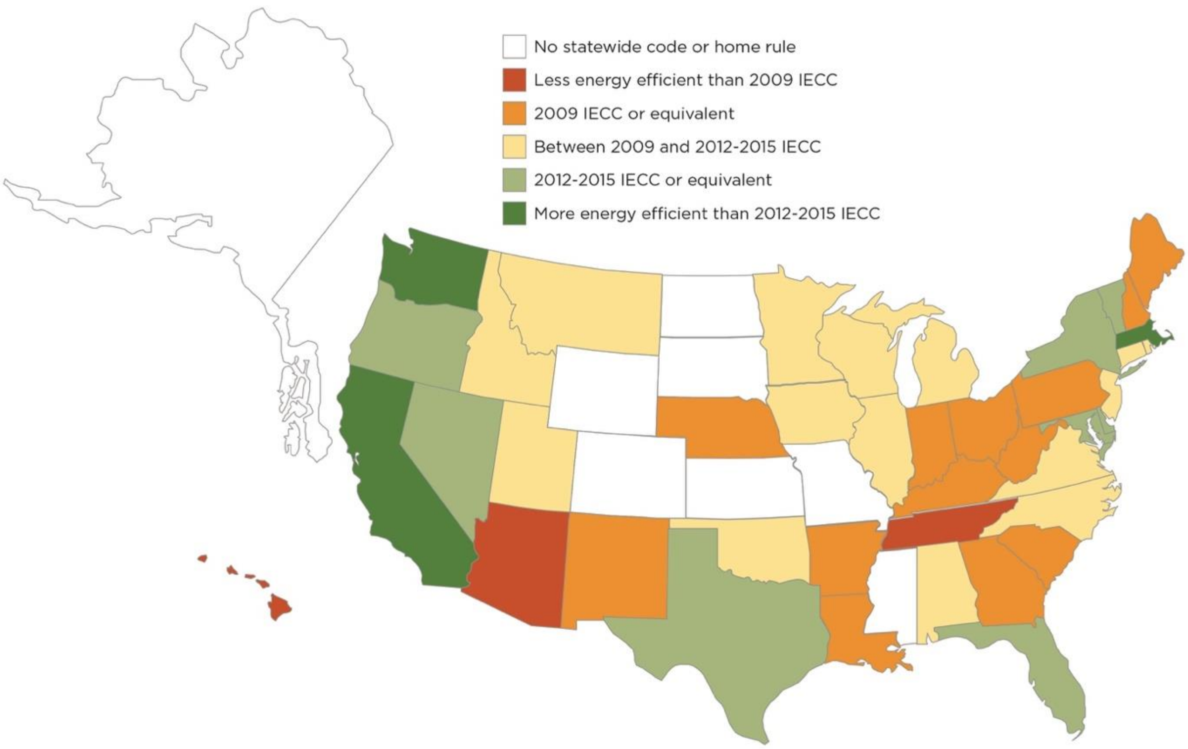
Figure 2. **Residential Energy Code Efficiency Improvement Over Time**[9]



[8] *Cost-Effectiveness Analysis of the 2009 and 2012 IECC Residential Provisions—Technical Support Document*, PNNL, April 2013, p. 41-42, .https://www.energycodes.gov/sites/default/files/documents/State_CostEffectiveness_TSD_Final.pdf.

[9] Adapted from Building Codes Assistance Project, *Tackling Energy Codes with Energy Modeling: Preparing Design Professionals to Face Building Performance Demands*, August 9, 2016, p. 6 (adapted from US DOE), bcapcodes.org/wp-content/uploads/2016/08/Preparing-Design-Professionals-FINAL-08092016.pdf.

Figure 3. **Current US Residential Building Energy Code Adoption Status**[10]



Title 24 (California): California's Building Energy Efficiency Standards apply across the state and are updated on an approximately three-year cycle. The 2016 Standards continue to improve upon the 2013 Standards for residential and nonresidential new construction, additions, and alterations; they went into effect January 1, 2017.

EnerGuide (Canada): An EnerGuide rating shows a standard measure of a home's energy performance. The rating is calculated based on standard operation assumptions so that homes can be compared against each other using an energy efficiency scale that ranges from 0 to 100. A rating of 0 represents a home with major air leakage, no insulation, and extremely high energy consumption. A rating of 100 represents a house that is airtight, well insulated, sufficiently ventilated, and requires no purchased energy on an annual basis. A new home built to code standards would receive a rating between 65 and 72.

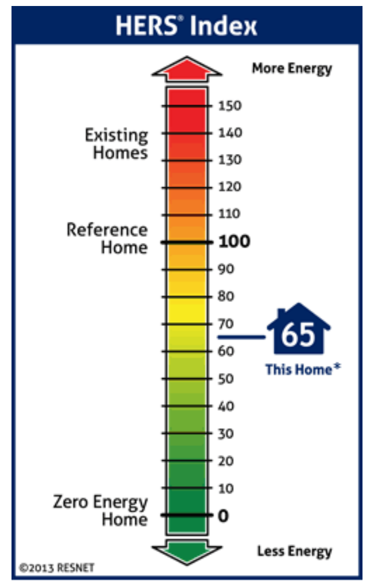
1.1.3 ANSI/RESNET/ICC 301-2014 ENERGY RATING INDEX

The ANSI/RESNET/ICC *Standard for Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index* provides a consistent, uniform methodology for

[10] "Status of State Energy Code Adoption," *US DOE Building Energy Code Program*, accessed November 2017, https://www.energycodes.gov/status-state-energy-code-adoption.

evaluating and labeling the energy performance of homes. This standard compares the energy use of a newly constructed home with that of a reference home that uses the prescriptive features of the 2006 IECC Standard Reference Design. The resulting Energy Rating Index (ERI) of the new home can range between 100 and 0.

Figure 4. **Sample Energy Rating Index**



To calculate an individual home's ERI, an accredited energy rater does an energy rating on the house and compares the data against a "reference home," a home designed through modeling to be the same size, shape, and type as the actual home, so that the resulting score is always relative to that of the assessed house.

ERI can further be used as a mechanism to provide consumers with informed buying choices for homes. Growing consumer demand for energy efficient houses and the energy community's efforts to educate the public about efficiency have helped drive uptake of energy-rated homes over the past few years (see Figure 5). An increasing number of builders have also leveraged ERI scores to market their energy efficient homes, and numerous Multiple Listing Services (MLS) across the country have started including them in their listings.

The RESNET HERS Index is the most common ERI implemented to date. In 2014, 33.8 percent of all new homes in the United States were HERS rated; the national average HERS Index Score of these homes was 63.[11] In 2015, 38 percent of new homes were HERS rated, with an average score of 62.[12] Note that, as RESNET explains, "the total number of HERS ratings conducted in 2014 is lower than reported for 2013. There were several reasons for this. The first is that the federal tax credit for energy efficient homes expired in 2014. Another reason was that 2013 was the first year for the RESNET National Registry, and it was discovered that there were technical features in the registry that resulted in over reporting of the number of total homes rated in 2013."[13] According to research conducted by the National Renewable Energy Laboratory, 22 percent of newly

[11] "Over 146,000 Homes in the US Were HERS Rated and Issued a HERS Index Score in 2014," RESNET, March 3, 2015, http://www.resnet.us/blog/over-146000-homes-in-the-u-s-were-hers-rated-and-issued-a-hers-index-score-in-2014/.

[12] "Over 190,000 Homes In The US Were RESNET HERS Rated And Issued A HERS Index Score In 2015 (30% Increase Over 2014)," RESNET, January 21, 2016, http://www.resnet.us/blog/over-190000-homes-in-the-u-s-were-resnet-hers-rated-and-issued-a-hers-index-score-in-2015-30-increase-over-2014/.

[13] "Over 146,000 Homes in the US Were HERS Rated and Issued a HERS Index Score in 2014," 2015.

constructed homes built in 2016 were HERS rated.[14] Details about RESNET and the HERS Index are available in Appendix B.

Figure 5. **RESNET HERS Scores Issued Over Time**[15, 16, 17, 18]

Year	HERS Index Scores Issued	% Change from Previous Year
2008	100,000	N/A
2009	116,000	16.0%
2010	120,000	3.5%
2011	120,000	0.0%
2012	128,000	6.7%
2013	218,000	70.3%
2014	146,860	-32.6%
2015	190,180	29.5%
2016	206,000	8.3%
2017	227,840	10.60%

1.1.4 FEDERAL AND REGIONAL VOLUNTARY PROGRAMS

The list below includes descriptions of all programs currently in the market that have been adopted to any degree by CEE members represented in the 2016 CEE New Homes Program Summary.

[14] "National Renewable Energy Research Laboratory Research Finds 22% of New Homes Completed in US in 2016 Were HERS Rated," RESNET, August 22, 2017, http://www.resnet.us/blog/national-renewable-energy-laboratory-research-finds-the-22-of-new-home-completed-in-the-u-s-in-2016-were-hers-rated/.

[15] "What's Behind the Growing Popularity of HERS® Index Scores?" RESNET, June 17, 2014, http://www.hersindex.com/growing-popularity-of-hers-index-scores.

[16] "Over 146,000 Homes in the US Were HERS Rated and Issued a HERS Index Score in 2014," 2015.

[17] "Over 190,000 Homes in the US Were HERS Rated and Issued a HERS Index Score in 2015," 2016.

[18] "Record Number of Homes HERS Rated in 2017," 2018, http://www.resnet.us/blog/record-number-of-homes-hers-rated-in-2017-over-227000-homes-hers-rated/

Figure 6. **Logos and Icons of Various Voluntary New Homes Programs**

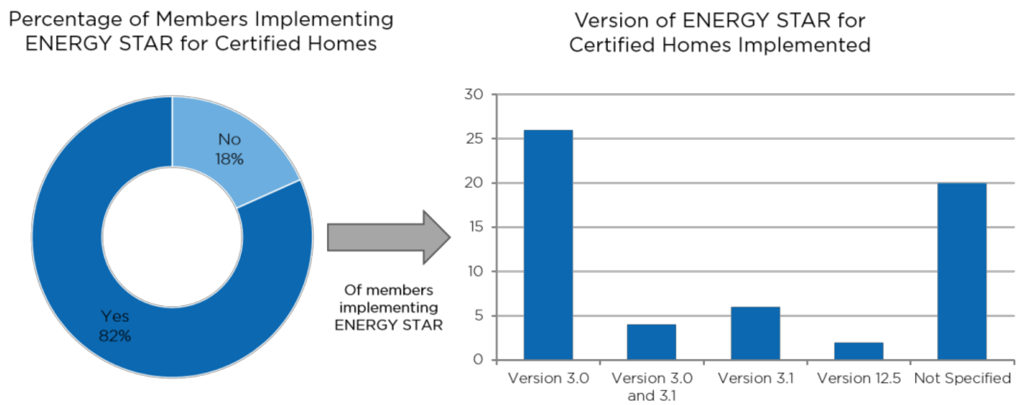
ENERGY STAR® Certified New Homes: The most common platform that members currently promote is the ENERGY STAR Certified New Homes program, with 91 percent of respondents from the 2015 CEE New Homes Program Summary indicating that they have adopted some version of the program.

Launched in 1995 as part of the ENERGY STAR suite of labels, this US Environmental Protection Agency (EPA) program is "an initiative to transform the housing market through the voluntary adoption of efficient technologies and practices. ENERGY STAR qualification signifies high-quality, meaningfully efficient, and cost-effective new homes that provide a competitive advantage to Partners relative to unqualified homes."[19] As of 2017, over 1.8 million certified ENERGY STAR new homes have been built across the United States.[20]

[19] "Overview of Evolving ENERGY STAR Qualified Homes Program & Methodology for Estimating Savings," US EPA, Version 3 Development Technical Document, 2011, https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/2011_Technical_Background.pdf?5deb-c3ee.

[20] "ENERGY STAR New Homes Partner Locator," National Program Indicators, ENERGY STAR, accessed December 2017, https://www.energystar.gov/index.cfm?fuseaction=new_homes_partners.locator.

Figure 7. **CEE Member Adoption of the ENERGY STAR New Homes Program**[21]



US EPA estimates that the incremental cost to construct an ENERGY STAR Version 3.0 home compared to a home with the same ERI Index score is between$50 and $425.[22] These costs come from plan review, pre-drywall inspection, and final inspection requirements. The additional features attributed to these expenses include branding, a systems approach, code change preparation, cost controls, and risk mitigation.

DOE Zero Energy Ready Home: The US Department of Energy's Builders Challenge program, which began in 2008, works to recognize leading builders for their achievements in energy efficiency. The DOE Zero Energy Ready Home—formerly DOE Challenge Home—represents a level of home performance with rigorous requirements that promote outstanding levels of energy savings as well as comfort, health, and durability. As of 2017, the Zero Energy Ready Home program has over 14,000 energy efficient homes across the United States.

Passive House: The Passive House Institute US (PHIUS) began in 2002 with the goal of making passive building a mainstream market force and best practice. PHIUS has trained more than 1,700 architects, engineers, energy consultants, energy raters, and builders. It also is the leading certifier of passive buildings, with more than 170 single and multifamily projects certified and about 90 more in the "pre-certified" pipeline.[23]

PHIUS has also promoted the adoption of passive building through partnerships with government, educational, corporate, and affordable housing organizations including the US DOE, RESNET, Carnegie Mellon University, Parsons College, the University of Oregon, Habitat for Humanity, and Rocky Mountain Institute.

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[21] "Summary of Residential New Homes Programs in the United States and Canada," CEE, July 2015.

[22] "Stepping Up From the HERS Index to ENERGY STAR," EPA (presentation), RESNET Building Performance Conference, February 16th 2015, slide 52, http://conference2015.resnet.us/data/energymeetings/presentations/Stepping-Up-from-the-HERS-Index-v1-2015-02-12RG.pdf.

[23] "Certified Projects Database," Passive House Institute US, accessed December 2017, http://www.phius.org/phius-certification-for-buildings-products/certified-projects-database.

LEED Homes Design and Construction: Leadership in Energy and Environmental Design (LEED) is a building certification that recognizes green building strategies and practices. In addition to energy, the program addresses features such as sustainable site development, material and resource considerations, and indoor environmental quality. Building projects satisfy prerequisites and earn points to achieve one of four levels of LEED certification: LEED Certified™ (40-49 points earned), LEED Silver® (50-59 points earned), LEED Gold® (60-79 points earned), or LEED Platinum® (80+ points earned). LEED now requires that projects achieve an ERI score of 70 or lower to follow the Optimize Energy Performance path.24

National Green Building Standard: The ICC/ASHRAE 700 National Green Building Standard™ (NGBS) is the only residential green building rating system approved by ANSI as an American National Standard. It provides practices for the design, construction, and certification of new green single and multifamily homes, as well as remodels. A project can receive a Bronze, Silver, Gold, or Emerald certification, depending on the number of green practices successfully incorporated in its design and construction.

HERO: The High Efficiency Residential Option (HERO) code is an optional part of the 2012 North Carolina Energy Conservation Code. This voluntary appendix delivers homes that are 30 percent more energy efficient than homes built to North Carolina's current code.

eco-rated Engineered Green Homes: eco-rated is an energy and environmental efficient certification program developed by the Northwest Energy Efficient Manufactured Home Program's team of building scientists, energy experts and industry partners. The program is designed for engineered factory-built homes.

Northwest Energy Efficient Manufactured Home (NEEM): The NEEM program began in 1988 and has over 200,000 certified houses as of 2017. Northwest Energy Works is an integral part of its design, implementation, and program management.

Using energy modeling software to inform decisions, the homes include many characteristics of the Passive House energy standard and are cost-optimized for net zero energy upon completion.

Enterprise Green Communities: Enterprise Green Communities is a national effort that works to improve the health and well-being of low-income families by addressing the quality of affordable housing. Its criteria align affordable housing investment strategies with environmentally responsive building practices to help people living in affordable housing be healthier, spend less money on utilities, and have more opportunities through their connections to transportation, quality food, and healthcare systems.

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[24] "Update: LEED for Homes v2008 Energy Requirements," US Green Building Council, October 1, 2014, https://www.usgbc.org/articles/update-leed-homes-v2008-energy-requirements.

R-2000 Homes (Canada): R-2000 certified new homes are best-in-class energy efficient homes using standards developed by Natural Resources Canada (NRCan) in coordination with key industry stakeholders. The R-2000 Net Zero Energy pilot aims to recognize the builders and homes reaching net zero energy performance in Canada and to pilot the next generation of the NRCan R-2000 Standard and EnerGuide Rating System in net zero energy applications.

Other Programs: Below is a list of other local or national offerings that are involved in the labeling of residential homes.

- Home Energy Score, US Department of Energy
- Living Building Challenge, International Living Future Institute
- GreenStar, Green Home Institute
- Green Building Rating System (AEGB), Austin Energy
- ecoSelect, ecoSelect Certifications
- Green Home Certification Standard, Florida Green Building Coalition
- EarthCraft House, Southface and Greater Atlanta HBA

1.2 New Home Program Trends

The 2017 CEE New Homes Program Summary includes information on 73 CEE member programs across the United States and Canada, with a collective budget totaling over $100 million. The majority of programs rely on REM/Rate™ for energy modeling and RESNET® HERS Raters for verification. ENERGY STAR® Certified Homes is the most common platform for new homes programs, with 80 percent of members adopting some version of the specification. Other prevalent platforms include tiered offerings based on ERI, DOE Zero Energy Ready Homes, and program-specific criteria such as percentage above local building code. An increasing number of members are also promoting connected features in their offerings, like additional incentives for installation of communicating thermostats.

Figure 8. **Select Results from 2017 CEE New Homes Program Summary**[25]

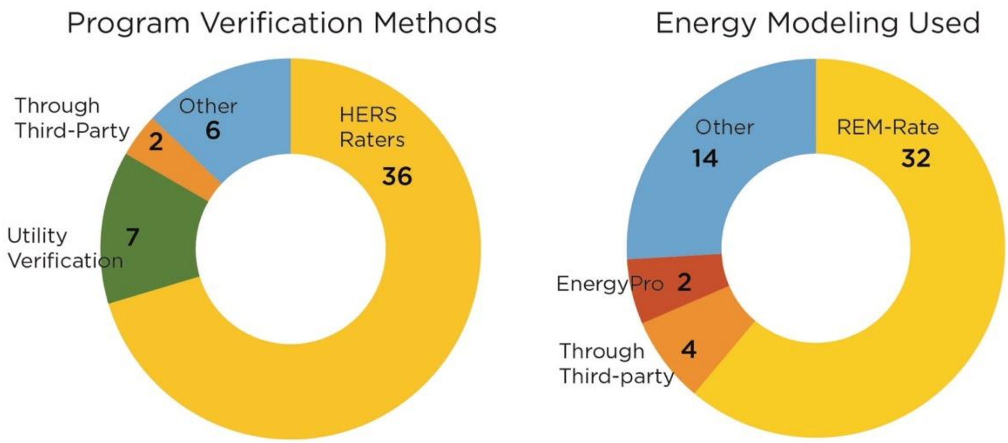
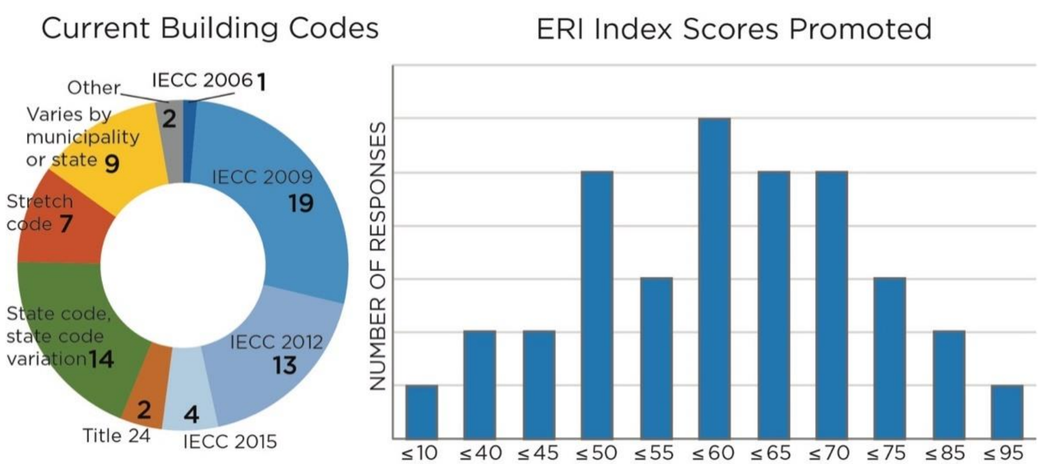


Figure 9. **Programs Incentivizing ERI Scores Beyond Those Promoted Through ENERGY STAR or DOE ZERH**



1.3 Building Code Trends

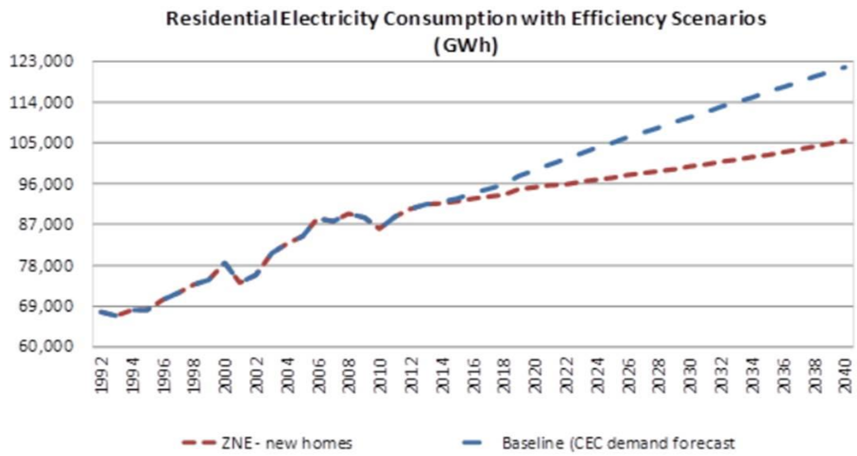
Energy efficiency building codes across the United States and Canada are becoming increasingly stringent. The state of California has policies in place with the goal that all residential new construction will be Zero Net Energy[26] by the year 2020. The rationale behind this initiative is

[25] "Summary of Residential New Homes Programs in the United States and Canada," CEE, July 2015.

[26] Zero Net Energy Code Definition: "A ZNE Code Building is one where the net of the amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single 'project' seeking development entitlements and building code permits, measured using the California Energy Commission's Time Dependent Valuation (TDV) metric." (IEPR 2013). Note that TDV is based on the forecasted seasonal and hourly costs for production, transmission, and distribution of electricity and natural gas, including peak and off-peak

multifaceted, including long-term savings and energy efficiency planning, improved indoor air quality and health, market transformation, greenhouse gas emission reductions, and investment in efficient technologies, renewable energy, and a green workforce. The Zero Net Energy (ZNE) Building Standards will be incorporated through California's state building code, Title 24, and supported by many auxiliary pilots, efforts, and investments.

Figure 10. **Projected California Efficiency Standards Under Title 24**[27]



The 2015 California state building code introduced several more stringent energy provisions related to air barriers, insulation, combustion closets, building envelope and duct leakage, hot water distribution efficiency, and drain water recovery.[28]

For the many states and jurisdictions adopting various versions of IECC, the 2015 and subsequent 2018 publications represent a new direction for the code with the introduction of an Energy Rating Index (ERI) path; this option gives builders the ability to comply through a performance path, instead of the traditional prescriptive path. The 2015 IECC also incorporates new performance testing requirements, including air leakage testing and duct leakage testing.

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considerations. "Update on Zero-Net Energy (ZNE) in California," Snuller Price, Energy + Environmental Economics (presentation), October 25th 2017, p. 4, http://cbe.berkeley.edu/centerline/wp-content/uploads/Snuller-Price-ZNE-Oct-25-2017.pdf.

[27] "California's Zero Net Energy Policies and Initiatives," Cathleen Fogel, California Public Utilities Commission (presentation), NASEO Getting to Zero Conference, September 18, 2013 slide 6, http://annualmeeting2013.naseo.org/Data/Sites/2/presentations/Fogel-Getting-to-ZNE-CA-Experience.pdf.

[28] "Fact Sheet: Energy Efficient Residential Construction," Institute for Market Transformation, 2015, p. 1, http://www.imt.org/uploads/resources/files/IECC_Fact_sheet-2015_residential_changes.pdf.

Figure 11. **IECC Energy Rating Index (ERI) Scores by Climate Zone**[29]

Climate Zone	2006 Score	2009*	2012*	2015	2018
Zone 1	97	79	74	52	57
Zone 2	96	79	73	52	57
Zone 3	94	78	71	51	57
Zone 4	92	82	76	54	62
Zone 5	91	82	80	55	61
Zone 6	92	83	79	54	61
Zone 7	93	85	78	53	58
Zone 8	96	86	79	53	58

* Scores determined by extrapolating HERS Index Scores from prescriptive requirements, assuming NAECA minimum equipment efficiencies for 2013.

1.4 Energy Savings Opportunities

The Florida Solar Energy Center (FSEC) conducted a report to analyze the ERI for various versions of the IECC and the associated energy savings. The savings shown reflect the vacation of the original 2006 Final Rule on gas furnaces.

Figure 12. **Best Case Whole Home Percentage Savings Over 2006 IECC**[30]

Climate Zone	2009 IECC	2012 IECC	2015 IECC: Prescriptive	2015 IECC ERI: Cusp Equipment*
Zone 1	18%	23%	28%	38%
Zone 2	17%	24%	28%	38%
Zone 3	17%	25%	29%	38%
Zone 4	12%	18%	24%	34%
Zone 5	10%	13%	20%	30%
Zone 6	8%	15%	24%	33%
Zone 7	8%	18%	28%	36%
Zone 8	9%	18%	29%	37%

* Includes scenarios with equipment configured to meet the 2015 National Appliance Energy Conservation Act (NAECA) equipment standard, as well as high-efficiency equipment on the cusp of wide-spread market adoption—heating systems, cooling systems, and water heating.

1.5 Non-Energy Benefits (NEBs)

Studies and anecdotal sources note the many non-energy related features and benefits that are associated with high-performing, energy efficient homes. While many of these benefits are hard to quantify or monetize, there are several efforts to track and measure the impacts, using a

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[29] "Energy Rating Index Performance Path: HERS Index Scores and Versions of the IECC," RESNET, accessed December 6, 2017, http://www.resnet.us/uploads/documents/EnergyRatings_FactSheet6_Final.pdf.

[30] *Analysis of HERS Index Scores for Recent Versions of the International Energy Conservation Code (IECC)*, FSEC-CR-1941-13, Florida Solar Energy Center, February 21, 2013, p. 14, http://www.resnet.us/uploads/documents/FSEC-CR-1941-13_R01.pdf.

variety of methodologies and techniques. In general, the NEBs associated with efficient homes can lead to increased customer satisfaction, reduced costs in ancillary expenses, and enhanced property value. For instance, studies of 1.6 million homes in Los Angeles County conducted through Energy Upgrade California found that homes labeled with energy-related metrics sold for a higher price than those without; a similar study in the Portland, Oregon area suggested that these labeled homes sell for roughly 30 percent more than unlabeled homes.[31]

1.5.1 COMFORT AND HEALTHY ENVIRONMENT

Effectively insulated and sealed homes minimize draftiness and the associated discomfort associated with air exchange. Higher insulation levels in the walls and attic, in addition to high performing windows, doors, and skylights, make homes warmer in the winter and cooler in the summer. Advanced duct systems contribute to balanced air flow throughout a house, also increasing overall comfort level for occupants. Increased comfort can in turn also help prevent household fires started by candles or stoves that are being used as a heating mechanism.[32]

EPA promotes the following attributes associated with homes that are built to the ENERGY STAR certified level:[33]

- The heating and cooling system has been engineered and installed to efficiently deliver comfort
- A constant supply of fresh, filtered air is provided, reducing indoor pollutants, dust, pollen, and other allergens
- Consistent temperatures are felt across every room, making the entire home comfortable year-round

The DOE Zero Energy Ready National Program Requirements go beyond those of EPA by including certification under EPA Indoor airPLUS, which can be especially relevant for individuals with chronic respiratory conditions.

Another factor that impacts overall comfort is lighting; incandescent bulbs can produce additional and unwanted heat in a room, while efficient LEDs keep spaces cool. Lastly, a highly efficient home can contribute to a pleasant living environment through reduced interior noise levels; a tight envelope helps make a quieter indoor space. Absorption control depends on the efficiency of a room's surfaces to absorb sound waves rather than reflect them.

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[31] "California Homebuyers Find More Value in Energy-Efficient Labeled Homes," US DOE Better Buildings Neighborhood Program, accessed December 6, 2017, https://energy.gov/eere/better-buildings-neighborhood-program/california-homebuyers-find-more-value-energy-efficient.

[32] *Preserving Affordable Multifamily Housing Through Energy Efficiency: Non-Energy Benefits of Energy Efficiency Building Improvements*, Elevate Energy, January 2014, p. 6, https://www.elevateenergy.org/wp/wp-content/uploads/Preserving_Affordable_Multifamily_Housing_Through_Energy_Efficiency.pdf.

[33] "Wall-to-wall Comfort," ENERGY STAR, accessed December 6, 2017, https://www.energystar.gov/index.cfm?c=new_homes.nh_wall_to_wall_comfort.

1.5.2 INDOOR AIR QUALITY

The quality of the air within a home can directly impact the health of its occupants. Dirty or clogged air filters in air conditioning systems are often loaded with allergens, dust, and germs that can have a negative impact on residents' health. Maintaining clean and properly installed air filters results in a more efficiently run system as well as healthier air quality in the home.

Indoor air quality is impacted by various environmental factors both inside and outside of the home, pollutant sources (combustion byproducts, building materials and furnishings, systems or equipment within the home, radon, pesticides, and outdoor air), and how air flow is managed through building design. The ventilation system of a home in turn impacts how much air pollution comes through the building; a tighter home prevents more infiltration than a leakier home.

The health impacts associated with poor indoor air quality range depending on many variables, including the type of pollutants. Exposure to air pollutants can result in allergies or discomfort and may yield symptoms of broader chronic conditions such as asthma, hypersensitivity pneumonitis, and humidifier fever.[34]

EPA Indoor airPLUS is a voluntary label for homes that outlines construction practices and product specifications intended to minimize exposure to these air pollutants. The requirements outlined in Indoor airPLUS address the following:

- Moisture control systems
- Heating, ventilating and air-conditioning systems
- Combustion-venting systems
- Radon resistant construction
- Low-emitting building materials

1.5.3 DURABILITY

The durability of a home can be improved through the materials and resources selected, as well as the building science employed during design and construction. The Building Science Consortium outlines the following factors that impact a home's durability: moisture flow, heat flow, ultraviolet radiation, and ozone.[35] The Resilient Design Institute outlines several design principles for addressing resiliency in homes, such as incorporation of diverse and redundant systems.[36]

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[34] "The Inside Story: A Guide to Indoor Air Quality," US Consumer Product Safety Commission, accessed December 6, 2017, https://www.cpsc.gov/Safety-Education/Safety-Guides/Home/The-Inside-Story-A-Guide-to-Indoor-Air-Quality/.

[35] "Understanding Green Homes & Durability: The Building America Systems Integration Approach," Building Science Consortium (presentation), Betsy Pettit, slide 25, https://buildingscience.com/sites/default/files/pr-0508_green_homes_and_durability.pdf.

[36] "The Resilient Design Principles," Resilient Design Institute, accessed November 2017, http://www.resilientdesign.org/the-resilient-design-principles/.

Moisture degradation is the largest factor limiting the service life of a building, and can have many damaging impacts on a home, such as mold, mildew, and rotting, which can be hazardous to health and costly to fix. Moisture control and water protection can be addressed through enclosure design as well as mechanical system design.

Damage from sunlight is another consideration; high performance windows can help prevent discoloration in carpets and furnishings by blocking out ultraviolet sunlight.

1.5.4 WATER EFFICIENCY

Measures such as low-flow showerheads and faucet aerators can help reduce total household water use. In addition, they often result in reduced water bills. WaterSense®, a partnership program by EPA, provides a labeling program that is backed by independent third-party testing and certification. Qualifying products meet certain specification requirements for water efficiency and performance. The list of residential products currently labeled by WaterSense includes:

- Homes
- Toilets
- Bathroom sink faucets
- Urinals
- Showerheads
- Pre-rinse spray valves
- Weather-based irrigation controllers

1.5.5 RENEWABLE ENERGY READY DESIGN

Renewable energy ready design refers to homes equipped with features that can help make the installation of renewable energy systems after the home is constructed easier and less expensive. Including these capabilities enables a homeowner to add renewable energy sources more easily in the future.

EPA has developed two specifications pertaining to Renewable Energy Ready Homes (RERH) for solar resources, each with an accompanying checklist.

- The Solar Photovoltaic (PV) RERH Specification details the site assessment as well as structural and system components needed to make a home solar PV ready.
- The Solar Water Heating (SWH) RERH Specification details the site assessment as well as structural and system components needed to make a home solar thermal ready.

In addition to the two specifications and checklists, EPA also has a RERH Solar Site Assessment Tool that helps builders and design teams determine if the proposed solar array location offers sufficient solar resource potential to meet the recommended elements of the RERH specification.

1.5.6 DISASTER RESISTANCE

According to the Center for Housing Policy, “Measures that promote disaster resistance in homes have close links to those that promote energy efficiency. Many of the same technologies that promote energy efficiency for a home also provide greater disaster resistance."[37] The selection of materials, building technologies, and systems can impact the overall resilience of a building and improve resistance to damage. Depending on climate and the type of storms affiliated with an individual region, designing disaster mitigation can reduce risk associated with wind and flying debris, flooding and water damage, and other weather event destruction.

There may also be insurance implications and opportunities associated with energy efficient homes. For example, the Fireman's Fund Insurance Company created a Green Homeowners insurance policy in 2008, which offered a five percent discount on coverage for homes with green features.[38]

The Insurance Institute for Business and Home Safety (INHS) has a national FORTIFIED™ Home standard that addresses features to help strengthen homes against hurricanes, high winds, hail, and severe thunderstorms.

1.6 Cost-Effectiveness

For members promoting new construction programs, cost-effectiveness calculations depend greatly on what baseline is used and on the specific methods for determining incremental savings. While some jurisdictions use current building code as a baseline, others develop a model home or use a standard as-built home to calculate savings. Quantifying energy savings is also challenging because of the variance that installation practices create in the overall performance of homes. Construction practices can significantly impact final energy consumption, and therefore quality assurance measures must be taken into consideration when evaluating total program cost-effectiveness. Lastly, there is no straightforward methodology for comparing prescriptive metrics to performance scales, making it difficult to precisely determine savings.

From the builder's viewpoint, using a performance method allows greater flexibility to deliver greater energy efficiency at a lower cost. Leading Builders of America estimates that a home that costs $3,000 extra to build for energy efficiency obtained through prescriptive methods only costs $1,300 for the same performance obtained by the alternative proposed approach for the 2015 IECC.[39] This method has the added benefit for builders of using an industry standard efficiency report to demonstrate code compliance. From the consumer's perspective, this particular proposal provides substantial reductions in utility bills—about $300 a year for a typical house compared to the 2012 IECC, or $850 compared to the 2006 IECC. In addition, it makes it likely that the rating is provided to the buyer since there is no cost to doing so, creating stronger markets for beyond-code homes by clearly demonstrating their lower operating costs and providing

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[37] *Linking Efforts to Improve Disaster Resistance and Energy Efficiency of Homes*, Issue Brief, Center for Housing Policy.

[38] "Fireman's Fund Green Insurance Fact Sheet," Fireman's Fund Insurance Company.

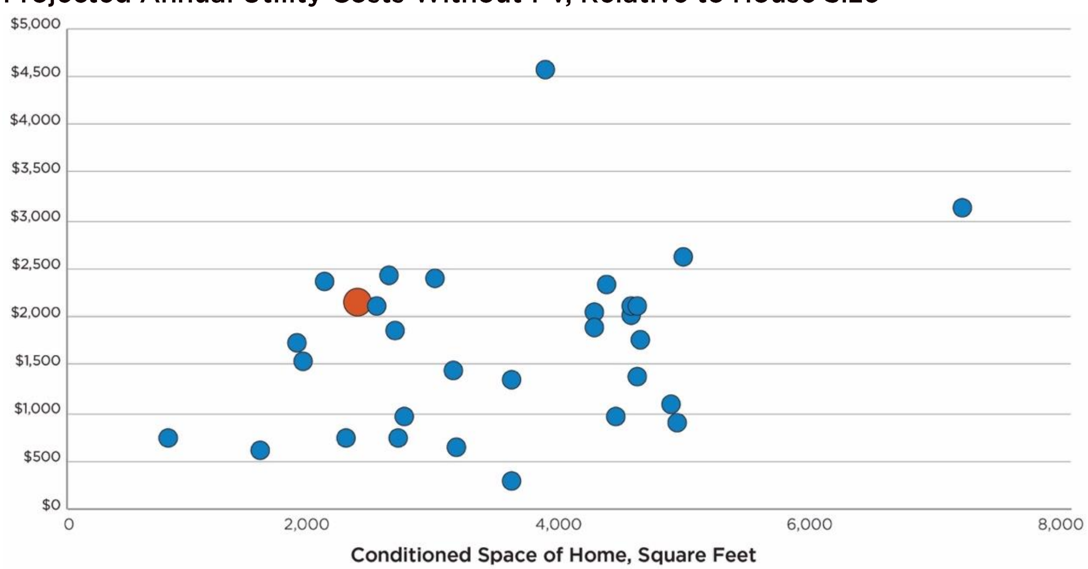
[39] "Energy Rating Index Performance Path: Benefits of the Energy Rating Index Score Option," RESNET, accessed December 2017, p. 1, http://www.resnet.us/uploads/documents/EnergyRatings_FactSheet_EnergyRating_Index.pdf.

guidance to the occupant on what their utility bills should be if they operate the home conservatively. From the viewpoint of compliance, a code official now has an additional tool to verify compliance using this path: documentation of the Energy Rating Index (ERI) score, and of compliance with the mandatory code provisions, prepared by a certified third party. The third-party verifiers improve compliance because they are quality checked on a random sample of their work. Result disclosure to the home's occupants can be anticipated, providing another layer of verification.[40]

EPA conducted analysis demonstrating estimates of representative incremental costs and savings over baseline IECC levels for several versions of the ENERGY STAR program. Version 3.0 homes yielded a net cash flow between $14 and $79 depending on climate zone compared to 2009 IECC homes.[41] Version 3.1 homes yielded a net cash flow between $18 and $55 compared to 2012 IECC homes.[42] Full details and breakdown of costs are outlined in the ENERGY STAR Version 3.1 Revision 08 Cost & Savings Estimates publication dated December 15, 2016.

DOE has compiled a number of case studies of actual homes that comply with the Zero Energy Ready Home program. Each one of these houses meets the requirements laid out in the

Figure 13. **Comparison of DOE Zero Energy Ready Home Case Study Homes[43] Projected Annual Utility Costs Without PV, Relative to House Size**



Note: The orange marker represents a typical home built to the 2006 IECC as a sample baseline.

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[40] "Fact Sheet: RE 188-13: Adding a Rating-Based Compliance Path to the IECC," Institute for Market Transformation, accessed December 6, 2017, p. 2, http://www.imt.org/uploads/resources/files/Fact_Sheet_on_ERI_Proposal.pdf.

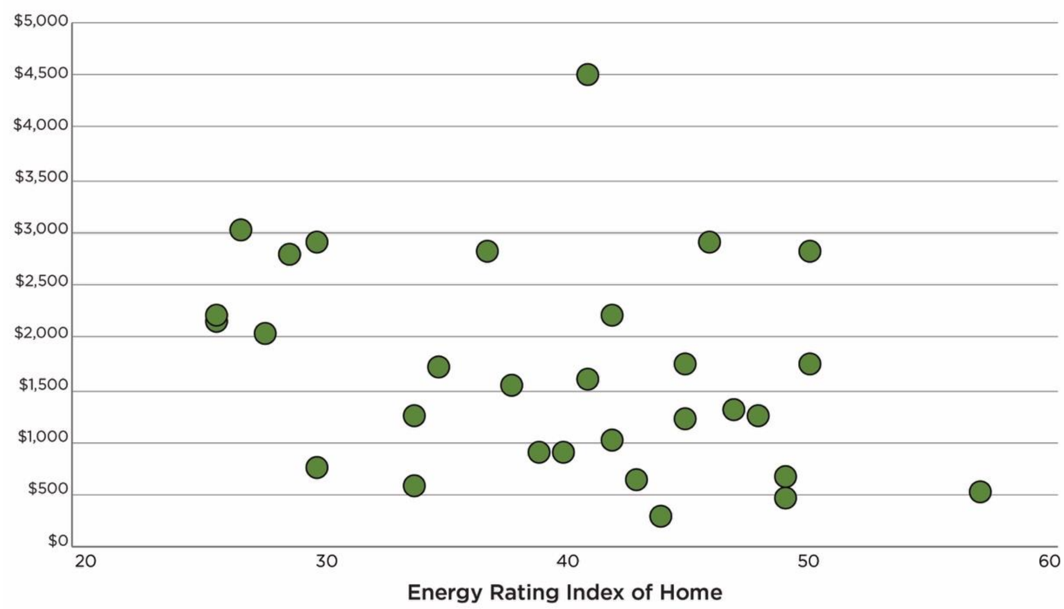
[41] *Cost & Savings Estimates: ENERGY STAR Certified Homes, Version 3 (Rev. 08)*, EPA, October 1, 2016, p. 24, https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/EstimatedCostandSavings.pdf?38bf-1827.

[42] *Cost & Savings Estimates: ENERGY STAR Certified Homes, Version 3.1 (Rev. 08)*, EPA, December 15, 2016, https://www.energystar.gov/ia/partners/downloads/ES_Version_3.1_Cost_Savings_Summary.pdf?ed1c-6bc9.

[43] "DOE Zero Energy Ready Home Resources," DOE, accessed December 2017, https://energy.gov/eere/buildings/doe-zero-energy-ready-home-resources.

specification and documents information about the constructed house. The following data demonstrate various results from roughly 30 of these homes, all built between 2012 and 2015.

Figure 14. **Projected Annual Energy Cost Savings, Without PV, Relative to Home's ERI**



1.7 Market Barriers

1.7.1 BUILDING MATERIALS, PRODUCTS, AND EQUIPMENT

The incremental cost of efficient resources or systems can drive up the price of an efficient home above that of a baseline home. Potential premiums can come from a variety of factors, including but not limited to:

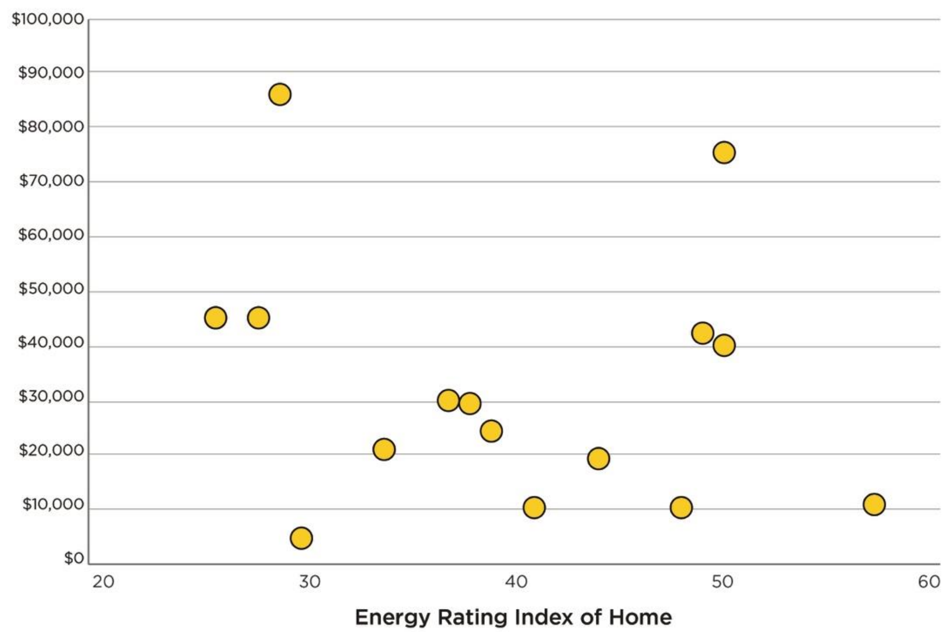
- **Production costs for niche products or materials** Some models or building components have less demand than their standard, mass-produced counterparts, resulting in higher cost per unit.
- **Increased design and energy modeling expenses** Supplemental considerations and whole house system design elements are often required to plan a highly efficient home, which can drive up the overall cost.
- **Additional installation requirements or instructions** Several components of a highly efficient home may require installation expertise or investment, resulting in higher overall costs. Envelope materials may take longer to install than traditional ones, and some equipment may have requirements or considerations that go beyond those of standard systems.
- **Higher initial cost for new technologies** Although products and practices that can be used to construct highly efficient homes are already available in the market, new options are continually under development and consideration for applications in new construction. Some

of these come with additional costs, whether from testing their application, higher initial production expenses, education and familiarization with products, or limited availability. Some examples of end uses that are either in their infancy or experiencing new developments include vacuum insulated panels, highly insulating and dynamic windows, lighting controls, building-integrated photovoltaics, and exterior-insulating finishing systems.

- **Investment in more raw materials** Highly efficient homes often install more square feet of insulation, use 2x6 framing instead of the traditional 2x4 studs, or opt for triple pane windows over standard double pane. These have implications for the total price of the home and can sometimes result in additional structural requirements or installation costs as well.

A sample of case study homes that were built to the DOE ZERH Program provided information on the incremental cost to construct these houses. While the graph below does not explain the variables or considerations specific to each home, such as size of the home, construction type, or equipment selected, it does demonstrate the wide range of costs beyond baseline homes that builders have identified.

Figure 15. **Incremental Cost (Without PV) to Builders to Construct DOE ZERH Relative to Home's Energy Rating Index**[44]



Despite overall project cost increases, there are several opportunities to reduce or minimize expenses through the design of highly efficient homes. Some examples include smaller or simpler HVAC systems, shorter piping requirements, and reduced framing materials.

[44] "DOE Zero Energy Ready Home Resources," DOE.

1.7.2 INDUSTRY PARTNERS AND WORK FORCE

To achieve scale in the high efficiency residential new construction sector, there needs to be:

1. A base of builders and contractors who are able and willing to construct these houses
2. Homebuyer demand for the product

These market changes entail education and awareness of critical building science elements, access to the various materials and supplies needed, and other resources to support the sizeable network of trade allies.

The residential new construction workforce consists of large national builders, regional builders, smaller contractors, and individual builders; the fragmented and localized nature of the industry results in many different touch points and stakeholders involved in the construction of each project. From a program perspective, encouraging market supply and demand requires high levels of coordinated communication with the trade ally networks to disseminate information effectively and develop a robust infrastructure.

As noted above, many materials and systems that are highly efficient come with additional installation requirements or considerations; these may require training or even certifications for the builders and contractors installing them in a new home.

Many new home voluntary programs have training or certification requirements that trade allies must meet and maintain to participate. These can apply across various stakeholder entities, including technicians, real estate professionals, subcontractors, raters, architects, builders, appraisers, supply firms, lenders, and inspectors. Education and training include time and financial investments, which can be a barrier for program uptake.

1.7.3 BUILDING CODES, STANDARDS, AND REGULATIONS

Regional minimum standards help to advance the market by increasing the baseline and driving greater levels of efficiency across the industry. While they ultimately serve to move building practices forward, local regulations sometimes create additional barriers for new home energy efficiency programs. The adoption of new building codes can result in initial market confusion as minimum requirements are adopted at municipal, local, and state levels. Proper workforce infrastructural elements, including certified inspectors, code officials, contractor base, and permitting bodies, need to be in place, apprised of the changes and capable of implementing them.

In addition, building codes impact the baseline from which programs can claim savings, affecting the overall deemed cost-effectiveness of an efficiency program's offerings. Although each program operates under different regulatory conditions, with varying metrics for evaluating savings, some face challenges achieving significant efficiency gains from their voluntary new construction programs as building code baselines ramp up. Building code adoption rates, adoption variance, and consistency of enforcement can impact program baselines, methodologies for claiming savings, and technical training considerations.

2 Initiative Goals, Strategies, and Activities

The purpose of this Initiative is to provide clear and credible definitions in the marketplace as to what constitutes highly energy efficient residential new construction, including criteria that help ensure quality construction practices. The core components address the following foundational objectives:

- Establish a framework for market differentiation based on performance of new residential construction through a tiered specification that leverages existing ANSI standards in the market
- Create opportunities for alignment and coordination with existing voluntary programs, where achievable
- Seek to harmonize metrics and methodologies with those most commonly referenced by state and local building codes, principally the Energy Rating Index (ERI) path included in both the 2015 and 2018 editions of the International Energy Conservation Code (IECC)
- Address quality assurance through minimum requirements that ensure robust measures above minimum code compliance
- Provide an elective platform from which members are able to support the adoption and inclusion of connected features within new home construction, increasing savings potential from program approaches that address energy efficiency, consumer engagement, or load management
- Offer optional considerations for programs interested in promoting non-energy benefits and other auxiliary considerations that characterize high performing homes, such as comfort, health, disaster resistance, risk mitigation, safety, durability, water efficiency, and indoor air quality

2.1 Notes and Future Considerations

House Size This Initiative does not dictate a stated position on house size but allows participants to elect whether or not to implement a sliding score as a mechanism for incentivizing the construction of smaller homes. While both ENERGY STAR and DOE Zero Energy Ready Home apply a Size Adjustment Factor (SAF) in their performance calculations, increasing the stringency of the specification for larger houses, the ERI found in the 2018 IECC is a purely fixed scale.

Referenced Standards This Initiative adopts the ERI, which is based on the ANSI/RESNET/ICC 301-2014 Standard. The referenced Standard is under continuous maintenance, in accordance with Section 10.9 of the *RESNET Standard Development Policy and Procedures Manual*. The ERI is also subject to the three-year code development cycle of the IECC.

It is therefore noted that the *CEE℠ Residential New Construction Initiative* references the ANSI/RESNET/ICC 301-2014 Standard version republished on January 15, 2016. If there are subsequent changes made to Standard 301-2014, CEE will evaluate these elements and consider formal revisions to this Initiative that reflect such updates.

Multifamily Buildings The proposed specification pertains to single family detached houses as outlined in the ENERGY STAR Certified Homes scope, though CEE believes there is additional opportunity to address other residential markets, primarily multifamily buildings of various heights and manufactured homes. Future iterations of the Initiative will explore strategies for incorporating requirements for other types of buildings that fall outside the scope of this initial publication.

Canadian Market The proposed specification can be adopted by any program but is most applicable in the United States market. CEE may develop a complementary specification that translates ERI levels into equivalent metrics relevant to the Canadian market at some point in the future, should it be deemed appropriate. Given that the building industry does not conduct much work across borders, and that there is not yet significant demand from members to pursue a Canadian conversion, CEE plans to wait until a future iteration of the Initiative to consider development of an alternative specification using energy units applicable in Canada's new construction market.

Connectivity Connected devices enabling two-way communication may unlock new program opportunities that complement traditional efficiency measures. CEE is exploring the potential of such products and systems to address customer engagement, load management including demand response, EM&V, and integration of intermittent renewable energy sources.

An integrated home leverages communicating capabilities to capture opportunities beyond those of individual and discrete connected end measures. It hinges on enhanced levels of data, learning capacities, controls, sensors, and more. As technology and consumer expectations are evolving, so are residential programs; multiple products are coming together in a shared space and potentially providing added value. In addition, connected capabilities may enable new avenues that support increased efficiency, load management, and behavior change opportunities.

To the extent that connectivity can advance energy savings, enhance the customer experience, and deliver grid benefit through the integrated home, CEE plans to explore and assess potential opportunities for binational coordination and ultimately enhance connected requirements in future iterations of the *CEE℠ Residential New Construction Initiative*.

Program Design This Initiative lays out voluntary requirements for programs to consider adopting in their new construction offerings. It does not provide recommendations for how these specifications could be deployed in the market to most effectively drive market transformation. CEE will consider developing supplementary resources that support this Initiative and offer suggestions for effective program delivery. This could include strategies for comprehensive design structure, practices for strengthening trade ally relationships, illustrations of contractor training and partnership opportunities, examples of marketing or messaging campaigns, and discussion of ongoing program maintenance.

Future Revisions CEE will assess the need to revise this Initiative based on market conditions, program needs, and emerging trends in the new construction industry. Members will evaluate when it is appropriate to update the Initiative and engage with industry stakeholders at relevant stages in this process.

3 Residential New Construction Specification

3.1 Eligibility[45]

As with the ENERGY STAR Versions 3.0, 3.1, and 3.2 specifications, any of the following homes are eligible:

- Detached dwelling units, i.e. single-family homes
- Dwelling units in any multifamily building with four units or fewer
- Dwelling units in multifamily buildings with three stories or fewer above grade
- Dwelling units that have their own heating, cooling, and hot water systems in multifamily buildings with four or five stories above grade,[46] separate from other units, and where dwelling units occupy 80 percent or more of the occupiable square footage of the building.[47] When evaluating mixed-use buildings for eligibility, exclude commercial and retail space when assessing whether the 80 percent threshold has been met.

Note that compliance with these guidelines is not intended to imply compliance with all local code requirements that may be applicable to the home to be built.

For reference, ENERGY STAR national program requirements, including definitions and eligibility details, are outlined on the EPA website.

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[45] "National Program Requirements: ENERGY STAR Certified Homes, Version 3 (Rev. 08)," ENERGY STAR, last revised December 14th 2015, p. 1, https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/ES%20NPR%20v84%202015-12-09_clean_508.pdf?99f2-6220.

[46] Central systems for domestic hot water are allowed if solar energy provides at least 50 percent of the domestic hot water needs for the residential units.

[47] Units that have their own heating, cooling, and hot water systems separate from other units in multifamily buildings with four or five stories above grade, including mixed-use buildings, but where dwelling units occupy less than 80 percent of the residential, i.e., excluding commercial and retail space for mixed-use buildings, occupiable square footage of the building may earn the ENERGY STAR through either the New Homes Program or the Multifamily High Rise Program if permitted prior to July 1, 2012. Units in buildings of this type that are permitted after this date shall only be eligible to earn the ENERGY STAR through the Multifamily High Rise (MFHR) Program.

3.2 Tiered Specification Structure

The following specification is designed to promote increasingly stringent Energy Rating Index scores as the founding principle, with minimum quality assurance prerequisites to bolster the incremental energy gains. This underlying concept may be modified or adapted in several ways, described below, to address the specific needs and goals of an individual program.

This specification does not dictate how renewable energy is incorporated or credited, but rather leaves this consideration up to individual programs to determine. As the tiers become increasingly stringent, including renewables will inevitably become necessary to reach the target levels. CEE recommends that programs encourage adoption of all cost-effective efficiency measures before inclusion of renewables; additional notes about renewables are in 4.2.

3.2.1 ENERGY RATING INDEX LEVELS

The individual tier levels represent maximum ERI scores that may garner energy savings in various areas across the country, depending on the relative baselines. While the Base tier reflects a score that some members will find useful to employ in their service territories at this time, CEE anticipates that it will become obsolete as the market advances; members will assess when to retire the Base tier in response on industry trends and program needs.

For the subsequent tiers, CEE provides a maximum ERI score, with more tailored climate-specific scores recommended where applicable. Given that the new construction industry is largely localized, CEE believes that variance of individual ERI scores promoted across the United States will not hinder the ability for this Initiative to drive coordinated market transformation.

Tier 5 is the most advanced tier and is conceptually considered a “zero net energy” level. While CEE is not aware of any homes that have achieved an ERI below 26 before the inclusion of renewables, an ERI of 10 provides a very aggressive stretch target that could potentially be met through future technological advancements. Many members have expressed interest in having a tier that nominally represents a “zero net energy” home and note that a home with an ERI of 10 represents the same efficiency gains as one with an ERI of 0, given that renewables must be included once the maximum technical potential is reached. Programs may determine subsequently how to promote, message, or frame this Tier 5 in their jurisdictions to drive the greatest uptake in their markets.

3.2.2 QUALITY ASSURANCE REQUIREMENTS

As part of a comprehensive program that delivers high performing homes, the CEE specification proposes minimum quality assurance measures as a fundamental requirement across all tiers. It is important that homes receive robust verification to ensure that they are being constructed to the appropriate standard, garnering the energy savings they are designed to achieve, and leading to greater customer satisfaction.

CEE recommends ENERGY STAR Certified Homes as the specific platform to achieve quality assurance measures, as this program is explicitly designed with such provisions in mind and demonstrates a cost-effective approach to achieve these goals. Where adoption of this minimum prerequisite is not possible, or if a program determines that an alternative mechanism is more appropriate for their respective goals, CEE allows program administrators to implement an alternative requirement that addresses quality assurance. For those opting to employ a measure other than ENERGY STAR Certified Homes, CEE requests that detailed information about the requirement components and its associated costs be provided to CEE.

As houses become increasingly efficient, it becomes even more important to address performance and ensure that building science principles are properly employed. For this reason, CEE also recommends that programs adopt additional requirements beyond the ERI score for higher tiers. The DOE Zero Energy Ready Home is one such vetted program, with criteria specifically designed to address the considerations relevant to high performing homes.

CEE recognizes that there are many other criteria or components that programs may be interested in addressing through their new construction offerings. While this specification does not require any of them, there may be merit to promoting additional features designed around non-energy benefits, customer satisfaction, or further energy gains. See Additional Optional Components for details about these options and methodologies for project eligibility.

CEE believes that any strategy can offer credible energy savings and promotes consistent strategies for broader market transformation, provided it implements a tiered approach of requiring ERI scores that move towards zero net energy.

Figure 16. **CEE New Construction Specification Levels**

	Base	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Energy Rating Index Score	≤ 75	≤ 65*	≤ 55*	≤ 45*	≤ 30	≤ 10
Quality Assurance: ENERGY STAR Certified Homes or similar	✓	✓	✓	✓^	✓^	✓^

* For Tiers 1, 2, and 3, CEE provides recommended ERI target scores broken down by individual climate zone.

^ For Tiers 3, 4, and 5, CEE recommends, but does not require, the inclusion of additional quality assurance measures, such as the DOE Zero Energy Ready Home, to address the increasingly complex building science considerations associated with highly efficient homes.

Figure 17. **Recommended ERI Target Scores**[48, 49, 50]

Climate Zone	Tier 1		Tier 2	Tier 3
	2018 IECC (ERI Path)	2015 IECC (ERI Path): eqCusp+10%	2015 IECC (ERI Path) Stretch: eqCusp+15%	ASHRAE SSPC 90.2 Proposed Standard
Zone 1	≤ 57	≤ 52	≤ 49	≤ 43
Zone 2	≤ 57	≤ 52	≤ 49	≤ 43
Zone 3	≤ 57	≤ 51	≤ 48	≤ 45
Zone 4	≤ 62	≤ 54	≤ 51	≤ 47
Zone 5	≤ 61	≤ 55	≤ 52	≤ 47
Zone 6	≤ 61	≤ 54	≤ 51	≤ 46
Zone 7	≤ 58	≤ 53	≤ 50	≤ 46
Zone 8	≤ 58	≤ 53	≤ 50	≤ 45

"eqCusp" denotes incorporation of higher efficiency equipment on the cusp of significant market adoption as of 2013.

4 Additional Optional Components

The CEE specification does not require the adoption of any features that are outside the scope of demonstrable energy savings. The subjects outlined in this section are areas that CEE will consider incorporating into the specification requirements in future revisions of the Initiative. At this time, however, there is not enough data to credibly demonstrate guaranteed energy efficiency savings. For this reason, they remain as optional areas for members to individually assess and determine their appropriate role in their respective new homes programs.

4.1 Ancillary Benefits and Enhanced Building Science

Programs may find value in promoting features that do not fall strictly within energy performance metrics. These may address areas of particular relevance in given regions, such as water efficiency or load management, or ones that incorporate features outside of strictly efficiency, such as the non-energy benefits outlined in Section 2.5. For programs interested in applying ancillary components, this section provides a directory of platforms that address various considerations for new construction. While not comprehensive in scope, the following list offers programs or specifications that address facets outside of efficiency.

[48] "Energy Rating Index Performance Path: Overview of the ERI Performance Path in the 2015 IECC," RESNET, 2014, http://www.resnet.us/blog/wp-content/uploads/2014/06/EnergyRatings_FactSheet1_Final.pdf.

[49] *Analysis of HERS Index Scores for Recent Versions of the International Energy Conservation Code (IECC)*, 2013.

[50] Levels proposed for 90.2 Standard, developed by ASHRAE SSPC 90.2. The goal of the Standard is to recognize new homes with energy costs that are approximately 50 percent of the energy cost of a home that is minimally compliant with the 2006 IECC. Additional analysis is available in *Maximum Energy Efficiency Cost Effectiveness in New Homes Construction,* Florida Solar Energy Center, May 20, 2015, http://www.fsec.ucf.edu/en/publications/pdf/FSEC-RR-584-15.pdf.

- EPA Indoor airPLUS construction specification
- DOE Zero Energy Ready Home PV-Ready Checklist
- Green Builder® Coalition's Water Efficiency Rating Score (WERS)®
- RESNET Water Efficiency Rating (WER) Index Standard (in development)
- Florida Water Star℠
- WaterSense Labeled New Homes Partnership Program
- Institute for Business and Home Safety (IBHS) FORTIFIED Home
- DOE Zero Energy Ready Home Solar Hot Water-Ready Checklist

Additional analysis and comparison of impacts relative to code is necessary for all of the above ancillary services and non-energy benefits.

4.2 Renewables

The ERI score is generated by a method that credits on-site renewable generation such as solar PV or hot water against fuel use for both gas and electricity. If a program administrator wishes to distinguish efficiency from renewables, it can specify that the ERI score be calculated ignoring the contribution of renewables. Alternatively, an administrator might want to credit renewable energy only after a minimum threshold has been met using efficiency alone; this methodology is employed in the ERI path of the 2018 IECC, which includes prescriptive backstops for those opting to use PV.

4.3 Connectivity

Members may determine that there is merit to promoting connected requirements for a variety of potential grid, program, and customer benefits. Connected capabilities have the potential to achieve increased efficiency gains, optimize equipment and building performance, add market value to the home, enable greater consumer engagement and amenity, and enable load management opportunities such as demand response, energy storage, and peak load shifting. For programs interested and able to include connected requirements in their offerings, CEE offers the following two strategies for consideration:

- Any products or equipment installed in the house would meet the connected requirements outlined in the respective ENERGY STAR or CEE specifications, where available.
- CEE connected criteria advocate for multiple pathways to connect, including a direct, on-premise open standards connection option to ensure most consumers realize benefits.

Diversity in the conditions encountered by CEE members, such as regulatory environment, terrain, customer density, and metering infrastructure, may require a variety of communication technologies to reach devices for demand response, energy efficiency, and other amenities afforded by connectivity. Acceptable pathways must address this diversity and provide consumers with flexibility; CEE believes that having an on-premise connection option helps provide consumers, utilities, manufacturers, and third parties with flexibility, and will ultimately enhance interoperability within an integrated home.

The home would have minimum infrastructural components and elements designed to support future applications and technologies, including enhanced data reporting. Although CEE does not provide specific consensus criteria or language for infrastructural elements at this time, we note some examples of such requirement concepts below:

- The house must have multiple built-in pathways for connection that enable signals and data to meet diverse communication conditions; this may entail at least one non-cloud means of two-way communication and data reporting, such as radio frequency signal communication for populations not served by wireless internet connectivity.
- The house must install a smart meter that can report data at a certain frequency and level of granularity.
- The house must be equipped with energy monitoring and reporting capabilities that can also provide disaggregated load energy information to customers, a utility, or another authorized third party.

For reference, an overview of the CEE connected consensus positions can be found in Appendix C.

4.4 Minimum Prescriptive Requirements

CEE recognizes that adoption of a pure performance path leaves it entirely up to contractors to choose how they meet these levels and what measures they use to reach the respective targets. In some circumstances, programs may wish to require certain building techniques, design strategies, or technologies as fundamental components that must be included in all projects. This may be especially applicable relative to varying climate factors, unique construction types, local code structures, or cost-effectiveness considerations based on the fuels for which the program claims savings. CEE leaves it up to programs to determine whether the inclusion of minimum prescriptive requirements is appropriate.

5 Initiative Participation

Initiative Participation is an opportunity for individual efficiency organizations to amplify the impact of their local efficiency programs. By giving voice to participation in this Initiative, individual organizations are counted as part of a collective, harmonized effort to advance efficiency. As with all CEE initiatives, participation in the *CEE℠ Residential New Construction*

Initiative is voluntary. To be considered an Initiative participant, the following are the minimum requirements:

1. Promote at least one of the tiers within the CEE Residential New Construction Specification through either an incentive-based or an educational program.

2. Communicate to CEE that you voluntarily elect to participate in the Initiative. If employing a quality assurance requirement other than ENERGY STAR Certified Homes, provide CEE with a description of the measures and associated costs. CEE typically publishes publicly available program information furnished by Initiative Participants in an annual program summary and in other communications to key market players about Initiative impacts, which serve to advance the goals of the Initiative.

This Initiative is offered for use to any CEE member who agrees to the terms of use.

Appendix A **Organizations and Abbreviations**

ANSI—American National Standards Institute

ASHRAE—*formerly* the American Society of Heating, Refrigerating and Air Conditioning Engineers

CEE—Consortium for Energy Efficiency

CFA—Conditioned Floor Area

Coalition—Green Builder® Coalition

DOE—US Department of Energy

EGC—Enterprise Green Communities

EIA—US Energy Information Administration

EPA—US Environmental Protection Agency

ERI—Energy Rating Index

FGBC—Florida Green Building Coalition

FSEC—Florida Solar Energy Center

FWS—Florida Water Star

HERO—High Efficiency Residential Option

HERS—Home Energy Rating System

HUD—US Department of Housing and Urban Development

HVAC—Heating, ventilation, and air conditioning

ICC—International Code Council®

IECC—International Energy Conservation Code

ILFI—International Living Future Institute

IMT—Institute for Market Transformation

IRC—International Residential Code

LBA—Leading Builders of America

LEED—Leadership in Energy and Environmental Design

MLS—Multiple Listing Service

NAHB— National Association of Home Builders

NGBS— National Green Building Standard

NRCan—Natural Resources Canada

NRDC—Natural Resources Defense Council

PHIUS—Passive House Institute of the United States

PV—Photovoltaic

RDI—Resilient Design Institute

RESNET—Residential Energy Services Network

SAF—Size Adjustment Factor

SEER—Seasonal Energy Efficiency Ratio

SHGC—Solar Heat Gain Coefficient

Appendix B **Background Information**

International Energy Conservation Code[51]

The first edition of the International Energy Conservation Code (1998) was based on the 1995 edition of the Model Energy Code promulgated by the Council of American Building Officials (CABO). It included changes approved through the CABO code development procedures through 1997. CABO assigned all rights and responsibilities to the International Code Council and its three statutory members at that time, Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International (SBCCI).

The IECC is founded on principles intended to establish provisions that are consistent with the scope of an energy conservation code that adequately conserves energy; do not unnecessarily increase construction costs; do not restrict the use of new materials, products or methods of construction; and do not give preferential treatment to particular types or classes of materials, products or methods of construction.

The IECC is available for adoption and use by jurisdictions internationally. Its use within a governmental jurisdiction is intended to be accomplished through adoption by reference in accordance with proceedings establishing the jurisdiction's laws. The code is kept up to date through the review of proposed changes submitted by code enforcement officials, industry representatives, design professionals, and other interested parties. Proposed changes are considered through an open code development process in which all interested and affected parties may participate.

The contents of the code are subject to change both through the Code Development Cycles and by the governmental body that enacts it into law. While the development procedure of the IECC assures the highest degree of care, ICC, its members, and those participating in the development of the code do not accept any liability resulting from compliance or noncompliance with the provisions because ICC and its members do not have the power or authority to police or enforce compliance with the contents of the code. Only the governmental body that enacts the code into law has such authority.

ERI Background and Methodology

The ANSI/RESNET/ICC 301-2014 Energy Rating Index (ERI) optional path was first introduced in the 2015 IECC through Section R406, "Energy Rating Index Compliance Alternative." In addition

[51] 2012 International Energy Conservation Code®, International Code Council, May 2011.

to the prescriptive option, builders can choose to meet a target ERI score through various combinations of construction choices. The ERI value is defined as a numerical score where 100 is equivalent to the performance of a home built to the 2006 IECC and 0 is equivalent to a zero net energy home. Every integer on the scale is equivalent to a one percent change in the total energy use of the rated design of the home relative to the total energy use of the ERI reference design home, which is based on the 2009 IECC. Verification of ERI compliance must be conducted by an approved third party.

To date, the RESNET HERS Index is one of the most common systems to use an ERI, although other options could enter the market in the future.

RESNET and the HERS Index[52]

The Residential Energy Services Network (RESNET) is a not-for-profit membership corporation that is governed by a board of 20 who are elected by the membership. RESNET is a recognized national standards-making body that builds energy efficiency rating and certification systems in the United States through a consensus standard development and amendment process, a transparent review and adoption process, and a formal public review and comment process.

Developed in 2006, the Home Energy Rating System (HERS) Index is a numerical rating system that measures a home's energy efficiency. It is also a nationally recognized system for inspecting and calculating a home's energy performance.

RESNET has created a publicly available online National Rating Registry that contains information on certified HERS Raters and Home Energy Ratings. Each rated home is entered in this database, including the home's address, the rating company that rated the home, the date that the rating was completed, and the HERS Index Score of the home.

[52] More information on RESNET and the HERS Index can be found at http://www.resnet.us and http://www.hersindex.com/.

Appendix C CEE Connected Principles

Energy-consuming devices with connected capabilities may have the potential to unlock new savings opportunities that complement traditional efficiency measures. Connected products and systems may be useful for programs beyond new savings through applications relevant to customer engagement, load management including demand response, program EM&V, and integration of intermittent renewable energy sources.

Currently, we believe CEE members are in agreement on the following principles.

- Use of open, nonproprietary communication standards to achieve interoperability is required. Interoperability with multiple products and manufacturers is desirable so that customers continue to retain flexibility for future product choice across manufacturers and service providers and so that the costs to connect are minimized. Currently, connectivity within the physical premises of the building though open standards in addition to any other connection pathways is necessary to enable many types of DSM programs.
- Establishing multiple pathways to connect is likely necessary to ensure that the majority of consumers realize benefits. The diverse conditions encountered by CEE members require a variety of communication options to enable signals and data to reach devices for demand response, energy efficiency, and other amenities afforded by connected systems. Acceptable pathways must address this diversity and provide consumers with flexibility.
- Understanding the location of connected products and maintaining a network of connected products at the substation level at a minimum to maximize the load management benefits of connected products.
- Acceptable communication pathways must secure customer data and adequately protect privacy consistent with the expectations of regulators.
- Products must be responsive to grid signals, in addition to reliability signals. Connected products should support emerging behavior change based on information and variable pricing demand response programs.
- Connected devices must demonstrate the ability for a utility signal or equivalent to reach the connected product consistently and reliably in a predetermined increment of time.
- Capability to share basic energy data, such as amps, watts, operational status during a demand response event, or average consumption, is required. We are currently establishing consensus lists of “must have” and “nice to have” data.