Programs to Promote Zero-Energy and Zero-Carbon New Homes and Buildings

Steven Nadel

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White Paper

ACEEE

About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

About the author

Steven Nadel has been ACEEE's executive director since 2001. He has worked in the energy efficiency field for more than 40 years and has over 200 publications. His current research interests include decarbonization strategies for the buildings, industrial, and transportation sectors; federal, state, and local energy and climate change policy; utility-sector energy efficiency programs and policies; and appliance and equipment efficiency standards. Steve earned a master of science in energy management from the New York Institute of Technology and a master of arts in environmental studies and a bachelor of arts in government from Wesleyan University.

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Executive summary

Key findings

• We identified 22 programs—across 13 U.S. states and one Canadian province—that promote new zero-energy and zero-energy-ready homes and buildings (as defined below); 14 are residential programs, and 8 serve commercial buildings.

• Most of the programs focus on zero-energy-ready new construction, but several have zero-energy paths.

• Several programs explicitly target affordable housing, while other programs give higher incentives for affordable housing.

• Together, the programs have an annual budget of approximately $110 million for 2024. This is about 70% higher than the total budget in our similar 2020 study.

• More than 5,000 new single-family homes, nearly 25,000 new apartments, and 222 new commercial buildings totaling 9.5 million sq. ft. have been completed through these programs. These figures do not include most of the 25,000 homes completed under the DOE Zero-Energy-Ready Homes program, a growing national program.

• A majority of the completed homes and apartments are in Massachusetts and New York, while a substantial majority of completed commercial buildings are in Oregon, New York, and Vermont.

• Many other projects are currently under construction, including more than 60,000 apartments and 325 commercial buildings (totaling more than 94 million sq. ft.). California accounts for a large share of these pending projects.

• Relative to our 2020 study, we noticed a few trends. For example, many new-construction programs require electric space and water heating. Also, some programs that allow fossil-fuel heating provide extra incentives for electrifying these end uses. Several program managers note that as their electric grids become increasingly clean, going all-electric can become a path to zero emissions.

As baseline building energy codes become more stringent, a growing number of efficiency program administrators are focusing all or a portion of their new-construction programs on zero-energy and/or zero-carbon buildings. In addition, a growing number of programs are also focusing on improved implementation of current building codes (Garfunkel and Waite 2024). If the United States is to dramatically reduce greenhouse gas emissions, we need to build new homes and buildings to minimize energy use and emissions, which means using zero-energy/carbon designs—or getting as close to this goal as possible.

What is a zero-energy building? What is a zero-carbon building?

A zero-energy building is an energy-efficient building in which, over the course of a year, the amount of energy that it produces or that its site produces (typically from photovoltaic panels) equals or exceeds both the amount it purchases from utilities and the energy losses associated with generating this electricity and bringing it and natural gas to the building. Some buildings and programs are seeking to

move to net-zero carbon or net-zero emissions, meaning that carbon dioxide emissions are net zero over the course of a year. The difference between zero energy and zero carbon is that the latter accounts for the carbon emissions associated with electric power generation, including when that power is needed and which generating plants are operating at those times.

Short of zero energy or zero carbon, some programs promote zero-energy-ready buildings, which are typically highly efficient—that is, efficient enough to be operated with onsite energy—but they lack the solar energy systems needed to make the building truly zero energy. Zero-energy-ready buildings often include the floor and roof configurations, conduit or wiring, and electric panel capacity that make it easy to hookup electric heating and cooking equipment and a solar system in the future. Zero-energy-ready buildings are sometimes called near-zero; while zero-energy ready has multiple definitions, such buildings typically use 25–50% less energy than current building code requirements. Many of the programs we profile in this paper promote both zero-energy and zero-energy-ready buildings.

Key lessons are already emerging

In this paper, we profile 22 zero-energy/carbon programs. Our Key Findings above summarize our analysis of those programs. All programs report many lessons learned, including the following key lessons:

- Residential programs find that it is important to train builders on how and why to build to zero energy/carbon, as well as to make special efforts to target the largest builders, who can have the greatest impact.
- Commercial programs find that building a community of practitioners is very important, as is intervening early in the design process and using this early intervention to set and follow through on energy design goals.
- Programs report that it is useful to have simple incentive structures that are easily understood by builders, designers, and developers.
- Programs also find that it is essential to highlight the multiple benefits of zero-energy homes and buildings. These benefits include impacts on comfort, health, building resilience, and employee satisfaction, in addition to operating cost savings.

These programs are an important contributor to efforts to transform new-construction markets and ultimately make zero-energy and zero-carbon common practice.

Introduction

As baseline building energy codes become more stringent, a growing number of efficiency program administrators are focusing all or some of their new-construction programs on zero-energy and/or zero-carbon buildings. This paper aims to aid these efforts by providing information on current programs.

What is a zero-energy building? What is a zero-carbon building?

According to an official definition by the U.S. Department of Energy (DOE), a zero-energy building (ZEB) is "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" (Peterson, Torcellini, and Grant 2015, p. 4). In other words, over the course of a year, the amount of energy that a building produces or its site produces (typically from photovoltaic panels) equals or exceeds both the amount of energy it purchases from utilities and the energy losses associated with generating this electricity and bringing it and natural gas to the building. This is sometimes referred to as net-zero energy because the building sometimes needs external energy, but this is offset by extra energy produced at other times. Other definitions of ZEBs address issues such as whether offsite renewable energy can be used, either from community-based projects or by purchasing renewable-energy credits.

Some buildings and programs are seeking to move not just to zero energy but also to zero carbon (sometimes called zero emissions), meaning that carbon dioxide emissions are net zero over the course of a year. The difference between zero energy and zero carbon is that the latter accounts for the carbon emissions associated with electric power generation, including when that power is needed and which generating plants are on the margin at those times. The emissions from producing building materials (e.g., steel and cement) are sometimes included as well. These additional emissions are often labeled as embodied carbon. The White House is now developing a definition of zero-carbon buildings with two phases; embodied carbon is included in phase 2 (DOE 2024a).

Many current programs use a zero-energy framing to create market awareness and a foundation for the path to zero carbon.

Why ZEBs?

If the United States is to dramatically reduce greenhouse gas emissions, we need to build new homes and buildings to minimize energy use and emissions, which means transitioning to zero-energy/carbon or near-zero-energy construction. A 2019 ACEEE study found that zero-energy new buildings are a key ingredient in efforts to use energy efficiency to cut U.S. energy use and greenhouse gas emissions in half by 2050, with remaining needed emissions reductions coming from no- and low-emissions energy sources (Nadel and Ungar 2019). States such as California (CPUC 2020) and organizations such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (ASHRAE 2023) and Architecture 2030 (2023) have established goals to make zero energy and/or zero emissions the standard for new buildings by 2030. ZEBs generally have many nonenergy benefits relative to standard buildings, including that they offer improved comfort; improved occupant health and productivity; more living/working space (because they need less space for heating and cooling systems); and higher occupancy rates and resale values due to the attractiveness of the zero-energy concept to building purchasers and renters (Pande et al. 2019).

Zero energy and zero-energy ready

ZEBs use no net energy on an annual basis. Zero-energy-ready buildings are typically highly efficient—efficient enough to be operated with onsite energy—but they lack the solar energy systems needed to make the building truly zero energy. Zero-energy-ready buildings often include the floor and roof configurations, conduit or wiring, and electric panel capacity that make it easy to hook up electric heating and cooking equipment and a solar system in the future. Zero-energy-ready buildings are sometimes called near-zero; while there are multiple definitions of zero-energy ready, such buildings commonly use 25–50% less energy than standard construction. Many of the programs profiled in this paper promote both zero-energy and zero-energy-ready buildings.

The relationship between ZEBs and electrification

ZEBs are highly efficient and often use electric heat pumps to provide heating, cooling, and hot water. In many states, electricity generation is rapidly decarbonizing. Furthermore, all-electric construction avoids the costs of gas piping and hookups. Some programs profiled in this brief are available only to all-electric homes and buildings or include all-electric options. But some zero-energy homes and buildings do include a small amount of fuel use (e.g., some homes might use gas for cooking). Many zero-carbon buildings do not use fuel.

Above-code specifications that support zero-energy and zero-energy-ready construction

Various above-code standards and rating systems are available to demonstrate compliance with zero-energy design and operation. These include the Passive House specification (both international and U.S versions) (IPHA 2024; PHIUS 2024); the DOE Zero Energy Ready Homes (ZERH) specification and program (discussed below); the Living Future Institute's Living Building Challenge, which includes a comprehensive living-buildings specification and certifies zero-energy and zero-carbon performance (International Living Future Institute 2024); and Leadership in Energy and Environmental Design (LEED) Zero, which certifies buildings that are zero carbon, zero energy, and zero water (USGBC 2024). Also, some residential programs reference ENERGY STAR® NextGen, a specification that combines the ENERGY STAR New Homes certification with high-efficiency electric appliances for heating, water heating, and cooking and a requirement for installing wiring for an electric vehicle (EV) charger (EPA 2024).

The economics of zero-energy homes and buildings

Zero-energy homes and buildings often cost a little more than conventional homes and buildings, but as experience is gained, costs are going down. Furthermore, some of these costs can be offset by cost savings made possible by very low energy use, which avoids the cost of gas lines and allows the use of simple, relatively inexpensive heating and cooling systems (Petersen, Gartman, and Cordivae 2019). A study by the U.S. Green Building Council's Massachusetts chapter illustrates the economics of ZEBs. As figure 1 shows, it examined six building types and found that zero-energy designs could typically reduce building energy use by 44–56% and reduce total building costs (mortgage, energy, and other costs discounted over 30 years) by 0.3–9.8%. In its primary scenario, the simple payback period on incremental costs was 6–19 years, depending on the building type.

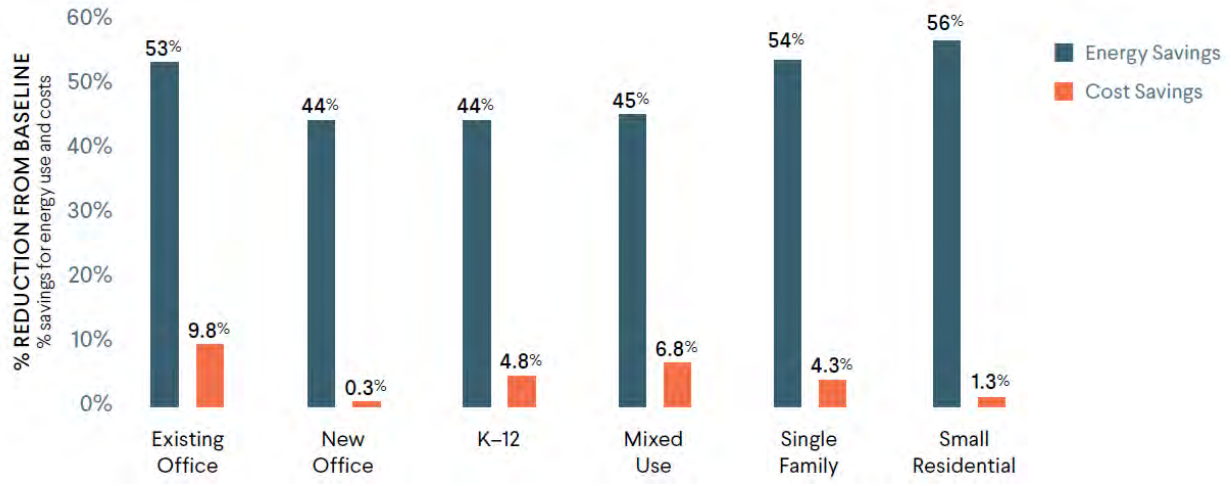

Figure 1. Zero-energy building percentage reduction in energy use and cost for six building types.
Source: **USGBC Massachusetts 2019.**

Progress on ZEBs to date

The number of zero-energy and near-zero homes and buildings has grown steadily in recent years. As of mid-2022, nearly 700 net-zero (energy or emissions) commercial and multifamily buildings have been catalogued in the United States and Canada (NBI 2022). This is a dramatic increase from the 78 buildings identified in a 2012 report (NBI 2012). For the residential sector, there were 38,646 net-zero or zero-energy-ready (ZER) single-family homes as of mid-2022, up 440% from 2020 (EEBA 2022).

New-construction programs

For many years, utilities and other program administrators have operated programs to improve the efficiency of new homes and buildings. Generally, these programs also cover major renovations to existing buildings. They also typically use current building energy codes as a base and then encourage construction of homes and buildings that are significantly above code. For example, many new-home programs use the ENERGY STAR® New Homes specification, which typically requires about 15% energy savings beyond code. These programs pay builders an incentive for meeting the ENERGY STAR specification, and often provide training and marketing assistance. For commercial buildings, new-construction programs typically have two tracks—prescriptive and performance. With a prescriptive track, the program provides incentives (typically to the developer) for specific beyond-code measures such as higher-efficiency heating and cooling equipment and lighting control systems. With a performance track, computer simulations of the proposed design are used to help optimize performance of the overall building. These results are compared with the same building designed to merely meet the requirements of the current code, with incentives paid per unit of energy savings beyond code. Prescriptive approaches are often viewed as easier to use, but they typically offer lower energy savings than performance approaches.

Zero-energy programs often build on these frameworks. For example, new-home programs may have more-stringent specifications and higher incentives for zero-energy-ready homes and sometimes also provide incentives for solar systems. Achieving net zero in commercial buildings almost always requires using the performance path, with design assistance and computer modeling provided or funded by the program. The program descriptions below provide further details.

Research questions

As noted above, as baseline building energy codes become more stringent, a growing number of program administrators are focusing all or some of their new-construction programs on ZEBs. This paper intends to aid these efforts by providing information on current programs; it thereby offers support for program implementers considering zero-energy programs. The information here builds on and revises a 2020 ACEEE paper on this subject (Nadel 2020) and seeks to answer the following questions:

- What programs are utilities and states offering to encourage new zero-energy/carbon and zero-energy-ready homes and buildings?
- What services and incentives are available? How are they structured?
- What participation levels have these programs achieved?
- How much have these programs cost and saved so far?
- What lessons have they learned?
- What do the programs' experiences indicate for future efforts?
- What significant changes have been made to these programs and metrics since the 2020 ACEEE paper on this subject?

To make the scope of this project manageable, we focus on programs funded by utilities and states, which are often large programs, though we briefly mention a federal program. We also concentrate on new-construction programs (including major renovations) rather than retrofit programs.

Methodology

Because this paper is an update of a 2020 ACEEE paper with a similar title (Nadel 2020), we began our work by reaching out to all of the programs covered in that earlier paper. We also asked experts on new-construction programs for examples of other zero-energy programs that they were familiar with. As a result, several programs were added that were not in the 2020 paper. Still, it is possible that we missed some programs. Next, we reached out to each of the program administrators for an interview to learn more about the program and the lessons learned. We also asked program managers to complete a one-page data form. On the basis of this information, we compiled short write-ups on each program and summarized the available data. We then sent the draft write-ups and data to each program administrator for verification.

We now describe the programs we researched, and then discuss the available data. We end with a general discussion (including lessons learned) and our conclusions.

Programs

In total, we compiled information on 22 programs. Figure 2 shows the locations of the programs, which include 14 residential programs and 8 commercial programs.

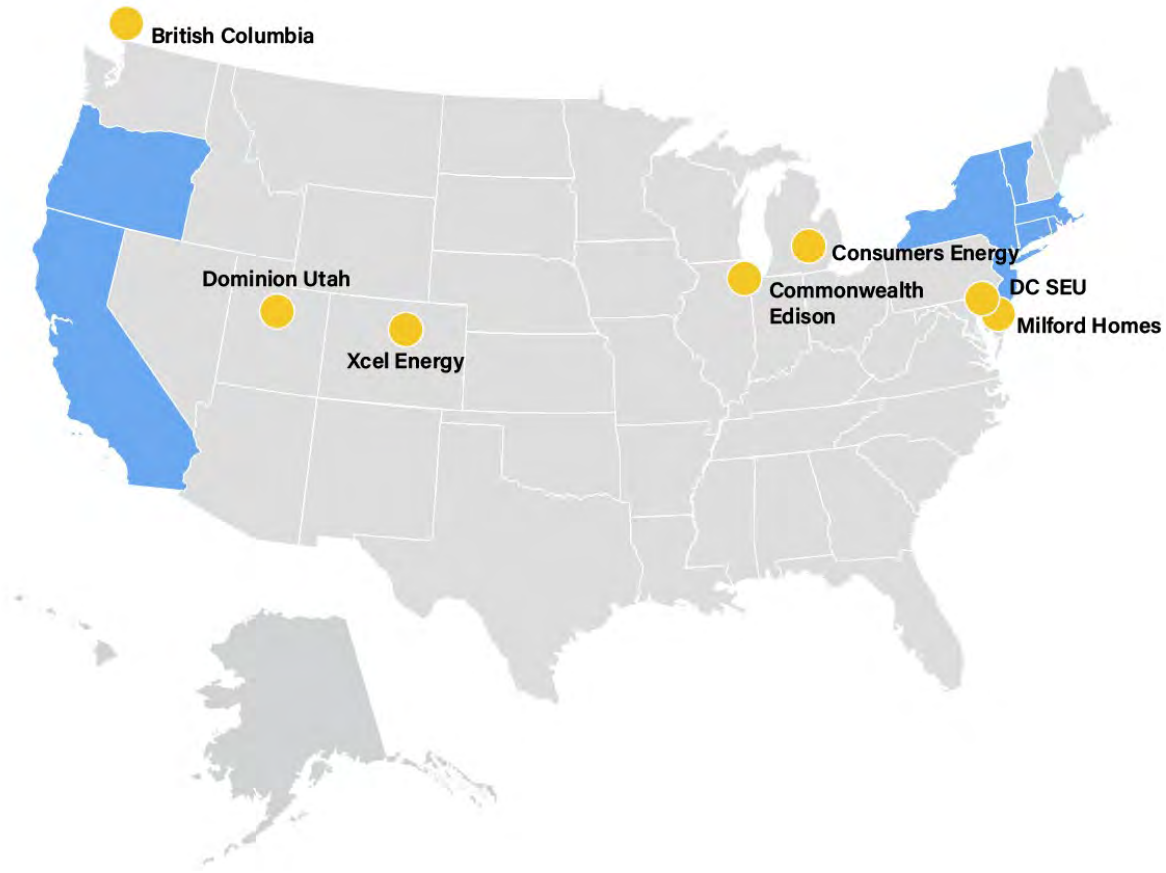

Figure 2. States and programs profiled in this brief. States that are shaded blue have programs that serve the majority of the state. Yellow dots indicate programs operated by individual program administrators that only serve portions of states.

Residential

Residential programs address single-family homes, multifamily buildings, and in a few cases, modular homes. Here, we discuss the programs in descending order based on size and scope. If a program combines several markets, we discuss the program under its largest market.

Single-Family

DOE Zero-Energy-Ready Homes

The DOE introduced the ZERH program to home builders in 2013. The program's Version 2 specifications reduce energy use by approximately 50% or more when compared to a code-minimum home built to the 2009 International Energy Conservation Code (IECC). This ZERH Single Family Version 2, which took

effect at the beginning of 2024, represents about a 15–20% increase in energy efficiency compared to the Version 1 specifications first published in 2013. Version 2 also provides approximately 10% energy savings compared with the latest version of ENERGY STAR's Single Family New Homes specification. Both programs have a separate specification for multifamily buildings. ZERH Multifamily Version 2, which includes a prerequisite certification under the ENERGY STAR Multifamily New Construction program, takes effect at the beginning of 2025. Many ZERH-certified homes significantly exceed the minimum specification. In addition to requiring energy savings, program specifications are designed to manage moisture, comfort, and indoor air quality risks as enclosures become more tightly sealed. Both ENERGY STAR and ZERH require third-party inspections to ensure that their specifications are implemented accurately. ZERH has a variety of training and marketing aids for builders and program operators (DOE 2024c) and is working with 14 utility programs and other local and regional programs (DOE 2024b). We discuss some of these programs later in this paper.

In 2022, Congress revised the long-standing tax credit for energy-efficient new homes (Section 45L) by increasing the available incentives and updating qualification requirements to reference the ENERGY STAR Residential New Construction program and DOE ZERH program. Under this new incentive, which took effect in early 2023, eligible contractors can claim a $5,000 tax credit for each certified ZERH home or apartment; for multifamily, however, the credit is reduced to $1,000 per apartment if workers are not paid prevailing (union) wages. The ZERH program version under which the home must be certified is determined by the DOE ZERH program implementation schedule on the ZERH website. From 2013 through early 2024, the program certified more than 21,000 homes, and the numbers of certified homes quadrupled between 2020 and early 2024, with recent growth driven in part by the Section 45L federal tax credit (J. Van Mourik, program director, ZERH, Building Technologies Office, DOE, pers. comm., February and April 2024). Figure 3 shows a sample home.

Figure 3. A zero-energy home by New Town Buildings in Denver, Colorado. This home is part of the DOE Zero Energy Ready program. *Source:* DOE 2014.

NYSERDA

From 2016 through 2020, the New York State Energy Research and Development Authority (NYSERDA) offered several programs to encourage highly efficient new homes that were categorized as "low rise"—a definition that varied over time and ranged from single-family homes to three-story multifamily buildings. The program had three efficiency tiers, and each had to meet the ENERGY STAR Certified Homes Version 3.1 specifications. Tier 3 was essentially the zero-energy tier; it required a final Home

Energy Rating System (HERS) rating of 10 or below, including any credits for onsite solar systems. Excluding the solar systems, tier-3 homes generally had to have a HERS rating of 40 or below (or 50 or less for dwelling units under 1,500 sq. ft.). For tier 3, incentives evolved over time, launching at a high level and modulating downward as energy codes advanced, ending at $4,000 per home for one- and two-family homes and for the first 10 townhouses a builder built (plus an additional $200 per unit for low- and moderate-income units). For single-family homes, participation at the highest tier was modest: 52 tier-3 homes were completed by early 2020, and an additional 47 homes were committed. Participating single-family homes were primarily in upstate New York (Buffalo, Rochester, Albany, and the Hudson Valley), and completed tier-3 homes were primarily in areas with above-average incomes (M. Brown, program manager, NYSERDA, pers. comm., June and July 2020). Additional incentives were available through other NYSERDA and utility programs for solar and other renewable energy systems and for ground-source heat pumps (NYSERDA 2018).

From 2021 to 2022, NYSERDA offered the New Construction—Housing program. This program included single-family and multifamily new construction and gut-rehabilitation whose energy performance exceeded the New York building code by at least 20–30%, with higher incentives for the higher level of savings and for homes purchased or rented by low- and moderate-income households (NYSERDA 2022a). During this two-year period, program eligibility evolved from achieving a minimum of 20% energy savings above code to encouraging electrification through higher incentives to requiring that projects achieve carbon neutral performance (eliminating fossil fuel systems in buildings). By the end of 2022, 29,320 housing units were in the pipeline for this program (R. Filbey, program manager, NYSERDA, pers. comm., March 2024).

As energy codes evolved and technical solutions were refined and validated, NYSERDA's new-construction programs moved away from a standard-offer incentive at the point of construction, launching instead other market development approaches. One of these was the 2021 Building Better Homes program, a market capacity building program geared toward single-family home builders pursuing carbon neutral construction. Builders applied to participate and could receive design support, consultation services, marketing support, and incentives for building high-efficiency model homes; for example, homes that met Passive House, DOE ZERH, or Living Future specifications received up to $12,500 (NYSERDA 2024a.) While the Building Better Homes program was always intended to be rolled out in phases, New York's May 2023 zero-emissions building legislation brought forward the timing for residential buildings under eight stories to be built to zero-emissions or all-electric standards, which prompted a significant program redesign (R. Filbey, program manager, NYSERDA, pers. comm., March 2024). The program closed to new applicants in December 2023 and is being revised for a relaunch in 2024 (NYSERDA 2024a).

Southern New England

In Connecticut, Massachusetts, and Rhode Island, utilities have often worked together to develop zero-energy and zero-energy-ready programs. For example, in Connecticut, the two major utilities (Eversource and United Illuminating) offer many programs jointly under the Energize Connecticut banner. Their residential new-construction program serves both single and multifamily properties and has three tiers based on performance as measured by the HERS Index. Lower HERS scores indicate higher efficiency. The program pays the highest incentives for homes with a score of 15 or less (which essentially means close to zero-net energy), medium incentives for HERS scores of 16–45, and lower incentives for HERS scores of 46–55. As of 2024, only all-electric homes are eligible; in earlier years, homes using gas were also eligible, but a bonus was paid for all-electric homes. For single-family homes, the basic 2024 incentive is $7,500 for tier 1 (HERS 55), $10,000 for tier 2 (HERS 45), and $12,500 for tier 3 (HERS 15). Incentives per unit are lower for single-family attached homes and multifamily apartments.

In addition, there are bonuses for projects using high-efficiency air-source or ground-source heat pumps and for homes earning energy-saving certifications such as Passive House or ZERH (Energize Connecticut 2024). The program offers extensive training on Passive House and electric heating techniques. In 2023, 285 single-family homes, 150 townhouses, and 1,700 multifamily units were completed. The utilities have found it useful to work closely with builders and design teams and to give them options so they can choose the best fit for their projects. Design charrettes and pilot proof-of-concept projects have been helpful in enlisting builders. The utilities are finding that custom and affordable housing developers are open to high-efficiency all-electric homes, but that production and speculative builders are reluctant to switch from the types of systems they have used in the past. They also note a need for electrification technologies that can be used for domestic hot-water loads in multifamily apartment buildings (N. Jones, energy efficiency consultant, Eversource, pers. comm., February 2024).

In earlier years, Energize Connecticut sponsored an annual Zero Energy Challenge, a design and build competition for residential construction. Common features included photovoltaic systems or solar energy systems, insulated concrete forms, structural insulated panels, and geothermal heat and air-conditioning. Each home received incentives for building with advanced technologies through the Energize Connecticut Residential Construction program. Homes entered into the competition could win prizes up to $5,000 depending on final HERs rating, affordability of construction, and net operating costs (Energize Connecticut 2020).

In Massachusetts, all utilities work together via the Mass Save consortium to develop a common program. The program is broadly similar to the Connecticut program discussed above. Only all-electric homes are eligible to enroll starting in July 2024. The current framework has two tiers: tier 1 for HERS scores of 36–45 and tier 2 for HERS scores of 35 or less. As in Connecticut, the utilities are finding that production builders are often hesitant to use electric heat, in part due to the high cost of electricity in the state. As the program shifts toward driving all-electric construction, the administrators are looking to lean on national standards such as Passive House and ENERGY STAR NextGen (J. Martell, senior analyst, National Grid, pers. comm., February 2024). To address the high cost of electricity, several Massachusetts utilities are proposing separate rates for homes heating with heat pumps (National Grid 2023; Unitil 2023).

Rhode Island has also operated programs for many years. In 2018, National Grid, which then served most of the state, offered a pilot Path to Zero Energy Ready program somewhat similar to the Massachusetts program. This was an add-on to its regular new-construction program and provided additional support and incentives. Under this path, homes could meet the DOE ZERH specification, the Passive House Institute U.S. PHIUS+ specification, or the requirements of a voluntary Rhode Island stretch code. The pilot had five participating projects in 2018, with a total of 114 units. Of these projects, 96 were affordable housing and 18 were market rate. The program also included training (13 sessions in 2019), design charrettes, Passive House consulting support, and free DOE ZERH certification (National Grid 2020b).

Since then, National Grid sold its Rhode Island territory to Rhode Island Energy (an affiliate of PPL). RI Energy has continued the program including both Path to Energy Efficiency and Path to Zero Net Energy components. For 1–4 unit homes, Path to Energy Efficiency incentives are $500 per unit for 15–25% energy savings relative to baseline, $1,500 per unit for 26–39% savings, and $4,000 for 40% savings or more. Additional incentives of $1,000 are available for all-electric homes that save at least 26% and use cold-climate heat pumps. Under the Path to Zero, 1–4 unit homes can earn additional incentives of $1,000 per unit for DOE ZERH certification or compliance with the RI Stretch Code, and $1,500 per unit for Passive House certification. Buildings with five or more units are also eligible for incentives, but the incentives per unit are lower. For the Path to Zero, these buildings must enroll in the early design phase

of home design and can take advantage of free technical assistance to design teams (Rhode Island Energy 2024). The program continues to offer training and educational programs, and it finds that builders in the Path to Zero are often willing to share their experiences. Over the 2021–2023 period, a total of 121 zero-energy homes were completed, with an additional 354 in the pipeline. To put these numbers in perspective, an average of approximately 1,300 residential new-construction permits were pulled annually between 2020–2023 in the state (R. Pinnons, senior program manager, CLEAResult, pers. comm., February 2024).

In addition, the Zero Energy for the Ocean State (ZEOS) program for affordable housing is offered by a partnership between RI Energy, a housing nonprofit organization, and a state agency. Although we discuss this program in the multifamily section below, it also includes 1–4 unit buildings.

Efficiency Vermont

Efficiency Vermont has operated its Residential New Construction—High Performance Homes program since 2012. The low-income program has two tiers: Efficiency Vermont Certified and High Performance. The latter can be considered zero-energy ready. A High Performance home requires high levels of insulation (e.g., R-40 wall insulation and R-60 ceiling insulation); tight construction (e.g., less than one air change per hour as measured with a blower door at 50 Pascals of pressure); and the integration of high-efficiency whole home air exchange heat recovery ventilation to ensure excellent indoor air quality and moisture control. Generally, equipment in the home must be ENERGY STAR and WaterSense certified, and heat pumps must meet the Northeast Energy Efficiency Partnerships cold-climate heat-pump specification. The High Performance program includes design review and consultation, a preliminary energy rating (HERS), an insulation inspection (before the drywall goes up), a preliminary blower door test, and final verification, including a second blower door test. Homes meeting the Efficiency Vermont Certified level are eligible for a $5,000 incentive, and $6,000 for the High Performance tier. In addition, both tiers are eligible for an additional $1,000 all-electric incentive (Efficiency Vermont 2020a).

In 2022, Efficiency Vermont developed a more cost-effective single tier for market-rate homes that is similar to the low-income High Performance tier. Under this new tier, Efficiency Vermont Certified 3.0, projects are eligible for a $750 incentive, plus an additional $500 if the home is all electric (Efficiency Vermont 2022). Other incentives for market-rate builders are also available for specific equipment, including Drain Water Heat Recovery (up to $400) and air exchange heat recovery ventilation ($350–700). Efficiency Vermont is currently working to expand this list of incentives to further encourage high energy efficiency above code building practices. Efficiency Vermont does not provide incentives for solar systems (due to its regulatory structure), but such incentives are available through Vermont Low Income Trust for Electricity (VLITE) for income-qualified customers (VLITE 2024). Since the program's launch, 186 homes have qualified for the High Performance tier. Efficiency Vermont continues to explore ways to simplify its program requirements without significantly affecting performance. It recommends that programs educate lenders and appraisers on how to properly value the benefits of high-performance homes. Efficiency Vermont also shares cash-flow modeling examples with builders to help them sell these homes (T. Yandow, program manager, Efficiency Vermont, pers. comm., February 2024).

California

In 2008, California state agencies set a goal of moving the residential building code to net-zero-energy construction by 2020 (CPUC 2008). Since then, steady improvements have been made in each code cycle. In addition, California utilities funded a series of demonstration programs and case studies showing that zero energy is possible (e.g., Dean 2018; Frontier Energy 2020). In the 2020 California building code, the goal was basically met. The new code requires that a solar system be installed on new

homes with approximately enough capacity to meet the home's electricity needs, not counting space heating. Natural gas space heating is still allowed, so the code essentially requires zero-net electricity, with space heating not included. A 2025 update to the code is now being developed. For homes, a proposed draft establishes a performance baseline based on both heat pump water and space heating systems. Other systems can be used, but the additional energy used by these systems relative to the performance baseline must be offset with efficiency measures not required by the code (CEC 2024).

California investor-owned utilities assist with development of the building code and also offer energy efficiency programs to encourage performance beyond building code requirements. The current residential program, California Energy-Smart Homes, is run by TRC on behalf of Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). The program covers single-family homes, townhomes, and low-rise multifamily buildings. It requires all-electric new construction, typically requiring the following measures: heat pump water heating; heat pump space heating; communicating thermostats; induction cooking; a 240-volt plug for electric vehicle (EV) charging infrastructure; battery storage readiness; and thermostatic mixing valves on water heaters, which let water overheat prior to peak periods to reduce energy use during those periods (California Energy Smart Homes 2024). The program provides outreach and technical assistance to builders, as well as incentives of $3,000 per home for single-family and duplex, and $1,600 per apartment for multifamily and accessory dwelling units. The program also focuses on outreach to production builders. In the second half of 2023, more than 200 single-family homes were completed and more than 2,000 single-family homes were enrolled (if multifamily is included, these participation numbers nearly double).

Commonwealth Edison

Serving the greater Chicago area, Commonwealth Edison (Com Ed) is the largest utility in Illinois. To promote zero-ready homes, Com Ed has two programs: an all-electric residential new-construction program begun in 2020, and a pilot Affordable Housing New Construction Program.

The All-Electric New Construction Program includes various prescriptive requirements to ensure that participating homes substantially exceed building code requirements. Program requirements include an air tightness of 2.0 air changes per hour or less (at 50 Pascals of pressure, as measured by a qualified home rater); an air-source heat pump with a seasonal energy efficiency ratio of at least 18 and a heating seasonal performance factor of at least 10; a heat pump water heater (HPWH); ENERGY-STAR-certified lighting, appliances, and thermostats (including an electric dryer); low-flow water fixtures; and several comfort and indoor air quality requirements. The program provides an incentive of $3,000–5,000 per participating home or apartment, depending on unit size. There is also an additional $200 incentive for the home rater. Induction ranges are encouraged but not required, as are measures to make these new homes photovoltaic-, electric-vehicle-, and battery-storage-ready (e.g., by installing electric service and wiring so that adding these systems later will be easy) (Com Ed 2024a). In 2020, 11 homes participated, followed by 18 in 2021, 28 in 2022, and 68 in 2023. The program is targeting 115 homes in 2024. Many of the participating homes are single family, but some are low-rise multifamily. A lesson learned is the importance of builder and home rater training on issues such as envelope air tightness and right-sizing equipment (K. McSweeney, senior manager, Slipstream, pers. comm., February 2024).

The new Affordable Housing New Construction program targets affordable housing assistance. A special component of the program is the Passive Building Pathway, a pilot program involving six multifamily projects with a total of 253 low-income apartments. The program requires Phius certification. Each project goes through five steps, with incentives paid at several steps in the process. The steps (and incentives) are as follows: (1) submit an application and have it accepted; (2) conduct a feasibility study ($10,000 incentive upon completion); (3) submit design certification ($15,000 incentive plus $1,000 for

builder Phius training if needed); 4) sign an incentive agreement; and (5) obtain Phius certification ($5,000 incentive per income-eligible unit). Projects that do not earn Phius certification may still earn lower incentives through a companion non-Phius affordable multifamily program offering (Com Ed 2024b). The six-year budget for the pilot is just under $1 million. Of the six pilot projects, one is expected to be completed in 2024 and the rest in 2025 or 2026. At first, the program found it challenging to recruit builders as they were not familiar with Phius; that problem has now been addressed and even though applications for the pilot are closed, Com Ed continues to get inquiries from builders. A decision on whether to make this program a standard offering will be made after several projects are completed (V. Ryman, energy efficiency senior program manager, Com Ed, pers. comm., February 2024).

District of Columbia Net-Zero Energy Program

The District of Columbia is planning to adopt a building code requirement by 2026 that would require new construction to be net-zero energy for both residential and commercial projects. This is part of the District's effort to reduce its greenhouse gas emissions and energy use by 50% by 2032, while also increasing renewable energy use to supply 50% of its energy by 2032 (District of Columbia 2019). To help provide a foundation for this new code, the DC Department of Buildings (DOB) and the DC Sustainable Energy Utility (DC SEU—the District's main provider of energy efficiency programs) developed a voluntary program to promote net-zero-energy buildings including single-family, multifamily, and commercial projects. To qualify for the program, a project must meet either a DC voluntary net-zero code specification or an alternative specification such as the Passive House, LEED Net-Zero, DOE ZERH, or Living Future Institute Zero Energy Certification standards. Applicants must also submit a renewable energy plan to meet energy needs with solar electric, solar thermal, or geothermal measures. If limitations prevent onsite renewables, applicants can propose an alternative plan.

The heart of the net-zero-energy incentives program is the Green Ambassador, who works with the project applicant to answer questions and facilitate interactions with DOB and the DC SEU to move the project swiftly through the permitting and DC SEU incentive processes. The program also includes a $10,000 incentive per project (payable when the building permit is issued) and accelerated permitting. The incentive may be used for items such as performance testing and modeling costs; incremental construction costs, such as for envelope improvements; or special equipment, such as multistage heat pumps, HPWHs, induction cooktops, enthalpy recovery ventilators, and solar systems. In addition, DC SEU also provides incentives for some specific measures such as heat pumps (Boyd and Loncke 2020).

The program began in 2019, and as of early 2024, 13 projects have been approved; most are residential, but two mixed-use residential/commercial buildings are included. According to the Green Ambassador, keys to successful projects are the use of a multipronged approach including outreach and education efforts, incentives, technical assistance, and clear communication with all involved project stakeholders (A. Delgado, Green Ambassador, DC Department of Buildings, pers. comm., February 2024).

Consumers Energy

Consumers Energy serves large portions of Michigan. In 2021, it began a pilot All Electric New Home Construction Program that covers both detached and attached single-family homes (e.g., duplexes and townhomes). The program promotes all-electric, high-efficiency, solar-ready new homes. Under the initial program (which recently closed), to qualify for a full incentive, homes must have a HERS rating of 40 (not counting solar); include a cold-climate heat pump and ENERGY-STAR-certified appliances and lighting; and either install a solar photovoltaic (PV) system or complete DOE's ZERH PV-Ready Checklist. For market-rate homes, incentives were $10,000 plus an additional $2,500 for a HERS score of 35 or less

and $500 for installing a level-2 EV charging station. Homes with a HERS score of 41–45 could receive a $7,500 incentive, with a $5,000 incentive possible for homes with a HERS score of 46–50. For income-qualified homes, all incentives except for the EV-charger incentive were doubled. Income qualification was based on participation in an affordable housing program, location in an income-qualified census tract, rent roll documentation, or resident income documentation (i.e., at least half of the residents are below 200% of the federal poverty level or 80% of area median income) (Igoe 2021). As of the end of 2023, 48 homes were completed and 7 are still under construction. Of the completed homes, 37 are income qualified and 11 are market rate. A total of 10 of these 48 homes have a HERS rating of 35 or less. The program manager notes that the incentive was very helpful to entice builders, and that home energy raters were also helpful in encouraging and assisting builders in participating. Interviews with homeowners indicate high comfort and that energy bills were about what they expected (R. Igoe, residential manager, ICF, pers. comm., March 2024).

The program's next phase will start in spring 2024. The plan is to leverage existing standards and the federal 45L new home tax credit. The new program is tentatively planning to provide incentives of $5,000 for ENERGY STAR NextGen, $10,000 for DOE ZERH, and $15,000 for Passive House. The program plans to enroll some production builders and to improve cost effectiveness so that it can transition this effort into its residential new-construction program. In the future, it also plans to explore incorporating load management and solar energy into the program (R. Igoe, Residential Manager, ICF, pers. comm., March 2024).

Dominion Energy Utah

Dominion Energy provides natural gas service to about a million customers in Utah, including in Salt Lake City and many of the densely populated areas north and south of the city. Dominion's Thermwise program for buildings provides prescriptive rebates for specific measures. In addition, in 2020 it began a Pay for Performance Program that offers incentives of up to $1,400 based on gas savings over baseline and provides a small bonus incentive ($50) for homes meeting the DOE ZERH specification. The program also includes training in high-efficiency construction techniques for builders. By the end of 2023, 100 homes and 11 apartments had been completed. Dominion is also doing two demonstration Net Zero Home projects with local nonprofit organizations. Those projects highlight the use of natural gas in net-zero construction. The goal is to explore more-efficient and cost-effective options of achieving net zero while using both natural gas and electricity, combining zero-ready construction with hybrid heating systems (i.e., electric heat pumps combined with a natural gas space- and water-heating system), with the renewable energy coming from onsite and offsite sources as well as from renewable natural gas (biogas). Due to the high cost of land, further nonprofit demonstration projects have not been able to move forward (B. Taylor, energy efficiency supervisor, Dominion Energy, pers. comm., February 2024).

Xcel Colorado

Xcel will start a new all-electric new-home program for homes that receive their building permit after July 2024. The program incorporates both the DOE ZERH specification and the ENERGY STAR NextGen specification as minimum requirements. It has three program tiers, with incentives of $10,000, $12,000, and $15,000 per home, respectively. For tier 1, as part of the NextGen spec, homes must have an HPWH and an ENERGY STAR heat pump (cold climate air source, or ground source). For tier 2, envelope heat loss (as measured by average UA[1]) must be 10% better than the 2021 IECC code, air infiltration must be

[1] UA is a U-factor × Area (UA) calculation for each building assembly, with the results summed to determine the overall UA of a building. In the United States, U-factor is expressed in terms of Btu/hr·ft.^{2}·degree F.

less than or equal to 1.5 air changes/hour when measured at 50 Pascals of pressure (ACH50), and balanced ventilation and all-electric cooking are required. For tier 3, the envelope UA must be at least 25% better than IECC 2021, air infiltration must be no more than 1.0 ACH50, and continuous envelope insulation is required. This program is being designed as a market transformation program to lead to widespread construction of high-efficiency all-electric new construction. The program will provide resources and training to builders on how to meet the requirements; it will also offer design assistance, plan review and inspection, and verification services, all at no cost to the builder (Buchanan 2024).

Multifamily

Several zero-energy-ready programs have a specific focus on multifamily homes. Here, we describe a few programs that are open to multiple building types, but that have primarily worked with multifamily projects.

NYSERDA

In addition to the combined single- and multifamily programs described above, NYSERDA has offered the Buildings of Excellence competition for carbon neutral multifamily buildings since 2019. In the first four rounds, 65 winners received up to $1 million in financial awards per building to help cover design and construction costs (NYSERDA 2024b, IEI 2023). These projects will deliver more than 8,000 housing units, the majority of which serve low-to-moderate income individuals. Round 5 of the competition is expected to launch in 2024. An ongoing cost analysis of winning projects—most recently published in July 2023 and including rounds 1–3—found the following: (1) projects were designed using Passive House principles; (2) on average, buildings anticipate achieving energy savings of 30% or more (with many projects achieving far greater net performance through the use of renewable generation); and (3) the average percentage of incremental costs for featured projects ranged from less than 1% to just over 10% (varying by building type) without incentives, and with incentives, the average incremental costs ranged from zero to 5% (NYSERDA 2023). Because NYSERDA support for zero-emissions housing is looking to pivot from financial incentives for construction to technical assistance (especially in the early design phase), the Buildings of Excellence competition provides an opportunity to highlight and reward the most exceptional projects.

NYSERDA's long-running New Construction programs aim to support market development, capacity building, and above-code projects. Having delivered the stated goals of advancing code and building technical capability in the marketplace, the business case for financial incentives has declined, leading to incentives decreasing over time and in most cases ending. Additionally, successful engagement with the primary affordable housing regulator and funder—that is, NYS Homes & Community Renewal (HCR)—has resulted in HCR integrating the very standards NYSERDA has long been promoting into its baseline requirements (NYSHCR 2023). Now that HCR requires much of what NYSERDA had been funding through its programs, NYSERDA's support for new construction of affordable housing is primarily delivered by directly funding HCR, which NYSERDA argues is a more efficient mechanism to drive carbon neutral construction in this sector.

Figure 4. The low-rise NetZero Village in the New York Capital Region. *Source*: Goodell 2019.

New Jersey Clean Energy Program

The New Jersey Clean Energy Programs are operated by contractors hired by the New Jersey Board of Public Utilities. One program is a residential new-construction program. Although it covers single-family and multifamily, we list it under multifamily because a slight majority of participating units have been multifamily. The program has three tiers: ENERGY STAR, DOE Zero Energy Ready, and Zero Energy Ready Plus Renewable Energy. Incentives for zero-energy ready are $1,500 per unit for multifamily, $2,500 for townhouses, and $4,000 for single-family detached. An additional incentive of $30 per million Btu saved relative to the New Jersey building code is available. For renewable energy, the program provides an additional $750 (multifamily)/$1,500 (townhouse)/$2,000 (single-family detached). For single-family detached and attached houses, it also pays the energy rater $1,200 for certifying a zero-energy-ready home and an additional $500 if the home is in an urban enterprise zone or meets affordable housing criteria. The rater incentive was added to help cover the additional costs of zero-energy-ready certifications. In addition, the state Housing and Mortgage Finance Agency has 4% and 9% tax credits for "green" affordable homes. Zero-energy-ready homes are eligible for the 9% credit, which has helped promote zero-energy-ready homes (NJ HMFA 2023). From 2019 through 2023, the program completed 2,649 zero-energy-ready homes and apartments, of which 1,305 are single-family or townhouses and 1,344 are multifamily projects. The program manager notes that raters have been important to the program's success, with some raters encouraging builders to go deeper and meet zero-energy-ready requirements (P. Gleeson, associate director, TRC, pers. comm., February 2024).

A substantial revision of the program is planned for 2025; a proposal for this new program was released for comment. Under this proposal, the new-construction program will cover both residential and commercial, including several rebate tiers as well as a high-performance tier. Under this latter tier, three levels of incentives proposed for different efficiency levels: (1) ENERGY STAR or LEED, (2) DOE Zero Energy Ready, and (3) Passive House (TRC 2024). In addition, a new Garden State Challenge pilot program was proposed that will be a competition with monetary awards for the best building designs "that will be aesthetically pleasing, low to no-carbon, will provide superior comfort, enhance health and safety, be replicable and quicker to construct than other comparable buildings, and most importantly,

inspire the industry to promote and ultimately achieve New Jersey's strategy for 100% Clean Energy by 2050" (TRC 2024).

Massachusetts

In Massachusetts, in addition to the residential new-construction program discussed above under single-family programs (and which also includes multifamily), the state's utilities offer a second statewide program under the Mass Save banner to promote affordable multifamily construction meeting Passive House standards. The program was launched in July 2019 and began with training for builders in Passive House design and construction techniques. The program helps pay for a project feasibility study (up to $5,000) and for energy modeling (75% up to $20,000). Financial incentives of $3,000 per unit are offered for meeting Passive House standards. Upon completion of a design that meets program standards, an incentive of $500 per unit is paid. The remaining $2,500 per unit is paid upon completion of construction and a final inspection, including a blower door test. In addition, performance incentives of $0.75 per kilowatt-hour (kWh) and $7.50 per therm are paid for actual first-year energy savings (Mass Save 2020). According to program staff, the feasibility studies have been helpful. Builders appreciate knowing up front the per-unit incentive, and program leaders have found that it is possible to exceed the Passive House standards (B. Giza-Sisson, energy efficiency consultant, Eversource, pers. comm., June and July 2020). More than 70 Passive House feasibility studies have been completed and 119 buildings with more than 6,700 units are on track for Passive House certification by 2026 (Mass Save 2024).

Rhode Island Zero Energy for the Ocean State (ZEOS)

The ZEOS program is a joint effort of RI Housing, the RI Office of Energy Resources, and the utility RI Energy. This is a competitive program that awards grants for zero-energy affordable housing. The program began in 2019 and is now in its third round. It seeks project proposals that offer replicable, innovative net-zero-energy technology solutions for homes, including onsite solar, air-source heat pumps, and demand responsive energy management systems. In the first two rounds, a total of 186 units of net-zero housing were supported including duplexes, townhomes, and low-rise multifamily. Examples include the Sheridan Small Homes pilot project, a development of five Passive House design-certified small homes, and Tiverton's Bourne Mill III, a new-construction project of 59 multifamily units in an all-electric building adherent to Passive House standards. The 2023 program is funded through $250,000 in grants from Rhode Island Housing, a statewide housing nonprofit; $250,000 in proceeds from Rhode Island's participation in the Renewable Greenhouse Gas Initiative; and incentives from RI Energy's new-construction programs (discussed above in the single-family section). In the third round, the ZEOS grant award was limited to $17,000 per unit for 1–4-unit properties and $7,000 per unit for larger multifamily developments. The total award cannot exceed $250,000 for any individual project. Winners of the latest round were announced in early 2024; four projects were funded with a total of 251 units. These include two multifamily developments in Providence and two smaller projects (2 and 7 units, respectively) in other towns (Xie 2023; Rhode Island OER 2023; Cowperthwaite 2024).

Efficiency Vermont

Efficiency Vermont has a multifamily program similar to its single-family program discussed above. It has two tracks: Efficiency Vermont Certified and High Performance. The High Performance track produces essentially a zero-energy-ready building. It requires R-12 continuous insulation (in addition to filling wall cavities with insulation); an air infiltration rate of less than 0.1 cubic feet per minute (cfm) measured at 50 Pascals of pressure; and a balanced heat-recovery ventilation system (Efficiency Vermont undated). Incentives for the higher tier are $2,700 per unit, including $400 provided by the gas utility. The program also pays 50% of the cost of system commissioning and 50% of modeling costs to support the integrated

design process, each up to $5,000 per project. It has an additional $300 per-dwelling-unit incentive for successful Passive House certification. Since the current program configuration began in 2016, it has completed 860 units, typically in buildings with 3–4 stories and 30–60 units per project. Efficiency Vermont finds that builders overwhelmingly look to meet the continuous insulation requirement using Zip-R structural insulated panels (Huber Engineered Woods 2020). Once a builder develops familiarity with the system, repeat use is likely. Integrating heat-recovery ventilation systems is more challenging due to first cost and a need for higher ceiling height. Efficiency Vermont finds that affordable housing developers readily choose the higher tier as they want energy costs to remain affordable for the life of the building. Market-rate housing developers are more likely to balk at the first cost, but several have participated in the program (S. O'Malley, energy consultant, Efficiency Vermont, pers. comm., June and July 2020).

Since 2020, construction costs have gone up 60–80% or more in Vermont. As in many other parts of the United States, Vermont is experiencing a housing crisis that produces considerable pain among both market-rate and affordable housing multifamily developers. Funding for affordable housing developers is tied to achieving Efficiency Vermont's High Performance track. Efficiency Vermont is moving ahead with plans to update the High Performance track requirements to coincide with an upgrade to Vermont's Energy Codes that will take effect July 1, 2024. The revised program will require a tighter building shell (verified by blower door test) to 0.075 cfm for a 50/sq. ft. building shell area and require hydronic distribution systems to be low temperature (to prepare for heat pump technology). Program administrators also learned more about hot-water recirculation systems and will require a mixing valve capable of accurate measurements with maximum flows of 2.0 gallons per minute. Traditional recirculating hot-water systems have a fair amount of waste heat associated with higher flow rates required by analog mixing valves. With these changes, the program will increase its per-unit incentive to $3,700. The administrators also found that the program's High Performance track requirements compare favorably with the federal 45L tax credit in the Inflation Reduction Act, so currently, six developers are pursuing the ZERH designation for the $5,000 per unit tax credit. Going forward, the administrators expect more developers to incorporate the 45L tax credit into their projects (L. Bonn, senior director, Emerging Opportunities & Program Design, VEIC, pers. comm., March 2024).

British Columbia Zero Energy Challenge

The Canadian province of British Columbia has developed a "step code" that contains five increasingly stringent steps. Step five is zero-energy ready—that is, approximately Passive House levels. The plan is to adopt this across British Columbia by 2032, but the province is currently promoting the steps through local building codes and voluntary programs (Pape-Salmon 2020).

The Zero Energy Challenge is an incentive program and juried design competition for buildings built to step five. The program began in 2018, and in January 2019, 16 winning projects were selected to receive design incentives of $0.40–3.50 (Canadian) per square meter of floor area (depending on building size). On the basis of these designs, 11 projects were selected to receive construction incentives of $10 per square meter for offices, $25 for institutional buildings, $40 for retail, $60 for low-rise multifamily, and $80 for high-rise multifamily (Clean BC 2019). Of these 11 projects, the majority are multifamily. In addition to the challenge, local jurisdictions are promoting the step code in various ways. One of the more innovative is a community that allows developers to build to a higher density if they build to step five (Z. May, director, Strategic Policy Building and Safety Standards Branch, Ministry of Municipal Affairs and Housing, pers. comm., June 16, 2020).

Green Communities Plus – A Pathway to Zero-Energy Ready for Affordable Housing

Enterprise Community Partners, a national nonprofit organization that focuses on affordable housing, has a certification program for affordable green communities. It has two levels: Green Communities and Green Communities Plus. Both have more than 30 mandatory criteria, including an integrated design process, design for a healthy living environment, stormwater management, and earning ENERGY STAR for Homes (new construction). The programs also have additional criteria for earning points for certification, such as resilient systems, passive solar strategies, and renewable energy ready. To earn the Green Communities Plus designation, projects must be net-zero or near-zero energy as shown by certification under DOE's ZERH program or Passive House. The first Green Communities Plus project (Cadence) was recently completed in Fort Collins, Colorado. Many affordable housing projects use federal Low Income Housing Tax Credits funds, which are allocated to each state. States prepare Qualified Application Plans (QAP) to spell out how they will pick winning projects based on a variety of criteria. As part of its QAP, the District of Columbia requires Green Communities Plus for projects over 50,000 sq. ft. of floor area, while Michigan, Wisconsin, and Louisiana give extra points for Green Communities Plus certification (M. Diller, policy program director, Enterprise, March 2024).

Modular Homes

Two programs focus specifically on modular homes. Modular homes are produced in a factory and shipped to the job site in large sections, which are then assembled onsite. In many cases, they can be used to replace manufactured homes.

Efficiency Vermont

Like many rural states, Vermont has a sizable percentage of mobile and manufactured homes. Some of these are quite old and inefficient. To help replace these with more-efficient homes, Efficiency Vermont worked with a local modular-home builder to develop several designs for zero-energy modular homes. The homes are highly efficient (e.g., 10-inch thick walls, triple-pane windows). As figure 5 shows, its designs include one-box (14 ft. wide by 40–70 ft. long) and two-box (e.g., 14 or 28 ft. wide and two stories) designs (Vermod 2020). Efficiency Vermont worked with the Vermont Housing and Conservation Board and other local partners to develop financing packages. For example, it currently works with U.S. Department of Agriculture Rural Development Section 502 direct loans for the primary mortgage and with the Champlain Housing Trust for a zero-interest second mortgage up to $35,000 that is repaid when the home is sold (VHCB 2020a). These programs target low- and moderate-income purchasers. Efficiency Vermont provides grants of $3,000 or $8,500 per home, the latter for income-eligible purchasers. It has occasionally obtained grants to pay for solar systems. Since the program launched in 2012, 88 homes have been completed (many of these are included among the high-performance homes shown for the Vermont single-family program in Appendix A).

More recently, due to the rising costs of manufacturing homes to the zero-energy modular (ZEM) standard, Efficiency Vermont is introducing the Advanced Manufactured Home program, which exceeds the DOE ZERH standard and is a much more affordable option compared to the ZEM homes. The Advanced Manufactured Home exceeds the ZERH performance standard by requiring air exchange heat recovery ventilation and all-electric heat pump heating and cooling along with tighter air infiltration requirements—all of which make these homes significantly more energy efficient, durable, and healthy compared to the U.S. Department of Housing and Urban Development's manufactured home standard. A $3,000 Efficiency Vermont incentive is available for these homes (T. Yandow, program manager, VEIC, pers. comm., March 2024).

Figure 5. Zero-energy modular homes on McKnight Lane in Waltham, Vermont. *Source*: VHCB 2020b.

Ze-Mod, Delaware

Based on Efficiency Vermont's concept, Milford Homes, a Delaware-based affordable-housing developer, started the Ze-Mod program in partnership with Energize Delaware, the statewide energy efficiency utility. The program worked with a local modular-housing builder to develop the designs (R. Huxtable, vice president, Milford Housing Development Corp., pers. comm., June 2020). Presently, it offers two designs: One that is 980 sq. ft., and one that is 1,204 sq. ft. Through Energize Delaware, Ze-Mod offers a $16,500 grant for a qualifying home, plus a $25,000 zero-interest second mortgage that is payable upon sale or refinance (Ze-Mod 2024). By the end of 2021, the program had completed four homes (Energize Delaware 2022).

Commercial

Energy Trust of Oregon

Energy Trust of Oregon's Path to Net Zero is probably the most advanced of the commercial programs, having completed 53 projects with a total of 4.2 million sq. ft. Figure 6 shows one of these projects. The program began with an eight-building pilot in 2009; that pilot found that focusing on the early stages of design leads to more net-zero buildings, as documented in the pilot's concurrent process evaluation (Dethman, Kunkle, and Lobkowicz 2012). Many early lessons from the pilot implementation were incorporated into an Allies for Efficiency training series on net-zero topics (built around peer-to-peer exchange), which ultimately positioned the market to accept a full-scale Path to Net Zero relaunch in late 2014.

According to Energy Trust, the program's design strategy has two key elements: (1) "early target setting" to position building owners and teams to set and achieve net-zero goals, and (2) "build a community around net zero" to support broad market adoption. Energy Trust finds that the greatest opportunity to identify and influence deep savings is pre-schematic design, where the program supports shoebox

modeling (simple models, often with only one zone); energy-use intensity (EUI) targeting,[2] and energy-related studies (i.e., daylighting studies and computational fluid-dynamic modeling of natural ventilation) that inform final energy modeling and savings calculations. About halfway through construction document preparation, the program conducts a project review and makes final recommendations to keep projects on track to achieve their original savings target (York et al. 2015).

The program also provides free training and education, which is critical to developing net-zero experts in the local market. The program offers Continuing Education Units (CEUs) to design professionals, while highlighting the latest net-zero technologies and strategies. This work has grown in recent years as the program increases its focus on helping design teams make cost-informed decisions.

Currently, the program includes early design assistance (a project kickoff meeting, up to $6,500 for a design charrette, and construction document review); technical assistance (60% of the cost to conduct energy studies such as shoebox modeling, computational fluid-dynamics analysis, daylighting studies, energy modeling, and commissioning design review, not to exceed $40,000); installation incentives ($0.30 per first-year estimated kWh savings and $1.20 per therm); solar-ready incentives (up to $1,800 to determine solar potential, up to $20,000 for a solar system, or up to $15,000 to build to solar-ready standards); assistance with energy metering (up to 50% of the cost up to $20,000); and $2,000 for net-zero certification by the International Living Future Institute (ETO 2024). The required energy savings for participation is 80% of average existing building EUI. For multifamily, the program's Market Solutions offer has precalculated packages of measures for multifamily projects using a whole building approach, with modeling done to develop the packages and incentives paid per sq. ft. based on "good," "better," or "best" options for efficiency.

Energy Trust estimates that about three-quarters of eligible commercial new-construction projects are participating in the program (S. Carlton, senior program manager, Energy Trust of Oregon, pers. comm., March 2024).

Figure 6. Yellowhawk Tribal Health Center. *Source*: ETO.

[2] EUI is Energy Use Intensity, typically measured in annual kWh per sq. ft. of building floor area.

NYSERDA

In the past, NYSERDA had a commercial new-construction program that offered three levels of support: (1) review of schematic design phase plans or equipment selections by a NYSERDA-approved technical consultant, providing suggestions for energy savings; (2) cost-shared energy modeling and analysis; and (3) technical and financial support for zero-net-energy (ZNE), deep retrofit, and smart building projects. To qualify for this third level, projects had to exceed the New York Construction Code by at least 25% (20% for all-electric buildings). Program eligibility ultimately evolved in 2022 to require projects to deliver 15% source energy savings or meet NYStretch-2020 (a stretch code) and its definition of carbon neutral ready. In the program's latest iteration, NYSERDA paid 100% of technical consultant costs up to $200,000 per project in the early design stages and up to $750,000 in project financial incentives ($800,000 for projects in disadvantaged communities) on a $1.50/sq. ft. or $2/sq. ft. basis. Projects in late design stages were eligible only for the project financial incentives and not for technical support (NYSERDA 2022b). As of March 2024, the program had 107 projects in the pipeline. While activity continues across these projects, the program closed to new applications in 2023 because state energy codes were evolving in a way that reduced the need for incentive support for commercial new construction.

In addition, NYSERDA runs a competitive commercial building program, Carbon Neutral Community Economic Development (originally, the Net Zero Energy for Economic Development). The program targets regionally significant economic development projects that are also net-zero energy or net-zero carbon. It includes net-zero facilities as well as net-zero community projects involving multiple buildings. The program has a budget of $10–15 million per year, and it has completed five rounds, with a sixth round planned for 2024. Across all five rounds, 60 projects have been awarded and three are now completed. Projects receive incentives based on a cost share of the incremental cost to build or renovate to a carbon neutral standard (NYSERDA 2023, 2024c; R. Filbey, program manager, NYSERDA, pers. comm., March 2024).

Efficiency Vermont

Efficiency Vermont has run a commercial new-construction program for many years, but the program periodically goes through redesign. For a long time, it had three tracks: equipment approach, high performance (holistic improvements to reduce energy use 10–20%), and net zero (including efficiency savings of 30–45% below code) (Efficiency Vermont 2024). This program included design charrettes (which were popular when well facilitated); a modeling requirement (though designers typically had already decided what type of envelope or system they wanted, so modeling rarely influenced design); and financial incentives of $70 per first-year million Btu of site energy savings (using site energy kept it simple and encouraged electrification).

The more recent Vermont Commercial Building Energy Standards (CBES) for new buildings includes many advanced energy efficiency requirements. The 2024 CBES, effective as of July 1, 2024, requires net-zero-ready characteristics such as design documents showing future rooftop solar areas and electrical panel readiness. The CBES standards are designed to create an organic shift toward zero-ready through the code revision process. Code is revised every three years, and the revision process is aimed at requiring zero-ready buildings by 2030. As the code evolves, the Commercial New Construction program evolves as well.

Given the current code, the commercial new-construction program focuses on four energy efficiency opportunity areas: building envelope airtightness (leakage maximum of 0.13 cfm75/sq. ft.); efficient LED lighting design (lighting power density 20% better than CBES); higher recovery efficiency energy

ventilation systems for designs that already incorporate energy recovery ventilators; and mechanical systems (electrically powered HVAC equipment that exceeds CBES by 10%).

Since the program's 2014 launch, 82 projects have been completed under various program designs. These projects contain 1.76 million sq. ft. of floor area, with an average of approximately 21,500 sq. ft. per project (L. Bonn, senior director, Emerging Opportunities & Program Design, pers. comm., February 2024).

Southern New England

As with residential new construction, utilities in Connecticut, Massachusetts, and Rhode Island work together and have similar commercial programs. For example, the Mass Save sponsors relaunched their C&I New Construction Program in 2020 to include several pathways, including a new net-zero-energy/low-EUI pathway (path 1) that assists with net-zero and zero-energy-ready buildings. This program targets an EUI of 25–35 or less, depending on building type. Buildings of 10,000 sq. ft. or more of conditioned space are eligible. The program's 2024 incentives are $2 per sq. ft. at the completion of construction, plus a bonus incentive of $1.50 per sq. ft. for meeting the EUI target based on one year of monitoring. It also includes a heat pump adder of $800 per ton for air-source heat pumps, $1,200 per ton for variable refrigerant flow (VRF) systems, and $4,500 per ton for ground-source systems.[3] In addition, the program includes early technical assistance; incentives for verification contractors to help assess building performance 2, 6, and 12 months into building operations, and a bonus incentive of $3,000 for achieving LEED Zero, Living Future, or Passive House certification (Mass Save 2022). As of June 2023, 31 projects were enrolled in path 1, with nearly 4 million sq. ft. of building floor area. More than 3 million of this floor area was in K–12 schools. A key for this program is reaching design teams as projects begin and getting these teams to set energy performance targets early in the design process (Mass Save 2023). Program administrators are finding that most buildings in this path use electric heat. As of 2024, only all-electric buildings will be eligible for any of the new-construction/major renovation participation pathways, with limited exceptions (such as for laboratories with high ventilation rates).

A Connecticut program very similar to the Massachusetts program was launched in 2020 by Energize Connecticut, but with somewhat less generous incentives. As of October 2023, seven projects totaling more than 413,000 sq. ft. were enrolled in path 1, and all but one of these is a school (Energize Connecticut 2023). Administrators find that getting cities and towns to share positive experiences with other cities and towns has been helpful, and that it is important to have a champion to help support high-efficiency projects and counterbalance naysayers. The program encourages use of solar systems, but regulators do not permit it to offer incentives for solar (K. Cullinane, manager, New Construction Energy Efficiency, Eversource, pers. comm., February 2024).

In Rhode Island, National Grid began a Zero Net Energy Building Pilot Program in June 2020 to gain experience with ZEBs and contribute to developing a full-scale program. This program defines a ZNE building as exceeding code by at least 30% and producing as much site energy as it uses on an annual basis. Zero-energy-ready projects were also eligible. Under the program, National Grid helped the owner select the design and construction team; provided design and technical assistance, including helping with goal setting and a design charrette; covered 100% of the energy modeling costs; and provided incentives up to $2.70 per sq. ft. (with a cap on total incentive). The majority of the incentive (70%) was paid after project completion, and the rest was paid after one year of monitoring and verification. Additional incentives (up to $15,000) were available to the design team (National Grid 2020a). The

[3] For this program, heat pump incentives are based on heating "tonnage" such that one ton is equal to 12,000 Btu per hour.

program did not include solar energy, but it did make referrals to programs that assist with solar. This program built on earlier pilot and local programs, including Repower Providence (City of Providence 2020), a Zero Buildings Pathway developed by the RI Energy Office (a ZEB voluntary stretch code), and a ZEB working group (State of Rhode Island Office of Energy Resources 2020).

More recently, RI Energy has taken over the program; it now largely bases the ongoing program on a modified version of the Massachusetts program with fewer tiers and a slightly lower baseline. RI Energy notes that COVID slowed down some projects, many of which are schools. The program pays for technical experts in ZEBs to assist design teams. Program staff members stress the importance of establishing a relationship with the design team and find that the earlier the engagement, the more impact they can have. They also find that they can appeal to companies that have sustainability and climate change goals, noting how ZEBs can help achieve these goals (S. Dagher, program-project manager, Lydos, pers. comm., February 2024).

California

As it did with residential new construction, California has established a goal to make commercial new construction net zero; in the case of commercial, the goal is net zero by 2030 (CPUC 2008). The California investor-owned utilities developed a set of ZNE case studies (e.g., Dean 2014), and they work with the California Energy Commission to help develop building code changes every three years. In addition, a prior commercial new-construction program, Savings by Design, included a few net-zero buildings. This program paid incentives based on estimates of project energy savings. In their market research on the commercial ZNE market, California's investor-owned utilities found—among other things—that of new commercial building floor area completed in the prior three years, 0.4% was zero energy or ultra-efficient (zero-energy ready) (Pande et al. 2019).

In 2023, California's investor-owned utilities launched a new commercial construction program (including high-rise multifamily) designed to promote electrification and decarbonization. This program, California Energy Design Assistance (CEDA), is managed by Wildan on behalf of the state's investor-owned utilities. The program includes outreach to architects and engineers, technical assistance, and three types of incentives: (1) design team incentives; (2) incentives per first year of estimated energy savings beyond a standard practice baseline (e.g., the building code); and (3) additional incentives for specified high-performance measures, primarily various types of heat pumps (CEDA 2023). The intent of the latter incentives is to encourage use of various types of heat pumps and to collect more data on them to help make the case that these systems should be encouraged or required in future iterations of the California building code. Presently, both all-electric and mixed-fuel buildings are eligible for CEDA, but the program aims to increase the share of all-electric buildings over time. Over five years, it is targeting 1,500 participating buildings, including 900 all-electric buildings. As of the end of 2023, several hundred projects had been enrolled in the program, but none were yet completed (A. Doeschot, program manager, PG&E, pers. comm., February 2024).

Consumers Energy

Consumers Energy in Michigan operated a Zero Net Energy Pilot Program that ran from approximately 2020–2022. The program provided building owners and their designers with five phases of zero-energy guidance, including design charrettes, energy modeling, construction incentives, and performance measurement and verification (Consumers Energy 2019). The program was really a zero-energy-ready program, as it was funded out of the utility's energy efficiency budget, which does not include solar systems. The program began with approximately a dozen projects, but many dropped out (due to staff turnover, we were unable to learn the reasons). Ultimately. four projects were completed with average

energy savings of about 35%. The projects were either all-electric or had only limited use of fossil fuels as part of hybrid heating systems. Originally, the program used a complicated incentive structure, but it confused customers and designers and resulted in large variability in cost effectiveness from project to project. Incentives were streamlined to a per-square-foot incentive, payable at two key points in the project: after phase 3 (finalized building construction), and after phase 5 (a full year of building operation with measurement and verification). Program staff found that a fixed EUI-based threshold did not work for some buildings and modified these thresholds as long as energy-saving goals—expressed in percentage savings below code—were met. Consumers Energy found that to reach ZNE goals, fossil fuel energy had to be minimized, so it encouraged all-electric projects. It also found that the design community needed to be educated that zero energy is achievable (in this case, the staff developed a design guidebook) (Consumers Energy 2019b). Ultimately, the program ended because administrators decided that the market potential for commercial ZNE-ready buildings was too small to justify a full-scale program. They have since offered a simpler commercial new-construction program to encourage various levels of energy efficiency, including deeper savings for customers interested in ZNE ready (Consumers Energy 2023; J. Wadel, Consumers Energy, Commercial & Industrial Pilot Programs, pers. comm., June 2020).

Data

Given that some programs are just getting started, most of the participation and savings so far are from a few mature programs. Below, we summarize the data collected across the programs. Many did not provide complete data, so this accounting is incomplete. Also, while we tried to be clear about what we wanted them to include, programs likely differed in their interpretation of these instructions; as a result, data between programs may not be directly comparable. Appendix A offers more detailed data on each program.

Start year

The Energy Trust of Oregon Pathway to Net Zero and Efficiency Vermont programs are the oldest programs in our survey, having begun in 2012. The NYSERDA new-construction programs began in 2016. The other programs are newer, including several that began in 2020 or later.

Completions

Many of the programs include zero-energy and zero-energy-ready homes and buildings as well as less-stringent efficiency tiers. We asked programs to provide the number of completions at zero-energy ready and above. Using this yardstick, across the programs—more than 5,000 single-family homes, nearly 25,000 apartments, and 222 commercial buildings—were completed through the programs we profile. Completed commercial buildings total approximately 9.5 million sq. ft. These figures do not include most of the 25,000 homes completed under the DOE Zero-Energy-Ready Homes program. Many other projects are in process, including about 64,000 apartments and 325 commercial buildings totaling more than 94 million sq. ft. Figure 7 summarizes the residential completions and pending projects by program, and figure 8 summarizes the commercial completions and pending projects. From discussions with program managers, it appears that a substantial majority of projects are zero-energy ready, and only some projects are truly zero energy.

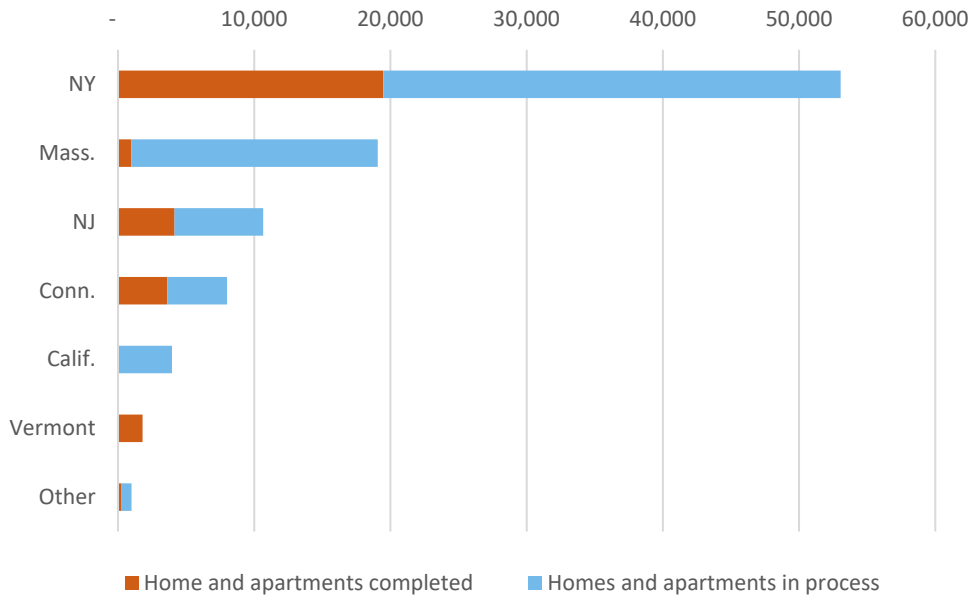

Figure 7. Completed and in-process homes and apartments by program. These figures are approximate, as not all programs reported all data.

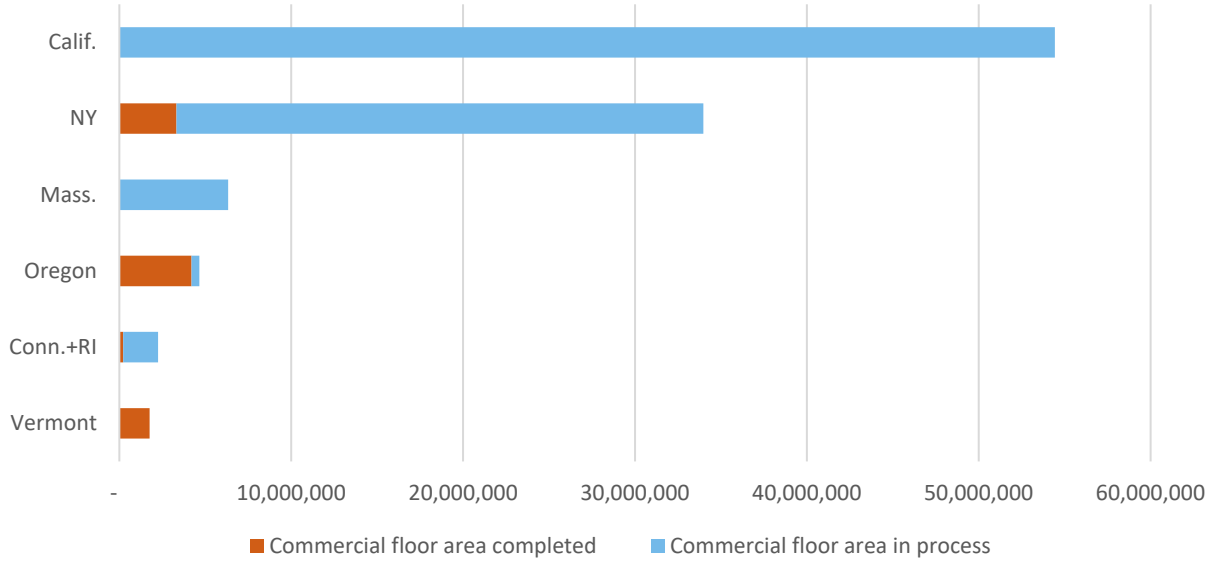

Figure 8. Completed and in-process commercial building floor area by program. These figures are approximate, as not all programs reported all data.

A majority of the completed homes and apartments are in New York, while a substantial majority of commercial buildings are in Oregon, New York, and Vermont. In the pending residential category, Massachusetts and New York dominate, and California and New York dominate in pending commercial buildings.

These completions are up substantially from those in the 2020 version of this report (Nadel 2020). Since then, completed single-family homes and apartments have increased by about a factor of 25, and the

completed commercial buildings have approximately tripled. Participation has often steadily ramped up, as figure 9 shows for the New Jersey Clean Energy Residential Program.

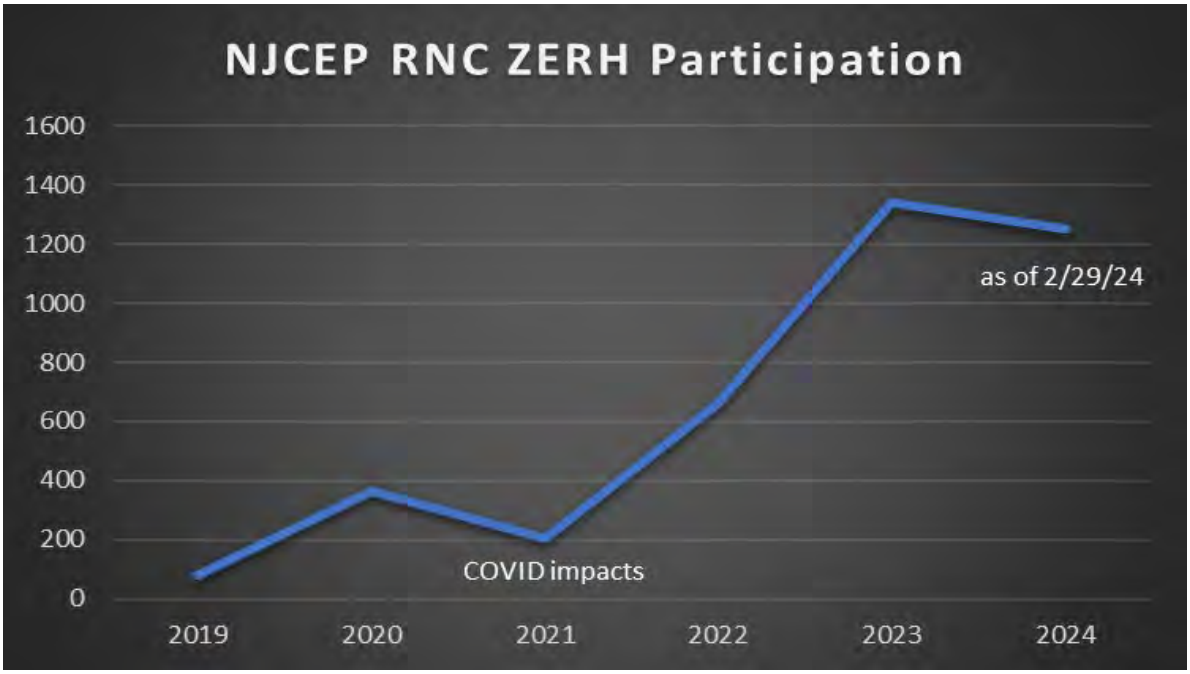

Figure 9. Participation by year in the New Jersey Zero Energy Ready residential new-construction program. *Source*: TRC.

Budgets

Total program budgets were approximately $88 million in the most recent completed year; however, we did not obtain budget information from some programs and other programs provided only incentive spending and not spending for staff, marketing, and technical assistance. Some programs provided only budgets for new-construction programs that include moderate efficiency improvements in addition to zero/zero ready. Planned spending for the current year is approximately $110 million, which is subject to the same limitations, but it is still a significant increase—about 70% higher than the planned 2020 budgets in our previous report (Nadel 2020). For the current year, four states account for more than $90 million in spending: California, New Jersey, New York, and Massachusetts.

Incentives

All the programs we report on in this paper provide financial incentives for homes and buildings meeting zero-energy and zero-energy-ready goals.

Residential programs all pay incentives, typically to the builder and usually on a per-home basis, with incentives per home often varying based on several tiers. Incentives per home vary from just a few hundred dollars to as much as $20,000. A few programs pay incentives per unit of energy saved based on estimated savings in the first year. All the programs we found include incentives for zero-energy ready, with qualifying criteria including homes meeting Passive House or DOE ZERH specifications and homes with HERS scores below specified values (e.g., HERS 45 in Connecticut). NYSERDA, Connecticut, and New Jersey are the only programs we found with explicit tiers for near zero (Connecticut and

NYSERDA's tier 3) or zero ready plus renewables (New Jersey). Many of the competitions (e.g., Connecticut, New York, and Rhode Island) also include solar.

Some of the programs focus on affordable housing (e.g., Massachusetts, Rhode Island, and Commonwealth Edison) and others provide higher incentives for low- and moderate-income housing (e.g., New Jersey and Consumers Energy).

A growing number of programs either require electric space and water heating (e.g., California, Connecticut, Massachusetts, Commonwealth Edison, Consumers Energy, and Xcel) or give additional incentives for electrifying these end uses or going all-electric (all end uses). Some programs provide extra incentives for obtaining third-party certifications such as Passive House. The modular-home programs also include referrals and assistance with low-cost second mortgages, and a few programs have extra incentives for mentoring, feasibility studies, and modeling.

The commercial programs all include various technical assistance services such as an initial design charrette and computer modeling. In addition, several provide incentives per sq. ft. for meeting program energy-saving criteria. Several provide incentives for energy savings beyond the state building code, while, for several years, NYSERDA paid incentives per million metric tons of emissions reductions, as estimated using its own specified procedures (NYSERDA 2019). In all programs except for Oregon's, the efficient design must exceed the building code by 25–50% (varying by state and sometimes by building type); in Oregon, energy use per sq. ft. must generally be at least 80% less than the average existing building. Many of the programs target net-zero performance, but zero ready also qualifies.

Appendix B shows examples of current incentives paid by specific programs.

Third-party specifications

Many of the programs use specifications developed by third-party organizations. Passive House was mentioned most frequently, but DOE ZERH and ENERGY STAR NextGen (combining ENERGY STAR and electrification readiness) were also common. By incorporating these specifications, programs can leverage the resources, training, and community of experienced practitioners to support the design and construction community in their local area. These common specifications also offer additional ways to market the program to builders and consumers concerned about health, comfort, and sustainability.

Energy savings

Only some programs were able to provide information on energy savings achieved from completions in the most recent year. Those programs saved nearly than 10 GWh (million kWh) and over 155 billion Btu of gas. We also note that on a per-building basis, programs typically target 25–60% energy savings.

Findings and Lessons Learned

As noted above, most of the programs we identified promote zero-energy-ready construction; only a few (NYSERDA, Energy Trust of Oregon, New Jersey, and Energize Connecticut) include a zero-energy tier. This is the case for a variety of reasons, including a long history of programs promoting energy savings, so programs are more familiar and comfortable promoting energy efficiency; a desire by programs to maximize cost effectiveness; limitations on the use of energy efficiency budgets to fund renewable energy; and limits on the amount of renewable energy that can fit on many building sites.

We found more residential programs (14) than commercial programs (8), in part because multiple utilities have separate single-family and multifamily programs. Several of the programs have been

operating for at least five years and are achieving substantial participation and savings. For example, the Energy Trust of Oregon Pathway to Net Zero program estimates that about 75% of large new commercial buildings are participating in its program. Several of the programs started recently; these programs have quite a few projects in process, but only a few completions so far.

Many of the residential programs use the Passive House specifications (participants can typically choose either the U.S. or international version) and/or the DOE ZERH specification. Most programs offer lower energy savings and incentives for ZERH than for the Passive House. Some programs use HERS ratings, although two (Massachusetts and Consumers) are planning to shift from HERS to Passive House or ZERH. In many of the residential programs, the majority of units are in multifamily buildings, including developments by affordable housing developers. A few programs explicitly target and assist new affordable housing. As one program notes, affordable housing developers try to keep operating costs low so that these homes will still be affordable in 40 years.

Programs find that training for builders is important, as are special efforts to target the largest builders. Efficiency Vermont recommends working with lenders and appraisers to ensure that they properly value the benefits of high-performance homes. They also provide materials on cash-flow modeling to help the builders sell these homes. Programs report giving builders options so that each builder can find an approach that works for them. Several programs work to train and/or incentivize home raters so they can do final quality control inspections. The modular-home programs show the importance of working with a local manufacturer to develop the designs and of not giving the manufacturer an opportunity to shift purchasers to less-efficient homes. These programs also provide access to low-cost mortgage financing.

For the commercial programs, the Energy Trust of Oregon finds that building a community of practitioners is essential, as is intervening early in the design process and using this early intervention to set and follow through on energy design goals. The program offers a variety of technical assistance services to facilitate early intervention, such as shoebox modeling and natural ventilation studies. Most of the commercial programs find design charrettes to be useful, and all provide assistance with computer modeling. In the commercial sector, education and municipal buildings have been good initial targets, as are multifamily (to the extent that they are part of commercial and not residential programs). Several programs pay incentives at two stages, such as an initial payment once designs are complete and the final payment when construction is complete. A few programs, such as in Southern New England, defer a portion of payment until a year after occupancy so the program can verify that the planned savings targets are reached in practice. Without such a scheme, obtaining post-occupancy data can be difficult, and, as the limited available data indicate, actual performance may not meet the goals. Paying builders and developers for actually meeting these goals may be a useful way to address this issue.

Relative to our 2020 report, many more programs are now requiring electric space and water heating, and other programs are providing extra incentives for electrifying these end uses. Several program managers note that as their electric grids become increasingly clean, going all-electric can become a path to zero emissions. The Consumers Energy commercial program finds that minimizing use of fossil energy makes it easier to reach net-zero-energy performance.

Zero and zero-ready homes and buildings often use ductless VRF heat pumps; several programs report that training contractors on their installation and maintenance can be useful. Programs also note that further work on HPWHs for multifamily buildings is needed. On the other hand, a few gas utilities are promoting renewable natural gas as a way to achieve net-zero energy, although this raises the question of whether new construction is the best use of limited renewable natural gas supplies.

Some of the programs have gone through substantial revisions to address changing circumstances; examples include a redesign of many of Efficiency Vermont's programs to incorporate some zero-ready measures in the state building code; changes in NYSERDA's programs to emphasize electrification and best uses of limited budgets; changes in utility ownership in Rhode Island; and the evolution of programs in New Jersey and Michigan.

Many program managers note that to promote zero-energy and zero-energy-ready homes and buildings, it is important to feature their many benefits—including their impacts on comfort, health, and worker satisfaction—along with operating cost savings. Program managers also report that it is useful to have simple incentive structures that are easily understood by builders, designers, and developers.

A few programs see their efforts as part of a market transformation approach to ultimately move toward ZEB codes. This is a major focus of California utilities, NYSERDA, and Efficiency Vermont. In some states, utilities can get energy savings credit for their contributions to code development and adoption (Garfunkel and Waite 2024).

Because many of the programs are new, it would be useful to repeat this research in a few years when these new programs have more results and additional programs have begun.

Conclusion

Programs to promote zero-energy and zero-energy-ready homes and buildings are growing in number, driven by a desire to achieve energy savings and greenhouse emissions reductions relative to even the most stringent building codes. Many programs have launched only recently. Several program implementers have five or more years' experience with these programs, and these implementers dominate the project completion counts. Particularly notable are the Energy Trust of Oregon commercial program, Massachusetts residential program, NYSERDA multifamily and commercial programs, and Efficiency Vermont programs addressing single-family, multifamily, modular housing, and commercial buildings. Collectively, these programs report many lessons learned, as we summarized above. All of these programs make important contributions to efforts to transform new-construction markets and ultimately to make zero-energy and zero-carbon building common practice.

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Appendix A: Data by Program

The following tables summarize the data that each program provided to us. Table A1 covers the residential programs. Table A2 covers the commercial programs. We sought to collect the data in as standardized a form as possible, but programs varied somewhat in their responses. Given this, care should be used in comparing programs. These data are best viewed as providing a broad picture. Furthermore, all of these programs are regularly changing. The data below capture a snapshot in time.

Table A1. Data provided by residential programs

Program administrator	NYSERDA	Massachusetts (all PAs)	Eversource CT
Program	New construction residential	Residential New Construction	Residential New Construction
Start year	2016	2022	2022
Period of most recent annual data provided	2023		2023
Completions since program beginning			
Number of homes	3421	373	968
Number of apartments	16,054	601	2,646
Number of commercial buildings	NA		NA
Commercial building total floor area	NA		NA
Completions in most recently completed program year			
Number of homes	50		442
Number of apartments	2856		1,741
Number of commercial buildings	NA		NA
Commercial building total floor area	NA		NA
Number of projects now in the pipeline but not yet completed			
Number of homes	336	457	289
Number of apartments	33,235	17,637	4,104
Number of commercial buildings	NA		NA
Commercial building total floor area	NA		NA
Total program budget in most recently completed program year	$21.5 million	$9,528,223	$ 3,456,748.00
Total estimated participant cost share in most recent year	NA		NA
Budget in current program year	$16.8 million	$9,528,223	$ 3,100,000.00
Are incentives available for design team (Y or N)?	Y	Up to 100% of the costs for Passive House feasibility study (max $5,000)	Y - Passive House Projects Only
Are incentives available for computer modeling (Y or N)?	N	75% of Passive House energy modeling costs ($500/unit, max. $20,000)	Y - Passive House Projects Only
Is other technical assistance available (Y or N)?	Y	We assist in the facilitation of energy charrettes	Y - Passive House Projects Only
Incentives for efficiency measures in most recent year (appropriate rows)			
(if efficiency and renewable incentives are combined, ok to enter these here)			
Per first year kWh saved			$ 0.75
Per lifetime kWh saved			$ 0.036
Per first year fossil fuel mBtu saved			NA
Per lifetime fossil fuel mBtu saved			NA
Per sq. ft. of floor area	$1-$20		$ 1.24
Per home	$1000-$4000		$ 2,621.94
Per apartment	$1000-$4000		$ 1,190.71
Per metric ton of CO2 saved			NA
Are renewable incentives included in your answer above (Y or N)?	N		N
Are separate incentives available for on-site solar systems (Y or N)?	N		N
Does your program use any third-party specifications?			
Passive House	Y	Yes - Currently MF only.	Y
DOE Zero Energy Ready Homes	Y (not compliance path but prerequisite for Phius certification)		Y
Living Buildings	N		Y
Other (please specify)	Not compliance paths but contribute to higher tier: Enterprise Green Communities 2020, Fitwell, LEED Platinum, International Living Futures Institute Zero Carbon, US EPA Indooor airPLUS, WELL Certificiation		ENERGY STAR™, NGBS, LEED
Annual estimated savings from completions in most recent year			
(please provide net savings if available)			
MWh of electricity (1000 kWh)	5,535		4,261
Decatherms of natural gas (million Btu)	62,580		11,275
Million Btu of other fuels			NA
Thousand gallons of water			NA
Are these net or gross savings?	Gross		Net

			Efficiency Vermont
Program administrator	NJ Board of Public Utilties	Rhode Island Energy	Residential New Construction
Program	Residential New Construction	Residential New Construction Progra	Zero Energy Modular and High Perfo
Start year		2018	2012
Period of most recent annual data provided	2023	2023	2023
Completions since program beginning			
Number of homes	588	26	186
Number of apartments	3,563	103	
Number of commercial buildings		NA	
Commercial building total floor area		NA	
Completions in most recently completed program year		2,023	
Number of homes		4	2
Number of apartments		48	
Number of commercial buildings		NA	
Commercial building total floor area		NA	
Number of projects now in the pipeline but not yet completed			
Number of homes	577	9	
Number of apartments	5,930	345	
Number of commercial buildings		NA	
Commercial building total floor area		NA	
Total program budget in most recently completed program year	$14,177,101	$1,591,952	$28,000
Total estimated participant cost share in most recent year	n/a	NA	
Budget in current program year	$19,665,582	$1,312,700	$594,500
Are incentives available for design team (Y or N)?	Y	Y	N
Are incentives available for computer modeling (Y or N)?	N	Y	N
Is other technical assistance available (Y or N)?	N	Y	Y
Incentives for efficiency measures in most recent year (appropriate rows)			
(if efficiency and renewable incentives are combined, ok to enter these here)			
Per first year kWh saved		N	
Per lifetime kWh saved		N	
Per first year fossil fuel mBtu saved	$30	N	
Per lifetime fossil fuel mBtu saved		N	
Per sq. ft. of floor area		N	
Per home	$500-6000 + $500 for affordable	Y	$2,500 - $14,000
Per apartment	$500-2250	Y	
Per metric ton of CO2 saved		N	
Are renewable incentives included in your answer above (Y or N)?	N	N	N
Are separate incentives available for on-site solar systems (Y or N)?	N	N	Not through Efficiency Vermont
Does your program use any third-party specifications?			
Passive House	Not yet, but it's being considered	Y	Y
DOE Zero Energy Ready Homes	Y	Y	Y
Living Buildings	N	N	N
Other (please specify)			NGBS, ENERGY STAR, IAP
Annual estimated savings from completions in most recent year			
(please provide net savings if available)			
MWh of electricity (1000 kWh)	17		13
Decatherms of natural gas (million Btu)	56,158		
Million Btu of other fuels	NA		
Thousand gallons of water	NA		
Are these net or gross savings?	Net		Gross

	Efficiency Vermont		
Program administrator	Multifamily New Construction	ComEd	PG&E
Program	High Performance Homes	Electric Homes New Construction	Califonria Energy-Smart Homes Prog
Start year	2016	2020	2022
Period of most recent annual data provided	2023	2023	2023
Completions since program beginning			
Number of homes		46	
Number of apartments	1,615	79	
Number of commercial buildings		-	
Commercial building total floor area		-	
Completions in most recently completed program year			
Number of homes		26	215
Number of apartments	144	42	-
Number of commercial buildings			N/A
Commercial building total floor area			N/A
Number of projects now in the pipeline but not yet completed			
Number of homes		24	1,980
Number of apartments		81	1,978
Number of commercial buildings			N/A
Commercial building total floor area			N/A
Total program budget in most recently completed program year	$392,386	$660,000	$5 million
Total estimated participant cost share in most recent year			NA
Budget in current program year	$1,731,000	$928,500	$12,800,000
Are incentives available for design team (Y or N)?	Y	ncentives go to the builder and rater	Y
Are incentives available for computer modeling (Y or N)?	Y	N	N
Is other technical assistance available (Y or N)?	Y	Y	Y
Incentives for efficiency measures in most recent year (appropriate rows)			
(if efficiency and renewable incentives are combined, ok to enter these here)			
Per first year kWh saved	$ 0.84		
Per lifetime kWh saved	$ 0.06		
Per first year fossil fuel mBtu saved	$ 603.61		
Per lifetime fossil fuel mBtu saved	$ 36.87		
Per sq. ft. of floor area	$ 2.84	Y	
Per home		$200/unit for HERs rater	
Per apartment	$ 2,724.90		
Per metric ton of CO2 saved	$1926 first year, $142 lifetime		
Are renewable incentives included in your answer above (Y or N)?	N	N	
Are separate incentives available for on-site solar systems (Y or N)?	Not from Efficiency Vermont		
Does your program use any third-party specifications?		N	
Passive House	$300/unit upon certification		Y
DOE Zero Energy Ready Homes			N
Living Buildings			N
Other (please specify)			N
Annual estimated savings from completions in most recent year			
(please provide net savings if available)			
MWh of electricity (1000 kWh)	468	1,190	NA
Decatherms of natural gas (million Btu)			NA
Million Btu of other fuels	650		NA
Thousand gallons of water			NA
Are these net or gross savings?	Gross	Gross	NA

Program administrator	DC Dept. of Buildings (DOB)	Dominion Energy	Milford Homes	
Program	Net-Zero Energy (NZE) Incentives Pro	ThermWise EE Programs for Builders	Ze-Mod	
Start year	2019	2017	2018	
Period of most recent annual data provided	2023		2021	
Completions since program beginning				
Number of homes	5		4	
Number of apartments	-			
Number of commercial buildings	-			
Commercial building total floor area	-			
Completions in most recently completed program year				
Number of homes	5	100		
Number of apartments	-	11		
Number of commercial buildings	-	NA		
Commercial building total floor area	-	NA		
Number of projects now in the pipeline but not yet completed				
Number of homes	7	130		
Number of apartments	105	40		
Number of commercial buildings	2	NA		
Commercial building total floor area	134,796	NA		
Total program budget in most recently completed program year		8,346,310		
Total estimated participant cost share in most recent year		NA		
Budget in current program year	$50,000	8,249,660		
Are incentives available for design team (Y or N)?	Y	N	N	
Are incentives available for computer modeling (Y or N)?	N	N	N	
Is other technical assistance available (Y or N)?	Y	Y	N	
Incentives for efficiency measures in most recent year (appropriate rows)				
(if efficiency and renewable incentives are combined, ok to enter these here)				
Per first year kWh saved				
Per lifetime kWh saved				
Per first year fossil fuel mBtu saved				
Per lifetime fossil fuel mBtu saved				
Per sq. ft. of floor area				
Per home		1420	$	16,500
Per apartment				
Per metric ton of CO2 saved				
Are renewable incentives included in your answer above (Y or N)?	Y	N	N	
Are separate incentives available for on-site solar systems (Y or N)?		N	N	
Does your program use any third-party specifications?		Y		
Passive House	Y		N	
DOE Zero Energy Ready Homes	Y	Y	N	
Living Buildings	Y		N	
Other (please specify)	Zero Energy, 2021 IECC Appendix RC		N	
Annual estimated savings from completions in most recent year				
(please provide net savings if available)				
MWh of electricity (1000 kWh)				
Decatherms of natural gas (million Btu)		4,814		
Million Btu of other fuels				
Thousand gallons of water				
Are these net or gross savings?				

Table A2. Data provided by commercial programs

			Efficiency Vermont
Program administrator	Energy Trust of Oregon	NYSERDA	Commercial New Construction
Program	New Buildings	New construction commercial	Net Zero Ready and High Performanc
Start year	2014	2016	2012
Period of most recent annual data provided	2023	2023	2023
Completions since program beginning			
Number of homes		NA	
Number of apartments	5	NA	
Number of commercial buildings	53	79	82
Commercial building total floor area	4,201,223	3,320,867	1,760,642
Completions in most recently completed program year			
Number of homes		NA	
Number of apartments		NA	
Number of commercial buildings	6	13	1
Commercial building total floor area	204,630	753,489	14,800
Number of projects now in the pipeline but not yet completed			
Number of homes		NA	
Number of apartments	2	NA	
Number of commercial buildings	10	149	
Commercial building total floor area	452,633	30,654,510	
Total program budget in most recently completed program year	$167,287	$6,300,000	$16,315
Total estimated participant cost share in most recent year	$167,287	NA	
Budget in current program year	$167,287	$6,100,000	$950,000
Are incentives available for design team (Y or N)?	Y	Y	Y
Are incentives available for computer modeling (Y or N)?	Y	Y	Y
Is other technical assistance available (Y or N)?	Y	Y	Y
Incentives for efficiency measures in most recent year (appropriate rows)			
(if efficiency and renewable incentives are combined, ok to enter these here)			
Per first year kWh saved			$0.09
Per lifetime kWh saved			$0.01
Per first year fossil fuel mBtu saved			$1,182.42
Per lifetime fossil fuel mBtu saved			$149.68
Per sq. ft. of floor area		$1.50 sq ft or $2 sq ft (based on performance threshold)	$1.10
Per home			
Per apartment			
Per metric ton of CO2 saved			
Are renewable incentives included in your answer above (Y or N)?	N	N	N
Are separate incentives available for on-site solar systems (Y or N)?	Y	N	N
Does your program use any third-party specifications?	N	Y	
Passive House			N
DOE Zero Energy Ready Homes			N
Living Buildings			N
Other (please specify)		LEED certification increased incentives in older versions of program but since 2020 have relied on performance thresholds exclusively	N
Annual estimated savings from completions in most recent year			
(please provide net savings if available)			
MWh of electricity (1000 kWh)	616	7,470	173
Decatherms of natural gas (million Btu)	1,308	16,774	
Million Btu of other fuels			14
Thousand gallons of water			
Are these net or gross savings?	Net	Gross	Gross

Program administrator	Massachusetts (all PAs)	Eversource CT	Rhode Island Energy
Program	Commercial High Performance New (	Commercial High Performance New (	C&I New Construction & ZNE Pilot
Start year	2020	2020	2020
Period of most recent annual data provided	2023	2023	2023
Completions since program beginning			
Number of homes			
Number of apartments			
Number of commercial buildings	5	3	
Commercial building total floor area		227,263	
Completions in most recently completed program year			
Number of homes			
Number of apartments			
Number of commercial buildings	2	3	
Commercial building total floor area	166,114	227,263	
Number of projects now in the pipeline but not yet completed			
Number of homes			
Number of apartments			34
Number of commercial buildings	48	9	17
Commercial building total floor area	6,333,886		2,028,000
Total program budget in most recently completed program year	$ 10,476,391	5,490,910	$ 11,087,900
Total estimated participant cost share in most recent year			25% cost share for ZNE TA study
Budget in current program year	$ 9,766,704	6,025,611	$ 11,362,800
Are incentives available for design team (Y or N)?	Y	Y	Y
Are incentives available for computer modeling (Y or N)?	Y	Y	Y
Is other technical assistance available (Y or N)?			Y
Incentives for efficiency measures in most recent year (appropriate rows)			
(if efficiency and renewable incentives are combined, ok to enter these here)			
Per first year kWh saved			N
Per lifetime kWh saved			N
Per first year fossil fuel mBtu saved			N
Per lifetime fossil fuel mBtu saved			N
Per sq. ft. of floor area			Y
Per home			NA
Per apartment			NA
Per metric ton of CO2 saved			NA
Are renewable incentives included in your answer above (Y or N)?		N	N
Are separate incentives available for on-site solar systems (Y or N)?	State runs SMART program	N	N
Does your program use any third-party specifications?			
Passive House			NA
DOE Zero Energy Ready Homes			NA
Living Buildings			NA
Other (please specify)			
Annual estimated savings from completions in most recent year			
(please provide net savings if available)			
MWh of electricity (1000 kWh)	969		NA
Decatherms of natural gas (million Btu)	24,152		NA
Million Btu of other fuels			NA
Thousand gallons of water			NA
Are these net or gross savings?			NA

Program administrator	PG&E
Program	California Energy Design Assistance (CEDA)
Start year	2022
Period of most recent annual data provided	2023
Completions since program beginning	
Number of homes	-
Number of apartments	-
Number of commercial buildings	-
Commercial building total floor area	-
Completions in most recently completed program year	
Number of homes	-
Number of apartments	-
Number of commercial buildings	-
Commercial building total floor area	-
Number of projects now in the pipeline but not yet completed	
Number of homes	316
Number of apartments	555
Number of commercial buildings	90
Commercial building total floor area	54,427,172
Total program budget in most recently completed program year	$16,638,152
Total estimated participant cost share in most recent year	NA
Budget in current program year	$17,809,382
Are incentives available for design team (Y or N)?	Y
Are incentives available for computer modeling (Y or N)?	Y
Is other technical assistance available (Y or N)?	Y
Incentives for efficiency measures in most recent year (appropriate rows)	
(if efficiency and renewable incentives are combined, ok to enter these here)	
Per first year kWh saved	$.20/kWh
Per lifetime kWh saved	NA
Per first year fossil fuel mBtu saved	$.20/Therm EE, $1.00/Therm Electrified
Per lifetime fossil fuel mBtu saved	NA
Per sq. ft. of floor area	NA
Per home	NA
Per apartment	NA
Per metric ton of CO2 saved	NA
Are renewable incentives included in your answer above (Y or N)?	NA
Are separate incentives available for on-site solar systems (Y or N)?	NA
Does your program use any third-party specifications?	NA
Passive House	No
DOE Zero Energy Ready Homes	No
Living Buildings	No
Other (please specify)	No
Annual estimated savings from completions in most recent year	
(please provide net savings if available)	
MWh of electricity (1000 kWh)	1,394
Decatherms of natural gas (million Btu)	57,568
Million Btu of other fuels	NA
Thousand gallons of water	NA
Are these net or gross savings?	Net

Appendix B: Sample Qualifying Criteria and Incentive Schedules

Here we provide information on qualifying criteria and incentives from various program websites (current as of spring 2024). Not all programs post these details.

Residential

California Energy Smart Homes

New Construction Single Family, Duplex, Townhome

- Communicating thermostats
- Induction cooking*
- Heat pump water heating
- Heat pump space heating
- Segregated circuits
- Install a 240-volt plug for electric vehicle charging infrastructure
- Battery storage readiness
- Thermostatic mixing valves

The multifamily low-rise is the same except that battery storage readiness is dropped.

All-Electric New Construction	**2024**	**2025**	**2026**
Single Family/Duplex/ Townhome (per unit)	$3,000	$3,000	$2,500
Multifamily/ADUs (per unit)	$1,600	$1,600	$1,400

Central Heat Pump Water Heater Targeted Measures	Incentive
Central System Design (per project/developer) Full MEP Design and documentation	$5,000
Central System Installation (per installed unit)	$500

Commonwealth Edison Electric Homes New Construction

Minimum program requirements

- All-electric space heating, water heating, and clothes dryer
- Air tightness <_2.5 air changes per hour at 50 Pascals depressurization
- Cold-climate air-source heat pump space heating and cooling, >_17.8 SEER, >_11.0 HSPF,
- or ground-source heat pump, >_22 EER, >_4.4 COP
- Heat pump water heating, >_3.45 UEF
- All LED interior and exterior lighting
- ENERGY STAR® certified refrigerators, dishwashers, and clothes washers
- Electric clothes dryer with moisture-sensing feature or heat pump dryer
- ENERGY STAR certified smart thermostats for compatible HVAC systems
- Kitchen and bathroom faucets rated for <_1.5 gallons per minute, and showerheads
- Rated for <_2.0 gallons per minute

Indoor air quality and comfort requirements

- Compliance with current Illinois Energy Conservation Code prescriptive envelope and window requirements.
- Continuous exterior insulation or other thermally broken construction techniques are recommended.
- Compliance with ASHRAE 62.2.
- Kitchen ventilation to outdoors required.
- Sealed sump basin and sealed plumbing rough-in (if applicable).
- Thermal isolation of slab-on-grade (if applicable).

Incentive Structure

Square Feet per Unit	Incentive
< 800	$3,000
800 – 1,500	$4,000
Over 1,500	$5,000

Energize Connecticut Residential New Construction

All-Electric Home Specification Sheet

Single Family & Single Family Attached Dwellings			
	Tier 1	**Tier 2**	**Tier 3**
Total UA Alternative Compliance or HERS Index Score[1]	Total UA ≥ 7.5% better than 2021 IECC or HERS Index Score ≤ 55	Total UA ≥ 15% better than 2021 IECC or HERS Index Score ≤ 45	Total UA ≥ 25% better than 2021 IECC or HERS Index Score ≤ 10
Heat Pump (Space Heating)[2]	Required		
Space Conditioning Connectivity & Controls[3]	Optional	Required	
Heat Pump (Domestic Hot Water)[4]	Required		
Hot Water Distribution Efficiency[5]	Required		
Envelope Infiltration Rate (ACH)	ACH50 ≤ 2.5	ACH50 ≤ 2.0	ACH50 ≤ 1.5
Duct Leakage Rate (CFM)	2021 IECC code minimum requirements	All ductwork must be located in conditioned space	
Balanced Ventilation Systems	Optional	Required HRV / ERV (≥70% SRE / ≥40% TRE)	
Induction Cooking[6]	Optional		Required
Electric Vehicle Readiness[7]	Required		
Solar PV[8]	Optional		Required

All-Electric Home Specification Sheet

Multifamily Dwellings

	Tier 1	Tier 2	Tier 3
Total UA Alternative Compliance or HERS Index Score[1]	Total UA ≥ 7.5% better than 2021 IECC or HERS Index Score ≤ 55	Total UA ≥ 15% better than 2021 IECC or HERS Index Score ≤ 45	Total UA ≥ 25% better than 2021 IECC or HERS Index Score ≤ 10
Heat Pump (Space Heating)[2]	Required		
Space Conditioning Connectivity & Controls[3]	Optional	Required	
Heat Pump (Domestic Hot Water)[4]	Required		
Hot Water Distribution Efficiency[5]	Required		
Envelope Infiltration Rate (ACH)	CFA > 850ft2: ACH50 ≤ 4.0	CFA > 850ft2: ACH50 ≤ 3.0	CFA > 850ft2: ACH50 ≤ 2.5
	CFA < 850ft2: ACH50 ≤ 5.0	CFA < 850ft2: ACH50 ≤ 4.0	CFA < 850ft2: ACH50 ≤ 3.0
Duct Leakage Rate (CFM)	2021 IECC code minimum requirements		All ductwork must be located in conditioned space
Balanced Ventilation Systems	Optional	Required HRV/ERV (≥ 70% SRE / ≥ 40% TRE)	
Induction Cooking[6]	Optional		Required
Electric Vehicle Readiness[7]	Required		
Solar PV[8]	Optional		Required

All-Electric Home & High Performance Certification Bonus Incentives				
All-Electric Home Incentive				
Requirements	**Tier**	**Single Family Applicant Rebate**	**Single Family Attached Applicant Rebate**	**Multifamily Applicant Rebate**
1. Projects pursuing the All-Electric Home Incentive must be built to the specifications indicated on the All-Electric Home Specification form(s) (Pages 3-4) 2. Incentives capped at $500,000 per project (Tier 1), $750,000 per project (Tier 2), and $1,000,000 per project (Tier 3)	☐ Tier 1	$7,500	$3,000	$1,500
	☐ Tier 2	$10,000	$4,000	$2,500
	☐ Tier 3	$12,500	$5,000	$3,500
Heat Pump Adder Incentive				
Requirements	**CEE Tier/ENERGY STAR®**	**Single Family Applicant Rebate**	**Single Family Attached Applicant Rebate**	**Multifamily Applicant Rebate**
Air source heat pump systems must meet Consortium for Energy Efficiency (CEE) Tier 2 specifications, and ground source heat pumps must meet current ENERGY STAR certified requirements.	CEE Tier 2 (Air Source) ENERGY STAR (Ground Source)	$250/Ton ($1,000 Cap/Unit) $150/Ton ($500 Cap/Unit)		$125/Ton ($500 Cap/Unit)
High Performance Certification Rebate Chart				
Requirements	**Qualifying Criteria (Please check all that apply)**	**Single Family Applicant Rebate**	**Single Family Attached Applicant Rebate**	**Multifamily Applicant Rebate**
1. Additional energy modeling and design incentives available for Single Family Attached and Multifamily Passive House projects with 5 or more units. Please refer to Passive House Incentives form. 2. Must provide all proper documentation for certification. 3. Passive House Certification Bonus Project cap is $60,000; all other certification bonus project caps limited to $20,000. 4. Rebate is available for up to a maximum of two certifications per home. 5. All projects must provide HERS Rating documentation from HERS Rating Path participation, above.	☐ Passive House*	$1,000	$1,500	$1,500
	☐ DOE Zero Energy Ready Home	$750	$500	$500
	☐ LEED for Homes	$500	$250	$250
	☐ NGBS Silver	$500	$250	$250
	☐ ENERGY STAR	$500	$250	$250

Mass Save All-Electric Homes

Component	Level 1	Level 2
Energy savings percentage or HERS Index Score	Savings ≥ 30% or HERS Index Score ≤ 45*	Savings ≥ 50% or HERS Index Score ≤ 35*
Heat pump for space heating †	Required	Required
Heat pump for water heating	Optional	Required
All-electric cookware	Required	Required
Infiltration rate (ACH)	ACH50 ≤ 1.5	ACH50 ≤ 1.0
Balanced ventilation systems (HRVs & ERVs)	Required	Required
Continuous envelope insulation ‡	Optional	Required
Electric vehicle-ready checklist	Required	Required

Home Type	Level 1	Level 2
Single-family	$15,000	$25,000
2-unit dwelling	$17,500	$30,000
3-unit dwelling	$20,000	$35,000
4-unit dwelling	$22,500	$40,000

New Jersey Residential New Construction

Table 1.

	Single Family (1 & 2 Family Homes)	Townhouse (3+ Connected Units)	Multifamily (5 Stories or less)	Multifamily (MFNC)
Energy Star	$1,000 per home + $30 per MMBtu saved	$500 per home + $30 per MMBtu saved	$500 per unit + $30 per MMBtu saved	$500 per unit + $30 per MMBtu saved
ZERH (Zero Energy Ready Home)	$4,000 per home + $30 per MMBtu saved Rater Incentive: $1,200 per home	$2,500 per home + $30 per MMBtu saved Rater Incentive: $1,200 per home	$1,500 per unit + $30 per MMBtu saved	N/A
ZERH + Renewables	$6,000 per home + $30 per MMBtu saved Rater Incentive: $1,200 per home	$4,000 per home + $30 per MMBtu saved Rater Incentive: $1,200 per home	$2,250 per unit + $30 per MMBtu saved	N/A
UEZ/Affordable Housing Bonus	+$500 per home	+$500 per home	N/A	N/A

Table 1 Notes:

• The above $30/MMBTU is based on calculated savings before any savings from renewable energy (RE) is added. RE represents renewable energy to offset the remaining annual energy load. MMBtu is the incremental annual energy saved as compared to the calculated annual usage of the baseline reference home, defined by the applicable energy code as described in more detail in the New Jersey Clean Energy Program Protocols to Measure Resource Savings.

• The UEZ or Affordable Housing bonus incentive is available for each single family detached and townhouse (i.e., multi-single) dwelling that is verified as being in an Urban Enterprise Zone (UEZ) or designated as Affordable Housing as defined below. Only one incentive type can be applied per unit. o

- "Affordable Housing" means any housing that an official document identifies as participating in a federal, state, or local affordable housing program. This may also include official documents showing identification from the New Jersey Housing and Mortgage Finance Agency, United States Low Income Housing Tax Credit (LIHTC), and United States Housing and Urban Development (HUD).
- An Urban Enterprise Zone (UEZ) is an area within a municipality (or group of municipalities) in New Jersey suffering from economic distress and meeting other criteria. A list of current UEZs within the State of New Jersey is available at https://www.nj.gov/treasury/taxation/businesses/salestax/uez-over.shtml

Rhode Island Energy Residential New Construction Program and Zero Energy Homes

Path to Energy Efficiency

A Program HERS Rater will review your plans to determine which incentive level the home will achieve and will perform inspections during the construction process to verify actual performance.

High Efficiency Electric Homes can qualify for an additional incentive if they meet the following requirements:

- Achieve Tier II or Tier III Path to Energy Efficiency incentive level (see below)
- Be Fossil Fuel Free*
- Install heat pumps from NEEP's Cold Climate Air Source Heat Pump List
- Submit an ACCA approved Manual J load calculation for review to ensure proper sizing
- Use an HVAC Check approved contractor

Path to Energy Efficiency Incentives					
Energy Savings Levels	**Air Leakage**	**1-4 Unit Bldg**	**5-10 Unit Bldg**	**11-30 Unit Bldg**	**31-75 Unit Bldg**
Tier I 15-25% savings	≤ 5.0 ACH50	$500	$300	$250	$200
Tier II 26-39% savings	≤ 4.0 ACH50	$1,500	$750	$600	$500
Tier III 40%+ savings	≤ 3.0 ACH50	$4,000	$2,000	$1,500	$1,000
ENERGY STAR® Label (additional)		$200	$150	$100	$100
High Efficiency Electric Homes (additional)		$1,000	$500	$250	$250

Path to Zero Net Energy

To qualify for the additional incentives below (either Option A or Option B) projects must:

- Enroll during the early design phase
- Achieve Tier II or Tier III Path to Energy Efficiency incentive level (see above)
- Be Fossil Fuel Free*

Projects seeking Passive House certification (Option B) are eligible to receive incentives in three installments:

- PHIUS Enrollment/Design Charrette
- PHIUS Pre-certification
- PHIUS Certification

Path to Zero Energy Ready Incentives				
Zero Energy Ready Options	**1-4 Unit Bldg**	**5-10 Unit Bldg**	**11-30 Unit Bldg**	**31-75 Unit Bldg**
Option A: DOE Zero Energy Ready Home Certified[1], or Compliant with Current Version of the RI Stretch Code[2]	$1,000	$750	$500	$500
Option B: Passive House Certified[3]	$1,500	$1,500	$900	$750

Commercial

Mass Save Commercial New Construction

PATH 1: NET ZERO/LOW EUI BUILDINGS	
Customer Incentives	
Construction Incentive	up to $2.00/sf
Post Occupancy Incentive	$1.50/sf
Space Heating Heat Pump Adder*	
• Air Source Heat Pumps:	$800/ton
• Variable Refrigerant Flow (VRF):	$1,200/ton
• Ground Source Heat Pumps:	$4,500/ton
ZNE Or PH Certification Incentive	$3,000
Technical Assistance For Net Zero Expert Consultant Services	50% of fee up to $10,000
Verification Incentive	50% of fee up to $10,000

PATH 2: WHOLE BUILDING EUI REDUCTION APPROACH	
Customer Incentives	
Incentive rate range (based on EUI % reduction)	$0.35/sf - $1.25/sf
Space Heating Heat Pump Adder*	
• Air Source Heat Pumps:	$800/ton
• Variable Refrigerant Flow (VRF):	$1,200/ton
• Ground Source Heat Pumps:	$4,500/ton
Technical Assistance	up to 75% cost share (capped at $20,000 per Sponsor)
Verification Incentive	50% of fee up to $10,000