Low Load and All-Electric Residential New Construction Study

R2015

A Report to the Connecticut Energy Efficiency Board

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1 Abstract

Connecticut's energy efficiency program for residential new construction is in a state of transition. Industry standard practice has approached efficiency levels historically promoted by Energize Connecticut, leading the program administrators, advisors, and regulators to consider whether a structural shift is needed as part of a program update and how the next generation of residential new construction programs should be designed. Concurrently, state policy has shifted toward greater interest in decarbonization, and the Connecticut Department of Energy and Environmental Protection (DEEP) has directed the investor-owned utilities that administer Energize Connecticut to shift the program to an all-electric program. This study was designed to identify best practices among industry-leading residential new construction programs outside Connecticut, help define what the next generation of residential new construction programs in the state may encompass, and provide actionable insights and input for on-going program planning. This work is based on interviews and secondary reviews of best practices among leading programs outside Connecticut.

Overall study recommendations address a need to upgrade program tiers and incentives; increase the share of program efforts designed to transform the market rather than just influence participating structures; future-proof program homes by preparing them for a more dynamic grid that accommodates dynamic pricing, demand response, and distributed energy resources; integrate state policy, codes and standards, and program activities to a greater degree; and adjust governance of the program a bit to encourage and allow for an updated program focus.

Immediate priorities for Energize Connecticut and DEEP are a shift of the program design to an all-electric offering that achieves electrification for residential new construction. This report includes a section that lays out how study recommendations apply to a program redesign focused on all-electric homes. Recommendations for the program design include a tightening of efficiency standards from current levels, increases in current bonus incentives for all-electric offerings, and broader market transformation activities. The report discusses the implications of rapid and slower transition time frames and how program approaches would differ between an all-encompassing all-electric program offering and one that shifts rebates to all-electric homes but continues to engage market actors who are not yet ready to shift all end-uses to electric appliances. This section also highlights the role policy, energy codes, comprehensive energy planning, and regulatory program oversight play in the transition. The report includes recommendations that Comprehensive Energy Strategy set the framework for the program's role, that Energize Connecticut and energy codes work together in a complementary fashion, that DEEP's oversight of the program align utility incentives with state policy shifts and ensure that measurement of program impacts allow for market transformation efforts.

2 Executive Summary

The Connecticut Energy Efficiency Board (CTEEB) commissioned an investigation of low-load residential new construction program approaches to help inform the direction that Energize Connecticut takes with its support of efficient new single-family and multifamily buildings. The study employed secondary research to identify and examine leading-edge residential new construction programs throughout the United States.

2.1 Background

This study was motivated in part by indications that industry standard practice within residential new construction has been catching up to program standards and by the need to find the next generation of efficiency improvements beyond past go-to measures and approaches. Updates to Connecticut's residential energy codes are scheduled for the fall of 2022, leading to further upward pressure on building practices. Meanwhile, Connecticut's energy-related policies have been moving toward greater focus on climate issues and reductions in greenhouse gases within the state. These policy considerations led to a directive during the implementation of this study in which the Connecticut Department of Energy and Environmental Protection (DEEP) instructed the state's utilities that administer Energize Connecticut to shift the focus of the residential new construction program toward an all-electric offering in 2023.

This study uses insights and experiences from leading programs to provide recommendations for Connecticut that address program design and state policy that apply for either a multi-fuel or electric-only focus. The recommendations are designed to maximize the impact of Energize Connecticut's program activities on the energy efficiency levels of residential new construction in the state and to reduce energy and carbon impacts from new homes in the years to come. Discussion and recommendations are informed by secondary research that was designed to inform Connecticut's program direction, including (but not limited to) promoting all-electric homes. Given DEEP's recent directives, we have shifted our focus to emphasize findings related to all-electric homes, but retain the broader perspectives of the study on advanced practices in achieving low-load new construction in the residential sector.

2.2 Adjust Program Design

We found that Energize Connecticut's new construction efforts are already a leading program nationally with its comprehensive tier-based set of offerings. However, there are several issues that need to be addressed for the program to keep up with changing industry practices and continue to push the market toward higher efficiency levels (and carbon reductions):

- The current tiers offer rebates for efficiency levels that are minimally better than current practices and energy codes that are about to be adopted.

- Connecticut's programs are largely resource acquisition-oriented and focus on measure or participant incentives by design with only a lighter touch effort to fundamentally transform new construction market activity.

This resource acquisition focus leaves more widespread energy savings on the table by concentrating (and counting savings) mostly on participating homes rather than on the opportunity to fundamentally alter builder and market actor practices, as market transformation approaches seek to do. Many leading programs take a greater market transformation approach than Energize Connecticut (and may have more flexibility to do so in their jurisdictions).

To improve performance, we recommend that Energize Connecticut:

- Update its tiers of offerings to place greater shares of the incentives at higher efficiency levels by eliminating the 51 to 60 HERS[1] level from its core program rebate.
- Increase the enhanced incentives associated with program-related standards that address identifiable future needs, including the All-Electric bonus incentive and the Zero Energy Ready Homes bonus incentive.
- Expand its non-financial offerings to builders and other market actors in the new construction market to more strongly support the transition toward very low load all-electric buildings through greater use of "market transformation" approaches.

During the course of this study, DEEP directed the program administrators for Energize Connecticut to develop a proposal for transitioning the Residential New Construction program into an all-electric offering that will begin accepting projects no later than July 2023. This proposal should include: (1) Interim targets for increasing the proportion of all-electric projects completed through the residential new construction program; (2) any necessary changes to incentive structures or levels; and (3) any perceived barriers to an all-electric new construction offering, including workforce development, education, and customer outreach needs and proposed solutions to those barriers.

The conditions of approval include the transition toward an all-electric offering, but not an end date that had been announced in DEEP's determination.[2] We discuss the implications of an aggressive timeline in the report, as well as some additional program activities that will be required to ensure a smooth transition in the market among the majority of builders and homebuyers who do not appear ready to make that leap yet. Continued support of market actors

[1] HERS refers to the Home Energy Savings Rating system that is commonly used to identify efficiency levels of homes.
[2] DEEP's full determination included the following text: "Therefore, in the Conditions of Approval, the Utilities are directed to develop a proposal for transitioning the Residential New Construction program to an all-electric offering by the end of 2023." However, the actual conditions of approval omitted the end date, which may afford more flexibility in timing.

that are not yet ready to transition to complete all-electric homes will save energy and facilitate more electrification in the future.

2.2.1 Preparing for Future Energy – Home Interaction

To balance electrical demand and supply, utilities are increasingly implementing demand response efforts, and some jurisdictions are moving toward more dynamic pricing. Increasing use of renewable generation affects the timing of supply (an issue in the Midwest), and efforts to electrify both buildings and transportation are increasing electrical demand (an issue being tracked in the Northeast, among other locations). In addition, distributed energy resources (DERs) are slated to become a growing part of the energy resource mix. These include customer-sited solar or storage options, including grid-interactive electric vehicles (EVs). The increase in energy supply from DERs will make them a growing part of energy supply planning and provides the state with opportunities to support its evolving climate and energy policies.

New construction and major renovation of buildings provide opportunities for demand response and distributed generation to become part of the solution for a changing balance of supply and demand now and in the future. Connecticut's energy system can benefit through further expansion of the residential new construction program's existing efforts to prepare new homes and multifamily buildings for upcoming energy-related needs. To achieve this, we recommend that Energize Connecticut, in coordination with DEEP, where needed,

- Continue to promote Zero Energy Ready Homes and Passive House-consistent approaches for its single-family and multifamily offerings;[3]
- Continue to require EV and photovoltaic (PV) readiness and expand these expectations to include battery storage readiness; and
- Promote demand response and dynamic pricing readiness as part of home design attributes encouraged by Energize Connecticut's residential new construction program.

2.3 Integrate Policy, Codes, and Program

We find that Connecticut's relevant policies and building energy codes are making advances, but do not appear to be as aggressive or as complementary to new construction efficiency programs as those in several leading states.

States with leading-edge new construction programs tend to have progressive climate or energy policies that set a high-level direction, and energy efficiency program goals and efforts are often

[3] We note that the federal Zero Energy Ready Homes program is designed for single-family homes, but expanding to serve multifamily buildings as well. Passive House can be used for single-family or multifamily homes, but the concept has shown its ultra-tight envelope approach to be more practical for current multifamily home construction, according to program interviewees.

directly linked to them. Policy sets the direction and establishes targets, such as intended levels of greenhouse gas reductions, and then directs energy efficiency programs administered by regulated utilities and public agencies to put into place initiatives or programs that achieve the stated goals. Sometimes, these efforts establish direct relationships between building energy codes and energy efficiency programs for coordinated efforts that simultaneously push and pull the market (in California and the Northwest), while stretch codes (in Massachusetts) have been shown to change local industry practices and preferential treatment for above-code homes (in some Washington municipalities) increases the incentive for market actors to adopt efficient designs.

Connecticut could better facilitate effective and aggressive new construction program efforts through policy and codes. To do so, we recommend that DEEP:

- As part of its preparation of Connecticut's Comprehensive Energy Strategy, lay out as much of a vision as feasible for how Energize Connecticut's residential new construction program will help achieve the state's relevant energy policies and what its priorities should be.
- Coordinate with the Office of the State Building Inspector on future code upgrades and state amendments to introduce, if feasible, a requirement that newly built residential buildings' energy-using systems be all-electric.

As discussed in the report, we applaud DEEP's move toward greater electrification. The research indicates such direction is a positive step in ensuring that program activities support state policies. We see a need for the desire to electrify to be put in context of its purpose in Connecticut — presumably, reducing current and future carbon emissions. A carefully paced transition toward all-electric construction can better ensure that builders that are interested in high efficiency, but not ready to fully leap into all-electric homes, continue to have a path toward fully low load all electric homes (with program support), rather than potentially stagnating their progression toward ever more efficient home construction. Ideally, the state's Comprehensive Energy Strategy would lay out a complete roadmap for achievement of state goals through Energize Connecticut and the state's other levers, including codes and standards, and its own influence on residential buildings it owns, funds, or controls.

2.4 Promote Forward-Looking Program Approaches

In leading states (California and New York), the regulations and directives that govern utility-administered energy efficiency programs establish the boundaries within which the utility programs operate and provide incentives to the utilities to maximize certain outcomes. Further, Illinois and Minnesota have recently updated their directives to align with policy in several ways. In Connecticut, a performance management incentive for the utilities is driven largely by quantified energy savings. Our research indicates that this incentive system could be aligned better with state policy directions that are shifting toward greater emphasis of carbon and electrification.

At the same time, cost-effectiveness expectations and computations set boundaries around the financial incentives the programs can offer to market actors and customers and set a tone for program designs. They also set some effective or perceived limits on the degree to which programs can engage in activities that prepare the market for changes without providing directly attributable energy savings (including some market transformation activities). The current Connecticut regulatory structure and policies governing energy efficiency programs are consistent with typical resource acquisition and demand side management programs focused on providing cost-effective energy savings. They appear to allow inclusion of indirect market impacts (non-participant spillover) as well, but these are not quantified or included in the actual cost-effectiveness computations. Doing so would provide clearer signals to the program about Connecticut's policy intent and the degree to which the program may and should strive to achieve systemic change in the market, whether or not the market actors involved in new construction actually participate in the rebate components of the program's offerings.

As a result, we recommend that the utilities include non-participant spillover in cost-benefit calculations for the new construction program, which may require DEEP-initiated market research or evaluation research to quantify these benefits and could potentially require clarification or broadening of countable savings associated with new construction program activities.

We recommend that DEEP shift a substantial share of the utility performance management incentives for the residential new construction program from energy savings associated with program participation to expected greenhouse gas emission reductions from program participation and related market effects.

Ideally, the program's market transformation efforts would be guided by an empirically derived roadmap that is informed by market and evaluation research and that translates DEEP-established policy goals and Connecticut-specific market information into a comprehensive strategy. The strategy should identify:

- Specific market changes that are needed for state policies and objectives for new construction to come into fruition;
- Which changes will occur naturally (or due to code upgrades alone);
- Which changes will require program intervention (and when during the technology adoption process);
- How various levers the state uses to achieve policy including energy efficiency programs will contribute to the overall policy objectives; and
- Where the greatest achievable potential lies in new construction and gut rehabilitation markets in Connecticut through prospective market research based on an assessment of specific homes built by builders and remodelers who participate partially in the new construction offerings.

The roadmap would be specific to new construction activities, but some of the program solutions (such as accelerating market adoption of heat pump technologies generally) may engage the entire Energize Connecticut portfolio.

3 Introduction

The state of Connecticut and its regulated investor-owned utilities provide rebates, information and education, technical assistance, and other market support to encourage energy efficient choices by consumers, businesses, and market actors in the state. These services—implemented under the brand Energize Connecticut— complement regulatory standards that specify minimum standards and seek to encourage greater adoption of energy efficiency than would have occurred through market forces alone. One of Energize Connecticut's program areas addresses residential new construction and gut rehabilitation and the approximately 5,000 single-family homes and multifamily units built in the state annually.[4]

3.1 Program Description

The residential new construction program provides educational outreach, technical trainings, and financial incentives to encourage builders and homeowners to integrate advanced energy-efficient building construction, techniques, and technologies into their new construction or major renovations and addition projects. At its core, financial incentives are based on a four-tiered incentive structure based on Home Energy Rating System (HERS) scores. Tiers are defined as follows:[5]

- Tier 1: HERS score of 51 to 60, offering rebates of $3,000 for a detached single-family home, $2,000 for an attached single-family home, and $1,500 for a unit in a multifamily building
- Tier 2: HERS score of 41 to 50, with rebates of $4,000, $2,500, and $2,000, respectively
- Tier 3: HERS score of 0 to 40, with rebates of $4,500 to $6,500,[6] $3,000 to $4,600, and $2,500 to $3,500, respectively
- Tier 4: HERS scores below 0, with rebates of $6,500, $4,600, and $3,500, respectively[7]

According to Energize Connecticut, most current program participants qualify for rebates at the 51 to 60 HERS range. The program bases these incentives on the assumption that a home built to

[4] We do not have readily available data on the extent of qualifying gut rehabilitation of existing residential homes and structures in Connecticut, but noted gathering of these data as a possible future activity.
[5] Taken from Residential New Construction Program 2022 Project Application. Retrieved from: https://energizect.com/your-home/solutions-list/residential-new-construction-program in July 2022.
[6] Amount depends on the specific HERS score.
[7] Scores below zero indicate net energy-producing homes

current energy codes should have a HERS score of 85,[8] a supposition that is not supported by recent evaluations and evaluator analyses, as described in Table 1 below.

Additional enhanced incentives ranging from $500 to $2,500 for detached single-family homes ($250 to $2,000 for attached single-family homes and $250 to $1,000 per unit for multifamily buildings) are offered for meeting standards for:[9]

- Passive House
- ENERGY STAR Homes (Version 3.1)
- LEED for Homes
- National Green Building Standard
- Zero Energy Ready Homes

Each of these programs promotes energy efficient designs with somewhat different emphases, including ultra-tight buildings (Passive House), future additions of on-site generation (Zero Energy Ready Homes), and adherence to sustainable considerations beyond energy (LEED for Homes and the National Green Building Standard). In addition, Energize Connecticut offers a CT Zero Energy Challenge that can provide prizes of $5,000 for winning homes and designs.[10]

Participation has been strongest in the multifamily offering—especially for Passive House specifications—and lighter among single-family homes. Participation levels among the available tiers is highest at the lowest efficiency tiers. Program staff indicate that requirements by the state agency that helps fund affordable housing has spurred interest in Passive House construction for multifamily buildings in Connecticut, leading to the higher participation levels among affordable multifamily construction. In contrast, demand for program-compliant efficiency is comparatively lower within single family (than in neighboring Massachusetts, for example) in part because code requirements and stretch code efforts across the state lines have been more aggressive and helped spur greater builder participation there.

[8] See https://energizect.com/your-home/solutions-list/residential-new-construction-program. Last retrieved July 8, 2022.
[9] Taken from Residential New Construction Program 2022 Project Application. Retrieved from: https://energizect.com/your-home/solutions-list/residential-new-construction-program in July 2022.
[10] More information about the CT Zero Energy Challenge is available at https://energizect.com/zero-energy-challenge-home. Last retrieved September 13, 2022.

Program staff presented data on Passive House construction in Connecticut in recent years to the Connecticut Energy Efficiency Board (CTEEB) in April 2022 reflecting 250 units in 13 buildings.[11]

3.2 Industry and Regulatory Developments

Industry practices, regulatory practices, and state policy have all changed since the current program structure was put in place.

An imminent change in building energy codes by the Office of the State Building Inspector will upgrade requirements for new construction to the 2021 IECC[12] model code (with amendments) in October 2022. Currently, the code is based on the 2015 IECC model code (also with amendments). These changes in code will result in upgrades in the naturally occurring level of energy efficiency of new construction in Connecticut (also known as standard industry practice).

While there are indications from neighboring Massachusetts that standard industry practices are better than current code minimums, Connecticut-specific information is more complex and, in the case of standard industry practice, less current. To assess the appropriateness of program standards, it is relevant to consider program minimums to both building energy codes (the absolute minimum permissible efficiency allowed) and to what is known about standard industry practice. We present such a comparison in Table 1, which shows that:

- The change in energy codes in Connecticut in October 2022 will bring minimum efficiency requirements for new construction in line with current program Tier 1 requirements (indicating a need for an upgrade in program standards).
- The most recent snapshot of standard practice from 2017 shows practices at that time were substantially less efficient than current program minimums (indicating a need for an update in information about current standard practice, which is currently underway).
- There is a discrepancy between Connecticut evaluator assessments of the efficiency levels associated with current code and similar information advertised by Energize Connecticut. (Energize Connecticut should resolve this discrepancy when the code adjustment takes effect in October 2022.)

[11] These figures were provided by Phius, so it is not clear whether all of these buildings and units participated in the Energize Connecticut program. Phius is a non-profit that advocates for and facilitates Passive House practices in the United States.

[12] International Energy Conservation Code

Table 1: Home Energy Rating System and Energy Rating Index Levels for Program Compared to Standard Industry Practice and Code Requirements

Customer Group	Approx.[a] HERS Score	Approx. ERI
Current Maximum Scores that Qualify for Program Rebates	60	n/a
Maximum Allowed by New Connecticut Code to be Introduced in October 2022[b]	n/a	60
Current Connecticut Code Adopted in 2018 (estimate #1)[c]	~60	55
Standard Industry Practice circa 2017 (median among non-program homes)[d]	70	n/a
Current Connecticut Code Maximum as Claimed on Energize Connecticut Website (estimate #2)[e]	85	n/a
New Massachusetts Stretch Code to Be Enacted in Fall 2022[f]	44-45	n/a

a) All values are estimates except the current program minimums.
b) Informal NMR estimate based on the body of their work and professional experience; provided to us in an email exchange in July 2022 for purposes of this report
c) NMR estimate
d) CTEEB report R1602 (Table 23); updated values will be available when R1968 is completed.
e) Energize Connecticut estimate
f) Applicable to more than 80% of MA communities. For proposed code see: 780 CMR Ninth Edition, Chapter 13: Energy Efficiency Amendments | Mass.gov

The efficiency standards shown in the table are the Home Energy Rating System index (or HERS score) and the Energy Rating Index (ERI). Both scores are normalized to a past value to allow for time-series comparisons and resemble one another. Likewise, with both scores, lower values indicate higher efficiency levels. To put HERS indexes and code requirements in context, a HERS score of 100 reflects the energy code represented by the 2006 IECC energy code. Each point reduction in the HERS score represents a one percentage point reduction in energy use off that standard.

State policy has shifted to greater interest in climate protection, greenhouse gas emissions, and electrification. For example, Public Act No. 22-5 establishes aggressive climate change goals for the state, which DEEP is charged with incorporating into its quadrennial Comprehensive Energy Strategy alongside the energy efficiency plans for Energize Connecticut programs established in the Conservation Load Management Plan and the state's integrated resource plan.

In fact, as we detail elsewhere in this report, DEEP has directed Energize Connecticut's program administrators to shift its residential new construction program to an all-electric offering as a way

to promote electrification of new homes in anticipation of a carbon-free or low-carbon electricity production.

3.3 Study Approach and Objectives

CTEEB's evaluation administrator commissioned this study to inform program updates. The study was designed and intended as a literature review of strategies and programs that are aimed at low energy consumption residential new construction, including the Passive House low energy construction standard, zero net energy standards, and other programs that promote highly efficient low load single-family and multifamily buildings, with a retrospective emphasis on all-electric.

As part of this study, we conducted background interviews with 4 program staff and stakeholders associated with Connecticut's program efforts, reviewed program information from 34 leading edge residential new construction programs outside Connecticut, and conducted interviews with 10 program managers or other informants from leading programs throughout the country who could provide more detail and perspective on those programs' approaches, strategies, and experiences.

3.4 Report Overview

One of the themes and patterns in our study results is the benefit of integration of policy objectives, regulatory standards, and efforts to induce voluntary action through energy efficiency programs and other market support. As noted in Table 2, our primary findings have implications for Eversource and Avangrid as the administrators of the Energize Connecticut program and for DEEP; some recommendations can be implemented immediately, while others require more time, more preparatory action, and greater interaction.

Table 2: Actions Covered in Report Recommendations

Action	Timing	Primary Party to Implement	Applicable Report Section(s)
Shift incentives and market engagement toward higher efficiency levels	Now	Utilities	5.1.3
Expand demand response and dynamic pricing readiness in new home designs	Plan now to implement later	Utilities	5.2.1
Incorporate essential DERs into program plans	Plan now to implement later	Utilities	5.2.1
Define how state climate goals are to be achieved by specifying the roles of building energy codes and new construction programs in Comprehensive Energy Strategy	Now	DEEP	6.3
Integrate utility program offerings and messaging with building energy code upgrades	Long term effort	DEEP Utilities	6.3
Increase the share of the utility performance incentives for new construction that is linked to expected greenhouse gas emissions from program participation and market effects	Begin now; treat as a transition	DEEP	7.4
Shift toward a market transformation approach for new construction based on a roadmap and with focused plans for builders at differing levels of migration toward low-load / all-electric homes	Now	Utilities DEEP	5.1.3 7.4

We organized this report with the primary audience and timing or staging of any recommendations in mind. Report sections are:

- Plan Transition to Electric-Only Program—This section features the strategies and insights from this study that directly inform recent direction from DEEP that Energize Connecticut's program administrators transition the program to an all-electric offering. We discuss study findings and recommendations specifically with this directive in mind and provide options for consideration by the program administrators and DEEP.
- Adjust Program Design—This section presents our observations about the current program structure and recommendations concerning upgrades. The main audience for this section is the program administrators and those who advise Energize Connecticut's program structures and design.
- Integrate Policy, Regulation, and Program—This section presents our observations about the integration (or lack thereof) of state energy and climate policy and the mechanisms intended to achieve them, including the utility-administered efficiency programs. The main audience for this section is DEEP.
- Promote Forward-Looking Efficiency Program—This section presents our observations about the ways governance of the utility-administered energy efficiency programs could be adjusted to allow more freedom and incentive for innovation for new construction efforts. The main audience for this section is DEEP; the program administrators are a secondary audience.

4 Plan Transition to an All-Electric Program

This section focuses on the upcoming transition of Energize Connecticut's residential new construction program to an all-electric offering. We present here the same directional insights about best and emerging practices as in the remainder of the report, but we tailor the discussion and recommendations to the upcoming efforts by Connecticut policymakers, regulators, and program administrators to transition Energize Connecticut's residential new construction program to an all-electric program. This section is intended to help inform a proposed plan for the transition by the program administrators (due October 15, 2022) and subsequent transition planning and implementation, while the remainder of the report takes a broader perspective on residential new construction and shares take-aways and insights from the overall study.

As noted, a directive by DEEP has instructed Energize Connecticut's program administrators to shift the program to an all-electric offering with projects accepted no later than July 2023. However, two aspects of the transition appear to be open for further consideration:

- ***Pace of the transition***—While the program needs to be *ready* to support all-electric homes under an updated design by July 2023, the *completion* of the transition to all-electric homes could be ***rapid*** (leading to support for just all-electric homes by the end of 2023) or ***slower*** (allowing for a longer phase out of support for highly efficient homes with some non-electric end-uses).
- ***Nature of the all-electric offering*** – An all-electric program could be ***rebate-focused*** and reserve direct financial incentives for all-electric homes while continuing to provide services and support (such as training and outreach) for highly efficient homes and for market actors that continue to install some non-electric end-uses, or it could be ***all-encompassing*** and limit program and market activities entirely to supporting homes and market actors that have already transitioned fully to all-electric homes.

These design decisions are key choices that define the program's focus and role in the market. We discuss program design, policy considerations, and program oversight topics below. Where applicable, we point to any key differences for a rapid transition or to an all-encompassing program redesign that is focused on all-electric home construction in all aspects of its activities.

4.1 Program Design Considerations

In Section 5 of this report, we recommend a tightening of HERS scores rebated by the program, an increase in bonus incentives associated with all-electric transitions, and greater emphasis on market transformation activities. All three of these recommendations apply to Energize Connecticut's upcoming transition to an all-electric offering.

4.1.1 Adjust HERS Tiers Downward

As noted in Section 3.2, industry standard practice and upcoming energy code adjustments have come close to the least efficient homes currently rebated through the residential new construction program. As a result, we recommend a tightening of the efficiency standards required for program incentives either by adjusting all the current tiers downward in the HERS scores required or by eliminating the tier 3 offering that currently applies to homes with HERS scores in the 51-to-60-point range. As discussed in Section 5, we find the tier structured to be a best practice and encourage Energize Connecticut to retain the tiered concept, just with updated tier levels with lower HERS scores (of approximately 50 or below).

If the transition to the all-electric offering is rapid, Energize Connecticut should consider tightening efficiency levels further. Just like renewable generation, electrification is most appropriate after available efficiency improvements already have been enacted.

4.1.2 Increase Incentives for Bonus Offerings Related to All-Electric and Electric-Ready

We suggest that Energize Connecticut increase current bonus offerings related to all-electric and electric-ready construction, such as the Zero Energy Ready Homes program and Passive House-related offerings. As we note in Section 5.1.4, these bonus offerings serve very similar purposes as all-electric homes and help prepare a path toward all-electric construction. This feature makes them a logical aspect of the current program to emphasize and build out.

Both Zero Energy Ready Homes and Passive Home standards allow for non-electric fuels. Hence, if Energize Connecticut's transition to all-electric is rapid, the manner in which these programs are incorporated into the residential new construction program will need to be limited to all-electric construction.

Further, we note that Zero Energy Ready Homes and Passive Home offerings are bonus offerings built on a program platform and do not present the underlying structure on which the program is built.

4.1.3 Expand Non-Financial Market Transformation Approaches

Energize Connecticut's residential new construction program currently employs elements of both resource acquisition programs and market transformation programs, but with an emphasis on resource acquisition strategies through its rebate offerings. As noted in Section 5.1.2, we recommend expanding the market transformation aspects of the program to seek a broader reach in the market, as most other leading residential new construction programs do.

In a transition to all-electric homes, continued market engagement and support will be important to ensure market actors continue to transition toward electric options for end-uses for which natural gas or bulk fuels have been common and encouraged in the past. Market observers note

continued barriers among homeowners, builders, and trade allies in adopting electric versions of some end-uses, especially water heating, cooking, and fireplaces. Barriers are rooted in preferences, perceptions, installation logistics, and sometimes technology availability. Support for market actors who are still in the transition stage toward electric appliances will be needed to ensure continued engagement of those who are committed to efficiency but not ready yet to drop all remaining non-electric appliances.

If the program transition to all-electric is all-encompassing, the program should expect slow adoption while the market catches up, and other mechanisms will be needed to fill the void left by Energize Connecticut for those market actors that continue to use some non-electric end-uses. Strategic use of energy codes and other state efforts could help fill that gap.

4.2 Policy, Code, and Program Considerations

In our discussion of the intersection of policy, energy codes, and utility programs in Section 6, we recommend that DEEP lay out how the residential new construction program fits into the state's overall energy and climate policy and goals to the degree feasible in its Comprehensive Energy Strategy. We also recommend that DEEP coordinate with the Office of the State Building Inspector to ensure that future energy code updates and Energize Connecticut's residential new construction program complement one another. Both of these recommendations apply as the state directs the residential new construction program to become an all-electric offering.

4.2.1 Lay Out Program Expectations and Role in Comprehensive Energy Strategy

In Section 6.1, we note that leading new construction programs take their direction from state policies that are increasingly focused on climate concerns, and the programs then serve as a mechanism to achieve those state goals. Alignment between policy makers, regulators, and program implementers are needed to promote consistency and effectiveness. Programs contribute more effectively when they are guided by clear policy goals and a clear vision for the roles they play individually to contribute to the overall goals. DEEP's directive that Energize Connecticut's residential new construction program shift to an all-electric focus is a step in that direction, as are other plans by DEEP for the updated Comprehensive Energy Strategy that are spelled out in the department's determination on the Conservation & Load Management Plan for 2022-2024.

Beyond these steps, we encourage DEEP to be as clear and comprehensive as possible in the Comprehensive Energy Strategy on the state's priorities and goals, what share of any climate (or other) targets the residential new construction program could and should strive to meet, and how the program fits into the broader statewide strategy.

4.2.2 Coordinate with Office of the State Building Inspector on Future Code Upgrades

As noted in Section 6.2, jurisdictions with leading programs use energy codes and voluntary programs in a coordinated fashion to push market activity toward higher levels of efficiency through voluntary action and increase the legally permissible minimum efficiency requirements through codes. These two levers can work together rather than just independently. We recommend coordination between DEEP and the Office of the State Building Inspector to ensure future code upgrades complement utility program efforts and vice versa. Foreshadowing and announcing what future code upgrades will require (and when) can drive market actors to participate in efficiency programs that are prepared to help them stay ahead of the upcoming requirements. Furthermore, other leading states have used stretch codes, code training, and expedited reviews of above-code building plans in similarly strategic ways.

With the transition to an all-electric focus in Connecticut, we note that the state's energy codes may need to follow suit at some point if the state decides to seek to electrify all new construction.

If the transition of Energize Connecticut's residential new construction program to all-electric is all-encompassing, additional burden will fall on energy codes to advance general (fuel-independent) efficiency levels of new construction and major renovations while Energize Connecticut addresses full electrification only.

4.3 Program Oversight Considerations

Section 7 of the report discusses a couple of program oversight levers to ensure that energy efficiency programs operate within the desired boundaries and emphasize the desired outcomes. In this section, we recommend that DEEP shift a substantial share of utility performance management incentives for the residential new construction program to greenhouse gas-focused metrics and that DEEP facilitate and encourage greater use of market transformation efforts by the program. The first recommendation is designed to complement Connecticut's increased focus on climate concerns and, relatedly, electrification. The second recommendation applies similarly to efficiency or electrification-focused efforts.

4.3.1 Shift Substantial Share of Utility Performance Management Incentive to Climate Metrics

As we note in Section 7.1, current utility performance management incentives for Energize Connecticut's residential new construction program are based largely on energy savings metrics with only small shares of incentives allocated to other performance goals. A shift in state attention toward climate concerns creates a disconnect between the performance incentives and the primary focus on which state policy needs the program to concentrate. We recommend that DEEP adjust the metrics for utility performance incentives for the residential new construction program toward climate-oriented metrics, such as greenhouse gas emissions prevented by program

activities. Further, the metrics should allow for the inclusion of credible non-participant spillover to encourage aggressive and innovative market transformation efforts.

If the program transition to all-electric is all-encompassing, electrification-focused metrics would need to take the place of market transformation-oriented metrics.

4.3.2 Facilitate and Encourage Shift Toward Greater Market Transformation Efforts

In Section 7.2 and Section 7.3, we discuss the role of cost-effectiveness calculations on Energize Connecticut's residential new construction program. While the details behind cost-effectiveness calculations for Energize Connecticut were not a focus of this study, it appears that cost-benefit considerations contribute to a greater focus on resource acquisition efforts that stress within-program savings over market transformation. Market transformation efforts seek to create direct and indirect effects on market actors' practices regardless whether the market actors ultimately meet exact program specifications for the homes they build or receive rebates for these homes. Market transformation impacts are more difficult to quantify and do not appear to be counted among the energy savings and benefits attributed to the residential new construction program in Energize Connecticut's cost-benefit calculations.

We recommend that these broader benefits be counted and serve as a factor that influences in the program's design and resource allocations. Estimating market effects will require some effort. The program team would need to identify the mechanism by which the program arguably affects industry practices and results in non-participant spillover. DEEP and the Energize Connecticut evaluators may need to conduct research to establish the degree of—and quantify—market transformation effects beyond the impacts associated with rebated homes. It is also possible that the regulatory or functional definition of benefits may need to be expanded, although the technical consultant team pointed out that the program does not currently bump against its cost-benefit limits so any existing barriers may be in perception more than in regulatory constraints.

The nature of any market transformation efforts will need to align with the program's overall focus. If the program transition to all-electric is all-encompassing, the program would need to focus more exclusively on electrification while market transformation activities would need to come from other efforts to fill the gap. (This is the same gap we mention in Section 4.1.3.)

5 Adjust Program Design

Energize Connecticut compares well to other residential new construction programs and fits among those recognized as industry-leading or cutting edge in many ways. Given the goals it was designed to accomplish—the cost-effective delivery of energy-saving efficiency improvements for ratepayers—the program requires adjustments rather than wholesale redesign. More recent goals and expectations by Connecticut regulators, including a greater emphasis on climate concerns and a desire to electrify energy use in the state, could require greater changes or acceleration.

We base our complimentary assessment of the program's current design to meet its traditional goals on the following:

- The program structure uses tiers of performance with increasing incentives, which is a common (and best) practice among the leading programs we reviewed and provides an entry point as well as advanced levels at which builders can participate and increase the efficiency of the homes they build. At their highest levels, these tiers extend all the way to net-positive homes that produce more energy than they consume.
- The program promotes and offers incentives for the optional adoption of multiple future-oriented standards such as zero energy-ready and the ultra-efficient Passive House standards.
- The American Council for an Energy-Efficient Economy characterized Energize Connecticut's residential (and commercial) new construction programs as leading programs, and one of our interviewees from a program we consider to be leading pointed back to Connecticut as probably being further along than they are.[13]

Program adjustments for additional advancement and future-proofing of the program include:

- Updating the existing efficiency tiers to be more aggressive;
- Expanding market transformation components of the program to prepare and challenge the market further in preparation for stricter minimum standards and the need (and, hopefully, desire) by market actors to build even more efficient and climate-friendly homes that are appropriate for the energy systems of today and those of tomorrow;
- Responding more aggressively to state policy directives concerning all-electric homes without leaving behind market actors who are still transitioning to the required

[13] See Nadel, S. 2020. "Programs to Promote Zero-Energy New Homes and Buildings." Washington, DC: American Council for an Energy-Efficient Economy. Last retrieved from https://www.aceee.org/sites/default/files/pdfs/zeb_topic_brief_final_9-29-20.pdf on September 14, 2022.

technologies to make that change happen, in part by leveraging *all-electric ready* requirements.

We discuss these changes, options, and recommendations with two separate time frames in mind: immediate and near-term adjustments and those that require planning and preparation now for implementation at a later time when market, policy, and technology conditions are appropriate.

5.1 Immediate Adjustments

Our comparison of Energize Connecticut's program approach to best practices and insights from elsewhere focused on efficiency levels promoted by the programs, program activities, and program structures. We draw on insights from this work to identify adjustments that the program administrators can make to advance residential new construction efforts to the next level.

Further, during this study, the Connecticut Department of Energy and Environmental Protection (DEEP), as part of its formal review of Energize Connecticut's Conservation and Load Management Plan for 2022-2024, directed the program administrators to identify barriers, develop a plan, and begin a transition to an all-electric residential new construction program by July 2023. While the final determination states that the transition to an all-electric residential new construction offering needs to be completed by the end of 2023, the end date is not specified in the conditions of approval, which may require some clarification and further discussion.

Regardless of the specific timing, the regulatory directive to the program is to develop a proposal for transitioning the residential new construction program to an all-electric offering that will start accepting projects no later than July of 2023. The proposal shall include interim targets for increasing the proportion of all-electric projects completed through the program, changes needed to incentive structures or levels, and any perceived barriers to an all-electric program, including workforce development needs, education needs, customer outreach needs, and proposed solutions to these issues.

5.1.1 Upgrade in Targeted Efficiency Levels

Energize Connecticut is following best practice and allows for effective market intervention across a wide range of market actors by continuing a tiered approach. The present tiers need updating, however, as the entry level provides incentives for Home Energy Rating System (HERS) scores that are only moderately more efficient than current code and approximately on par with the code being introduced in October. As noted above, the bulk of incentives are being offered at the 51 to 60 HERS level, and most participation occurs at this efficiency level. Best practice would suggest that programs should be one or two steps ahead of industry standard practice and code minimums.

As noted above, the incoming energy code for Connecticut will bring minimum new construction to HERS levels of about 60. Recent code upgrades have tended to result in efficiency

improvements of about 10 percent per code cycle, on average, since about 2006.[14] Staying ahead of energy codes by two cycles would require program efficiency standards at HERS levels of about 48.

Table 3 presents current tiers and enhanced incentives offered by the program currently. Core tiers are based on HERS-based performance, while enhanced incentives are offered for meeting additional standards identified by the Passive House Institute, the U.S. Environmental Protection Agency through its ENERGY STAR portfolio, the U.S. Green Building Council, and others.

Table 3: Energize Connecticut Incentive Structure

Tier	Incentives		Annual Participation
	Single-Family Detached	Multifamily	
Standard HERS-based tiers	$3,000	$1,500	SF: 500 MF: 1,400 units
51-60	$4,000	$2,000	
41-50	$4,500	$2,500	
0-40	$4,500-$6,500	$2,500-$3,500	
Below 0	$6,500	$3,500	
Passive House bonus	$750 (modeling)	$500/unit (modeling) $5,000 feasibility study $1,500/unit (certification)	13 MF bldgs.; 250 units
All-electric bonus[15]	$1,250-$2,500	$500 - $1,000 / unit	67[a]
Bonus for ENERGY STAR Homes, LEED, National Green Building Standard, or Zero Energy Ready Homes	$500	$250 / unit	ES: 484[b] LEED: 55[c] NGBS: 56[d]

[14] See Energy-Efficient Codes Coalition. "International Energy Conservation Code." https://energyefficientcodes.org/iecc/

[15] Reviewers of a draft version of this report wondered whether the all-electric bonus can serve as a basis for a mandatory all-electric program. We note that the bonus is an add-on to an established program structure. Hence, while the all-electric bonus contains elements that could be converted, it does not provide the core structure on which a program would need to be built.

Tier	Incentives		Annual Participation
	Single-Family Detached	Multifamily	
			ZERH: 140[e]
CT Zero Energy Challenge	$5,000 prize; $500 for HERS rating	$5,000 prize; $250 / unit for HERS rating	<10/year

a) Eversource data only. These participants include 17 single-family detached, 0 single-family attached, and 50 multifamily units.
b) Eversource data only. These participants include 39 single-family detached, 27 single-family attached, and 418 multifamily units.
c) Eversource data only. These participants are all multifamily units.
d) Eversource data only. These participants are all multifamily units.
e) Eversource data only. These participants include 5 single-family detached, 0 single-family attached, and 135 multifamily units.
NOTE: There are also single-family attached incentives. For purposes of brevity and simplicity, we are not showing those incentive levels here. Participation levels are for the most recently available year (generally 2021) to illustrate scale of participation. Participation data do include single-family attached homes.

5.1.2 Increase in Market Transformation Efforts

Connecticut's programs put the bulk of their resources on resource acquisition[16] activities through which financial incentives and complementary activities seek to cause direct increases in efficiency through rebated homes with a comparatively smaller effort on transforming the market in fundamental or structural ways. Market transformation efforts are part of the program effort, but not a primary focus.

That is, the residential new construction program is designed to spur builders of participating homes to make efficiency improvements that they were not already planning. The focus on participants rather than the broader market appears to be due largely to cost-effectiveness requirements and perceived expectations concerning Energize Connecticut activities.

[16] See also callout box on the next page for a definition offered by the Institute for Industrial Productivity (2012. "Energy Efficiency Resource Acquisition Program Models in North America.")
https://www.aceee.org/sites/default/files/publications/researchreports/ie126.pdf

The program does include market transformation elements through training and technical assistance that enable and may prompt permanent change among builders who take advantage of program incentives and among these builders' subcontractors. These efforts include training on building science and code updates, collaboration with Phius[17] on ultra-tight construction practices, and efforts through other parts of the program portfolio to reduce market barriers to heat pump technology adoption.

Resource acquisition: Energy efficiency resource acquisition programs seek to purchase energy savings in the public interest, often through financial or technical assistance.

Market transformation: Strategic interventions that attempt to cause lasting changes in the structure or function of a market, or the behavior of market participants, resulting in an increase in the adoption of energy-efficient products, services, or practices

However, the program is not directed primarily on the market overall and is seemingly prevented from focusing more than it currently does on market transformation by program staff understanding of cost-effectiveness limitations and the metrics by which success is defined. We discuss these barriers in the section titled Promote Forward-Looking Program Approaches.

As noted in Table 4, market transformation activities distinguish themselves from resource acquisition by seeking to mobilize the entirety of the market that the program is seeking to influence. The target goes beyond participants to include all relevant market actors, and goals are defined at a market level. As such, market transformation activities for new construction may encompass such components of the market as the real estate industry, home financing, supply chains and market perceptions concerning advanced building approaches and technologies, and others. In the case of an electrification focus, the program needs to address the markets for electric space and water heating options, as well as cooking and fireplaces included for ambiance.

[17] Phius is a non-profit that advocates for and facilitates Passive House practices in the United States.

Table 4: Distinctions between Resource Acquisition Programs and Market Transformation Initiatives[18,19]

Program Element / Characteristic	Resource Acquisition	Market Transformation
Scale	Program	Entire defined market
Target	Participants	All consumers
Goal	Near-term savings	Structural changes in the market leading to long term savings
Approach	Save energy through customer participation	Save energy through mobilizing the market
Scope of Effort	Usually from a single program	Results from effects of multiple programs or interventions
Amount of Program Administrators' control	PAs can control the pace, scale, and geographic location, and can identify participants in general	Markets are very dynamic, and the PAs are only one set of actors. If, how, where, and when the impacts occur are usually beyond the control of the program administrators
What is tracked, measured, and evaluated	Energy use and savings, participants, and free-ridership	Interim and long-term indicators of market penetration and structural changes, attribution to the program, and cumulative energy impacts
Timeframe for cost-effectiveness	Usually based on 1st year or cycle savings	Is usually planned over a 5 to 10-year timeframe

[18] Keating, et al. 1998. "Wheat, Chaff, and Conflicting Definitions of Market Transformation." American Council for an Energy Efficient Economy (ACEEE) *Proceedings of the 1998 Summer Study on Energy Efficiency in Buildings*, Vol. 7 pp. 7.157 – 7.169 and Sebold et al. 2001. "A Framework for Planning and Assessing Publicly Funded Energy Efficiency." Pacific Gas and Electric, San Francisco, CA. Study # SW040. As referenced in Prahl, Ralph and Ken Keating (California Public Utilities Commission). 2014. *Building a Policy Framework to Support Energy Efficiency Market Transformation in California*.

[19] Reviewers of a draft version of this report had several questions on this table and comments about how an element presented in this table is currently handled in Connecticut. We note that this table is a citation from the literature and meant only to provide context for the reader on industry-established concepts of resource acquisition and market transformation.

Other leading programs already tend to take a market transformation approach to shifting new construction practices—pushing at the highest edge of current practices. These market transformational efforts rely less on individually incentivizing specific measures and more on holistic "whole house" and market-wide achievements and the engagement of market actors than is possible from resource acquisition programs. For example:

- The Northwest Energy Efficiency Alliance's (NEEA's) new construction program efforts seek to work across the new construction community as a whole and offer technical conferences, trainings, tools, best practices, case studies, a library of energy models, and research and vetting of new approaches to home construction and applications of new technologies, as well as comprehensive tracking of new home and measure performance in a way that is linked to future code development—a topic that we discuss further in the section titled Integrate Policy, Codes, and Program. While NEEA is a regional collaborative, its efforts support local utility programs that work with builders and offer financial incentives for participating homes (thereby combining market transformation with a resource acquisition element).
- California's utilities and ComEd (the utility that serves northern Illinois) conduct emerging technology programs that feed pilots into program design. In California's case, these pilots and work in selected communities served as demonstration projects that seek to influence the builder community to engage in voluntary advancement of efficiency in their homes. In addition, California has builder-specific assistance on such things as re-usable prototype floorplans and related in-field support that seeks to directly shift market practices.
- New York has provided multiple layers of support for a full range of adoption levels, thereby serving builder segments based on their readiness to implement efficiency.
- During a past period of greater emphasis on market transformation in Wisconsin, the statewide energy efficiency program helped support an annual residential new construction conference that provided technical skills building and promoted the benefits of following advanced energy efficiency practices for the builders and their customers.

Generally speaking, market transformation-oriented programs require insight into the market structure, barriers, drivers, and dynamics. They are more sophisticated and more complex than simply offering rebates for near-term energy savings, so they are often informed by research and an established or implied roadmap that considers the market actors, supply chains, influencers, drivers, and barriers for decisions related to the targeted end-use, technology, or practice. Resulting activities for a new construction program may include:

- Direct to builders: Technical training (classroom, project site), certification, co-branding
- Indirect via market: Awareness building, certification, technology-specific market support
- Indirect to end users: Awareness building includes real estate market as well as end-customer-focused and builder/trade ally-focused efforts

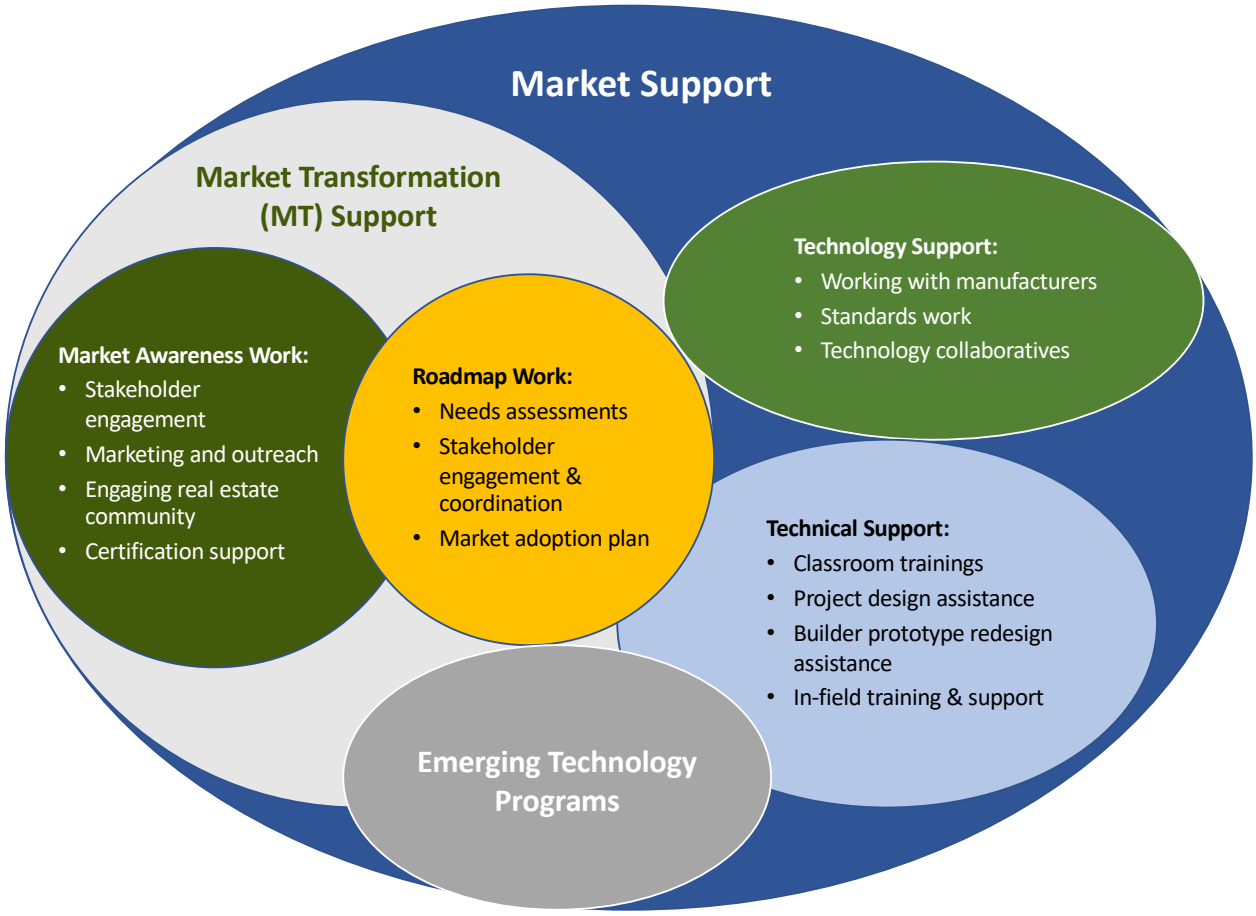
- Indirect via code support: Support of code development and enforcement with a linkage to voluntary beyond-code opportunities
- State to market: Leading by example, showcase buildings, spurring market activity[20]

Wisconsin provides one example of how research-based planning supports market transformation efforts. The Public Utilities Commission of Wisconsin recently funded the development of a roadmap to lay the steps needed to promote heat pump technology in the state. The study is providing a market and stakeholder needs assessment; defining the value propositions for market actors by use cases; assessing the coordination needed among utilities, regulators, and local governments; and providing implementation support.

Figure 1 illustrates a broad range of market support activities that we have seen other programs provide as part of their market transformation efforts. The activities listed are not those of any one program, but a generalization of the breadth of support that market support activities often entail. We offer them here to provide an illustration of the range of activities that Energize Connecticut might consider, but not as a blueprint to follow.

[20] Reviewers of a draft version of this report inquired about the leverage DEEP would have on state-funded construction of new homes. The leverage may be indirect via the state's Department of Housing or through state implementation of federal housing grants.

Figure 1: Illustrative Multi-Faceted Approach to Market Support



Connecticut's program efforts do not appear to reach this far into the market, but focus more on program participation, thereby leaving behind the potential benefits of market transformation initiatives in spurring broader application of highly efficient home design and construction. Given the proximity of Connecticut to Massachusetts and New York—both of which follow relatively advanced building practices—the state has the benefit of nearby precedents and practices it can leverage in promoting broader change in the new home building industry.

5.1.3 Recommendations

As a result, we recommend that Energize Connecticut:

- Update its tiers of offerings to place greater shares of the incentives at higher efficiency levels by eliminating the 51 to 60 HERS level from its HERS-based rebate.[21]
- Increase the enhanced incentives associated with standards that address identifiable future needs, including the All-Electric bonus incentive and the Zero Energy Ready Homes bonus incentive.
- Expand its non-financial offerings to builders and other market actors in the new construction and major renovation market to more strongly support the transition toward very low load all-electric buildings through greater use of "market transformation" approaches. Doing so would involve greater emphasis on industry-wide and market-wide activities already included in the program plan, such as education, training, and engagement of a wide range of market actors and technical training related to Passive House standards and building science; and publicization of CT Zero Energy Challenge winners. Further ideas to consider include:
    - Demonstration sites;
    - Engagement with builders and remodelers that is tailored to their current practices, including more work with individual builders on repeatable building plans and construction crew/subcontractor training on how to effectively and efficiently build these particular homes;
    - Integration of program efforts with other Energize Connecticut efforts that are seeking to overcome barriers to certain electric alternatives to equipment that has traditionally been gas-fueled (like water heaters, cooktops, and fireplaces); and
    - Working with the real estate industry to establish sustained demand for high efficiency and all-electric new construction and sustained benefit of high-performance homes at resale.

Ideally, however, the actual expansion of efforts should be guided by local insights about which building practices are widely feasible in the region (because they are practiced effectively by some builders in Connecticut or more commonly practiced in Massachusetts or New York), an understanding of the barriers that have prevented their adoption by the market in Connecticut, and the development of a program roadmap that promotes these practices and addresses the identified barriers. The roadmap should consider some segmentation of builders and remodelers, their subcontractors, and their equipment suppliers into segments by current efficiency practices so the outcome is an understanding of how to serve each group in a customized manner. The local market research required for such an effort is also an opportunity to develop relationships with builder and remodeler associations and individual builders and remodelers that may not yet exist.

[21] Note that we did not examine whether the 51 to 60 HERS tier is integral to any of the enhanced rebates and partner programs. If so, the relationship between the core offering and partner programs needs to be considered before eliminating a program tier.

The resulting program activities would include "program participation" as well as broader market engagements such as those in Figure 1 that seek to change practices whether or not the affected market actors ultimately seek rebates or count as participating homes or buildings.

In Connecticut, high efficiency multifamily building practices already have a foothold among new construction of affordable housing, in large part because public funding for new affordable housing has imposed requirements and expectations that resemble those of Passive House buildings.[22] Energize Connecticut is already leveraging these market trends in its work with affordable housing construction. The program should also seek to promote spillover from these practices to market rate construction (as many builders working on affordable housing may also construct market rate housing).

To the extent there is crossover in single-family building market activities from Massachusetts and New York, the program should seek to promote adoption of advanced practices in these neighboring states in Connecticut too. For example, in New York, the New York State Energy Research and Development Authority (NYSERDA) encourages participants to address embodied carbon and low global warming refrigerants by awarding more points to competition projects that address these issues and pushes integrated design and construction protocols that Connecticut could emulate. NYSERDA is also working with the Asthma and Allergy Association and HGTV to promote carbon-neutral homes as healthier, more comfortable, quieter, and more resilient. Connecticut could work with NYSERDA to join those partnerships. Massachusetts' successes are tied, in part, to the development of stretch codes and the rules that developed for programs' abilities to claim savings related to the codes. If Connecticut establishes (or considers) stretch codes, Massachusetts' processes and experiences could serve as a guide.

5.1.4 Additional Considerations for an Immediate Move to All-Electric

DEEP's directive that the program transition to an all-electric offering occurred while this study was in progress. With this directive, the program design will need to change substantially and quickly. We discuss here the implications of this directive for our recommendations and for the program.

Further, given differences between DEEP's determination on the Conservation and Load Management Plan for 2022-2024 and its conditions of approval,[23] it is unclear to us whether this transition is *required* to be completed by 2023 and the extent to which program activities may continue to serve newly constructed homes that include non-electric fuels, possibly without financial rebates. We assume that there is some flexibility in the timing and approach to ensure

[22] Program staff mentioned this trend in interviews. We did not explore more deeply, but are merely mentioning this observation here.

[23] The determination mentions a targeted end date for the transition to an all-electric program of the end of 2023, but the conditions of approval only speak of a transition that begins in July 2023 without a completion date.

effectiveness, albeit with clear direction to move toward electrification aggressively. Flexibility in timing would allow a more complete effort to transition market actors to all-electric construction.

Upgrade in Targeted Efficiency Levels

The transition toward an all-electric program will require a redesign of program standards for rebates and more non-financial support for builders who are ready to make the transition to all-electric homes now.

Our recommendation above to upgrade the efficiency levels rebated by the program stands, but the reference home used for HERS standards may need to be an all-electric home and the bonus incentives for partner programs would need to be reviewed for compliance and adherence to the all-electric directive.

Increase in Market Transformation Efforts

Because market actors do not react to state policy directives that fall short of regulatory requirements, the transition in the market to all-electric homes will continue to proceed at a more measured pace regardless of changes in Energize Connecticut's program design.[24] It is likely that some currently participating builders would cease to build program-qualifying homes for a time until they—and their customers—are ready to transition to all-electric across all appliances and end-uses. We note that the number of participants in the all-electric program component has been in the double-digits (see Table 3).

In particular, interviews with program staff, consultants, and evaluators active in Connecticut pointed to technical and market acceptance challenges of making heat pump water heating work in all housing scenarios,[25] as well as market preferences for gas cooking appliances and gas fireplaces among some consumers. (Interestingly, use of heat pump technology for space conditioning appears to face somewhat lower barriers given informants' input.)

Other states at the forefront of electrification efforts are continuing to help builders and homebuyers who are not ready to abandon some remaining non-electric end-uses and pursue a dual-pronged strategy. For example, California programs and pilots are simultaneously moving toward electrification, toward increased energy efficiency (with multiple fuels), and toward zero-energy with mandates for photovoltaic generation for new homes.

As a result, we envision a need for on-going market and technical support to builders who continue to use some non-electric appliances in order to prepare them to make the transition at a

[24] It would take regulatory action in the form of energy codes that require all-electric construction to propel the most rapid possible transition by the market.

[25] Reviewers of a draft version of this report noted that heat pump water heating may not be required for all-electric offerings. Alternatives involve trade-offs, however.

later time. Hence, our recommendation above to increase market transformation efforts stands and includes on-going work and support of builders with an interest in high efficiency construction that, for now, includes some non-electric end-uses, to the extent this is allowed and acceptable to DEEP. More specifically:

- Continued and increased promotion of net-zero-ready homes offers a solid path of continuing to prepare the market (and individual buildings being constructed now) for the transition to all-electric while promoting aggressive efficiency improvements regardless of fuel type. It would make sense for the program to encourage participation in the Passive House and Zero Energy Ready Homes programs, as they serve very similar purposes as all-electric homes. Passive House concepts favor electrification, but the fundamental ultra-efficient design reduces energy use and carbon emissions regardless of fuel type. Zero Energy Ready Homes also favor efficiency and ensure that homes constructed now can transition easily to zero energy use and, thus, very low or no carbon emissions.
- Support for transition in water heating, cooking, and fireplaces will need particular focus given the resistance from the market to electric versions of these end-uses. Preferences for gas cooking and fireplaces pose barriers among homeowners, while slowness of the plumbing industry to embrace (and stock) heat pump water heaters and the logistical challenges of placing them and coordinating installation with electricians are posing barriers for heat pump water heaters. In response to these broader challenges, ComEd does not currently require electric cooking in its Single-Family All Electric New Construction program, but does encourage builders to include it. However, most homes built in the last two years have included induction cooking. By not requiring induction cooking, but encouraging it, ComEd gave its participating builders the leeway to experiment with the new technology on their own timeline. Whether or not program activities include financial incentives, it will be important for the program to provide encouragement, assurance that the supply markets are able to handle any additional demand, and guidance on any logistical and technical questions or concerns. (In some cases, these efforts may involve collaboration with other aspects of the Energize Connecticut program portfolio working on the same technologies and supply chains.)
- Previous participants who opt not to go all-electric yet should continue to receive support, training, and technical assistance from the program to advance their efficiency levels even if they are not offered financial rebates for their homes and buildings. In particular, it is important to help them continue to increase the efficiency levels of the homes they build until they are ready for all-electric and to reduce the barriers for them, for their supply chains, and for end-customers of the remaining end-uses that continue to use non-electric fuels.

Guiding the Transition to an All-Electric Program

DEEP is already directing Energize Connecticut's program administrators to develop a plan for a transition to an all-electric program and to consider and address existing barriers. We suggest building onto this planning process with a research-based roadmap of the type we describe in the section titled Increase in Market Transformation Efforts (see the Wisconsin heat pump roadmap example). The roadmap could guide the nature of the program support needed for builders who transition to all-electric construction and those who do not. We advise builder-specific segmentation for the study so that the program can tailor its offerings at a mix of builder (and trade ally) types based on their readiness and interest in transitioning to all-electric construction and the efficiency level of their current construction projects.

5.2 Preparing for Future Energy – Home Interaction

Energize Connecticut's residential new construction program is designed with the future in mind. In addition to promoting high levels of efficiency that are possible with today's technology, the program design has an eye toward the future with program components for all-electric homes and the US Department of Energy's Zero Energy Ready Homes program standard. Through these efforts, the program seeks to "mak(e) homes 'ready' to support clean energy technologies and electric vehicles" (as noted in the program plan in the 2022-24 Conservation and Load Management Plan [CLMP]). As noted below, some of the dynamics of electrification and the addition of customer-sited generation require management of their impacts on the grid at a centralized (utility) and decentralized (building) level.

The Zero Energy Ready Homes program promotes high efficiency levels combined with either current adoption of customer-sited or community photovoltaic (PV) power or a series of preparatory steps that would facilitate the addition of customer-sited PV systems in the future. Homes tend to have HERS ratings in the lower 50s or better, and the PV preparation includes physical components (electrical system requirements and wiring), orientation and roof design, and informational components for the homeowner.

Meanwhile, homes at HERS tiers 3 and 4 are required by Energize Connecticut to be wired for easy subsequent additions of electric vehicle (EV) charging, and all participating single-family homes with suitable locations and roof types for photovoltaics are required to include certain electrical wiring and capabilities to facilitate later installation of solar generation that resemble those of the Zero Energy Ready Homes program requirements.

Practices from other states with leading new construction programs and efforts point to additional ways the program and the state could future-proof homes built now to meet anticipated needs of the homeowners, the energy system, and the state. These practices are based largely on the likelihood that:

- The need and use of time-based energy demand management will continue to grow as electric generation shifts increasingly to non-dispatchable renewable sources and increased use of electric transportation will add to electric loads. These trends seem likely to increase the use of demand response programs and shifts to dynamic pricing. In both of these cases, future homeowners may desire the option to enroll end-uses in their homes in demand response programs through which utilities control equipment operation for periods of time or have increased options to respond to more dynamic rates and incentives to more closely control their time of energy usage. For example, California is requiring that time-of-use rates be presented to customers as the default rate option.
- Utilities may seek ways of "storing" electricity generated from renewable sources in homes in creative ways, as has happened in Minnesota where a utility aggregator serving cooperatives and municipal utilities promotes the use of controls for (sometimes oversized or superheated) electric water heaters that time water heating to absorb wind energy when it is abundant for customer use in the form of hot water when it is needed.[26]
- Distributed energy resources (DERs) will continue to become more common as owners of single-family and multifamily homes install customer-sited photovoltaic systems and battery storage systems and integration of EV batteries with the grid become more common. Some utilities are currently researching ways to serve their customers with DER offerings in existing homes.

New construction is the most opportune time for the inclusion of technologies that will enable such functionality or flexible construction that will allow for later additions of systems, interfaces, or controls with lower costs and less hassle due to integrated designs and planning.[27] There is no obvious common pattern that would point to a specific best practice in preparing new homes for future technology, but a few utility and state programs point to the range of possibilities. These include:

[26] While these programs were designed for electric resistance water heaters, there is no reason they would not work for heat pump water heaters as well. Low demand periods with sufficient renewable generation generally allow for sufficiently long periods of time to pre-heat oversized water tanks using heat pump-only modes.

[27] Reviewers of a draft version of this report inquired about the role and unique opportunities for remodeling and additions in this context. Energize Connecticut's new construction program does serve gut rehabilitation projects as well as newly constructed homes and multifamily structures. Qualifying remodels and additions provide many of the same opportunities for the incorporation of demand response, distribution energy resources, and other future technologies as new construction. For demand response, opportunities for meaningful use of demand response may be somewhat greater in some built-up areas with existing utility capacity constraints, but the nature of the opportunities in buildings themselves is probably identical to that of new construction. For distributed energy resources, the opportunities are greater for new construction because site planning allows for optimization of solar (and, in rarer cases, wind) resources.

- NYSERDA's Multifamily Buildings of Excellence program gives points for carbon neutral-ready design including demand flexibility.
- California's statewide program requires EV charging readiness and battery storage readiness, while the state already mandates the inclusion of PV on new homes.
- ComEd's Single-Family All-Electric program requires communicating thermostats and encourages the selection of time-of-use rates, PV readiness, EV charging readiness, and battery storage readiness.

5.2.1 Recommendations

To expand further on the residential new construction program's efforts to prepare new homes and multifamily buildings for upcoming energy-related needs, we recommend that Energize Connecticut, in coordination with DEEP where needed:

- Continue to promote Zero Energy Ready Homes for its single-family program offering and Passive House-consistent approaches for its multifamily offerings.
- Continue to require EV and PV readiness and expand these expectations to include battery storage readiness.
    - Add the optional distribution by builders to their home purchasers of program-vetted information about the costs, benefits, and processes involved in adding PV and storage and facilitate adoption by interested homeowners with connections to relevant program offerings.
- Promote demand response and dynamic pricing "readiness" as part of encouraged home design attributes in its residential new construction program. This would involve:
    - Inclusion of control systems or interfaces that the Connecticut utilities' demand response programs do or could use if homeowners chose to participate in demand response offerings.
    - Inclusion of in-home electric usage displays to provide feedback for homeowners interested in monitoring or controlling their energy usage, along with promotion of time of use rates and supporting information about strategies for managing usage across rate periods.
    - Coordination with existing PV and storage programs and exploration within any roadmap study of the specific opportunities for integration of these programs and efforts by Connecticut Green Bank with new construction.

6 Integrate Policy, Codes, and Program

Review of leading new construction programs from other states as part of this study revealed just how much policy, codes, and programs interrelate. In some leading states, there is substantial effort to create linkages among these levers toward the objectives that energy efficiency programs are designed to accomplish, particularly as these objectives shift from a focus on promoting cost-effective energy solutions for ratepayers and residents to an increasing effort to reduce greenhouse gas emissions and electrify end-uses in homes, in buildings, and in transportation.

As examples of such integration, we point to examples such as:

- California, where state policies established by the legislature or by gubernatorial executive order result in initiatives and orders by the California Energy Commission and the California Public Utilities Commission. These actions, in turn, result in pilots and programs by the regulated utilities, which are actively involved in codes and standards, energy efficiency programs, and electrification initiatives (both for the state's building stock and in transportation). California also funds extensive clean energy technology research through a statewide research and development program with objectives linked back to state policy goals, as well as utility-specific emerging technology programs.
- The Northwest, where the regional energy efficiency organization creates market transformation initiatives, collaborates with utility and statewide energy efficiency programs, and leverages program efforts to advance energy code upgrades.
- Illinois, where a recent set of legislative acts—the Future Energy Jobs Act and the Climate and Equitable Jobs Act—have set into motion an expansion of traditional energy efficiency programs by utilities with greatly expanded savings goals and budgets, as well as incorporation of a path to electrification by allowing beneficial electrification.
- Minnesota, where the Energy Conservation Optimization Act has provided direction and permission for the Department of Commerce to expand the role of the utilities' Conservation Improvement Programs to consider or include such components as fuel switching and demand response within the program portfolios in an effort to expand the manner in which the programs serve the needs of state residents and complement state policy. Minnesota also supports the discovery and vetting of new technology by funding an applied research, development, and demonstration program that supports the adoption of new approaches by the utility energy efficiency programs.
- Closer to home, Massachusetts has used aggressive stretch codes and a permissive approach to allowing utility savings credit in communities that use the stretch code to increase efficiency levels of newly constructed single-family homes and increase program participation.

- As noted above, Energize Connecticut staff credit the state's public housing funding requirements with boosting the efficiency of newly constructed affordable housing and promoting participation in Passive House offerings.

Each jurisdiction is unique in how it seeks to promote its policy aims, but these states' examples point to the value of integration of policy, codes and standards, and voluntary energy efficiency programs. We present here some related activities in Connecticut and suggestions and recommendations for further integration of policy, codes, and programs.

6.1 Energy Policy Relevant to the Residential New Construction Program

There is much relevant energy policy in Connecticut that relates, directly or indirectly, to program plans for Energize Connecticut's program portfolio, including its residential new construction program. Most of the policy is either driven by or directed at the Department of Energy and Environmental Protection (DEEP). Recent policy directions have strongly emphasized climate initiatives, which is a shift from historic energy policy under which energy efficiency programs existed as an alternative to building new generation and to help consumers control their energy costs.

Current policy directives and initiatives of note include:

- Public Act No. 22-5, which was approved in May 2022, codified an earlier executive order by Governor Lamont and established as law the intent for zero greenhouse gas emissions by 2040 from electricity supplied to electric customers in Connecticut. The act also establishes overall state goals for the reduction of greenhouse gas emissions in Connecticut by 45 percent of 2001 levels by 2030 and 80 percent of 2001 levels by 2050.
- That prior executive order, issued in 2019, included a directive to DEEP to analyze pathways and recommend strategies for achieving a 100 percent zero carbon target for the electric sector by 2040. DEEP representatives have indicated that these goals require a combination of energy efficiency, demand response, and demand flexibility, as well as the establishment of electric vehicle (EV) infrastructure.
- DEEP is charged with establishing a Comprehensive Energy Strategy for the state every four years. An update is now underway, which will include a set of strategies to achieve the greenhouse gas emissions mentioned above. Information from an initial public presentation about the strategy's development indicated a plan to draw on modeling information from other states and specifically referenced a neighboring state's decarbonization roadmap. The development of the strategy reviews the findings of the state's integrated resources plan, the Conservation and Load Management Plan (which spells out Energize Connecticut's program plans, including those for the residential new construction program), clean energy investment plans developed by the Connecticut Green

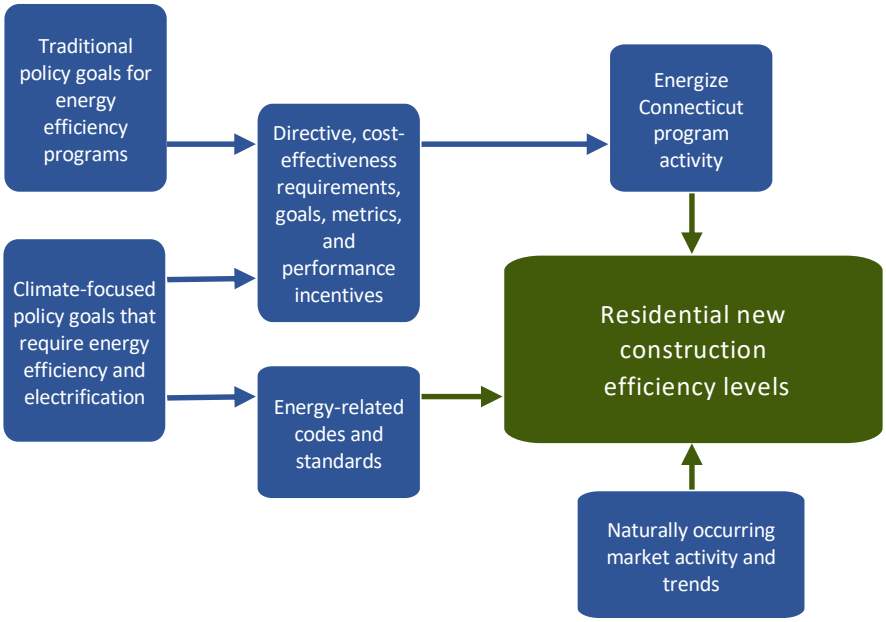
Bank, and the Energy Assurance Plan. We note that, conceptually, the Comprehensive Energy Strategy addresses both fundamental policy-oriented building blocks in the policy-code-program relationship we outline in Figure 2 below. (See the two left-most boxes.) As such it can provide the vision, clarity, and unifying policy direction for efficiency programs, including the residential new construction program.

Furthermore—as indicated in earlier sections of this report—DEEP directed the program administrators to transition the program to an all-electric offering as part of the conditions of approval for the overall Conservation Load Management Plan for 2022-2024. Specifically, DEEP's Final Determination on the 2022–2024 Conservation and Load Management Plan states that the utilities must "develop a proposal for transitioning the Residential New Construction program to an all-electric offering by July 2023."[28] It later states that by October 15, 2022, the utilities must "develop a proposal for transitioning the Residential New Construction program to an all-electric offering by the end of 2023."[29] The Schedule of Conditions of Approval states that the utilities must "develop a proposal for transitioning the Residential New Construction program into an all-electric offering that will begin accepting projects no later than July 2023."[30] The Conditions of Approval further elaborates that the proposal should include "interim targets for increasing the proportion of all-electric projects completed through the Residential New Construction program, any necessary changes to incentive structures or levels, and any perceived barriers to an all-electric new construction offering, including workforce development, education, and customer outreach needs and proposed solutions to those barriers."

Finally, we present in Figure 2 a generalized illustration of the interrelations of policy, code, and programs within the realm of residential new construction.

[28] See Department of Energy and Environmental Protection, Final Determination: Approval with Conditions of the 2022-2024 Conservation and Load Management Plan, June 1, 2022, page 16. Last retrieved from https://portal.ct.gov/-/media/DEEP/energy/ConserLoadMgmt/DEEP-Determination---2022-2024-CLM-Plan.pdf on September 19, 2022.
[29] Ibid. See page 19.
[30] See DEEP Determination: 2022-2024 Conservation and Load Management Plan, Attachment A: Schedule of Conditions of Approval, item 13. Last retrieved from https://portal.ct.gov/-/media/DEEP/energy/ConserLoadMgmt/Attachment-A---Schedule-of-2022-2024-Conditions-of-Approval.pdf on September 19, 2022.

Figure 2: Illustration of Policy, Code, and Program Interrelationships



6.2 Building Energy Codes

Building energy codes are an additional aspect of energy policy that is sometimes treated as a separate issue or independent input to the state policy equation.

Like other states, Connecticut's energy code-making entity (the Office of the State Building Inspector working together with the Codes & Standards Committee) sets minimum standards for new construction that effectively establish minimum efficiency levels. Typically, states, including Connecticut, apply model energy codes established by the International Code Council with state-specific amendments. These model codes, referred to as the International Energy Conservation Code (IECC) are updated every three years. Connecticut skipped the 2018 update but is set to adopt the 2021 version in October of 2022.

However, state energy codes can be part of a state energy plan and strategy. Some states with leading residential new construction efforts treat energy codes in this way, seeing codes and energy efficiency programs as related and interconnected. Existing models and approaches include the following:

- In California and New York, policy has driven codes and program design. Upcoming codes are leveraged to promote programs, while program designs and standards strive to stay two to three cycles ahead of code.
- The Northwest Energy Efficiency Alliance (NEEA) uses data from its own efforts and those of multiple regional collaborators to prove the achievability of new aggressive levels of

efficiency, which its codes program leverages when making suggestions for new code upgrades in the states NEEA serves. It is instructive to note that NEEA used to offer a more traditional incentive-based residential new construction program, but now only offers market support such as case studies, trainings, tools, and other resources. Their market support for residential new construction, branded BetterBuiltNW, is a part of its codes and standards program. Our contact at the Alliance told us that they made this change because quickly rising baselines (codes) made it nearly impossible to maintain a cost-effective resource acquisition program. That said, some of the utilities in the states NEEA serves still offer more traditional incentive programs that complement NEEA's initiative.

- In Massachusetts, towns are allowed to pass bylaws that raise the minimum energy code to the state's stretch code levels. Because of financial incentives, more than 80 percent of towns have adopted the stretch code. That rise in code along with continued support of incentives through the MassSave residential new construction program have lifted the level of energy efficiency in new construction significantly.

More specifically, California's statewide Energy-Smart Homes program works hand in hand with the statewide Codes & Standards program. Specifically, the program is aimed primarily at all-electric new construction, and the state has indicated it will be moving toward all-electric code requirements. The two programs inform and reinforce each other.

Pacific Gas and Electric's (PG&E's) ZNE Production Builder Demonstration was developed to demonstrate proof of concept of ZNE residential new construction codes by 2020. To help prepare builders for this code change, the program worked individually with builders to help redesign their prototype floor plans to accommodate different technologies/construction practices, provided in-the-field support to trade allies who were installing new technologies or using new building techniques for the first time, and helped builders work through supply chain issues.

NYSERDA's programs also work directly with their initiatives to move policy and code forward. To help support builders getting ready for the next code cycle, NYSERDA provides an online data library of measure performance. NYSERDA also uses the data it collects to prove cost effectiveness so that more stringent codes can be adopted. Like PG&E's program, NYSERDA's Building Better Homes program offers technical assistance to builders including floorplan redesign. Since the goal of NYSERDA's new construction programs is to stay 5 to 15 years (2 to 3 code cycles) ahead of code, this activity helps prepare builders for future code.

6.3 Recommendations

Connecticut could better facilitate effective and aggressive new construction program efforts through policy and codes. To do so, we recommend that DEEP:

- As part of its Comprehensive Energy Strategy, lay out as much of a vision as feasible for how Energize Connecticut's residential new construction program will help achieve the state's relevant energy policies and what its priorities should be.
    - Ideally, this vision would allocate an aspirational share of the climate reduction goals Connecticut is seeking to meet to the program so it has a target to plan around. The vision should also specify how priorities, such as greenhouse carbon emission reductions, affordability, and other considerations, should be balanced.
    - Establishing a roadmap, as Massachusetts has done, would be helpful, but we recommend that the roadmap be more specific in linking goals, strategies, and implementation mechanisms (such as the Energize Connecticut programs).
    - With the larger strategy and priorities still being worked out, we believe it is prudent to allow the utilities and market sufficient time for the full transition of the residential new construction program to all-electric offering to ensure that builders not ready to make the transition are not left behind. We applaud DEEP for acknowledging the need for a transition plan and some of its key components. We believe that the utilities—and the market—may need more time to complete (but not begin) the transition. We base this assessment on such factors as the small share of participating homes currently that follow the all-electric path and the fact that high efficiency for remaining in-home combustion will be needed to achieve the established climate targets.[31]
- Coordinate with the Office of the State Building Inspector on future code upgrades and state amendments to introduce, if feasible, a requirement that newly built residential buildings' energy-using systems be all-electric.
    - Doing so and communicating the intended timing of this transition widely to the market would ensure all-electric new construction within a reasonable timeframe (presumably one or two code cycles) and position the Energize Connecticut residential new construction program to support and accelerate the transition through financial, technical, and market support.
    - If such a code transition were clearly laid out for the code, participation rates in Energize Connecticut's all-electric offerings would likely increase substantially, and the residential new construction program could become an all-electric program without losing important influence in homes with continued use of combustion appliances and equipment.

[31] Reviewers of a draft version of this report pointed out a substantial share of residential new construction program participants (41% of Eversource's Q2 participants and 82% of single-family participants in 2021) use electric heat. Nevertheless, as we indicated elsewhere, other non-electric end-uses appear to pose greater market barriers.

7 Promote Forward-Looking Program Approaches

As the regulatory agency overseeing the utility-run energy efficiency program in Connecticut, the Department of Energy and Environmental Protection (DEEP) could more strongly pave the way for some of the practices we identified in other leading states and promote more innovation that aligns with state policy goals in several ways. We describe the role of incentives, cost-effectiveness requirements, and flexibility to conduct market transformation efforts below and then present recommendations for adjustments DEEP could make in each of these areas. Where relevant, we present examples from leading states, but parts of this discussion are not based on best practice, but rather on observations about Connecticut's current structure.

7.1 Incentives and Metrics

DEEP incentivizes Energize Connecticut's program administrators to prioritize certain objectives through the performance management incentives offered to the utilities and through the quantitative goals that are set and then tracked and reported as metrics.

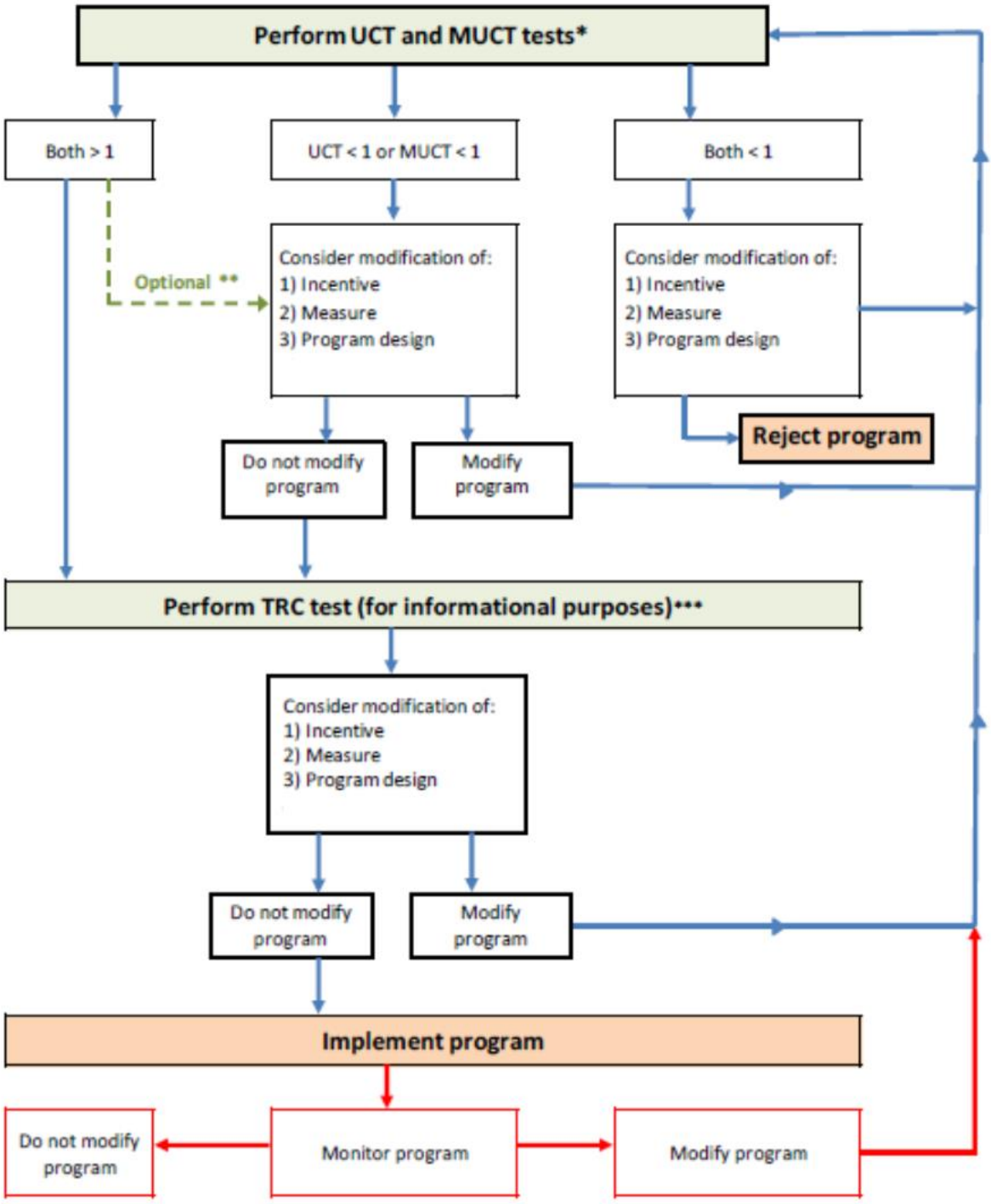
In Connecticut, a performance management incentive for the utilities is driven largely by quantified energy savings. While there is a secondary metric for residential new construction that is based on the percentage of participants with HERS scores of 50 or less, such secondary metrics are not weighed heavily. Also, while a step in the positive direction, framing incentives on the share of participation at a certain efficiency level promotes efficient home performance. A better metric for a program that seeks to change market practices would be framed as the share of all new homes being constructed that exceed code or past industry standard practice in some measurable way. As the current policy goals are oriented around overall reductions in greenhouse gas emissions, an appropriate metric for a holistic new construction program would be oriented around (decreased) total modeled greenhouse gas emissions from the entirety of newly built homes. Admittedly, such a metric would include and reward practices outside the program's control, but it would also provide an inducement and reward indirect effects, such as the influence that training and market support have on builder practices.

While we are not aware of specific metrics that have been developed along these lines in other jurisdictions, we note that the shift in emphasis to climate is pervasive and requires adjustments in metrics from general energy units of measurement to include time-based and generation-based considerations. Adoption of new climate-oriented metrics has adjusted slowly in measurements of program impacts and for incorporation into goals and performance metrics. This creates opportunities for thoughtful pilots of metrics that align with new policy imperatives.

7.2 Cost Effectiveness as a Barrier

We find that the benefit-cost process in place for Energize Connecticut programs may be too restrictive for residential new construction programs and is likely a barrier to optimized program design. As illustrated in Figure 3, programs must meet a Utility Cost Test or a Modified Utility Cost Test before they can be considered further and undergo a Resource Cost Test (for informational purposes). The Resource Cost Test does include consideration of non-energy impacts, including reductions in greenhouse gas emissions at a respectable $125 of valuation per ton of CO_2. However, the absence of these considerations in the initial screening tests may well hold back the program from optimizing its potential to contribute to state climate goals. Given the importance of climate goals to the state and the role new construction can play in reducing future carbon emissions, the benefit of reduced carbon emissions should be a primary factor and not a secondary for-information-only metric in deciding whether a program is cost-effective.

Figure 3: Connecticut Benefit-Cost Testing Process for Energize Connecticut Programs (as presented in the Conservation and Load Management Plan)



We understand from input provided by the program's technical consultant that benefits from non-participant spillover could be counted in Connecticut's cost benefit framework and that the program is currently not technically constrained in its activities by cost-benefit computations. At the same time, we understand that program staff feel constrained by cost-benefit requirements in the incentives they provide. Quantifying and including non-participant spillover benefits in the cost benefit computations would provide clearer direction to the program that Connecticut's regulators encourage broader market engagement efforts, including market transformation, to achieve policy goals for new construction in the state. This step would more actively encourage efforts to engage the broader market, whether or not they end up participating in the program through its rebate offers (and thus result in direct energy savings).

7.3 Support to Conduct Market Transformation

We discussed market transformation in the section titled *Increase in Market Transformation Efforts*, where we suggested that the Energize Connecticut residential new construction program should take on more elements designed to transform the market. Here, we circle back to that point and discuss what DEEP can do to support these efforts.

7.3.1 Taking a Broad View of Program Activities

The regulatory environment for market transformation initiatives differs from that of resource acquisition efforts in the types of activities for which spending is permitted and the manner in which program successes or metrics are defined. Regulatory oversight for market transformation programs tends to take a broader view of the influence program activity has and frames the desired outcomes of programs beyond program-participating first-year or measure life savings.

Examples of this form of flexibility in other states and regions include the Northwest Energy Efficiency Alliance (NEEA), which is a market transformation organization that reports impacts back to its funders but takes a broad view of its influence on market activity without requiring that savings be directly tied to a specific activity taken by someone who received a program rebate.

DEEP could more clearly encourage residential new construction metrics to encompass market-level activities where there is a good rationale for why program action may or should have spillover to non-participating homes or non-participating market actors that are nonetheless influenced by the program. Specific activities should have a rationale rooted in program objectives or related state policy goals and a clear theory of how the activities will lead, directly or indirectly, toward desired outcomes. These rationales could be defined in the Comprehensive Energy Strategy or in the Conservation and Load Management Plan.

We understand that non-participant spillover benefits can currently be included as inputs to Connecticut's cost benefit testing. However, it does not appear that utilities are currently quantifying or claiming spillover benefits. This may point to a need for more evaluation research or

for DEEP to explicitly direct utilities to quantify non-participant spillover as a measure of the effects the programs are having on the market.

7.3.2 Support

Beyond simply allowing market transformation activities, some states facilitate it directly. A few examples include the following:

- California and Minnesota both administer research, development, and demonstration grant programs that contribute to the pipeline of clean energy technologies. California's Electric Program Investment Charge (EPIC) program also funds market facilitation projects to support the development and preparation of the market to use the developed technology.
- Wisconsin is funding a roadmap to help define the activities needed to spur program influence and impact on the market so heat pump technology can gain a greater foothold in the state. As noted earlier, this study is providing a market and stakeholder needs assessment; defining the value propositions for market actors by use cases; assessing the coordination needed among utilities, regulators, and local governments; and providing implementation support. It is funded by the state agency that oversees the statewide Focus on Energy program.

7.4 Recommendations

To provide more flexibility and inducements to the utility program administrators of Energize Connecticut that are tied more closely with state priorities, we recommend that DEEP shift a substantial share of the utility performance management incentives for the new construction program from energy savings associated with program participation to expected greenhouse gas emission reductions from program participation and related market effects, perhaps gradually if new metrics need to be developed and implemented first.[32]

We also recommend that DEEP facilitate market transformation approaches for new construction by:

- Broadening the allowable definition and countable savings associated with well-supported market activities for the Energize Connecticut new construction program, where needed or identified as a barrier by program staff;

[32] Reviewers of a draft version of this report asked whether the focus here is on a shift to climate metrics or market transformational effects. We make this recommendation to combine both. Policy intentions are shifting to a climate focus, which makes the climate metrics primary, but the nature of a program to achieve the goals requires indirect market impacts that need to be included in the measurement of program outcomes.

- Direct program staff to incorporate market transformation efforts into its program design and to identify viable and credible pathways by which the program may be influencing non-participant activities; and
- Engage the evaluation process for Energize Connecticut to study and estimate the degree of non-participant spillover from program activities, as well as unrealized opportunities from potential activities.

Ideally, the market transformation approach would be guided by an empirically derived roadmap that translates DEEP-established policy goals and Connecticut-specific market information into a comprehensive strategy. The strategy should identify the market changes that are needed for state policies and objectives for new construction to come into fruition, which changes will occur naturally (or due to code upgrades alone), which will require program intervention, and how. The roadmap would be specific to new construction activities, but some of the program solutions (such as accelerating market adoption of heat pump technologies generally) may engage the entire Energize Connecticut portfolio.

Appendix A: Methodology

This study was designed to conduct secondary research on leading residential new construction efforts outside Connecticut in order to identify practices Energize Connecticut may consider as it updates future versions of its residential new construction program. New policy directives within the state and the need to relate learnings from out-of-state efforts prompted an internal focus and review of in-state information as well. We describe here, briefly, the study phases and methodology.

Stage 1: In-State Background Interviews

The study team conducted interviews of in-state stakeholders to obtain background and context and to be better understand informational priorities. We conducted four interviews in August 2021, one each of program staff at Eversource, program staff at Avangrid, policy staff at the Department of Energy and Environmental Protection, and the technical consultants to Energize Connecticut.

Stage 2: Out-of-State Secondary Research

The core part of the data gathering consisted of secondary research and interviews with leading residential new construction programs, relevant thought leaders on residential new construction, and regulators or stakeholders overseeing leading programs. From October 2021 to March 2022, our team reviewed and interacted with 34 such programs or organizations. The 34 programs were identified through a variety of means, including ratings by the American Council for an Energy-Efficient Economy, awareness of programs from past research our team has conducted, nominations from interviewees, and a general secondary search. Activities for these programs consisted of:

- Basic information gathering (for all programs);
- Review of public-facing information about the program details, designs, results, and strategies (with varying levels of effort depending on the unique features of a program, fit with study priorities, and prior coverage of similar program efforts); and
- Interviews with 10 program managers, stakeholders, and representatives covering high priority programs vetted with the evaluation administrator.

Table 5 lists these programs and summarizes the degree of our review.

Table 5: Programs and Thought-Leading Initiatives Consulted

Program or Initiative	Degree of Review
Arkansas Home Energy Data Platform	Background
British Columbia Zero Energy Challenge	Background
CenterPoint Smart Homes Pilot	Email inquiry
ComEd's All-Electric Residential New Construction Pilot	Interview
District of Columbia Sustainable Energy Utility's ZNE-Residential Initiative	Background
Dominion Energy-Utah's ThermWise Program (plus CarbonRight offsets)	Interview
Efficiency Vermont High Performance Homes Program	Interview
Efficiency Vermont Multifamily New Construction Program	Reviewed Public-Facing Program Info
Efficiency Vermont Zero Net Energy Modular Homes Initiative	Background
Energize Delaware Zero Net Energy - Residential / Milford Homes Modular	Background
Focus on Energy's ENERGY STAR Homes Program	Background and Knowledge from Past Work
MassSave Multifamily Passive House New Construction Initiative[a]	Interview
Minnesota Conservation Improvement Programs	Interview
Missouri Home Energy Data Platform	Background
National Grid-RI, Path to ZNE-Residential Pilot	Background
New Jersey Clean Energy Programs	Background
Northeast Energy Efficiency Partnership Home Energy Data Platform	Background
Northwest Energy Efficiency Alliance's Next Step Homes Program	Interview
NYSERDA Buildings of Excellence Multifamily Competition	Interview for Full Set of Programs
NYSERDA Low-Rise Residential New Construction Program	
NYSERDA Low-Rise Residential New Construction Program	
NYSERDA Mid-/High-Rise Multifamily New Construction Program	
Oregon Home Energy Data Platform	Background
Pacific Gas and Electric's Advanced Energy Rebuild Program	Interview

Program or Initiative	Degree of Review
Pacific Gas and Electric's Codes and Standards Program	Background and Knowledge from Past Work
Pacific Gas and Electric's Zero Net Energy Production Builder Demonstration Initiative	Interview
Phius (Passive House organization active in multiple states, including Connecticut)	Interview
Rocky Mountain Institute	Email interview
Sacramento Municipal Utility District's All-Electric Smart Homes Builder Incentives	Background
San Diego Gas & Electric's Codes and Standards Program	Background
Southern California Edison's California Advanced Homes Initiative	Background
Southern California Edison's Clean Energy and Resiliency Rebuild Program	Background
Southern California Edison's Codes and Standards Program	Background
Southern California Edison's Emerging Technologies Program	Background
Southern California Gas's Codes and Standards Program	Background

a) Reviewers of a draft version of this report noted that MassSave now offers an all-electric program offering as well.

Stage 3: In-State Program and Policy Reviews

During the analysis stage of our work, we added additional investigation into existing program details for Energize Connecticut and a review of established and changing policies and directives by DEEP. These included reviews of:

- Draft and then final determinations by DEEP on the 2022-2024 program plans for Energize Connecticut and conditions of approval for the program plans;
- Policy drivers in Connecticut that affect the stated and implied objectives of the utility energy efficiency program, including legislation and executive orders related to state goals on in-state reductions of greenhouse gas emissions;
- Cost-effectiveness processes and requirements for Energize Connecticut and current and planned adjustments by DEEP;
- Performance management incentives for the program administrators of Energize Connecticut;
- Connecticut energy code practices and upgrades; and
- Relationships between codes, what is known about industry standard practice, Home Energy Rating System (HERS) scores, and Energy Rating Index (ERI) scores.

These reviews became necessary as best practices identified during secondary research identified the importance of the integration of policy, codes, and programs; as actionable recommendations required greater Connecticut context than we had from background interviews; and as policy and directives to the program administrators evolved during the study.

Appendix B: Program Descriptions

For the programs we investigated more fully, we offer brief summaries of the programs overall, what makes them noteworthy, and any key take-aways for Connecticut.

ComEd's All-Electric Residential New Construction Pilot

- This prescriptive all-electric, energy efficient single-family program evolved from a pilot program that started in 2020. It encourages but does not require electric cooking, EV-readiness, storage-readiness, and solar-readiness. It includes indoor air quality and comfort requirements. The program largely works with niche builders and has not engaged production-type builders yet. Incentives vary based on the size of the dwelling. Provides training for builders, especially on ASHPs in cold climates. Incentives are $1,000 for dwellings less than 800 square feet, $1,500 for dwellings from 801 – 1,500 square feet, and $2,000 for dwellings greater than 1,500 square feet. The program had 11 participants in 2020, 18 participants in 2021, and has a goal of 60 participants for 2022 as its first full program (not pilot) year.
- The implementation team stressed the importance of developing relationships with and gathering data and information from market actors early and often. This will be important for Connecticut to do as it moves toward an all-electric offering. ComEd conducted structured interviews and quarterly surveys prior to launching the pilot, continued to conduct them for some time afterward, and now has developed such good relationships with the market actors that team members have ad hoc conversations as needed to continue to improve the program.

Dominion Energy-Utah's ThermWise Program (plus CarbonRight offsets)

- ThermWise is a fairly traditional natural gas resource acquisition program with largely prescriptive offerings that nonetheless offers tiers to builders so it is able to attract a full range of market actors. The program collaborates with the electric program offered in parallel by the local electric utility. The program addresses net-zero concerns by promoting renewable natural gas at a premium and carbon offsets that are available outside the utility's energy efficiency offerings.
- The program reinforces the importance of a tiered approach to program offerings so multiple components of the builder and homeowner markets can be addressed. One other unique take-away is the program's approach to seeking net-zero options for natural gas through sustainable natural gas and offsets.

Efficiency Vermont High Performance Homes Program

- Efficiency Vermont's High Performance Homes program is a higher tier add-on to its standard residential (single-family) new construction program, which is aligned with the state's stretch code. (The HPH program is several notches above in efficiency). The overall goal is ZNE readiness for all new construction by 2030, and both programs are intended to help achieve Vermont's climate action plan. The HPH program is shifting from a project focus to a builder focus as a way of influencing the market and participating builders' and subcontractors' standard practice without touching each home they build. This approach is new. Recent participation levels are 132 in the standard program and 25 (dedicated builders) in the HPH add-on out of about 1,000 new homes annually in the state.
- The program approach reinforces the value of a tiered approach, demonstrates the linkage between policy goals and program-based achievement of those policies, and the strategy of seeking market change rather than a home-specific approach.

MassSave Multifamily Passive House New Construction Initiative

- (Focused on Passive House component, not the full program) Passive House offerings in Massachusetts are similar to Connecticut, incorporating workforce development efforts, training, and certification assistance. Implementation is easier and uptake higher for multifamily than single-family because multifamily structures have more optimal envelope designs and internal heat gains. Uptake in Massachusetts is comparatively higher among market rate development than in Connecticut, in part because Passive House standards are a smaller leap from the state's stretch code, which does not exist in Connecticut. Meanwhile, uptake is comparatively higher in Connecticut for affordable housing due to standards by the main affordable housing agency that resemble Passive House standards.
- Passive House is a good standard to use for highly efficient multifamily new construction. The experiences in Massachusetts and Connecticut highlight the importance of non-program factors in program uptake. Codes, stretch codes, and non-regulatory standards work hand-in-hand with voluntary programs to achieve results collectively rather than individually. The full context needs to be considered; energy efficiency programs cannot be viewed in isolation.

Minnesota Conservation Improvement Programs

- Minnesota's utilities are required to implement energy efficiency programs (called Conservation Improvement Programs) to achieve savings targets based on a percentage of electricity and natural gas goals. The Department of Commerce provides regulatory oversight, sets policy, and provides support through the funding of an applied research program that provides grants for the study of relevant technologies and approaches that utilities could incorporate into their programs now or in the future.
- Utilities have much flexibility in designing their own portfolios; they can choose to include a residential new construction program, but are not required to as the focus is on total savings. Cost-effectiveness needs to be achieved at the sector level.
- Residential new construction code in Minnesota has not been updated since 2015 (using the 2012 IECC), so the residential new construction programs address a gap between current efficient practices and regulatory minimums. Voluntary approaches are preferred by the industry.
- Air source heat pumps are a big focus in Minnesota, and new construction lends itself well due to the tighter construction.
- Recent legislation elevates the role of climate goals (which CIP programs help address) and provides greater flexibility for demand response efforts and fuel switching. As part of this, natural gas utilities can offer electric efficiency measures. The role of electrification is still being worked out.
- Connecticut may be further along than Minnesota in some ways, but Minnesota prides itself on its flexible approach to conservation that sets high-level expectations and allows utilities and markets to figure out the details based on their expertise.

Northwest Energy Efficiency Alliance's Next Step Homes Program

- The Northwest Energy Efficiency Alliance's (NEEA) Next Step Homes Program evolved into their BetterBuiltNW state codes support program offered currently. While the previous program offered incentives to builders and developers, the current program offers market actors a slew of resources including a database of homes built above code, tools, training, marketing materials, case studies, and libraries of energy modeling elements. NEEA operates in a region where many states and municipalities were and are moving quickly toward electrification or decarbonization via state policies that put in motion more stringent new construction building codes. NEEA decided to move away from its traditional incentive program to a codes and market transformation program because its old program was no longer cost effective and could not keep up with the rising baselines caused by rapidly changing codes. Some of the utilities in the region still offer incentive programs that complement NEEA's, though not all do. The program is a part of NEEA's larger codes and standards program that has a goal of transforming the new construction market in the region by pushing for more stringent codes. By providing builders with resources to build above code, tracking the number of homes built above code, and tracking the measures adopted in those homes, NEEA effectively makes the case that higher codes are achievable and should therefore be adopted. The cost effectiveness metric NEEA uses for the program is the energy savings divided by the cost of the program over 20 years.
- To bring about major market transformation, such as all electric new construction in Connecticut, more market support activities will be required. While Connecticut's program may not become a codes program, reconsidering how to effectively allow for more market support activities within the cost-benefit test environment will be crucial to program success.

NYSERDA Family of Programs: Overall

- NYSERDA has three different energy efficient carbon neutral programs for new construction that address the market in different ways. On-site fossil fuel combustion is not allowed except for high efficiency wood and renewable fuels. Including other types of renewable energy in home design is not a requirement, but is encouraged and incentives are available through other programs. The programs are all aligned with and driven by state carbon neutrality policies which drive codes. NYSERDA is also involved in moving code forward. NYSERDA uses a mix of resource acquisition and market support goals and metrics to measure program success. In the long-term, NYSERDA hopes to move the market to Passive House, carbon neutral performance in 5 – 15 years, or 2 – 3 code cycles ahead of code. It uses the successes and case studies from its programs to prove cost effectiveness and drive cost compression. It uses cost data gathered through the programs to influence agencies to adopt strategic policies, cities and the state to adopt more stringent codes, and non-participating builders to participate in the programs. Participants include all types of builders including production builders. NYSERDA uses its data library of measure performance to convince builders who doubt newer technologies. Notably, NYSERDA encourages but does not require participants to use integrated design and construction protocols, to address embodied carbon, and to use low global warming potential refrigerants. On the marketing side, NYSERDA is partnering with HGTV to showcase carbon neutral homes with a focus on how much quieter, healthier, comfortable, and resilient they are.
- NYSERDA's programs demonstrate an effective link between state climate policies, codes, and energy efficiency programs. Policies and forecasted codes serve as warnings to the market that changes lie ahead. The programs effectively help builders learn new building techniques and technologies before they are required. In the last couple of years NYSERDA has moved away from a focus on zero net energy and toward a focus on carbon neutrality. The state policy for a carbon neutral grid was what drove this change. NYSERDA noted that it was important, time-consuming work to determine upfront what exceptions to the programs' requirements for carbon neutrality (all-electric) would be (e.g., emergency power generation). NYSERDA suggests that other program administrators ensure they focus on what it calls "no regrets" measures including building envelope, water efficiency including piping configurations, energy recovery, and dedicated outdoor air systems to name a few. Finally, NYSERDA's multiple program offerings and tiers within those offerings demonstrate a best practice that allows builders to participate as they are able.

NYSERDA Family of Programs: New Construction Program

- NYSERDA used to have separate offerings for multifamily and single family, but it has since merged the two programs for simplicity. NYSERDA's New Construction Program has a core requirement of 20 percent better than code and carbon neutral (all-electric) with a higher tier of 30 percent better than code, carbon neutral (all-electric), and a health commitment. The health commitment requires the project to pursue an additional certification that incorporates health-related benefits, such as Enterprise Green Communities (EGC) 2020, Fitwell, Leadership in Energy and Environmental Design (LEED) Platinum, International Living Futures Institute (ILFI) Zero Carbon, Phius CORE or higher, Phius CORE REVIVE, PHI Classic, EnerPHit, US EPA Indoor airPLUS, or WELL Certification. Regardless of tier, participants must have their homes certified by either ENERGY STAR or Passive House. Incentives are $1,000 per dwelling unit plus $1 per square foot of residential non-dwelling unit space (up to $300,000 per project) if the 20 percent above code threshold is met, and $2,500 per dwelling unit plus $2 per square foot of residential non-dwelling unit space (up to $500,000 per project) if the 30 percent above code threshold is met. The program offers additional incentives for emerging carbon neutral or electrification technologies and designs (up to $25,000) and mentorship technical support (up to $200 per dwelling unit or per 1,000 square feet of non-dwelling unit residential space). This program is also available for gut rehabilitation and adaptive re-use projects and mixed-use buildings.
- Through the tiered structure of this program and by offering many programs, NYSERDA offers a variety of options to builders. As Connecticut moves toward an all-electric offering, it will be important to keep options open to builders, especially those who are currently participating in the program, but who may not be ready yet to switch to all-electric. Tiers, multiple pathways, and multiple programs give builders options and goals (the next tier or program) to strive for.

NYSERDA Family of Programs: Building Better Homes

- NYSERDA is working in partnership with the New York State Home Builders Association and the Asthma and Allergy Foundation to launch this new initiative focused on healthy single-family homes. This program is focused on promoting and tracking (to the extent possible) the health and comfort aspects of carbon neutral buildings. Participating homes must be carbon neutral (all electric) and meet New York's stretch code. Approved participants have access to up to $250,000 per two-year agreement for carbon-neutral design or redesign support ($20,000 per home design), professional consultation services support (up to $100,000 every two years), carbon-neutral marketing costs (up to 50% cost share), and carbon-neutral model homes ($6,000 per home). Additional incentives are available for homes certified as meeting Passive House, DOE Zero-Energy Ready, or Living Building Challenge standards ($5,000 per home), model homes built to Passive House standards without certification ($2,000) and model homes certified to Passive House, DOE Zero-Energy Ready, or Living Building Challenge standards ($6,500). NYSERDA planned to launch a competition component in mid 2022, but that has not been confirmed as of the date of this writing. Also in 2022, NYSERDA planned to launch a consumer awareness campaign.
- As it moves toward an all-electric new construction offering, Connecticut should consider new partnerships it could forge to promote the health and comfort benefits that may have broader appeal to buyers than "energy efficiency" or "green home."

NYSERDA Family of Programs: Multifamily Buildings of Excellence Competition

- NYSERDA's Multifamily Buildings of Excellence Competition started in 2019 and is in its third round. It requires buildings to be carbon neutral (all-electric) and has two pathways: demonstration projects and early design stage support. Winners of the early design stage can later apply in another round as a demonstration building. As a part of the competition, NYSERDA encourages builders to demonstrate how their designs will increase building resiliency, including passive survivability, and improve health, comfort, and productivity for occupants in a manner that can be replicated at scale. NYSERDA also encourages applicants to demonstrate their ability to generate interest in and demand for carbon neutral-ready and resilient buildings. Incentives from the Buildings of Excellence Competition can be stacked with incentives from the New Construction Program. In the competition's first round there were 28 winners, and in its second round there were 14 winners. NYSERDA collects each project's design, cost, measure, incentive, and performance data. It publicly shares the cost, incentive, and measure data in

downloadable spreadsheets to help other builders. It also creates best practices from the data collected.

New construction competitions, which Connecticut has hosted through its CT Zero Energy Challenge, provide an alternative approach to the market, often with high rewards and high visibility for builders. This approach should continue to be utilized in the next phase of Connecticut's programs, perhaps with multiple pathways for dual-fuel and all-electric until the market is ready for electric only.

Pacific Gas and Electric's Zero Net Energy Production Builder Demonstration Initiative

- Pacific Gas and Electric's (PG&E) Zero Net Energy Production Builder Demonstration Initiative was a pilot program with a goal of bringing ZNE to scale by working hand-in-hand with production builders to solve their specific challenges such as redesigning prototype floorplans to accommodate different types of equipment, working through supply chain and purchasing decision-making issues, and providing training and technical support for the trades. This pilot was not a resource acquisition program as it was housed under California's Emerging Technology Program and therefore was not held to strict cost benefit tests. The driver behind this program was a policy announcement that the state code for residential new construction would be ZNE by 2020. PG&E sought to 1) prove this code change was possible and 2) help to start transforming the market by working with some of the largest builders. Through this program, six single-family homes were built to a standard of zero net time-dependent energy use. The program reimbursed builders up to $15,000 in incremental costs. The program created case studies for each of the homes with cost, measure, and performance data that it used to further promote ZNE design in the marketplace. An interesting non-energy benefit that was realized through this program was reduced waiting times for hot water if the hot water points are centered in the home.
- Using a pilot program as proof of concept for a larger, upcoming market change (be it code or program-related) can be a useful tool. It is particularly useful when cost, measure, performance, non-energy benefits, and other data are collected and used to demonstrate to builders the viability and successes of new building practices. Connecticut should consider the merits of piloting an all-electric new construction program prior to launching a full-fledged program. Doing so would allow Connecticut to gather data and create compelling case studies to convince the wider market.

California Statewide Energy-Smart Homes

- The California Statewide Energy-Smart Homes Program launched in January of 2022 and is focused on transitioning residential new construction to all electric in alignment with the state's push toward all-electric new construction codes which have been driven by the state's climate policies. Currently the program has both all-electric and dual-fuel pathways, but the plan is to phase out the dual-fuel pathway in the next five years. While not a codes and standards program, it works with the codes and standards program. As of this writing, the program is under a filing to make it a market support (market transformation) program instead of a resource acquisition program due to its involvement in codes. This change would give the program more flexibility with respect to costs and benefits and when benefits are realized. This flexibility will be needed when the code changes to all electric for new construction. Currently, the avoided cost of gas infrastructure is included in the cost benefit test and the program can claim savings from fuel-switching.
- The program requires a number of prescriptive measures and for homes to have an energy efficiency energy design rating (EDR[33]) delta of greater than or equal to one for all-electric homes and greater than or equal to two for dual-fuel homes. EV readiness and battery readiness are required measures. Rehabilitation projects are eligible for the program.
- For all-electric homes, the program offers incentives of $3,500 plus $10 per 0.1 increase in the energy efficiency EDR delta over one for single-family homes and $2,200 plus $5 per 0.1 increase in the energy efficiency EDR delta over two for multifamily units. For dual-fuel homes, the program offers incentives of $800 plus $5 per 0.1 increase in the energy efficiency EDR delta over two for single-family homes and $450 plus $6 per 0.1 increase in the energy efficiency EDR delta over two. Incentives decrease starting in 2023 and through 2025. The program also offers training for builders and trades and technical support through application review.
- The program's goal for this year is 25 single-family homes. As of this writing, the program has 15 all-electric applications, 1 dual-fuel application, and zero complete projects.
- An "emerging technology" the program is helping builders to experiment with is "cluster water heating" (e.g., one large heat pump water heater (HPWH) for up to four

[33] Energy design rating (EDR) is a way to express the energy performance of a building using a scale of 0 to 100. A score of 100 represents the performance of the designed building if it were built to the 2006 International Energy Conservation Code (IECC). A score of zero represents a building that has zero-net-energy consumption based on the energy consumption of the proposed design. The efficiency EDR is based on the energy efficiency features of the building such as space heating, cooling, ventilation, and water heating. To calculate a home's energy efficiency EDR delta, subtract the standard efficiency EDR from the proposed efficiency EDR.

multifamily units) to address the lack of HPWHs large enough for central hot water heating in multifamily buildings.

- Moving the market toward all electric new construction requires major lifts in market education and support. California is keeping builders who are not ready to build fully electric in the program by offering a dual-fuel pathway that is time limited and has decreasing incentives over time. This is a good approach for Connecticut to consider.

Phius (Passive House organization active in multiple states, including Connecticut)

- Energize Connecticut already works with Phius and is probably more familiar with the concept of Passive House and the associated standards than the study team. We focus here on contextual insights rather than a detailed program description. For reference, Phius equates to a HERS score of 35 or better with ultra-tight construction practices, balanced ventilation, and continuous insulation. There is no requirement that homes be all-electric, but air source heat pumps and heat pump water heating are almost always included in Passive House homes and low load is a key component. By 2030, Phius expects its current standards to be code; it is currently already referenced by Massachusetts' stretch codes.
- Several residential new construction efforts throughout the country use Passive House concepts and standards without explicitly identifying Phius or Passive House as their origin, in part to remain program neutral. Passive House is currently being implemented or used by Xcel Energy as part of a rebuild program after a fire in the Boulder area, by NYSERDA, by MassSave, by ComEd, and by Energize Connecticut. Some incentive levels are relatively high – as high as $37,000.
- Passive House is more cost-effective in multifamily settings than single-family because the typical multifamily structure is more conducive to ultra-tight construction.
- Connecticut's desire to advance its residential new construction standards are consistent with greater use of Phius program efforts and standards, especially in multifamily construction.

Appendix C: Additional Concepts for Consideration

During the course of the study, analysis, and synthesis, we identified several additional concepts, issues, and questions that may be of value to Energize Connecticut in the future, but that we did not fully explore and did not include in the body of the report. We offer them here as food for thought for future consideration and/or for the sake of completeness:

- Regional collaboration & standards—Market practices and market actors cut across state and utility boundaries. As a result, there is value in thinking more regionally in setting program standards and providing market-focused services. Our report is focused on what Energize Connecticut and DEEP can do within Connecticut, but we call out the benefit of thinking regionally and collaborating with neighbors in ways that will result in consistent offerings for market actors the programs are seeking to influence.
- Modular homes efforts—We gave a light touch to modular home efforts in our secondary research in favor of site-built single-family and multifamily construction. We do want to acknowledge that there are potentially valuable modular home efforts underway that have market transformation potential in Vermont and Delaware.
- Complication of tax credit as added incentive for efficiency and distributed energy resources—Federal (and sometimes state) tax credits provide additional drivers for some efficiency upgrades and the installation of distributed energy resources in homes. While energy efficiency programs do tend to mention them, these drivers are challenging for energy efficiency programs to incorporate into marketing and promotions as tax incentives are complicated and depend very much on household circumstances and filings. Often, the best programs can do is to mention potential tax rebates and suggest that households talk to their tax advisor. This limits the benefit of these incentives as part of program messaging because programs cannot be specific about just how much—or even whether—a household will receive any additional benefit beyond energy savings and program-specific rebates. This is a missed opportunity without an easy solution. The recently passed Inflation Reduction Act affects the current (or future) opportunities and needs review.
- Gas customer equity—Some interviewees raised the question of equity across customer types and suggested that the contribution to all-electric program efforts by Connecticut utility customers via their natural gas bills needs further discussion. We wanted to acknowledge this question, but also comment that the benefits of electrification efforts are societal in nature. Reducing greenhouse gas emissions is a benefit to all Connecticut residents, regardless of the fuels they use or the utilities that serve those fuels.
- Timing of decarbonization—An executive directive in Connecticut has specified that electric generation shift to be free of fossil fuels by 2040. Before that time, there may (and

probably will) be fossil fuel emissions associated with electricity used in homes. As a result, electrification of in-home appliances will not be fully free of fossil fuel emissions. Electrification may occur now, but the climate benefits will require the transition to non-carbon generation over time.

In addition, we note the following potential future data collection for information that would be available and useful to assesses, compute, or estimate as the program evolves:

- Market size and characteristics for gut rehabilitation of existing residential structures, including primary drivers leading to the projects.

Appendix D: Selected Program Requirements / Metrics

We offer here a partial list of metrics of interest to Energize Connecticut from some other leading programs that were able to provide them easily. We focused on information on costs, savings, incentive offerings, and participation. Please note that programs differ in how they define or gather all of these metrics; we have not standardized them but offer them here mostly for context.

Table 6: Selected Metrics Across Programs

Program	Incremental Costs	Savings	Incentive	Participation
MassSave			Core Incentive: $0.50/kWh + $50/MMBTU + $2,500 * savings percentage compared to industry standard Additional Incentives: -Feasibility Study: $5,000 -Energy Modeling: $500/unit max or max $20,000 -Pre-Certification: $500/unit -Certification: $2,500/unit -Net Performance Bonus: $0.75/kWh, $7.50/therm All-Electric Incentives (new): Range from $15,000 to $25,000 per single-family home depending on level; higher amounts for duplexes and higher occupancy buildings (up to $40,000 for the upper tier of 4-unit buildings).	6 builders
Passive House (CT)			NA	Single Family: 5 -Certified: 2 -Design Certified: 1

Program	Incremental Costs	Savings	Incentive	Participation
				-Submitted/Registered: 2
				Multifamily: 59 -Certified: 8 -Design Certified: 28 -Submitted/Registered: 28
ComEd SF All-Electric Residential New Construction	Minimum $3,540[i]	SF: 7,000 – 8,000 kWh MF: 4,000 – 5,000 kWh[ii]	<800 sf = $1,000 800-1,500 sf = $1,500 >1,500 sf = $2,000	11 homes (2020) 18 homes (2021) 60 homes (Goal for 2022)
PG&E ZNE Production Builder Pilot/Demonstration	$36,700[iii]	3-55% below builder's standard practice[iv]	Up to $15,000 in incremental costs	6 SF homes[v]
CA Statewide Energy-Smart Homes[vi]	None available[vii]	All-Electric: 2,317 MWh and 6,446 therms[viii]	All-Electric: -SF: $3,500 + $10/0.1 EDR Δ > 1.0[ix] -MF: $2,200 + $5/0.1 EDR Δ > 1.0[x]	All-Electric: -15 applications[xi] -target of 1011 new construction installations for 2023
		Mixed-Fuel: 7,928 MWh[xii]	Mixed-Fuel: -SF: $800 + $5/0.1 EDR Δ > 2.0[xiii]	Mixed-Fuel: -1 application[xv]

Program	Incremental Costs	Savings	Incentive	Participation
			-MF: $450 + $6/0.1 EDR Δ > 2.0[xiv]	-target of 150 for 2023
NYSERDA Buildings of Excellence	$0/sq ft - $105/sq ft or 0% - 25%[xvi]		Early-Design Support: -$250,000 Demonstration Projects: -$20/sq ft up to $1,000,000	Round 1: 28 Round 2: 14 Round 3: Launched April 2022
NYSERDA New Construction Housing			Single-Family and Multifamily Incentives: -$1,000/dwelling unit (up to $300,000/project) if 20% performance threshold is met -$2,500/dwelling unit (up to $500,000/project) if 30% performance threshold is met Additional Incentives: -$2/sq ft commercial space (up to $250,000) for carbon neutral ready and 15% source energy savings compared to ECCC -up to $25,000 reimbursement for designing carbon neutral or electrified solutions	

Program	Incremental Costs	Savings	Incentive	Participation
			-mentorship incentive of up to $200/dwelling unit or /1,000 sq.ft. of non-dwelling residential space (up to $10,000/project)	
NYSERDA SF Building Better Homes			Total Incentive up to $250,000/2 years -$20k/home design -Up to $100,000 in technical support/2 years -Up to 50% of marketing costs/2 years -$6K/model home -Add'l $5k/home designed for Passive House, ZER or Living Building Challenge certification -Add'l $2k for model homes built to Passive House (no cert) -Add'l $6.5k for model homes Passive House, DOE Zero Energy Ready, or Living Building Challenge	
NEEA Next Step Home (no longer running)		Goal: 30% savings compared to state code	NA	12 pilot homes (phase 1) 28 homes (phase 2) 79 homes (phase 3)

Table notes:

[i] For mechanical equipment only, does not include envelope costs

[ii] Savings above IECC 2018. Calculated (claimed) savings, not evaluated

[iii] Includes design, equipment, and installation. Incremental design costs were approximately $18,700. Incremental design and installation costs expected to be decreased in future projects.

[iv] Modeled savings, not evaluated

[v] Pilot program

[vi] Has alterations/Rehab Pathways and has three webinars and five lunch and learns with trades in 2022

[vii] New program (launched January 1, 2022)

[viii] Annualized first-year energy savings (gross) for 2022, modeled

[ix] Additional incentives available for alterations (incentives decrease for 2023-2025)

[x] Additional incentives available for alterations (incentives decrease for 2023-2025)

[xi] In 2022 and as of May. No completes yet.

[xii] Annualized first-year energy savings (gross) for 2022, modeled

[xiii] Additional incentives available for alterations

[xiv] Additional incentives available for alterations

[xv] In 2022 and as of May. No completes yet.

[xvi] Before incentives or tax credits, relative to NY's code in place at time of permit