Clean Energy Fund New Construction Program

Market Assessment and Single-Family Impact Evaluation – Year 1

Final Report

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Glossary of Key Terms

For purposes of this evaluation and the evaluated study period, key terms are defined as follows:

Advanced clean energy (ACE) building – any building built substantially above minimum code requirement. This would include all buildings that qualify for program participation: including but not limited to ENERGY STAR Homes and Multifamily, Passive House, Net Zero Energy performance.

Net Zero Energy (NZE) performance or building – an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy. Survey data was used to determine whether a property is NZE.

NZE-capable –buildings that incorporated clean energy and/or efficiency measures and have been estimated to have achieved Energy Use Intensity (EUI) reduction of more than 15%. This definition may not follow other, stricter definitions.

Standard building – in the New Construction Program, defined as a construction project built to meet the applicable minimum code requirements.

NYS – New York State.

NCP – New Construction Programs. NYSERDA past and current new construction programs include: Low-rise Residential New Construction Program, Multifamily New Construction Program, New Construction – Housing Program, Commercial New Constriction Program, the New Construction – Commercial Program, the Buildings of Excellence (BOE) Competition, the Carbon Neutral Community Economic Development Program, and the Net Zero Portfolio Support.

Integrated Design –a collaborative method that encourages the owner, developer, architect, and others on a project to engage at the beginning of the project and establish a process for guiding decision-making based on everyone's input. In more traditional delivery methods, such as design-bid-build, owners/developers engage with design and construction entities separately on a project.

Property – the sampling unit for the market assessment participant and non-participant surveys. It is a parcel of land owned by a single party and is typically a single-family home, or one or more similar buildings on a commercial or multifamily property.

Dwelling unit – a single unit providing complete independent living facilities (sleeping, eating, cooking, and sanitation) for one or more persons.

Single-family – a building with one to two dwelling units and townhomes.

Multifamily – a building with three or more dwelling units.

Period of interest 2016 to mid-2021 – this period corresponds to participating buildings with a status of Complete in project tracking from the inception of the program through mid-2021. These buildings overlap the nonparticipants buildings constructed from 2016 through 2019 per the Tax Parcel records.

Home Energy Rater (Rater) – certified individuals who provide modeling, verification, and testing to complete a Home Energy Rating on dwelling units. The Rater completes the Home Energy Rating in accordance with industry standards, most notably "Mortgage Industry National Home Energy Rating System Standards" and EPA's ENERGY STAR Certified Homes Program technical standards and requirements.

Ekotrope and REM/Rate – Ekotrope and REM/Rate are modeling software platforms used by home energy raters to perform home energy ratings and determine home-level impacts for program tracking purposes.

Participant – Any owner/developer and their design teams who had applied for funding or membership within one of the new construction subprograms included in the scope of this study.

Non-participant – Any owner/developer and their design teams who had not applied for funding or membership within one of the new construction subprograms included in the scope of this study. A stakeholder who applies for funding but whose application is cancelled or rejected is considered a participant and not a non-participant.

Low-to-Moderate Income (LMI) household – Low-income households are those that have incomes at or below 60% of the State Median Income (SMI). Moderate-income households are those with annual income between 60% and 80% of the SMI or the Area Median Income (AMI), whichever is greater.

Direct impacts – Direct impacts are defined as the impacts expected from projects directly funded by NYSERDA, either immediate or lagged.

Indirect impacts –Market effects that are expected to accrue over the longer term from follow-on market activity that results from NYSERDA's investments. Indirect impacts across NYSERDA initiatives may not be additive due to multiple initiatives operating within the same market sectors.

User Defined Reference or UDR Home – REM/Rate models use a UDR Home feature to create a reference home based on NYS code that is compared to the rated home to determine impacts.

2016 reference home – Ekotrope uses a reference home that reflects NYS code, which is compared to the rated home to determine impacts.

1 Introduction

This section presents a program description, the study goals, and a summary of the evaluation approach.

1.1 Program Description

The New Construction Team provides funding for commercial, low-rise residential, multifamily, and institutional customers that pay into the Systems Benefits Charge Program (SBC). Past and current programs in the market include: Low-rise Residential New Construction Program, Multifamily New Construction Program, New Construction – Housing Program, Commercial New Constriction Program, the New Construction – Commercial Program, the Buildings of Excellence (BOE) Competition, the Carbon Neutral Community Economic Development Program, and the Net Zero Portfolio Support. The New Construction Team also engaged in a significant number of other services that provide market support.[1] These subprograms aim to accelerate the market adoption of efficiency, electrification, energy storage, but also renewables, and electric vehicle charging infrastructure in new or substantially remodeled buildings. The overall goal of these programs is to move the market to pursue and ultimately achieve carbon-neutral or net zero energy performance one to three code cycles before such code requirements are adopted. The program portfolio is continuing to evolve its priorities and will pivot to better focus on future interventions at the project planning stages and adaptive reuse projects and other harder to decarbonize project types.

Owners or developers and their design teams can apply to NYSERDA for whole-building incentives in addition to targeted financial and technical support. The applicants are generally expected to include a NYSERDA-approved Primary Energy Consultant in their project team to act as the primary technical resource for their participation. Participants may use a consultant of their choice, subject to NYSERDA approval. The applicants in the New Construction Housing programs are also expected to select and comply with the third-party performance standard they intend to rely on to guide their project's design. NYSERDA accepts multiple third-party performance standards for housing projects, including: ENERGY STAR programs and Phius (Passive House Institute US) and Passive House Institute (PHI) standards.

Owners or developers of a large volume of construction projects can also receive the Carbon Neutral Portfolio Support, which includes technical support for the development of institutional protocols, performance standards, change management strategies, portfolio evaluation/benchmarking tools and protocols, and standardized designs, details, and specifications. Additional incentives or support are also

[1] PON 3609, PON 3717, PON 3716, RFP 3928, PON 3843, and PON 3771

available for new housing where dwelling units will be occupied by households with low to moderate incomes (that is, those earning no more than 80% of the State or area median annual income).

1.2 High-Level Approach Summary

Table 1-1 maps the study objectives to the data sources used to meet those objectives. In Table 1-1 and throughout this document, the Market and Impact Evaluation Team refers to organizations (i.e., owners/developers and their design teams) participating in the NCP as “participants” or “participating organizations.” Comparable groups not participating in the initiatives are referred to as “non-participants” or “non-participating organizations.”

Table 1-1. NCP study objectives, research questions, and data sources

Objectives	Primary Evaluation Question(s)	Data Sources
	Market Evaluation	
Calculate percent of trained building professionals (architects, engineers, etc.) knowledgeable about clean energy Integrated Designs	• Has the market participant taken part in a NYSERDA training offered as part of NCP? If no, why not? If yes, have they used their training on real live projects, and how? If so, what percentage of their projects is influenced by the training? • Does the market participant have adequate knowledge of the subject? • What are the remaining knowledge gaps in the industry?	73 participating and 87 non-participating architects, engineers, building developers, or owners via a self-reporting web-phone survey. 73 participants and 87 non-participants discussed a total of 89 and 87 properties, respectively. Secondary data, where applicable. ***See Section 3 for Methodology Details***
Determine incremental cost of building an advanced clean energy building (this would include all buildings that qualify for program participation, such as ENERGY STAR Homes to Passive House and NZE/CN performance) over a standard building	• Did the NZE project(s) utilize integrated design? If not, why not? • What is the average cost of building a NZE project with integrated design? • What is the average cost of technology solutions selected to develop NZE projects? • What is the average total cost of building a standard construction project? (Note that this cost information will likely not be highly specific in either web or phone surveys.) • What is the average difference in time it takes to design an advanced clean energy building over a standard building? • What is the average difference in time it takes to review an advanced clean energy building over a standard building? • What are the incremental costs of different solution sets?	
Determine percent of new construction in NYS using integrated design and construction practice and model measure packages outside of the program	• What is the total number of new construction projects in NY, by sector (residential, commercial, or multifamily)? • How many new construction projects are utilizing integrated design and construction practices to produce NZE buildings? • How many new construction projects are using integrated design and construction practices to produce NZE-capable buildings? • How many new construction projects are utilizing model measure packages outside of NYSERDA programs?	
Determine number of advanced clean energy buildings in NYS	• How many advanced clean energy housing units are in NYS? • How many advanced clean energy commercial buildings are in NYS? In what sectors (office, education, etc.), are there more clean energy commercial buildings in NYS?	Survey and secondary data referenced above
Assess prevalence of integrated design, advanced clean energy equipment and building	• What is the percent of all new construction specifications including integrated design practices?	Survey data referenced above

Objectives	Primary Evaluation Question(s)	Data Sources
practices in new building specifications	• What is the percent of all new construction specifications including advanced clean energy equipment and construction practices?	
Determine main drivers of market actors' decision-making process and choices as well as challenges in the development process (planning, construction, working with clients and trades on clean energy advanced buildings)	• What factors influence the inclusion of advanced clean energy measures in a project? • Are customers able to find qualified vendors and products to meet the NZE design spec? Do customers and vendors understand the difference between NZE and Net Zero Carbon? • If they are not building to NZE standard, do we know why? Even if they are building to NZE, what do they find most challenging? What are they still looking for assistance on? • Are customers ready to start tackling refrigerants and/or imbedded carbon issues? • What are the biggest challenges architects and engineers face during the development process?	Survey data referenced above
Determine level of planning activity cities and communities are undertaking and barriers communities face in reducing GHG emissions and achieving carbon neutrality, including level of involvement Economic Dev. Agencies have in outreach activities that pursue NZE performance	• What, if any, planning efforts are communities engaging in to reduce GHGs or to achieve carbon neutrality? What actions are communities taking to move the community to carbon neutrality? • What are the biggest challenges communities face in reducing GHG emissions? • What, if any, outreach activities are Economic Development Agencies engaging in to pursue net zero energy performance? • What level of awareness do Economic Development Agencies have of the benefits and costs of pursuing NZE performance? • Why do Economic Development Agencies choose not to promote NYSERDA program incentives for economic development projects? What are the biggest challenges for economic development projects in setting NZE or carbon neutrality goals?	Program partner (community and advocacy organizations, economic development agencies) interviews ***See Section 3 for Methodology Details***
Impact Evaluation		
Evaluate/verify gross energy impacts and realization rate	• What is the annualized evaluated gross energy savings based on electric (kWh) and fuel savings (MMBtu) at customer sites? • What is the ratio of the sum of evaluated savings divided by the sum of the program-reported savings?	Utility billing data, project modeling and other files ***See Section 3 for Methodology Details***

1.3 Market Evaluation Objectives

The market assessment study goal was to assess NYSERDA's testable hypotheses about the effectiveness of New Construction Team market intervention on new construction market capabilities in NYS. NYSERDA documented their hypotheses in the New Construction Logic Model shown in Figure 1-1 (i.e., the theory of how the program will affect the market)[2] and outlined the measurable indicators that would

[2] The logic model in the next figure and hypotheses were outlined in NYSERDA's Clean Energy Fund NCP Chapter, published prior to May 2022. Note that NYSERDA restructured the Clean Energy Fund Investment Plans into the Compiled Investment Plans (CIPs) in May 2022. Also note that NYSERDA updated the NCP logic model when the CIPwas filed. The updated

provide evidence of program effectiveness. The Market and Impact Evaluation Team conducted primary research to assess market indicators associated with the NCP outcomes noted in the logic model and will track those indicators over time.

Figure 1-1. The New Construction Program logic model

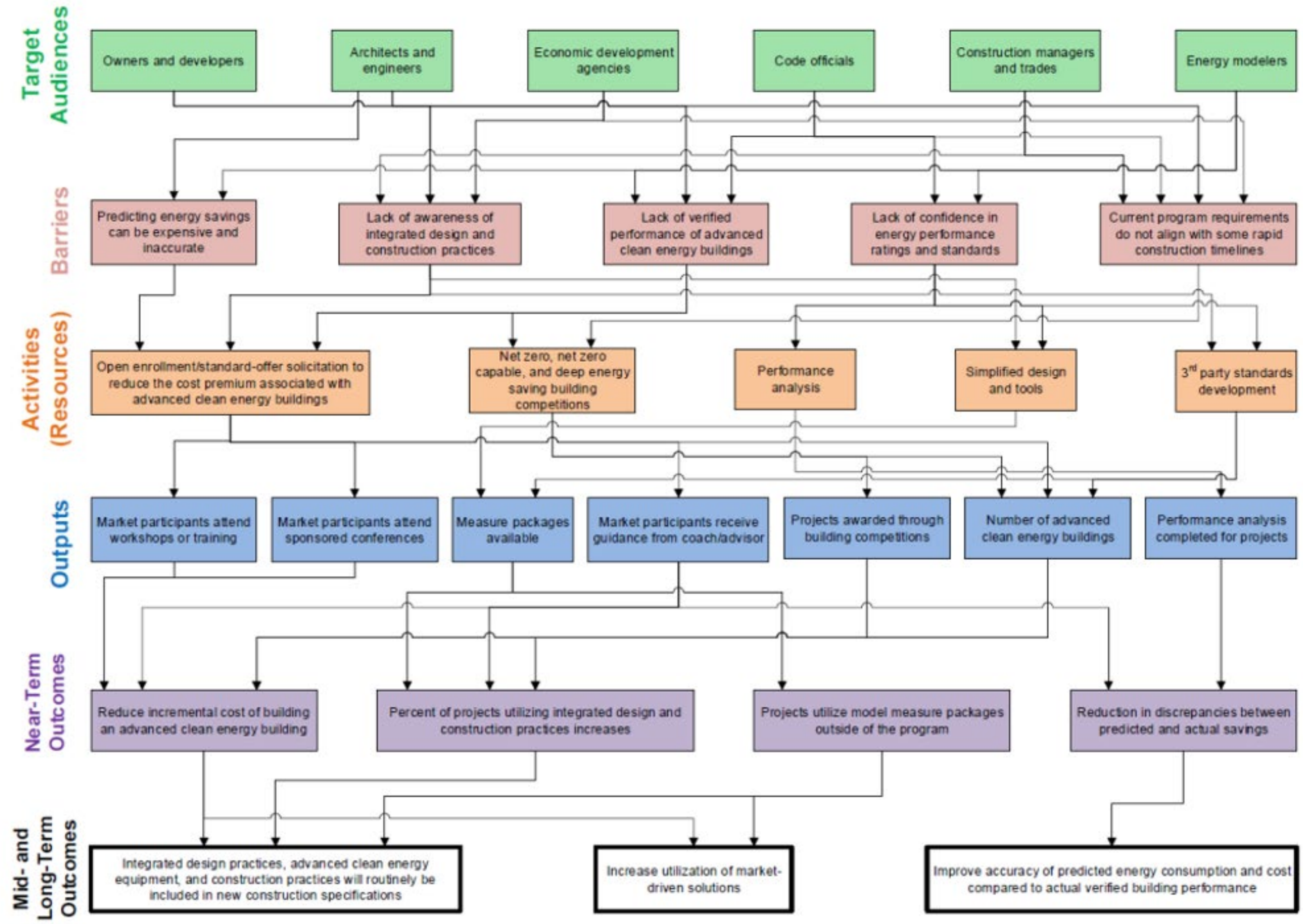


Table 1-2 summarizes all the indicators associated with the New Construction Team program outcomes outlined in the Clean Energy Fund (CEF) Investment Plan and the NCP logic model. The market study includes primary data collection and analysis for three of the outcome indicators, as shown in the table, and secondary data analysis to inform a few output[3] indicators that are tracked by the program.

logic model is not shown in this report because the logic model updates were made at the time the 2021-2022 NCP market evaluation was nearly concluded. That is, the prior version of the logic model, documented in the Clean Energy Fund NCP Chapter, reflects the hypothesized NCP effect on the market for the evaluated properties in this evaluation.

[3] Output indicators or metrics of program activities are typically not assessed by the evaluation but rather tracked by the program.

The market study also examines additional topics: 1) project development decision-making, including New Construction Team influence and barriers to building an ultra-efficient or clean energy building; 2) use of New Construction Team resources (e.g., training) designed to increase knowledge of clean energy construction practices; and 3) program experience (i.e., program satisfaction and suggestions for improvement).

Table 1-2. Clean Energy Fund New Construction Program metrics

	Market Indictor Metric	Source of Metric
Outputs	Number of housing units recognized through Buildings of Excellence competition	Program reported
	Number of advanced clean energy housing units in NYS	**Secondary research**
	Number of advanced clean energy commercial buildings in NYS	**Secondary research**
	Number of projects awarded through the Net Zero Energy/Carbon Competition	Program reported
	Number of participants attending workshops and trainings	Program reported
	Number of case studies developed and distributed	Program reported
	Number of model measure packages available	Activity postponed
	Number of projects that utilize coach/advisor	Program reported
	Number of projects that complete a Performance Analysis through the program	Program reported
	Number of attendees at sponsored conferences	Program reported
Outcomes	Incremental cost of building a Net Zero Energy building over standard construction practices	**Primary Research** - Participant and non-participant owner/developer surveys
	Percent market penetration of projects utilizing integrated design and construction practices to achieve Net Zero Energy and Carbon Neutral performance	**Primary Research** - Participant and non-participant owner/developer and design professional surveys
	Projects that utilize model measure packages outside of the program (Note that the model measure package component of the program has not yet been implemented)	**Primary Research** - Non-participant owner/developer surveys and design professional surveys
	Discrepancies between predicted and actual savings	**Impact analysis**

1.4 Impact Evaluation Objectives

As noted earlier, the incentives and technical support offered as part of the New Construction Team programs span several sectors (multifamily, single-family, commercial, and institutional). While all these sectors will receive an impact evaluation, single-family is the focus of the impact effort undertaken in this phase of work. There are two primary objectives for the Single-Family Residential New Construction Impact Study. They are:

- **To evaluate Verified Gross Energy Savings (VGS).** VGS is the annualized evaluated gross energy savings based on electric (kWh) and fuel savings (MMBtu) at customer sites.
- **To calculate a Verified Gross Savings realization rate (VGSRR).** VGSRR is the ratio of the sum of evaluated savings divided by the sum of the program-reported savings.

Note that the VGSRR provided in this report is relative to the official Scorecard savings submitted by NYSERDA for the projects in the population used in this study.

2 Results, Key Findings, and Recommendations

2.1 Market Assessment

This section presents findings relevant to market indicators that suggest New Construction Team program effectiveness. For most analyses and results reported in the subsequent sections, the Market and Impact Evaluation Team used the property as the unit of analysis. Property refers to a parcel of land and it is a proxy for a new building or a home. Section 3 documents the approach the Market and Impact Evaluation Team used to identify properties. Table 2-1 denotes the number of completed surveys on newly built properties by sector and group. Participant properties examined were constructed from 2016 through mid-2021, per NYSERDA records. Non-participant properties examined were listed as built from 2016 through 2019 in the Tax Parcel data.[4]

Note that most participant properties were accounted for in the Tax Parcel data, however with an earlier construction completion date. Since the NCP requires additional activity (inspections and paperwork) after construction is complete, it is not surprising that the NCP completion dates lag the Tax Parcel data completion dates (see Section 6.1.2 for more details). Most participant properties mapped to Tax Parcel data show dates between 2016 and 2019. Thus, these years have been selected for the non-participant Tax Parcel sample frame ensuring the actual construction vintage of participant and non-participant properties are the same.

Table 2-1. Number of surveys on properties by sector and respondent type

Respondent Type	Single-family	Multifamily	Commercial
Participants (Property surveys from)			
Owner/Developers	29	24	9
Design Professionals	9	7	2
Both Owner/Developers & Design Professionals Discussed the Property	3	4	2
Total	**41**	**35**	**13**
Non-participants (Property surveys from)			
Owner/Developers	12	16	15
Design Professionals	8	20	11
Unclear if Owner/Developers or Design Professional	2	1	2
Total	**22**	**37**	**28**

[4] http://gis.ny.gov/parcels/ The TPD is a product of the Statewide Parcel Map Program, whose mission is to "collect, assemble, maintain, and provide access to statewide tax parcel GIS data." The dataset accounts for every property in New York with fields describing key parameters such as address, owner, year built, land area, building area, and sector. Parcel data updates are dependent on individual communities updating the statewide data as property ownership, build status, and other parameters change.

For a few analyses, the unit of analysis was the organization, which the Market and Impact Evaluation Team referenced where applicable in subsequent sections. Where applicable, the Market and Impact Evaluation Team also integrated feedback from the interviewed program partner organizations. Last, the Market and Impact Evaluation Team had limited data on LMI single-family project properties and multifamily non-LMI project properties; thus, could not compare results by LMI status.

2.1.1 Measures Installed in Buildings

Since the measure-level data is not tracked in the program tracking data, the survey collected information on the efficient and clean energy measures incorporated in the properties by participating owners/developers and their design teams to confirm the program is incenting advanced clean energy new buildings and to allow for a direct comparison with non-participants.

The responders to the survey were asked to identify advanced clean energy measures that were "ultra" efficient. The introduction was as follows:

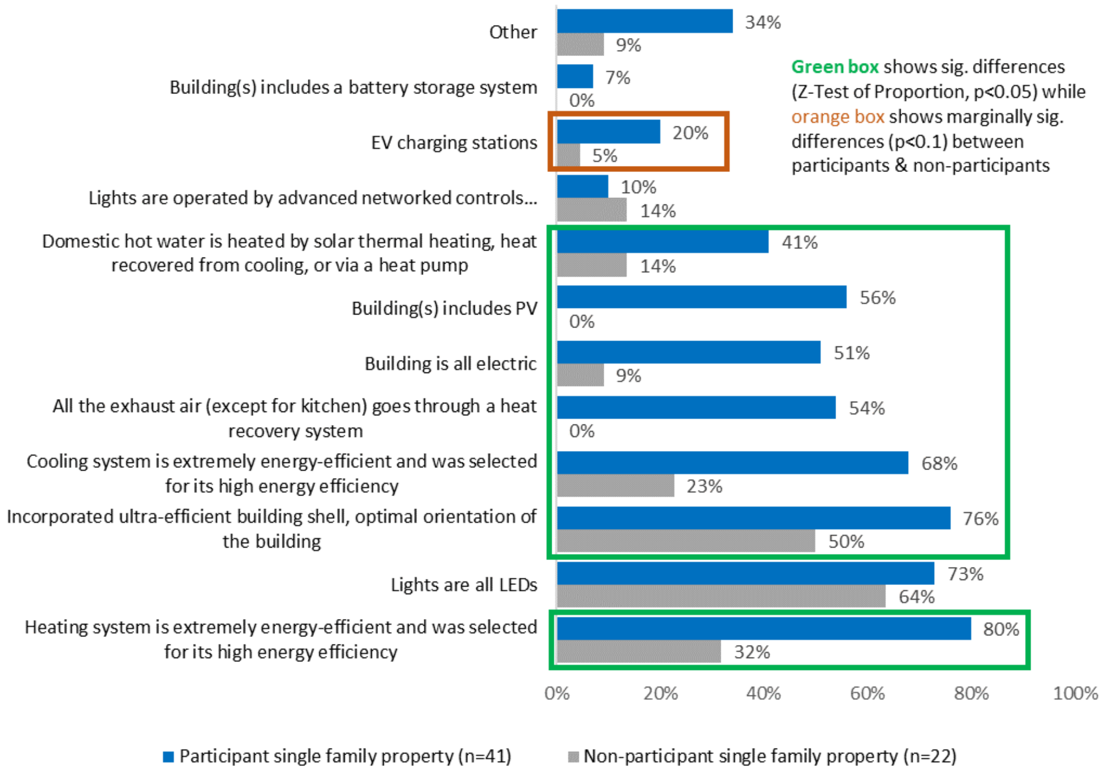
> *Does the building(s) at [SITENAME1/2] incorporate any ultra-energy efficient or other features that made the building(s) use much less energy than a typical building built to code? Please review the following list and check all that apply.*

This question was followed by a set of twelve measure categories that were each clarified with a definition and/or examples of what was meant by ultra-efficient. The measure descriptions are summarized in the figures presented in this section and the full wording can be reviewed in Appendix B in the owner and developer survey instrument. The intention was to distinguish advanced clean energy measures from marginally better technologies.

2.1.1.1 *Single-Family*

The single-family participant properties were incorporating more clean energy and/or energy efficiency measures than non-participant properties. The Market and Impact Evaluation Team examined multiple metrics to ascertain whether participants incorporated more clean energy and/or efficiency measures compared to non-participants. Figure 2-1 shows types of measures the participants were significantly more likely than non-participants to incorporate into their properties.

Figure 2-1. Reported measures (unit of analysis=single-family property)



The Market and Impact Evaluation Team asked owners or developers or their design teams whether they incorporated an extremely energy-efficient heating or cooling system into the property. The Market and Impact Evaluation Team then asked those noting such measures to describe the measure for independent assessment of whether the measure was indeed "extremely energy efficient". Participants described the heating or cooling in single-family properties as: air source heat pump (8 responses), mini split heat pump (6 responses), unspecified heat pump (4 responses), high-efficient furnaces (4 responses), geothermal heat pump (2 responses), and highly efficient boilers (1 response). Non-participants described the heating or cooling in single-family properties as: highly efficient furnaces (3 responses), ultra-efficient boilers (1 response), split system condenser and air handlers (1 response), variable refrigerant flow (1 response), and high-efficient computer operated central air with zone dampers (1 response).

Among those who reported incorporating an extremely energy-efficient heating or cooling system into a single-family property, significantly more participants (61%) reported installing a heat pump system than non-participants (14%;[5] Z-Test of Proportions significant, $p<0.05$).

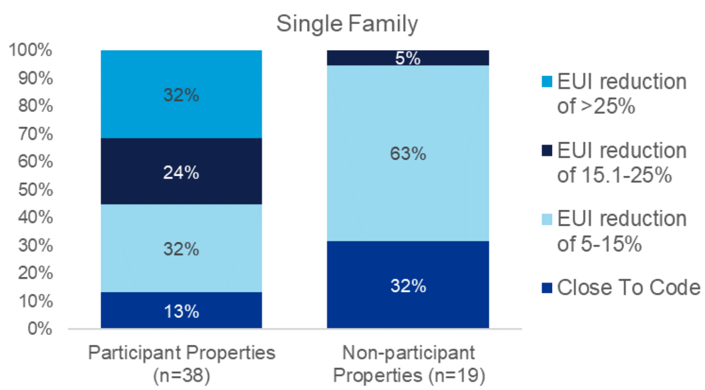
[5] Counted reported variable refrigerant flow system as a heat pump technology.

The Market and Impact Evaluation Team also reviewed the survey responses referenced in Figure 2-1 together with the open-ended descriptions for heating, cooling, and measures reported under the "other" category. This analysis resulted in the development of a performance tier metric. To develop this metric, the Market and Impact Evaluation Team used the Department of Energy (DOE) Energy Use Intensity (EUI) data by building type to estimate property EUI reduction based on measure specific responses to bin properties into these four tiers (see Section 3 for more detail).

1. EUI reduction of <5% ("Close to code" tier)
2. EUI reduction of 5.0-15%
3. EUI reduction of 15.1-25%
4. EUI reduction of >25%

More participant than non-participant properties were in the EUI reduction of 15.1%-25% and greater than 25% tiers, which indicates that participating single-family new construction properties appear to be built considerably above code than non-participating properties (Figure 2-2, Chi-square Test significant at $p<0.05$).

Figure 2-2. Distribution of properties by performance tier metric (unit of analysis=property)*



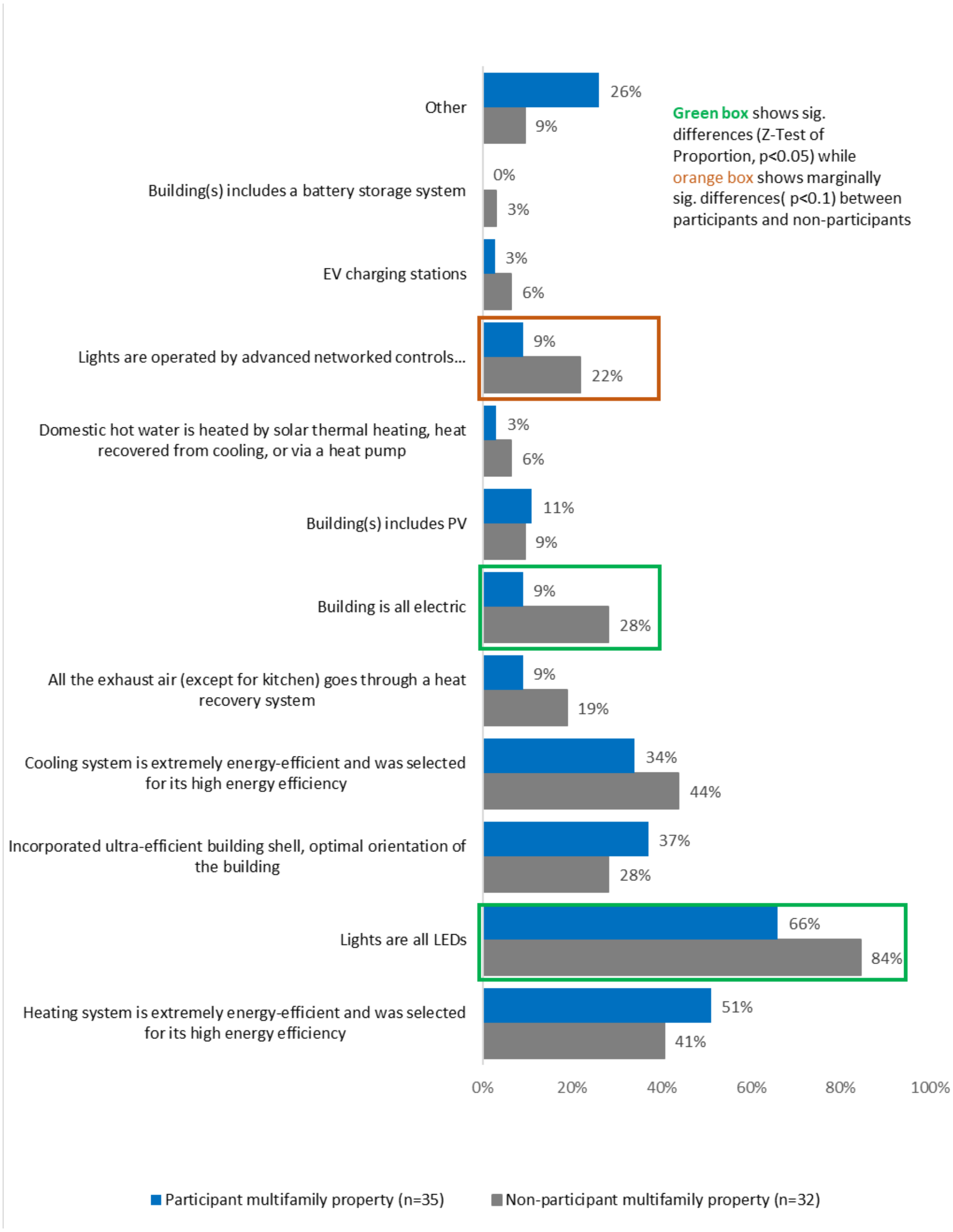
* Don't Know responses excluded.

As noted previously, the reported clean energy and energy efficiency measure data is the key input for the performance tier metric. The respondent recall of types of measures incorporated into a property may not be completely accurate, especially on properties that were completed a long time ago (e.g., in 2016). This recall bias affects both participant and non-participant property samples.

2.1.1.2 *Multifamily*

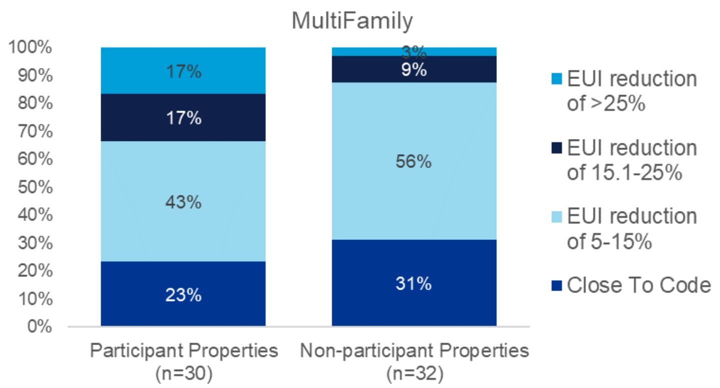
At first glance, the clean energy and/or energy efficiency measure adoption by multifamily participants and non-participants appears to be similar, except for a couple of measures (Figure 2-3).

Figure 2-3. Reported measures (unit of analysis=multifamily property)



Further analysis revealed that participating multifamily properties appeared to be more efficient than non-participating properties. The Market and Impact Evaluation Team reviewed the survey responses referenced in Figure 2-3 together with the open-ended descriptions for heating, cooling, and measures reported under the "other" category. As explained in Section 2.1.1.1, this expanded assessment of reported measures resulted in the development of a performance tier metric. Figure 2-4 shows the distribution of multifamily properties that were binned in each performance tier (see Section 3.1.1. for an expanded description of the tiers). More participant than non-participant properties were in the EUI reduction of 15.1-25% and greater than 25% tiers (Z-Test of Proportion, $p<0.05$).

Figure 2-4. Distribution of properties by performance tier metric (unit of analysis=property)*



* Don't Know responses excluded.

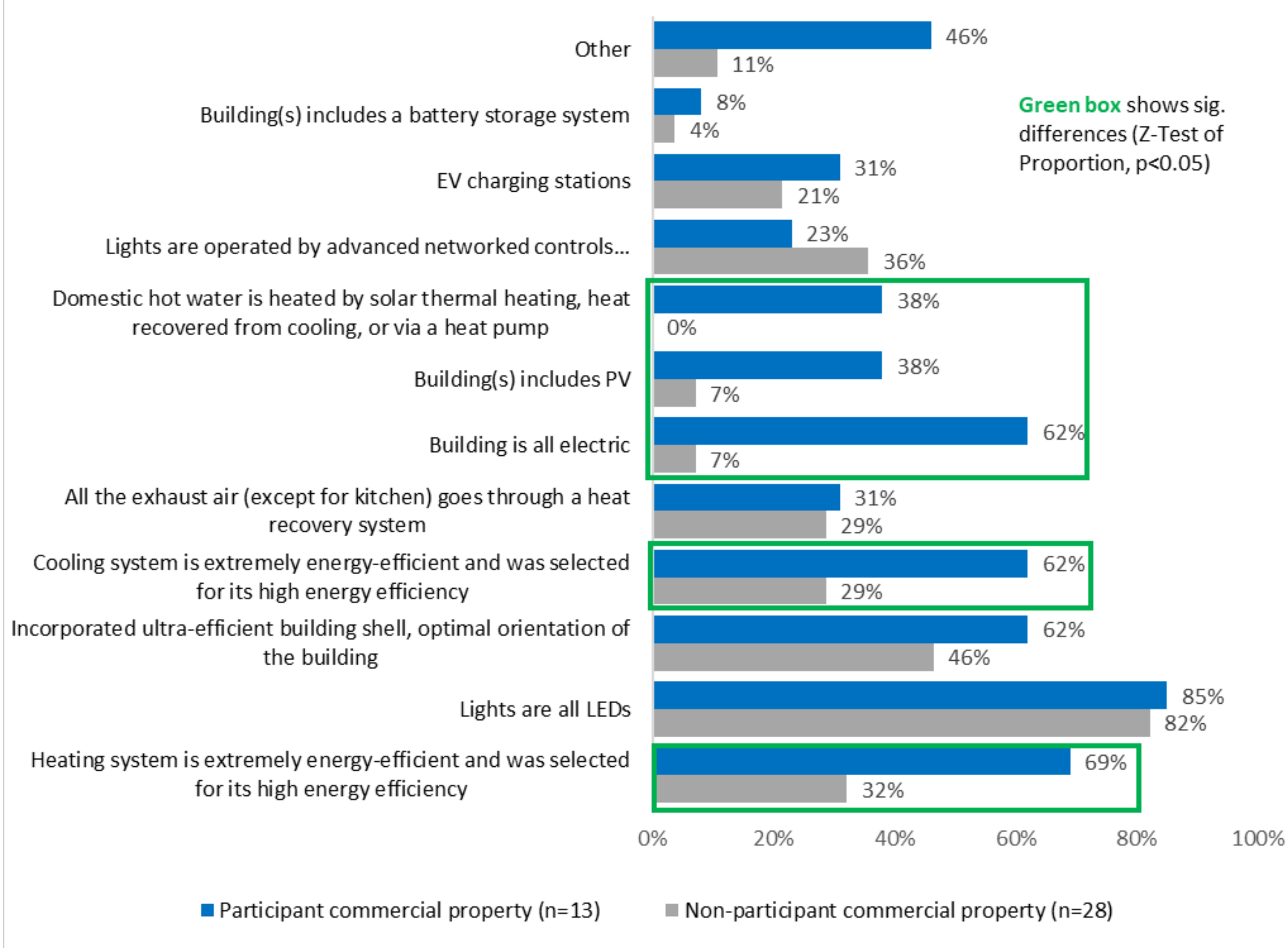
The respondents provided open-ended responses describing the heating and cooling system they selected for the project. Participating owners, developers, or design professionals described the heating/cooling in the multifamily properties as: high-efficient furnace (8 responses), unspecified heat pump (3 responses), air source heat pump (1 response), and geothermal heat pump (1 response). Two respondents discussed a water heater rather than a space heating or cooling system. Non-participants described the heating/cooling in the multifamily properties as: heat pumps (8 responses), split units (2 responses), variable refrigerant flow (VRF) system (1 response), and geothermal heating and cooling (1 response). Two responses were unclear.

As expected, most non-participant (83%) and participant (63%) multifamily properties were sub-metered.

2.1.1.3 *Commercial*

The commercial participant properties were incorporating more clean energy and/or energy efficiency measures than non-participant properties. Figure 2-5 shows which measures the participants were significantly more likely than non-participants to incorporate into commercial properties.

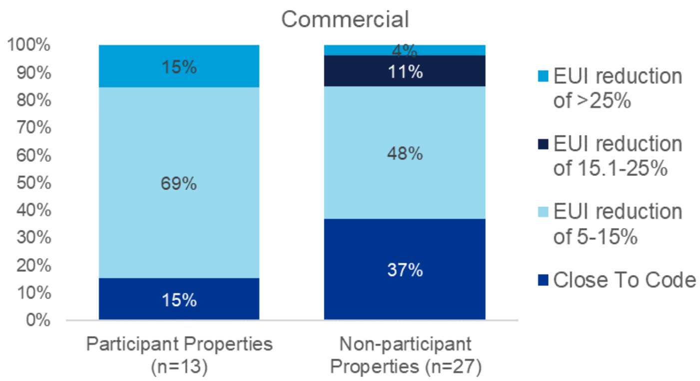
Figure 2-5. Reported measures (unit of analysis=commercial property)



Those who noted incorporating an extremely efficient heating and/or cooling system into a property described the system(s). Participating owners, developers, or design professionals described the commercial heating and/or cooling system(s) as: geothermal heat pumps (2 responses), water source heat pumps (1 response), air source heat pumps (1 response), and high-efficient boilers (1 response). Non-participating owners, developers, or design professionals described the commercial heating and/or cooling systems as: heat pump technology (4 responses), variable refrigerant flow (VRF) or volume (VRV) systems (3 responses), highly efficient furnaces (2 responses), ice storage for cooling, and individual condenser units for HVAC (1 response each).

Additional analysis revealed that participating commercial properties appeared to be more efficient than non-participating properties. The Market and Impact Evaluation Team reviewed survey responses referenced in the graphic above together with the open-ended descriptions for heating, cooling, and measures reported under the "other" category. As noted previously, this expanded assessment of reported measures resulted in a development of a performance tier metric. Figure 2-6 shows the distribution of commercial properties that were binned in each performance tier (see Section 3.1.1. for an expanded description of the tiers). More participant than non-participant properties were in the EUI reduction of greater than 25% tier, the highest identified efficiency/clean energy performance tier (Z-Test of Proportion marginally significant, p=0.08).

Figure 2-6. Distribution of properties by performance tier metric (unit of analysis=property)*



* Don't Know responses excluded.

A minority of participant (31%) and non-participant (25%) commercial properties were sub-metered.

2.1.2 Integrated Design

To inform the market indicator in the NCP logic model titled "percent of projects utilizing integrated design and construction practices to achieve NZE and NZE-capable performance," the owner/developer and design professional survey collected information on whether integrated design was used to design and build a property(ies) the Market and Impact Evaluation Team inquired about.

2.1.2.1 *Properties Using Integrated Design and Construction Practices*

NYSERDA NCP program staff leverages the American Institute of Architects' or AIA's guidelines for integrated design. AIA describes integrated design as an Integrated Project Delivery (IPD) approach. IPD is a collaborative method that encourages the owner, developer, architect, and others on a project to prioritize the best interests of a project rather than their individual goals. IPD engages all parties at the beginning of the project and establishes a process for guiding decision-making based on everyone's input. In more traditional delivery methods, such as design-bid-build, owners/developers engage with design and construction entities separately on a project.

Integrated design is not standard practice, and the term "integrated design" is not consistently understood or defined in the market. To estimate the percent of properties that used integrated design or IPD, participating and non-participating owners/developers were asked to report on if they used the following practices on their property(ies):

1. Engaged all key project stakeholders, including building owners, designers, energy modelers/consultants and builders at the beginning of the project planning (a key IPD feature)
2. Established a clear decision-making process to guide key project decisions that enabled participation from all stakeholders (a key IPD feature)
3. Achieved Passive House certification, submitting project as early in the design process as possible to allow time for full design consultation during the design stage to ensure certification (Passive House certification process embodies IPD principles)
4. Used a "Design Build" delivery model for the project where the design firm/team also is responsible for construction (encourages IPD because one entity—the design-build team—works under a single contract with the project owner)
5. Design drawings were prepared prior to selecting the builder team, commonly referred to as the "Design-Bid-Build" approach (traditional construction delivery approach)

To determine who used the IPD method, the Market and Impact Evaluation Team used the following approach to bin those using the IPD.

- If practice #5 referenced above (Design-Bid-Build approach) was solely noted/selected, the Market and Impact Evaluation Team interpreted that response as "Not relying on the IPD."
- If practice #5 referenced above (Design-Bid-Build approach) was noted/selected together with practices #1, #2, or #3 referenced above, the Market and Impact Evaluation Team flagged those responses as "Likely used some aspects of IPD practices."
- If practices #1, #2, or #3 referenced above were noted/selected and practice #5 was not selected, the Market and Impact Evaluation Team flagged those responses as "Likely used IPD practices."
- If option #4 was noted/selected and no other options were noted, or if the answer was "Don't Know" or missing, the Market and Impact Evaluation Team flagged those responses as "Not enough information to determine if IPD principles were used." Similarly, if "other" response was given and that response could not be categorized into any of the five practices referenced above, the Market and Impact Evaluation Team flagged those responses as "Not enough information to determine if IPD principles were used."

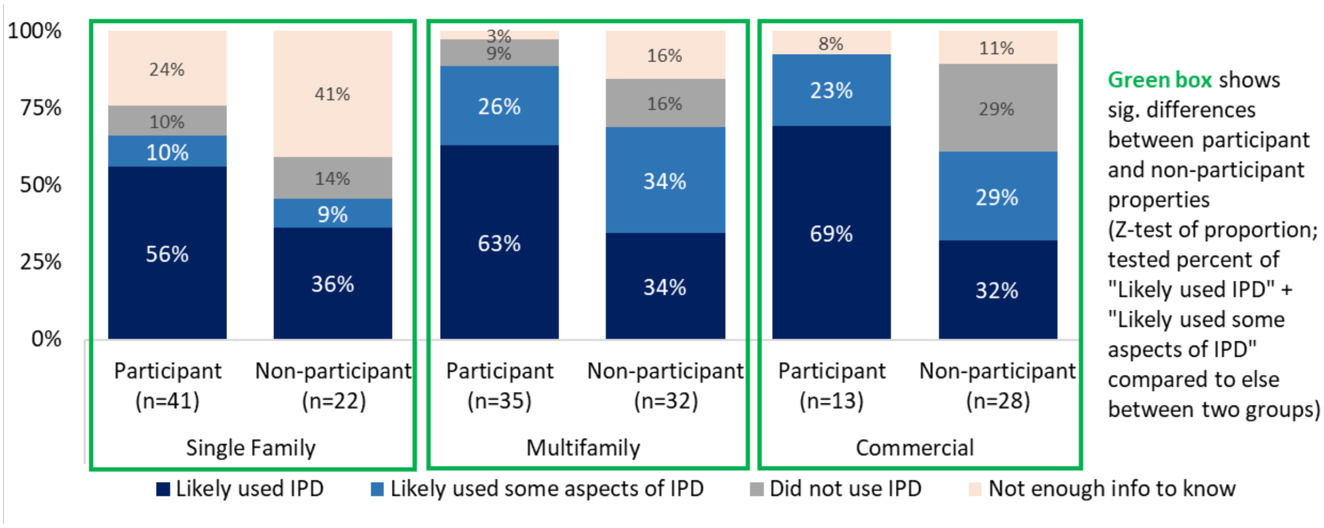
The survey responses revealed that stakeholders of participant properties in all sectors relied on IPD practices more than the stakeholders of non-participant properties (Figure 2-7).

Note that the participant properties are a small percentage (less than 5%) of new construction projects in the market.[6] That is, the non-participant sample reflects the NYS new construction market.

[6] Single-family, multifamily, and commercial participant properties comprise 5%, 2%, and 1% of total new construction in NYS, respectively (and about 4% of the total new construction square footage in NYS). The Market and Impact Evaluation Team leveraged Tax Parcel and mapped participant properties to this data to derive these estimates. Also note that the participant

Also note that multifamily non-participant properties covered most of newly constructed square footage in NYS (62%), followed by commercial properties (26% of newly built square footage) and then single-family (12% of newly built square footage). See Appendix A for more details.

Figure 2-7. Properties using IPD principles by sector (unit of analysis = property)



The Market and Impact Evaluation Team asked design professionals involved with both participant and non-participant properties additional questions on integrated design to assess whether the proportion of non-participant properties using IPD (see Figure 2-7) might be an overestimate. Design professionals discussing non-participating projects (n=29) reported a low level of awareness of integrated design. About 38% reported being aware of integrated design, and among those that were aware, about one-third reported receiving training on integrated design. This means that only 7% of surveyed non-participating design professionals received training on integrated design. However, for participant design professionals, 59% of respondents (n=17) reported being aware of integrated design. Of those, 30% said a member of their firm received training on integrated design. This means that approximately 15% of surveyed participating design professionals received training on integrated design.

When asked what type of contracting leads to the incorporation of more ultra-efficient features in a build, more than half of non-participant respondents noted that direct employment or being under retainage with the owner led to the inclusion of more ultra-efficient features (Table 2-2). Note that it is possible that direct employment or under retainage with the owner leverages integrated design or some aspects of it.

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property sample is heavily skewed toward upstate NYS (as expected because 90+% of 2016 to mid-2021 participant properties were in upstate NYS) while the non-participant sample reflects both the upstate and downstate new construction.

Table 2-2. Contracting that encourages energy efficient build (unit of analysis=design professional organizations)

Thinking about ultra-efficient features of projects your firm has completed in the 2019 and 2020 in your opinion, what type of contracting agreement leads to the installation of more ultra-efficient features in a build?	Percent Reporting (n=29)
Direct employment or under retainage with the owner	55%
Joint owner, design team, & contractor agreement, also called integrated design	21%
Design-Bid-Build	17%
Design-Build	3%
Other	3%

Design professionals estimated that on average, 69% of built interior space that they worked on was through direct employment or under retainage with the owner (Table 2-3). Note that these metrics are based on respondents discussing all their projects in 2019 and 2020 whereas the findings in Figure 2-7 illustrate responses on integrated design that are specific to actual projects the Market and Impact Team inquired about. The recall is generally better when focus is on a specific project rather than on many projects.

Table 2-3. Contracting structure (unit of analysis=design professional organizations)

Considering the volume of work your firm has conducted in 2019 and 2020 and the contracting mechanisms under which your firm conducted this work, can you approximate the % of interior space where each contracting method applied?	Mean Percent (n=29)
Direct employment or under retainage with the owner	69%
Design-Bid-Build	23%
Joint owner, design team, & contractor agreement, also called integrated design	8%
Design-Build	1%

Three interviewed partners commented on integrated design. One was un-familiar with the concept. Another said the market is moving toward a more full-service type of design and build firm offering. The third noted they are not explicitly promoting the concept.

2.1.2.2 *NZE Properties Using Integrated Design and Construction Practices*

These results should be interpreted with caution due to the small number of NZE self-reported properties in the participant and non-participant samples.

The Market and Impact Evaluation Team explored how many participant and non-participant properties were using IPD or NZE buildings specifically. To identify NZE properties, the Market and Impact Evaluation Team asked participating and non-participating owners/developers and design professionals to estimate how much less energy the property in question uses than a built-to-code home/building development. Reporting 0% would mean there is no difference in property building energy usage compared to the typical built-to-code building(s), whereas 100% would mean the property has zero net energy use (i.e., it produces the amount of energy that it uses). The Market and Impact Evaluation Team leveraged these responses to identify NZE properties in both participant and non-participant samples.

About 10% (or 9 out of 89) participant properties were identified as NZE. Seven were single-family, one was a multifamily property, and one was a commercial development. Nearly all (six of seven) single-family NZE properties leveraged integrated design or IPD. The one NZE multifamily and the one commercial property also leveraged the IPD.

No non-participant properties were identified as NZE.[7]

2.1.2.3 *NZE-Capable Properties Using Integrated Design and Construction Practices*

The Market and Impact Evaluation Team also examined respondents' IPD responses on NZE-capable building properties. NZE-capable buildings are built substantially above code. The Market and Impact Evaluation Team considered NZE-capable buildings to be those properties that were binned into the EUI reduction of 15.1% or more tiers (discussed previously) and not identified as NZE. This definition may not follow other, stricter definitions.

About 31% (or 28 out of 89) participant and 11% (or 9 out of 82) non-participant properties were identified as NZE-capable. All of these participant and non-participant NZE-capable properties leveraged IPD or some aspects of IPD.

The Market and Impact Evaluation Team combined participant and non-participant NZE and NZE-capable integrated design responses to estimate the percent of NZE/NZE-capable properties that used integrated design. The Market and Impact Evaluation Team extrapolated the estimate to the population and weighted it by sector and participant/non-participant market share to ensure: 1) property distribution by sector is accounted for and 2) participant responses are weighted down since they account for a small proportion of the overall properties in the market. This analysis revealed that 8% of properties in the market are NZE/NZE-capable and have leveraged integrated design or some aspects of integrated design.

2.1.3 Incremental Cost

To be able to inform the market indicator in the NCP logic model titled "reduction in incremental cost of building a NZE building over standard construction practice," the survey collected information on the incremental cost of high-efficiency construction for properties, including NZE and non-NZE properties. The survey instructed respondents to not consider incentives from NYSERDA, utilities, or government agencies when providing the incremental cost estimate. The Market and Impact Evaluation Team examined responses from only the non-participant properties where respondents reported they

[7] One respondent said that their property was NZE; however, they did not indicate installing a PV system. Thus, the Market and Impact Evaluation Team considered that response questionable and selected to not count it as an NZE home.

incorporated clean energy and/or energy efficiency measures. Participant properties had to incorporate clean energy and/or energy efficiency measures to participate in NCP. Note that the Market and Impact Evaluation Team provides incremental cost estimates across all properties that incorporated clean energy and/or energy efficiency measures by sector (or buildings built above code). The small number of NZE properties in the participant (9 properties) and non-participant (zero properties) samples were not sufficient to provide reliable estimates of incremental cost for the NZE property segment of the population.

As expected, the survey responses indicate that participant and non-participant properties that incorporated clean energy and/or energy efficiency measures were more expensive than similar developments built as minimally code compliant (Table 2-4). Although non-participants reported an average lower incremental cost of high-efficiency construction for the single-family and multifamily sectors and a higher incremental cost for the commercial sector relative to their corresponding participant sectors, those differences were not statistically significant.

The range in total construction costs was progressively variable between single-family, multifamily, and commercial properties. This is expected since single-family homes are more similar in size, function, and construction methods across study groups. Multifamily and commercial buildings include an enormous range in size, cost, functions (such as storage to hospitals or different mixed-use elements for multifamily), and construction methods. Non-participants reported greater costs for single- and multifamily properties but lower costs for commercial properties relative to the participant sectors.

Table 2-4. Construction cost (unit of analysis=property)

Source: Participant & Non-participant Survey	Groups	Single-family	Multifamily	Commercial
Average property construction cost, excluding land purchase & demolition	Participants	$460,448 (n=41)	$11,492,400 (n=35)	$25,757,513 (n=13)
	Non-participants	$677,662 (n=22)	$20,522,429 (n=32)	$19,691,342 (n=28)
Range of construction costs reported[a]	Participants	$93k to $1.8 million per home	$1 million to $79.4 million per property	$200k to $170 million per property
	Non-participants	$234k to $2 million per home	$500k to $169 million per property	$280k to $343 million per property
Average percent change - property cost compared to a similar construction if it was built as minimally code compliant, excluding land purchase, demolition, incentives & considering equipment cost trade-offs	Participants	9% more, on average, weighted by total $ spent on the property (n=26)	11% more, on average, weighted by total $ spent on the property (n=16)	11% more, on average, weighted by total $ spent on the property (n=10, Limited data)
	Non-participants	4.3% more, on average, weighted by total $ spent on the property (n=14)	5.3% more, on average, weighted by total $ spent on the property (n=29)	13.3% more, on average, weighted by total $ spent on the property (n=24)

[a] Imputed missing property cost data using mean cost per square foot by sector and reported property square footage.

2.1.3.1 *Drivers of Incremental Cost by Sector*

A regression analysis was conducted to assess drivers of incremental cost. The regression analysis leveraged both the participant and non-participant incremental cost responses (a total of 119 data points). The incremental cost was the dependent variable in the regression analysis. It was expressed as incremental cost (in percentage terms) per square foot.

Results show one significant predictor of incremental cost (Table 2-5). As properties are binned in higher EUI reduction tiers (from 0-5% to >25% EUI reduction tiers), incremental cost (in percentage terms) per square foot increases. This pattern remains when controlling for sector and if participant or non-participants predictors are included in the model.

Table 2-5. Additional incremental cost per square foot analysis (property data)

Variables	Description	Standardized Coefficient (β)
Group	1=participant and 0=non-participant	0.118
Sector	Multifamily (SF=0, Commercial=0, MF=1) (Reference case is SF, or compared to SF)	0.098
	Commercial (SF=0, Commercial=1, MF=0) (Compared to SF)	0.143
Performance Tier	Scale variable where 1=0-5% EUI reduction, 2=5-15% EUI reduction, 3=15-25% EUI reduction and 4=>25% EUI reduction.	0.204 [a]

[a] Significant at $p<0.05$

Both participants and non-participants could opt and did opt for different energy-efficient or clean-energy solutions when designing and building the properties. To explore the nuances of those solutions (to the extent possible), the Market and Impact Evaluation Team looked at the open-end responses on efficient heating and cooling incorporated into a property. The results of this inquiry shown in the Table below illustrate:

1. Participants opted for air source heat pumps and geothermal options more than non-participants.
2. Non-participants more so than participants opted for variable refrigerant flow or volume systems.

Additionally, about half of respondents who reported incorporating a highly efficient system in a property selected a heat pump technology (see data in Table 2-6). The participants and non-participants who selected a heat pump technology for the properties the Market and Impact Evaluation Team inquired about reported that the heat pump technology cost about 10% and 26% more, respectively, than a minimally code compliant equivalent on average.[8] These participant and non-participant average incremental costs (in percentage terms) were significantly different (T-Test significant at $p<0.05$). Non-

[8] The Market and Impact Evaluation Team weighted the incremental percent responses by the size of the build (i.e., square feet).

participants, as noted previously and shown in Table 2-6, generally adopted variable refrigerant flow or volume more than participants, while participants adopted air source heat pump and geothermal systems more.

Note that other than the HVAC and shell measure (which are further discussed in the subsequent section), the Market and Impact Evaluation Team had no other nuanced information on the measures for the properties inquired about. Thus, the Market and Impact Evaluation Team could not assess in more detail the incremental cost by measure to ascertain how cost of different measures (when combined) in a project impacts the total project incremental cost.

Also note that the surveys did not inquire as to whether the heat pump systems were providing cooling only or cooling and heating, an important distinction for assessing building efficiency.

Table 2-6. Heating and cooling open-ended codes by respondent group

Observations	Heating and cooling system type code based on open-ended responses of those who said they incorporated a highly efficient heating or cooling	Participants (n=32)	Non-participants (n=30)
		% who incorporated	% who incorporated
Non-participants chose these solutions more	Ductless mini split heat pumps	13%	20%
	Variable refrigerant flow or volume	0% [b]	20% [b]
	PTAC unit	0%	3%
	Multiple technologies (traditional + heat pump or unique solution like ice storage plant)	4%	13%
Participants chose these solutions more	Air source heat pump	19% [b]	3% [b]
	Water source heat pump	2%	0%
	Heat pump without specifying the type	13%	10%
	Geothermal system	13% [a]	3% [a]
	Furnace or boiler (various solutions: hot air split condenser/air handler, condensing gas, tankless-radiant floor heat, etc.)	29%	20%
Non-participants gave this response more	Offered generic answer (ENERGY STAR, highest efficiency equipment, etc.)	8%	17%

[a] Marginally significant at $p<0.1$, Z-Test of Proportion

[b] Significant at $p<0.05$, Z-Test of Proportion

2.1.3.2 *Incremental Cost of Heating/Cooling and Shell Solutions*

Additional analysis revealed that projects that included an ultra-efficient shell in its design was more expensive than a minimally code compliant building shell, on average (Table 2-7). It is no surprise to see high incremental cost for the ultraefficient shell measures, even after weighting by building size. An interviewed partner contact noted that material cost for ultra-efficient shell (defined as: ultra-efficient building shell, e.g., substantially better than code insulation, Low-E or triple-paned windows, optimal orientation of the building) is much higher than if building per minimum code requirements.

Also note that participants reported on average significantly lower incremental cost for ultra-efficient shell and highly efficient HVAC systems in their properties than non-participants (Two Independent Samples Z Statistic Test significant at $p<0.05$). The Market and Impact Evaluation Team did not inquire about the average total cost of shell and HVAC solutions in the survey. The New Construction Team has made a substantial effort however to work with recipients of the Buildings of Excellence program awards and has published and regularly updates incremental cost as reported by project teams for key measures. That information is available at: https://www.nyserda.ny.gov/All-Programs/Multifamily-Buildings-of-Excellence/Winners/Resources.

Table 2-7. Owner/developer shell and HVAC cost (unit of analysis=property)

Source: Participant Survey	Participant Properties	Non-participant Properties
How much does the cost of the efficient building shell compare to a minimally code-compliant building shell?	10% more, on average, weighted by building size (range of responses: 0% to 100% more) (n=36; combined sector data [a])	18% more, on average, weighted by building size (range of responses: 30% less to 45% more) (n=32; combined sector data [a])
How much does the efficient HVAC system cost compare to a minimally code-compliant equivalent?	12% more, on average, weighted by building size (range of responses: 30% less to 100% more) (n=45; combined sector data [a])	23% more, on average, weighted by building size (range of responses (25% less to 55% more) (n=29; combined sector data [a])

[a] The Market and Impact Evaluation Team combined because there were no statistically significant differences in incremental cost responses by sector.

2.1.4 Timeline Impact When Designing Advanced Clean Energy Buildings

The inclusion of efficient or environmentally friendly features into a property that respondents discussed resulted in an increase in the timeline for the design phase (Table 2-8). Building an advanced clean energy building compared to a code-compliant building does increase the timeline for both participants and non-participants. Although there appear to be differences between participant and non-participant sector responses in terms of how much the inclusion of efficient or environmentally friendly features increases the design phase timeline, those differences were not statistically significant (likely due to a large variability in responses in each subgroup).

Table 2-8. Timeline of building an advanced clean energy building (unit of analysis=property)

Groups	Single-Family	Multifamily	Commercial
Participants: Timeline change (in months) for the design phase due to the inclusion of the efficient or environmentally friendly features	~ 2 month (51 days) increase on average (n=26)	Less than half a month (9 days) increase on average (n=21)	2 month (68 days) increase on average Limited data – (n=10)
Non-participants: Timeline change (in months) for the design phase due to the inclusion of the efficient or environmentally friendly features	~1 month (23 days) increase on average Limited data – (n=14)	Over 1 month (42 days) increase, on average (n=29)	~1 month (26 days) increase on average (n=23)

2.1.5 Model Packages

The model measure package component of the NCP program has not been implemented. Thus, there is no value in estimating the indicator for the program intervention that never occurred.

2.1.6 Energy Modeling

The CEF IP in effect at the time of this research concluded that improvements in energy modeling would lead to higher adoption by providing prospective adopters more confidence in the savings projections of high efficiency measures. This panel of questions informs how often as-built conditions are modeled using actual billing data to calibrate the models and how good the models are as predictors of actual building performance.

respondents reported modeling energy consumption prior to the construction, for about 70% of participant and 26% of non-participant properties (Z-Test of Proportion significant at $p<0.05$). Note that modeling energy consumption prior to the construction was required for 100% of program participants. Of those participants who did not report modeling energy consumption prior to the construction, slightly over one-third noted "don't know" and the rest noted "no". This indicates that the recall of this activity may not be the best.

A majority of participants reported modeling as-built conditions using billing data (69%, or 42 of 61) while a minority of non-participant properties (29%, or 6 of 21) reported doing so (Z-Test of Proportion significant at $p<0.05$).

Those who modeled energy consumption prior to the construction and modeled as-built conditions using billing data noted that the modeled and post energy performance were roughly equivalent for threequarters of participant properties and all non-participant properties. This supports using energy modeling to estimate savings and that those saving will reliably predict actual outcomes.

REM/Rate modeling software was most often mentioned for energy consumption modeling. In contrast, Ekotrope (a software NYSERDA is moving toward) was seldom mentioned. Many participants and non-participants could not name the software. Those that could name the software (often design professionals in the samples) said: REM/Rate (15 participant responses), EQuest (4 non-participant and 3 participant responses), RESNET (4 participant responses and note that RESNET is not a modeling software[9]), Trace700 (3 non-participant responses), DesignBuilder (2 non-participant and 1 participant response), EnergyPlus+ (2 non-participant and 1 participant response), WUFI (2 participant responses), Ekotrope (1 participant response), and Passive House Planning Package (PHPP) (1 participant response).

2.1.7 Participant Decision-Making Process

To ascertain the influence of the program on participant decision-making, the Market and Impact Evaluation Team collected data on respondent predisposition to invest in ultra-efficient or environmentally friendly features as well as the influence of the program and likely actions in the absence of the program.

Collectively, findings reported below indicate that participating owners/developers who had moderate experience incorporating efficient or environmentally friendly features into a property valued program support. Multifamily respondents in particular needed program support to incorporate those features in the property they discussed.

Slightly over half (52%, 27 of n=52) of participating owner developers reported completing at least one new construction project where they installed efficient or environmentally friendly features prior to program participation. For 74%, 41%, and 69% of single-family, multifamily, and commercial properties, respectively, participating owners/developers noted they had plans to incorporate efficient or environmentally friendly features before learning of the program. Multifamily respondents were the least likely group to note this response compared to other groups (Chi-square Test significant at $p<0.05$).

The Market and Impact Evaluation Team asked respondents to discuss what they would have done if they had not participated in the program. The results shown in Table 2-9 reveal that for a minority of multifamily and commercial properties and little less than half of single-family properties, participating

[9] RESNET is a recognized U.S. standards-making organization for building energy efficiency rating and certification. They have developed the HERS rating system. They also accredit energy rating software programs. It is possible that some respondents may have perceived certain software programs as RESENET software programs rather than programs accredited by RESNET.

owners/developers would have not made any changes to the building practices if they had not participated in the program. That is, without program support, they would have either postponed the construction, reduced the number of efficient features, or limited the efficiency of equipment.

Table 2-9. Owner/developer and design professional perceptions on properties if not participating (unit of analysis=property; multiple responses allowed)

Source: Participant Survey	Single-Family (n=36)	Multifamily (n=36)	Commercial (n=14)
We would not have made any changes to the building practices used for project at the specific site	42%	28%	28%
We would likely have postponed the project for at least a year	3%	0%	7%
We would likely have reduced the number of ultra-efficient or environmentally friendly features pursued	28%	28%	28%
We would likely have pursued less efficient equipment or systems than we did	17%	44%	14%
Other	11%	0%	21%

When owner/developers were asked to rate how critical the NCP's support was for a project on a scale of 0 to 10, where 0 meant "not at all critical" and 10 meant "extremely critical," the average rating across multifamily properties was 7.48 (n=27). For single-family properties, the average rating was 6.26 (n=31). For commercial properties, it was 4.7 (n=10). The average ratings between multifamily, single-family, and commercial properties were significantly different (ANOVA significant at $p<0.05$). These ratings should be interpreted with caution because it is unclear whether the respondents were responding to whether funding was critical to constructing a commercial building or constructing an advanced clean energy building.

The majority of participant single-family (65%, n=31) and commercial (55%, n=11) properties and nearly half (44%, n=27) of multifamily properties could have been built without NCP funds, per surveyed owners/developers. The differences in responses on this question between the groups referenced above were not statistically significant. Note that the respondents are commenting on whether the building would have been built, whereas, on the question on what they would have done without the program, the respondents commented on whether they would have made changes if the program was not around.

2.1.8 Barriers to Building an Advanced Clean Energy Building

Financial barriers were noted as key obstacles (Table 2-10). Similarly, nearly all interviewed program partners (4 of 5) echoed the same message: the up-front cost or a perception that it costs much more to build an advanced clean energy building is a key barrier. One partner explained that they tried to leverage non-energy benefit messaging on advanced clean energy buildings (e.g., resiliency) to encourage adoption and move past the financial argument. The customers did not respond to such messaging, only to the financial value proposition. Another partner explained that the financial value proposition is in highlighting the long-term benefits and "ideally [advanced clean energy building] not costing more in the long run." Two partners discussed that the perception of high up-front cost is partly a function of not knowing how to build an advanced clean energy building and make a profit.

Participants gave significantly lower ratings than non-participants across nearly all the barriers the Market and Impact Evaluation Team inquired about. This indicates that participants are less sensitive to barriers than non-participants or the program affected participant barrier perceptions on building an advanced clean energy building(s).

Table 2-10. Owner/developer and design professional rating of barriers (unit of analysis = organization; source: surveys)

Barrier	Participants		Non-participants	
	n	Mean Score On 0-10 Scale [a]	n	Mean Score On 0-10 Scale [a]
Upfront cost of construction feature/design choice	36	6.3 [c]	68	7.4 [c]
A lack of available financing or funding	36	4.8 [b]	66	6.5 [b]
Not enough lifetime savings associated with feature/design choice	35	4.4 [b]	68	5.8 [b]
Not enough qualified subcontractors	35	4.0 [b]	68	4.6
A lack of staff with knowledge of the design	35	2.7 [b]	68	4.3 [b]
Lack of customer demand for feature/design choice	35	2.7 [b]	68	4.9 [b]
Lack of available equipment	33	1.9 [b]	68	4.0 [b]

[a] 0-10 scale: 0 means not a barrier at all and 10 means a very significant barrier.
[b] = ANOVA significant at $p<0.05$; [c] =ANOVA marginally significant at $p<0.1$

A few participants expanded upon the barriers they noted. One stated, "Bank financing that doesn't factor in annual energy cost reduction with high efficiency construction [is a problem]." Another explained, "If government incentives would help offset higher costs, I would pursue development of passive house level building and helping educate home buyers of the many long-term benefits. It is clearly in the long-term benefit for buyers as well as the environment, but there are not enough financial incentives to help deal with the high cost and challenge of dealing with contractors who can properly execute each step." A third respondent discussed a "lack of data" and that "we need to know what true operating costs would be."

Policies are starting to address adoption of efficient and fossil fuel free buildings. One program partner contact noted the market case for electric buildings is starting to be less important due to a recent policy shift requiring all new construction to be all-electric in NYC that will start to go into effect in 2024. The state legislature adopted a similar policy for NYS that will begin to go into effect in 2025. Also note that the policies referenced above were adopted two to five years after the completion of evaluated projects and will go into the effect five to eight years after the completion of evaluated projects.

2.1.9 Suggestions for Improvements

The most common suggestion was the need for larger incentives (5 responses). While this is a common response during program evaluations, it may suggest the need to increase awareness of different incentive levels for targeted projects that meet higher criteria. Others suggested having an easier participation process (4 responses), and one recommended the program "move away from a required check list and instead have a point scoring system that allows decision-making to determine where to invest." Educating home buyers and (the public) on the benefits of energy efficiency and high performing buildings was another common recommendation for program improvement including offering incentives specifically to support the education for home buyers on the benefits of a carbon neutral or net zero energy home (2 responses).

Non-participants offered similar suggestions to improve the program, starting with offering more incentives, specifically "tax credits" or "lower property taxes." The Market and Impact Evaluation Team recognizes that NYSERDA cannot offer tax credits or lower property taxes. NYSERDA could work with entities, though, that could offer, for example, a sales tax exemption on construction. When the Market and Impact Evaluation Team interviewed one industrial development agency (or an IDA), the Market and Impact Evaluation Team learned that they 1) offer sales tax exemptions on construction, 2) offer mortgage tax exemptions, and 3) are piloting different lower tax payment programs to assess ways to encourage economic development in their jurisdiction. The Industrial Development Agency contact noted that they and other Industrial Development Agencies would benefit from NYSERDA reminding them of their programs and exploring a partnership (if feasible) that would leverage NCP offerings and tax abatement policies.

Additionally, half of non-participants stated they were unaware of the program (34 responses, n=68). Non-participants who were unaware of program suggested more advertising or informing them of NYSERDA's programs (7 responses).

2.1.10 Satisfaction With the Program

Participants note moderate satisfaction with the program (Table 2-11). The promptness of the incentive payment and communication from program representatives were given the highest satisfaction ratings. Incentive amount was given the lowest satisfaction ratings. Multifamily participants were most satisfied with the incentive level (average rating of 5.3, n=18), followed by single-family participants (average rating of 3.1, n=14) and then commercial participants (average rating 1.6, n=9).

Table 2-11. Owner/developer & design professional average satisfaction scores (unit of analysis = organization)

Source: Participant Survey	Owner/Developer	
	n	Mean Score (On a 0-10 Scale [a])
Promptness of rebate/incentive payment	46	6.9
Communication from program representatives	47	6.9
Time to approve application	46	6.4
Steps in application process	48	6.3
Program materials	47	6.3
Overall application process	48	6.2
Effort required to provide invoices	47	6.0
NYSERDA-sponsored training	20	4.1
Incentive amount compared to project cost	46	4.0
Program overall	50	6.4

[a] 0-10 scale: 0 means not at all satisfied and 10 means extremely satisfied

2.1.11 Participated in NCP-Sponsored Events

To increase knowledge of clean and resilient building construction practices and knowledge of carbon-neutral, Net Zero Energy, or integrated design concepts in the market, the NCP sponsors events (conferences, webinars, in-person building tours and presentation events) on new construction practices for advanced clean energy buildings. The events or sessions are typically delivered by another entity, such as Building Energy Exchange, Passive House Institute or ASHRAE.

Most participating and non-participating owners/developers did not participate in NCP-sponsored events. Among those who attended the NCP-sponsored events, the most popular event was the New York State Green Building Conference (see Table 2-12). Furthermore, design professionals were more likely to report attending an NCP-sponsored event than owners/developers.

Table 2-12. Owner/developer and design professional training participation (unit of analysis = organization; Source: surveys)

Training Events	Participants Percent Reporting		Non-Participants Percent Reporting	
	Owners / Developers (n=43)	Design Professionals (n=17)	Owners / Developers (n=40)	Design Professionals (n=33)
New York State Green Building Conference	16%	59%	7%	28%
ASHRAE	7%	59%	5%	33%
Passive House Accelerator	5%	35%	2%	8%
Northeast Sustainable Energy Association (NESEA) Pro Tour	5%	35%	2%	6%
Building Energy Exchange	5%	12%	2%	14%
PHIUS or Passive House Alliance Events	5%	18%	0%	0%
None	60% [a]	18% [a]	78% [b]	47% [b]
Other, please specify:	9%	6%	2%	3%
Don't know	14%	6%	7%	6%

[a] [b] Differences between owner/developer and design professional responses are significant (Z-test of proportion).

Those that attended events gave low satisfaction ratings when asked to rate their satisfaction with trainings sponsored by NYSERDA (average rating score of 4.1, see Table 2-11). However, there were no follow-up questions asked and so it is not clear why this score was low or if respondents understood that the survey was referring to events sponsored by NYSERDA or other trainings offered for other programs or by other organizations.

Among the 24 participants that attended an NCP-sponsored events, the top three cited reasons for attending the event were: 1) a desire to increase the knowledge base in HVAC technology (19 responses), 2) a desire to learn about architectural or design choices to reduce energy used for building construction (16 responses), and 3) a desire to increase their knowledge of energy-efficient lighting technology (13 responses). Twelve participants cited wanting to investigate ways to receive incentives or rebates as a reason to attend a training. Twelve also cited wanting to network with other new construction entities, and twelve reported wanting to increase their knowledge of how to reduce building costs. Non-participants' top three cited reasons for attending the events were identical to participants: 1) a desire to increase the knowledge base in HVAC technology (18 responses), 2) a desire to learn about architectural or design choices to reduce energy used for building construction (18 responses), and 3) a desire to increase their knowledge of energy-efficient lighting technology (17 responses).

Approximately 41% of the 29 participants who had not attended NCP-sponsored events said they had no time to attend events. About 38% of participants noted they were unaware of the NCP-sponsored events, which may indicate an opportunity for additional promotion of sponsored events. All other responses were unique. Of the 53 non-participants who reported not attending NYSERDA-sponsored events, 61% cited a lack of awareness as the primary reason for not participating. The second most common reason was not having any time to attend (24% of respondents).

2.1.12 Market Study Key Findings and Recommendations

Finding 1: Program participant properties showed an increased penetration of the highest efficiency tier buildings compared to the non-participant population (15% of commercial participants compared to 4% of non-participants, and 32% of single-family home participants compared to 0% of non-participants), which includes those building with qualitatively better building components (including highest-efficiency envelope and highest efficiency mechanical systems, such as geothermal) and renewables. This performance tier points to the future as the program segues to promoting carbon neutral and low carbon designs. In addition to promoting the highest efficiency tier, NYSERDA's more typical participants perform better than the non-participant market in general. For example, the average single-family home participating in the New Construction Program performed 14% and 35% better than code for modeled electric and gas use, respectively.

Policies relating to code and product standards are now shifting in favor of carbon neutral new construction. Regardless of the drivers of change, the New York City Local Law 154, passed in December 2021, stipulates that by 2024 all new buildings must be all-electric if less than seven stories or all-electric by mid-2027 if more than seven stories. Still, the adoption of carbon neutral construction as well as other efficient, electrification, energy storage and renewable technologies (other than lighting) is not widespread as reflected in the survey data. Thus, the current programmatic efforts focusing on incentivizing planning stages and carbon neutral projects are needed.

Note that the NCP philosophy is to focus on strategies that are ahead of building energy code advancement.

Finding 2: Financial barriers are key obstacles to building substantially above code. Across all sectors, participant and non-participant properties that incorporated energy efficiency, electrification and other clean energy measures were more expensive than similar developments built as minimally code compliant. The top three reported barriers to building substantially above code were 1) the up-front cost of clean feature(s), 2) lack of available financing and 3) lifetime savings that impact financial value proposition. These top three barriers were shared by both participants and non-participants. Participants also reported low satisfaction with the NCP incentives, suggesting those could be larger. Similarly, four of five interviewed program partners echoed the same message: the up-front cost or a perception that it costs much more to build an advanced clean energy building was a key barrier.

Non-participants suggested the program should offer more incentives, specifically "tax credits" or "lower property taxes." The Market and Impact Evaluation Team recognizes that NYSERDA cannot offer tax credits or lower property taxes. However, NYSERDA could work with entities that could offer a tax incentive. When the Market and Impact Evaluation Team interviewed a local IDA (an agency that encourages economic development), the Team learned that they 1) offer sales tax exemptions on constructions, 2) offer mortgage tax exemptions, and 3) are piloting different lower tax payment programs to assess ways to encourage economic growth in their jurisdiction. The IDA contact noted that their agency is open to collaboration with NYSERDA.

a. **Recommendation:** Consider a more active partnership with state or regional economic development organizations and even NCP partners to educate owners/developers and design professionals of not only the NCP incentives but also other available incentives.

b. **NYSERDA Recommendation Response**: Implemented. NYSERDA already markets its programs to Industrial Development Agencies (IDAs) through support of the New York State Economic Development Council events, meetings and IDA Trainings, as well as through other State Agencies advancing economic development including Empire State Development and Department of State. However, there are over 100 individual IDAs across the State, and they can only support commercial projects (i.e., not single family or multifamily projects). The New Construction Team also has established a significant network of channel partners throughout the State that actively promote programs and projects across all New Construction supported sectors.

Finding 3: The program appears to be helping the decision-makers minimize incremental cost of efficient shell and HVAC systems. The participant property decision-makers claimed significantly lower incremental cost for the efficient shell and efficient HVAC system than non-participating property decision-makers. The reported incremental cost of these two efficiency solutions was generally 10%-12% for participant and 18%-23% for non-participant properties that incorporated these solutions.

a. **Recommendation:** Explore how the participant properties incorporated the efficient shell and highly efficient HVAC systems without paying more than 10-12% premium for those solutions and share insights to the wider market.

b. **NYSERDA Recommendation Response**: Implemented. NYSERDA has published successful case studies and solution sets, as well as cost and performance data in multiple venues. This includes promoting case studies on the Program and Initiative case studies section of the NYSERDA website as well as the Buildings of Excellence website. NYSERDA also actively participates in the New Building Institute's National Getting to Zero database and shares information into the national dataset. The New Construction Team also has established a significant network of channel partners where carbon neutral and net zero energy projects are highlighted through: sponsorships of events such as New Buildings Institute Getting to Zero Forum, NESEA pro tours, and the NYS Green Building Conference; as well as though Gallery Talks, webinars and other events with organizations including Building Energy Exchange, Passive House Accelerator, and AIA.

Finding 4: A minority of design professionals are trained on integrated design. Only 38% of non-participant design professionals reported being aware of integrated design, and among those that were aware, about one-third reported receiving training on integrated design. This means that less than one-tenth (7%) of surveyed design professionals who worked on non-participant properties received training on integrated design. Furthermore, a minority (23%) of surveyed design professionals who worked on non-participating projects noted that integrated design leads to the incorporation of more ultra-efficient features. This finding is related to the fact that very few reported being trained on the integrated design. However, awareness was found to be higher for design professionals who worked on participant properties; 59% reported being aware of integrated design, with approximately 15% of surveyed participating design professionals received training on integrated design.

One group that did leverage integrated design more frequently was NZE/NZE-capable building design professionals. Nearly all NZE/NZE-capable buildings used integrated design. Key outcomes of integrated design are reduced incremental cost to achieve building performance, and improved building operational performance as related to comfort and energy costs. The higher use of integrated design in these best-in-class buildings implies that integrated design is useful when building NZE/ NZE-capable buildings. However, these properties were found to be a small subset of the above-code new construction market. Between 2016 and mid-2021, about 4% to 8% of the market were NZE/NZE-capable buildings that leveraged integrated design. Given this insight, the NCP program staff should consider re-thinking the target for this metric.

It should be noted that the market is unlikely to be fully served by an integrated design model. Surveyed design professionals noted other contractual arrangements that could lead to integration of clean energy and energy efficiency features in construction, such as a retainage-based contractual arrangement in construction. One program partner involved extensively with the design community and familiar with integrated design felt that integrated design (and associated contracting) was an outdated concept and that the market is moving toward a more full-service type of design and build firm offering.

a. **Recommendation:** In addition to encouraging an integrated design model, the program team should investigate adding intervention strategies that could work for those that leverage nonintegrated design contracting (such as design-bid-build) arrangements to encourage carbon-neutral and Net Zero Energy construction.

b. **NYSERDA Recommendation Responses**: Implemented. Good design practices can occur prior to bidding, and integrated project delivery can still occur in these contracting arrangements. The New Construction Team will continue to work with the market to explore design and construction practices that help reduce incremental costs, reduce construction time, and improve building operational performance related to health, comfort, resiliency, and productivity.

2.2 Impact Evaluation

While all three sectors in the NCP will be evaluated over the contract period, the single-family sector is the focus of this section, as it had sufficient activity for sampling and study this year. Qualifying customers include those who own or rent a single-family home or live in a townhouse or multifamily home with up to four units.

2.2.1 Single-Family Program Activity and Description

Table 2-13 shows Single-Family Scorecard[10] annual electric and natural gas/propane savings by year and overall. A participant in this table is a unique address with electric savings with a status of "Completed."[11] The Scorecard savings are the official savings claims made by NYSERDA through the CEF and are the basis for determining the VGSRR. The Market and Impact Evaluation Team merged Scorecard savings into the program participant data drawn from Salesforce to develop the population reflected below.

A total of 2,529 participants produced claimed savings of 6,054 MWh during the period studied, with 2,441 of those also producing 147,389 MMBtu of natural gas or propane savings. The vast majority of this latter savings group (98.3%) is natural gas. Only 88 participants (3.5%) had electric-only savings.

Table 2-13. Electric single-family new construction Scorecard savings

Year of Completion	Electric		Natural Gas/Propane	
	Participants	Savings (MWh)	Participants	Savings (MMBtu)
2016	236	649	236	20,509
2017	569	1,903	544	37,226
2018	470	814	458	19,637

[10] Reflects projects status as of 2/3/2022.

[11] A status of Completed was given to a site when its construction was complete, all deliverables were accepted, and final payment was approved by NYSERDA.

2019	674	1,452	645	41,519
2020	475	1,012	460	24,542
2021 (through April)	105	224	98	3,956
Total	2,529	6,054	2,441	147,389

Figure 2-8 presents the distribution of electric Scorecard savings at the site level. Just over 90% of sites have Scorecard savings at or less than 4,000 kWh, with most of them between 1,000 and 2,000 kWh. There are a set of 23 sites with savings that exceed 15,000 kWh each, which would be consistent with a net zero energy or near net zero energy home. These participants underwent further scrutiny to ensure they were indeed homes that qualified for the single-family program channel. Internet research and a review of project data showed that these participants do qualify as single-family as defined in the program. Nineteen of them are single-family homes, one of them is a townhouse, two are multifamily homes with less than four units in them, and one is a duplex (side by side mobile homes).

Figure 2-8. Scorecard electric kWh savings distribution

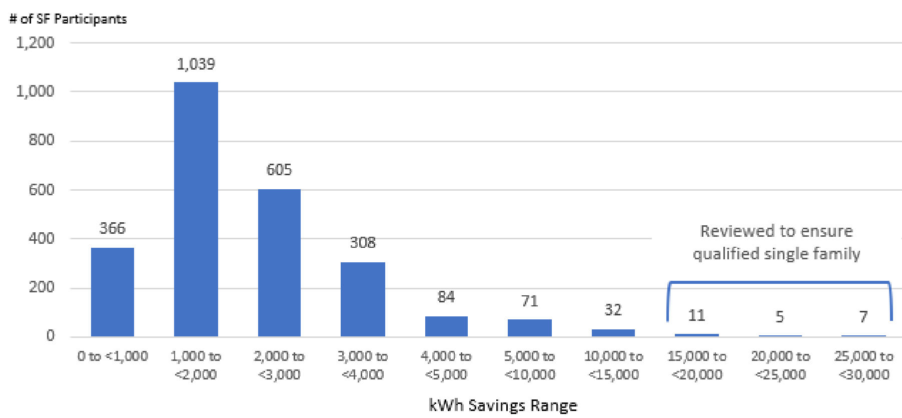


Figure 2-9 presents the distribution of natural gas and propane scorecard savings at the site level. In this distribution, 50% of sites with gas savings have between 25 and 50 MMBtus of Scorecard savings, with many of the remainder spread evenly among the next three highest bins. A set of 25 sites has savings at or exceeding 150 MMBtus each. Like their electric counterparts, these participants underwent review to ensure they were program qualifying sites. Secondary research indicated that these 25 sites do adhere to program qualification guidelines. All but one was confirmed as a single-family home. The final one appears to be a lot in a fully developed community, with all program paperwork noting it is single-family.

Figure 2-9. Scorecard natural gas/propane (MMBtu) savings

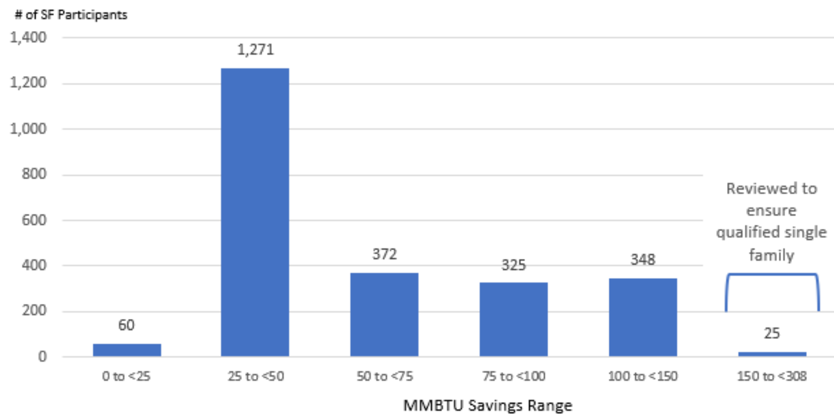
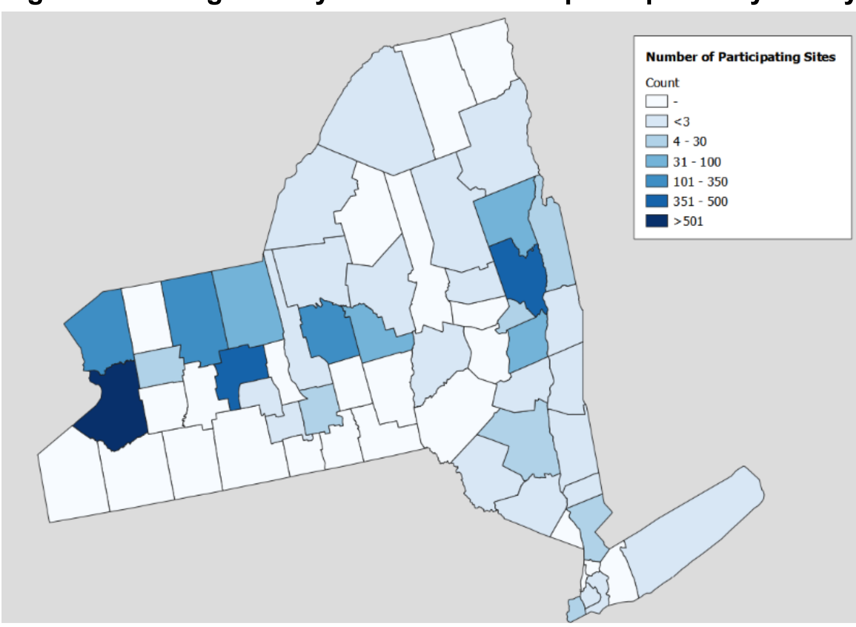


Figure 2-10 shows program activity by county. Participation is spread across 38 counties, ranging from fewer than three participants to more than 500. Twenty-three counties did not have any participation during the population period examined. Recall that this program interfaces with the market through builders that construct homes beyond code efficiency. The heaviest activity is in metropolitan areas upstate, including Albany, Syracuse, Rochester, and Buffalo.

Figure 2-10. Single-family new construction participation by county



2.2.2 Building Simulation Savings by End Use from Sampled Models

The program tracks total building savings at the address level, not by end use. The Market and Impact Evaluation Team ran the building simulation models of a sample of homes to understand the end uses driving program impacts, checked baselines used to determine the impacts, and gathered consumption data of the as-built homes for use in adjusting savings impacts. Table 2-14 shows total electric savings by end use, and Table 2-15 shows the same information for gas savings. Only those models with billing data and the correct baselines were used to produce the end-use shares shown in the tables.

Appliances and lighting produce nearly 75% of the total electric savings among the homes modeled, with heating producing another 20%. Most gas savings is in the heating end use (85%). Overall, 14% of electric consumption[12] and just over 35% of gas consumption is estimated as saved based on the modeling work of participating homes over comparable code-built homes.

Table 2-14. Electric savings by end use (sample with correct code baselines)

End Use	n	Modeled Savings (kWh)	Modeled Savings as % of Total	Savings as % of Modeled Baseline Consumption
Heating	52	13,823	20%	3.0%
Cooling	25	4,519	6%	2.0%
Appliances and Lighting	59	52,116	74%	10.7%
Total	59	70,458	100%	14.4%

Table 2-15. Natural gas and propane savings by end use (sample with correct code baselines)

End Use	n	Modeled Savings (Therms)	Modeled Savings as % of Total	Savings as % of Modeled Baseline Consumption
Heating	43	15,258	85%	30.1%
DHW	43	2,557	14%	5.0%
Appliances and Lighting	3	43	0%	1.2%
Total	44	17,858	100%	35.2%

Table 2-16 shows the electric savings and gas/propane savings by end use for models with gas heating with billing data and the correct baselines (56). The study team does not provide a comparable table for electric heated homes as there very few in the sample. The end use savings estimates are slightly different from the tables above due to a focus on gas heat only participants, but the percent of consumption represented by each is nearly the same as those provided above.

[12] House consumption is estimated by adding modeled savings and as built consumption.

Table 2-16. Electric, gas and propane savings by end use in gas heated homes

End-Use	Electric			Gas		
	Modeled Savings (kWh)	Modeled Savings as % of total	Modeled Savings as % of consumption	Modeled Savings (therms)	Modeled Savings as % of total	Savings as % of modeled baseline consumption
Heating	13,575	18.8%	3.1%	20,525.30	85.8%	30.9%
Cooling	4,397	6.1%	0.9%	-	0.0%	0.0%
Appliances and Ltg	54,083	75.1%	10.9%	54.60	0.2%	0.1%
DHW	-	0.0%	0.0%	3,349.00	14.0%	5.0%
Total	72,055	100.0%	14.5%	23,929	100.0%	36.0%

2.2.3 Adjustments to Savings

The Market and Impact Evaluation Team explored savings adjustments for application of the VGSRR in three primary areas, itemized below and discussed in turn thereafter.

1. Reviewing mechanisms in place to track single-family new construction activity that support filed savings claims,
2. Examining baselines used in the modeled homes that drive the natural gas and electric impact estimates, and
3. Analyzing actual electric and gas consumption for comparison and calibration of modeled consumption estimates.

2.2.3.1 *Scorecard vs Salesforce Savings*

NYSERDA used Salesforce as a platform to track program activity during the period evaluated. A process was developed to move savings from this platform to the Scorecard for officially claimed savings. This system pulls the Salesforce field that carries actual modeled savings as gathered from the REM/Rate batch reports or from the Ekotrope system for upload into the Scorecard. The Market and Impact Evaluation Team examined this process and observed that if either the electric or natural gas/propane actual savings (i.e., the modeled savings) is blank or zero (“0”) in Salesforce, the extraction process that informs the Scorecard pulls in savings from an estimated savings field. Such an event might happen when no savings have been reported when a project is closed. While this did not happen frequently, there were nine instances where the Scorecard had electric savings when Salesforce did not and 14 instances for gas savings. This results in a tracking system adjustment to Scorecard savings of -0.3% and -0.4%, respectively, summarized in Table 2-17.

Table 2-17. Instances of unsupported Scorecard savings

Instances/Savings	Electric	Natural Gas/Propane
Total Participants (n)	2,529	2,441
Total Savings (kWh/MMBtu)	6,053,840	147,389
Participants with Scorecard savings with No Salesforce savings (n)	9	14
Scorecard savings with No Salesforce savings (kWh/MMBtu)	18,810	648
Percent Change in Savings from Scorecard	-0.3%	-0.4%

The Market and Impact Evaluation Team's understanding is that NYSERDA is aware of this issue and may be in the process of rectifying it. The results provided shows that this issue has a very small impact on savings due to isolated incidents of misapplication. The Market and Impact Evaluation Team has deemed this minor adjustment to be marginal enough to not be included in the determination of verified gross savings in this study. However, the issue has since been corrected and is now reporting accurate actual energy savings.

2.2.3.2 *REM/Rate and Ekotrope Model Baselines and Code Compliance*

An area of potential savings adjustment can be driven by savings baseline conditions not conforming to NYS code and amendments or the application of an inappropriate baseline in the building simulation models and ensuing Scorecard estimates of savings. The sampled participant homes sampled were completed between November 2018 and December 2020. Unfortunately, permit dates were not regularly available for the sampled sites to definitively confirm the applicable code for baseline use. However, based on these dates, the evaluators assume the applicable code is IECC 2015 with New York State amendments, which became effective for homes permitted after October 2016.

The review of savings baselines began with checking the Ekotrope Reference Home and REM/Rate UDRs used by modelers for adherence to NYS 2016 code and amendments. During this process, it was noted that Ekotrope used a single reference home for all models run. However, there were several UDRs available to REM/Rate modelers for baseline selection, including some that referenced the preceding code (2010). A comparison of the Ekotrope reference home and 2016 REM/Rate UDR confirmed the building characteristics in each conformed to 2016 NYS code with amendments.

Following this confirmation, the Market and Impact Evaluation Team reviewed the models available from the participant group with validated utility billing account numbers. While not all models could be fully run, their file names often signaled the UDR used when REM/Rate was the modeling software. The sample of homes where baselines were examined included 90 homes with electric savings and 73 with natural gas/propane. Table 2-18 shows these results for homes with electric savings. The first three columns show the baseline applied in the models, the number of each, and the Scorecard savings associated with them. The last column shows the savings adjustment. Twenty-five of the 90 sites examined used a 2010 UDR in REM/Rate. The Market and Impact Evaluation Team was able to run 14 of those models with the 2016 UDR to understand the savings impact from the misapplication of the 2010 code. On average, moving those homes to the 2016 code reduced their electric savings by 52.8%. Homes already modeled in REM/Rate with the 2016 UDR, Ekotrope, and those not definitively known to have used a 2010 baseline are categorized as having the correct baseline savings in this analysis. The adjustment to accommodate this baseline savings issue was incorporated in the site-level estimates of savings with the calibration work (discussed next) to produce the final VGSRRs.

Table 2-18. Electric baseline savings adjustment

Baseline	n	Scorecard Savings (kWh)	Baseline Savings Adjustment
REM/Rate UDR 2010	25	130,030	47.2%
REM/Rate UDR 2016	20	33,940	100.0%
Ekotrope	40	53,350	100.0%
Unknown or no file	5	21,770	100.0%

Table 2-19 shows these results for homes with natural gas and propane savings and is laid out the same as the electric results above. In this case, 20 of 73 sites examined used a 2010 UDR in REM/Rate. The Market and Impact Evaluation Team was able to run 12 of those models with the 2016 UDR to understand the savings impact from the misapplication of the 2010 code. On average, moving those homes to the 2016 code reduced their electric savings by 45.1%. Consistent with the electric adjustment above, the adjustment to accommodate this baseline savings issue was incorporated in the site level estimates of savings with the calibration work (discussed next) to produce the final VGSRRs.

Table 2-19. Natural gas and propane baseline savings adjustment

	n	Scorecard Savings (Therms)	Baseline Savings Adjustment
REM/Rate UDR 2010	20	22,240	54.9%
REM/Rate UDR 2016	17	7,880	100.0%
Ekotrope	29	11,050	100.0%
Unknown or no file	7	3,820	100.0%

The Market and Impact Evaluation Team acknowledges that the above analysis is highly dependent on the mix of REM/Rate models performed per year and the rate at which modelers misapply the 2010 code as baseline. The Market and Impact Evaluation Team believes this analysis to be representative of the sample but may not represent the entire population. The Market and Impact Evaluation Team's understanding is that NYSERDA has been moving steadily toward use of Ekotrope to determine program impacts, which consistently uses the correct baseline. To the extent program changes are made to ensure the use of the correct baseline UDR in REM/Rate modeling moving forward or abandons its use in favor of Ekotrope, this factor may no longer be appropriate for application. Under these circumstances, an Alternative Prospective Realization Rate absent this adjustment may be appropriate for future use. The Market and Impact Evaluation Team provides these realization rates later in this section.

2.2.3.3 *Model Calibration*

The third savings adjustment made in this study was the calibration of savings by the relationship between modeled consumption and actual consumption. This calibration process is described in Section 3.2.4, including the weather normalization process, data cleaning, and distribution of both electric and gas calibration factors. Below are the results of both the calibration-only analysis and the calibration plus baseline adjustment analysis because they produce different realization rates. The calibration-only analysis provides an Alternate Prospective Realization Rate (APRR) for consideration under the condition that all models are using the appropriate savings baseline.

Figure 2-11 shows a scatterplot of the scorecard versus calibration-only adjusted savings; meaning only the Scorecard savings are adjusted in this graphic by the ratio of weather-normalized to modeled consumption for each site in the sample (77 electric, 65 gas/propane). The red diagonal lines in the graphs show where all points would fall if the calibration-only adjusted savings were the same as the Scorecard savings (i.e., a 100% realization rate). Each graph shows the calibration-only realization rate. For electric, this is 104.5% ±5.9%, and for natural gas/propane it is 112.8% ±10.7%. These realization rates do not reflect the baseline issues observed and discussed in Section 2.2.3.2.

Figure 2-11. Scorecard vs calibration-only gross savings

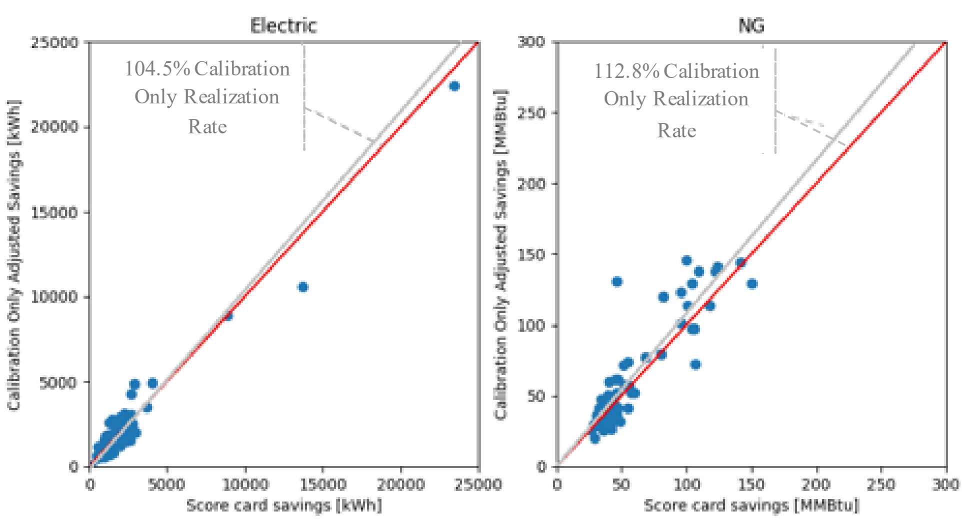
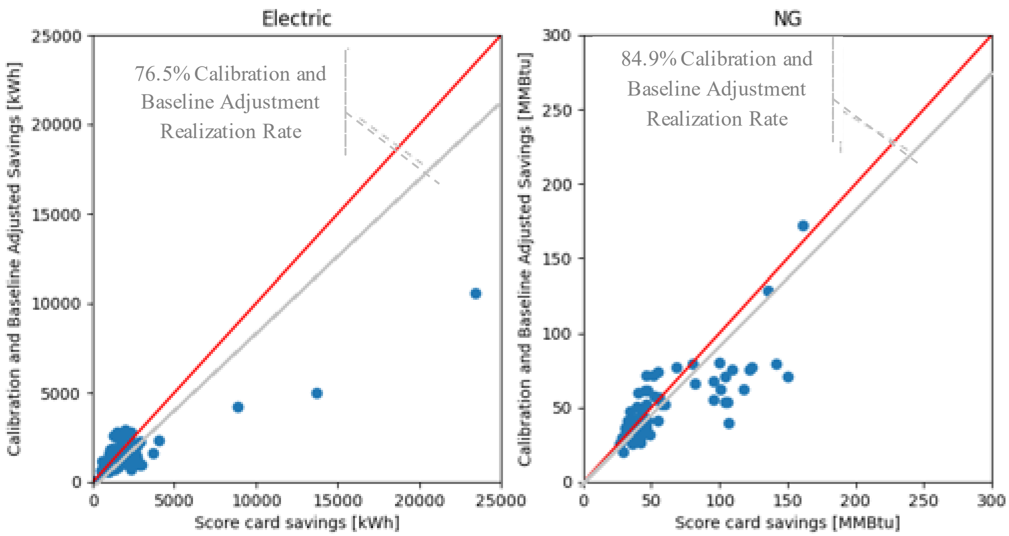


Figure 2-11 shows the scatter plot of the Scorecard savings versus the savings with both the calibration and baseline adjustments made. The baseline adjustment is only made to sample points that used the 2010 UDR in lieu of the 2016 UDR. The impact of the baseline adjustment is seen by comparing Figure 2-11 to Figure 2-12. The downward pull results in an electric calibration and baseline-adjusted realization rate of 76.5% ±26.5%, and for natural gas/propane of 84.9% ±26.6%.

Figure 2-12. Scorecard vs calibration and baseline-adjusted gross savings



2.2.3.4 ***Program-Level Single-Family Savings and VGSRR/APRR***

The VGSRR was computed from a sample drawn from a population of projects with Scorecard status of Complete between August 18, 2016, and April 30, 2021. It includes both the consumption calibration adjustment to savings and an adjustment for mis application of 2010 baselines among the sample.

This study provides a VGSRR for application from 2016 Q3 through 2021 Q2 and APRR for application from the 2021 Q3 through 2022 Q4. Table 2-20, Table 2-21, and Table 2-22 present both VGSRR and APRR values in the format required by the DPS. These tables have also been provided in excel as part of this reporting deliverable. Note that the columns labeled electric and gas usage in Table 2-22 are the VGS from this study, per NYSERDA guidance.

Table 2-20. Direct impact reporting table 1

Parameter (Description of strata)	Realization Rate Analysis Type - Weighted/ Unweighted	Realization Rate - by Strata	Evaluated Savings as a Percent of Evaluated Consumption Baseline (%)	Confidence Interval/ Relative Precision (by strata)	Sample Size (n) (by strata)	Population Size (N) (by strata)
Electrical Savings Annual kWh - Single Family New Construction	Weighted	76.50%	11.4%	±26.5% @90% c.i.	77	2,529
Natural Gas and Propane Savings Annual MMBTU - Single Family New Construction	Weighted	84.90%	27.5%	±26.6% @90% c.i.	65	2,441
Electrical Savings Annual kWh - Single Family New Construction	Weighted	104.5%	27.5%	±5.9% @90% c.i.	77	2,529
Natural Gas and Propane Savings Annual MMBTU - Single Family New Construction	Weighted	112.8%	36.5%	±10.7% @90% c.i.	65	2,441

Table 2-21. Direct impact reporting table 2

Parameter (Description of strata)	Type (VGSRR/APRR)	Effective from date (Year Quarter)	Effective until date (Year Quarter)	Electricity Savings Annual MWh (Realization Rate)	Natural Gas Savings Annual MMBtu (Realization Rate)
Electrical Savings Annual kWh - Single Family New Construction	VGSRR	2016 Q3	2021 Q2	0.765	N/A
Natural Gas and Propane Savings Annual MMBTU - Single Family New Construction	VGSRR	2016 Q3	2021 Q2	N/A	0.849
Electrical Savings Annual kWh - Single Family New Construction	APRR	2021 Q3	2022 Q4	1.045	N/A
Natural Gas and Propane Savings Annual MMBTU - Single Family New Construction	APRR	2021 Q3	2022 Q4	N/A	1.128

Table 2-22. Direct impact reporting table 3

Parameter (Description of Strata)	Con Edison District Steam Savings Annual MMBtu (Realization Rate)	Heating Oil Savings Annual MMBtu (Realization Rate)	LPG (Propane) Savings Annual MMBtu (Realization Rate)	Other Fuel Savings Annual MMBtu (Realization Rate)	Electricity Usage Annual MWh (Realization Rate)	Natural Gas Usage Annual MMBtu (Realization Rate)
Electrical Savings Annual kWh – Single-Family New Construction	1	1	N/A	1	4,629,265	N/A
Natural Gas and Propane Savings Annual MMBtu – Single-Family New Construction	1	1	0.849	1	N/A	125,121
Electrical Savings Annual kWh - Single Family New Construction	1	1	N/A	1	N/A	N/A
Natural Gas and Propane Savings Annual MMBTU - Single Family New Construction	1	1	1.128	1	N/A	N/A

2.2.4 Impact Evaluation Key Findings and Recommendations

Table 2-23 summarizes the two impact adjustments made to the single-family new construction Scorecard savings and precisions that accompany each. The last row shows the final single-family Verified Gross Savings and Realization Rate (VGS and VGSRR). The verified gross electric savings is 4,629 MWh and the verified gross natural gas/propane savings estimate is 125,121 MMBTU with verified gross realization rates of 76.5% and 84.9%, respectively. Precisions around the results are lower than anticipated due primarily to the baseline issue driving a wider variation of gross savings than anticipated.

Table 2-23. Summary of electric and natural gas/propane impact results

	Electric			Natural Gas / Propane		
Savings	kWh	Realization Rate	Precision (90% c.i.)	MMBTU	Realization Rate	Precision (90% c.i.)
Scorecard Savings	6,053,840	N/A	N/A	147,389	N/A	N/A
Model Calibration Adjustment/APRR	6,327,454	104.5%	±5.9%	166,284	112.8%	±10.7%
Baseline Adjusted Savings	4,629,265	76.5%	±26.5%	125,121	84.9%	±26.6%
Final VGS/VGSRR	4,629,265	76.5%	±26.5%	125,121	84.9%	±26.6%

Finding 1: Scorecard savings are slightly overstated due to the extraction process that pulls Ekotrope or REM/Rate modeled savings through Salesforce into the Scorecard. The current system of moving single-family savings from Salesforce to the reporting system is automated to pull actual modeled savings that are input from REM/Rate and Ekotrope models. However, if no actual savings is present in Salesforce or if it has a zero (0) listed as the savings it, the program appears to extract and credit estimated savings into the Scorecard.

a. **Recommendation:** Revisit the extraction process to ensure that when actual savings equal zero, that the zero savings is pulled from Salesforce as opposed to reverting to the estimated savings. The Market and Impact Evaluation Team's understanding is that this recommendation may already be underway at NYSERDA.

b. **NYSERDA Recommendation Response**: Implemented. This data extraction process has been revised.

Finding 2: Many single-family REM/Rate models from a single vendor incorrectly used 2010 code as the baseline for impacts reported in the Scorecard, which had a substantial effect on the realization rate. Use of REM/Rate as a modeling software requires the selection of a User Defined Reference Home or UDR that reflects code at the time of permitting to produce program impacts. This baseline issue did not happen with the Ekotrope models. Note: Program team had terminated this vendor from the program due to performance issues directly related to their modeling ability prior to the evaluation work occurring and the issue was not noted in any other vendors models during this evaluation.

a. **Recommendation:** Regularly create and gather the baseline or reference homes used for modeling and monitoring the correct application of code during its monthly program QA/QC activities, given its importance to accurate savings claims. This will make savings more auditable for NYSERDA and evaluators. This issue was observed with the use of REM/Rate where savings are dependent on the individual rater selecting the correct UDR to produce savings. If this issue is rectified (and verified), the Model Calibration Adjustment realization rate may be considered as an Alternative Prospective Realization Rate (APRR). This provisional realization rate can be applied to projects if Ekotrope is used for modeling and the baseline on the platform is verified as being of appropriate code,[13] or all REM/Rate models are confirmed to consistently use the appropriate UDR. Once these changes are implemented and it has been verified, the program can

[13] Ekotrope models are run on an online platform where the baseline home can be uploaded a single time for use on all subsequent homes in the program by all raters.

apply the APRR to projects occurring after the evaluation period. However, the APRR requires a re-evaluation of the provisional value within 18 months after the report filing date. The APRR realization rates available for use are: 104.5% for electric and112.8% for gas/propane. However, as APRRs cannot exceed 100% per DPS VGS Guidance, an APRR of 100% will be applied.

b. **NYSERDA Recommendation Response**: Implemented/In Progress. The model selection issue was limited to a single vendor who had been terminated from the program due to an inability to meet program quality requirements. The issue specifically arose after the new code went into effect, so it impacted a sub-set of their work. Since this is a market transformation program that in part works with the market to continually help improve the market's performance, there will always be a similar risk at each code change. The program team will continue to work with all vendors and builders to continue to improve market capacity and improve modeled and predicted results, as well as verified and M&V results. NYSERDA will also work to ensure that current-code reference homes are used to estimate savings for single family homes going forward.

Finding 3: Based on the savings from the sample of single-family models reviewed with appropriate baselines, appliances and lighting are driving much of the electric savings (74%). Appliances and lighting tend to be short-lived measures that are transient in nature.

a. **Recommendation:** Work with program vendors to review the end uses producing electric savings among recent single-family participants to see if electric savings continue to be driven by appliances and lighting. To the extent the NCP is intended to achieve long-term electric savings, pursuing more diverse savings that are directly integrated into the home will be more productive in achieving that goal.

b. **NYSERDA Recommendation Response**: Implemented. Since 2021, New Construction programs began to require significant envelope performance improvements beyond code, and are fossil fuel free buildings, and therefore significant electric savings are generated from space heating and cooling equipment, as well as domestic hot water equipment.

Finding 4: The current single-family program tracking system collects program savings, but not consumption of the treated homes.

a. **Recommendation**. As NYSERDA moves to an increased focus on NZE homes and greenhouse gas metrics, it might consider tracking the modeled base usage of homes in addition to savings. This would allow administrators to track program performance in terms of savings as a percent of consumption for each fuel. This can be a valuable metric for single-family projects within the NCP and programs of a similar nature.

b. **NYSERDA Recommendation Response**: Pending. There are significant requirements already in place for participant compliance with program rules. Program participants routinely indicate that additional requirements would present undue burden and would likely impact their decision to participate in the programs. Program team will evaluate if there is a no effort way to collect additional baseline information in future modeling efforts, as appropriate.

2.3 Indirect Savings

To estimate indirect savings for the NCP, the Market and Impact Evaluation Team used the survey and program data inputs to determine the magnitude of the causal linkage between program activities and a market response. These linkages, along with other findings, determined the gross interior area (GIA) constructed in New York with Advanced Clean Energy (ACE) features that were influenced by the program (the influenced ACE GIA). The indirect savings are then estimated as the product the influenced ACE GIA and the average program savings per square foot.

2.3.1 Causal Linkages

The NCP program theory and logic were reviewed to theorize linkages and causality between program activities and expected outcomes. Table 2-24 summarizes the pathways hypothesized as leading to indirect savings as well as the questions in the survey that may provide evidence of the pathway.

Table 2-24. Indirect savings causation analysis for achieving direct and indirect energy savings

Program Activities	Expected Outcomes	Evaluation Metric	Savings impact
Standard offer	Continued support for NCP projects through resource acquisition projects	Savings MMBtu developed in the impact evaluation for participants	Increases direct and NOMAD savings.
	Participants gain confidence and extend the practices to NP construction	Participating developer, owner, and design professionals reporting adoption and influence	Participants were asked about prior and current experience with NYSERDA and how important the support was for the project.
Buildings of Excellence and the NZEED competitions	Showcases successful projects for replication by the new construction community	Savings MMBtu developed in the impact evaluation for participants	Increases direct and NOMAD savings.
	Participants gain confidence and extend the practices to NP construction	Participating developer, owner, and design professionals reporting adoption and influence	Participants were asked about prior and current experience with NYSERDA and how important the support was for the project.
	Nonparticipants become aware of the success of the program	Nonparticipating developers, owners and design professionals report adoption and influence of NYSERDA	Nonparticipants were asked about prior and current experience with NYSERDA and how important the support was for the project. Nonparticipants were also asked about the influence of the design professionals.

2.3.2 Quantitative Inputs

This section describes the quantitative inputs that were used to calculate indirect savings.

Total gross interior area (GIA) built in New York 2016-2019. Value: 602 million square feet.

The source of the population of all buildings constructed in New York in the period of interest is the New York State Tax Parcel data set. The Tax Parcel data is a product of the Statewide Parcel Map Program, whose mission is to "collect, assemble, maintain, and provide access to statewide tax parcel GIS data." The dataset accounts for every property in New York, with fields describing key parameters such as address, owner, year built, land area, building area, and sector. Parcel data updates are dependent on individual communities updating the statewide data as property ownership, build status, and other parameters change. The TPD was selected as the data source because it includes all properties in the state, although the updates may lag field events by several years. The GIA is the sum of the reported area of all the properties constructed in the period of interest, including participants and non-participants and all regions, including Long Island.

Responses were expanded to the populations (either participant or non-participant) by applying stratum case weights and the gross interior area of the building reported by the responder. See Appendix A for more details.

Percentage of constructed space built with ACE features. Table 2-25 summarizes the gross interior space built in New York and the presence of ACE measures. The population GIA is a function of the responder reported GIA built in New York and the reported mix of ACE measures present in that construction. Most new construction was reported to include at least some ACE features, although not necessarily at the level that would meet program eligibility requirements.

Table 2-25. Percentage of New York newly constructed gross interior space with ACE features

Parameter	New York GIA (million sqft)	GIA with ACE Features
Total new construction	602	
Pct of total GIA		99%
New York GIA (million sqft)		594

NYSERDA influence on New York construction: Nonparticipants and participants were asked to characterize the influence of NYSERDA and the design team in selecting the ACE features in their new construction. Table 2-26 summarizes the GIA built without direct NYSRDA support (i.e., incentives or technical support) and the influenced of experiences with NYSERDA or by the design professionals associated with the project. The starting point for Table 2-26 is the last column in Table 2-25. The subsequent columns disaggregate the GIA with ACE features by the level and type of NYSERDA influence.

Table 2-26. Characterization of NYSERDA influence on GIA in New York

Parameter	GIA with ACE Features	Ace Features and No NYSERDA Direct Support	Ace Features and No NYSERDA Direct Support		
			& No NYSERDA Influence	& NYSERDA Influence (Aware)	& NYSERDA Influence (Unaware/ Designer)
New Construction GIA (sqft)		557			
Pct of Total GIA	**99%**		65%	27%	1%
GIA (sqft)	**594**		390	160	8

The influence estimates incorporate the responses to the question, "how important was your previous experience with NYSERDA's programs in your decision to install [ACE features]" and also "how important was your [design professionals] influence in your decision to install [ACE features]" on a scale of 0 to 10. The first responses reflects where the responder is aware of NYSERDA influence. The second response reflects the designer's influence on the customer and NYSERDA's influence on the designer.

The indirect savings was computed as the product of the GIA (with ACE features but not incented) and the highest of the Aware and Unaware influence factors.

NYSERDA influence on design professionals: The weighted average influence factor for design professionals was 28% and was factored into the GIA in Table 2-26.

Both participants and nonparticipants reported that the design professionals were more influential on the decision to install ACE features than NYSERDA (unweighted average of 2.0 versus 2.7 on a scale of 0 – 10). Design professionals reported an average NYSERDA influence of 2.6. However, the impact of the design's indirect influence depends on each site's combination of ACE construction, whether incentives were received, GIA, and finally the reported influence.

Average savings per square foot: Average electricity savings (kWh/sq ft) and thermal savings (MMBtu/sq ft) were derived from the program tracking. The impact evaluation VGSRR from Table 1-3 were applied yielding a program average savings of 1.53 kWh/sqft for electricity and 0.0133 MMBTUs/sqft for natural gas/propane. The program average savings was proportionally adjusted based on the expected savings of the measure mix reported for each responder's new construction. Combining all the savings for un-incented new construction with ACE features that was influenced by NYSERDA yields a final average savings of 0.35 kWh/sqft for electricity and 0.0037 MMBTUs/sqft for natural gas/propane.

2.3.3 Indirect Impacts

Table 2-27 presents the indirect annual savings associated with projects with a Complete status in the Scorecard as of September 30, 2021. For reporting purposes, the indirect savings are allocated by program and market focus (market or low-moderate income (LMI)), proportional to the funding committed for that sub-program through September 30, 2021. Indirect savings reflects multiple NYSERDA activities (i.e., incentives, training, demonstration projects) and program funding was selected as the best proxy for holistic indirect program influence. The total indirect annual savings for all program activity from 2016 through September 2021 is the product of the funding committed in the time period of interest and the fuel specific Savings/Funding Ratio described in Table 2-27.

Table 2-27. Indirect savings summary for program activity through September 2021

	Electric Savings	Units	Natural Gas / Propane Savings	Units
GIA contributing to indirect savings	595,651,909	Square feet	595,651,909	Square feet
Average annual savings/sq ft	0.35	kWh/sq ft	0.0037	MMBtu/ sq ft
Indirect annual savings, through Q3-2021	209,689	MWh	1,790,850	MMBtu
Committed Funding through Q3-2021	$80,812,284	$	$80,812,284	$
Savings/Funding Ratio	0.0026	MWh/$	.022	MMBtu/$

A more detailed distribution of indirect savings is presented in Table 2-28 and Table 2-29 for electric and natural gas, respectively. The subsector savings was computed as the product of the Savings/Funding Ratio for each fuel and the cumulative committed funding reported for that sub-sector.

Table 2-28. Detailed indirect annual electric savings (MWh)

Project ID	Primary Sector	Market Rate	LMI
CNC001	Commercial	4,145	0
C00016	Commercial	15,043	0
C00017	Multifamily	7,699	13,671
C00018	Multifamily	1,788	15,236
CN003	Single-Family	8,707	51,127
CNC005	Single Family	217	1,227
CNC004	Buildings of Excellence Competition	8,013	40,656
CNC002	Net Zero Energy for Eco Dev	42,159	0

Table 2-29. Detailed indirect natural gas/propane savings (MMBtu)

Project ID	Primary Sector	Market Rate	LMI
CNC001	Commercial	35,401	0
C00016	Commercial	128,475	0
C00017	Multifamily	65,756	116,754
C00018	Multifamily	15,272	130,125
CNC003	Single-Family	74,362	436,647
CNC005	Single Family New Construction	1,857	10,481
CNC004	Buildings of Excellence Competition	68,436	347,227
CNC002	Net Zero Energy for Eco Dev	360,057	0

3 Methods

3.1 Market Assessment Methodology

3.1.1 Survey Sample Design and Disposition

The primary research method for the market assessment was conducting a survey with participating and non-participating building owners/developers and design professionals. The intent of the non-participant and participant surveys was to gather specific information about an actual property, which is a parcel of land owned by a single party and is typically a single-family home, or one or more similar buildings on a commercial or multifamily property. A property or a parcel of land was selected as the sample unit (in lieu of selecting a unique NYSERDA applicant or a participating developer with a diverse portfolio of developments) for the following reasons:

- The survey was an opportunity to collect building-specific information and thus supplement limited measure data in the program tracking records.
- Richer and more accurate data can be collected at the building level on new construction practices. Asking respondents about a specific building should increase accuracy because the respondent does not need to estimate what their average practice might be and is therefore not subject to whatever inherent biases might be associated with their average estimate.

Participants and non-participants were asked about two properties or parcels of land. Since the building practices within a development are likely similar, the respondent was asked about a single building selected from two different developments. The buildings associated with a property were grouped by ZIP code, and the largest single building within that project was defined as the property sampling unit.

The non-participant sampling unit is also called a property or a parcel of land. The non-participant sampling frame is the New York Tax Parcel data, a comprehensive listing of New York properties that includes the year built, which can be used to identify new buildings. A non-participant development includes all the buildings on the same street within the same community built within the years of interest (since 2016) as a proxy for development. The largest building within the development was selected as the property sampling unit.

The Market and Impact Evaluation Team defined the participating building population as the properties that are complete. At the time of sampling, no properties were complete under the Buildings of Excellence Competition and Net Zero Energy for Economic Development or NZEED in the program tracking data. Table 3-1 and Table 3-2 summarize the participant and non-participant property survey completes.

Table 3-1. Participating owner/developer and design professional survey data collection summary

	Single-Family Properties	Multifamily[a] Properties	Commercial Properties
Population (Period of interest 2016 to mid-2021	2,529	149	40
Initial Target Sample (Adjusted due to data collection challenges)	66 (20-30)	50 (30-40)	47 (20-30)
Finale Sample	41	35	13
Confidence/Precision	**90% / 13%**	**90% / 12%**	**90% / 18%**

[a] The Market and Impact Evaluation Team included mixed-use properties under this category.

Table 3-2. Non-participating owner/developer and design professional survey data collection

	Single-Family Properties	Multifamily[a] Properties	Commercial Properties
Sample Frame (Period of interest 2016 to mid-2021) [b]	32,618	4,082	3,835
Initial Target Sample (Adjusted due to data collection challenges)	66 (20-30)	54 (20-30)	68 (20-30)
Finale Sample	22	32	28
Confidence/Precision	**90% / 18%**	**90% / 15%**	**90% / 15%**

[a] The Market and Impact Evaluation Team included mixed-use properties under this category. Also, the Team excluded five respondents or sites from the sample because those five participated partially or fully in NYSERDA's Multifamily Performance Program.

[b] Sample frame included only those newly constructed properties for which the Market and Impact Evaluation Team had contact building owner, developer, or design professional information. The contact information came for the Dodge database, a database of construction projects and bids. Dodge contact data was appended to the Tax Parcel data prior to sampling.

Table 3-3 summarizes the participant and non-participant square footage information.

Table 3-3. Sample and population square footage

Period of interest 2016 to mid-2021	Sq. Ft. in NYS	Sample Sq. Ft.	Percent Sq. Ft.
Participant properties	21,138,960	~4 million	19%
Non-participant properties	623,487,462	~5 million	1%

The original sample design had intended to use a "development" as the sampling unit, while still selecting a single building within the development as the target of the survey. However, there was no reliable gross interior space for characterizing the area of the development, so this approach was abandoned.

The Market and Impact Evaluation Team relied on multiple outreach methods (email and telephone) to complete surveys with participating building owners/developers and design professionals. The Market and Impact Evaluation Team reached out to all 175 participating building owners/developers and their design teams, and completed 89 (41 single-family, 35 multifamily, and 13 commercial) participant property surveys. [14] The Market and Impact Evaluation Team reached out to over 1,000 non-participating

[14] The respondents from nearly 50 organizations provided input on either one or two properties.

building owners/developers and their design teams, and completed 82 (22 single-family, 32 multifamily, and 28 commercial) non-participant property surveys.

Due to a lower-than-expected response rate and small participant populations for multifamily and commercial properties, the Market and Impact Evaluation Team did not achieve the original participant and non-participant survey completion property sample targets. To attempt to reach the original 90%/10% confidence/precision by sector samples, the Market and Impact Evaluation Team revised the incentive approach, leveraged multiple email reminders and telephone attempts, and even engaged NYSERDA to encourage participants to respond. These efforts had limited success in driving up response rates.

While the response rate was lower than expected, the respondents were knowledgeable and included organizations' executive staff (owners, presidents, vice-presidents, CEOs, CFOs) as well as facility or construction directors, energy managers, or project managers.

3.1.2 Selection of Years of Interest to Inform the Non-Participant Sampling

Table 3-4 tabulates the number of participant properties or parcels built by year according to Tax Parcel data and NYSERDA program tracking records of the year of construction. The years were not always in agreement. The highlighted cells (in yellow) indicate the number of parcels where NYSERDA participant tracking and the Tax Parcel data years of construction agree. However, many NYSERDA records indicate a later construction date than Tax Parcel data or there is no construction date value, even though Tax Parcel records indicate the project was built. The Market and Impact Evaluation Team hypothesizes that the later dates are because NYSERDA NCP requires additional activity (inspections and paperwork) after construction is complete.

Table 3-4. Number of participant parcels constructed in Tax Parcel Data and year built

		NYSERDA Tracking: Construction Completion Year								Sum of Participant Parcels by Year
		Unknown	2016	2017	2018	2019	2020	2021	2022	
Tax Parcel Data: Year Built	2014								1	1
	2015	17	1		4	3	5			30
	2016	373	45	1	16	20	4	1		460
	2017	271		3	140	189		3		606
	2018	7		1	382	196	6	2		594
	2019	15			8	305	82	19		429
	2020					1	51	2		54
	Total	**683**	**46**	**5**	**550**	**714**	**148**	**27**	**1**	**2,174**

Table 3-5 tabulates the total number of parcels built each year according to the Tax Parcel data and the number of participant parcels built in the same year that could be mapped to the Tax Parcel data. Very few participant parcels that were mapped to Tax Parcel data have a tax parcel construction date prior to 2016, which is expected. Very few participant parcels were mapped to a Tax Parcel construction date of 2020. This is because Tax Parcel data records for 2020 are incomplete. Thus, most participant parcels mapped to Tax Parcel data show dates between 2016 and 2019, and so these years have been selected for the non-participant Tax Parcel sample frame, ensuring the actual construction vintage of participant and non-participant parcels are the same.

Table 3-5. Number of participant and non-participant parcels by year

		Tax Parcel Property Records	Number of Participant Parcels	Percent of Mapped Participants by Year
Year Built in Tax Parcel Data	2014	11,171	1	0%
	2015	11,127	30	1%
	2016	11,767	460	21%
	2017	10,845	606	28%
	2018	11,235	594	27%
	2019	9,660	429	20%
	2020*	1,474[a]	54	7%
	Total	67279	**2,174**	

[a] 2020 Tax Parcel records are incomplete

3.1.3 Channel Partner In-Depth Interviews

NYSERDA partnered with certain organizations to (1) promote the NCP offerings and generate leads (especially for the Building of Excellence or BOE) and (2) to support the education of design, construction, and end-use communities on topics of clean energy and energy efficiency. NYSERDA also leveraged the partners to disseminate lessons learned from the BOE projects. The Market and Impact Evaluation Team interviewed seven NCP partners to learn about the market and barriers to building properties with clean energy and/or energy efficiency features.

The Market and Impact Evaluation Team also interviewed one Industrial Development Agency in NYS to learn of their level of involvement in stimulating NZE or carbon-neutral construction in their jurisdiction. The Market and Impact Evaluation Team attempted to interview one to two more local economic development agencies. However, the economic development agency contacts, which generally were executive staff, were busy and opted to not be interviewed.

3.2 Impact Evaluation Methodology

This section reviews the activities performed to produce VGS and the VGSRR. Section 3.2.1 provides a detailed program description and a discussion of the context of the impact evaluation work. An overview of the methods used is summarized below and is followed by a more detailed discussion of each activity.

The program uses HERS raters to verify as-built conditions and model each participating home with REM/Rate or Ekotrope. This study assumes that the as-built observations of the HERS raters accurately reflect the home. These ratings are done in accordance with industry standards, including “Mortgage Industry National Home Energy Rating System Standards” and EPA’s ENERGY STAR Certified Homes Program technical standards and requirements.

The evaluation included the following activities:

- Check for accurate transcription of modeled savings to the Scorecard savings reported to NYS.
- Examination of the baseline conditions used by the models to verify if they are appropriate, in turn indicating the modeled savings are correct. If determined not to be correct, the Market and Impact Evaluation Team made necessary adjustments to savings.
- Calibration of the as-built models with actual utility monthly billing data to account for operational differences in the home that would be expected to impact savings with adjustment of the modeled savings, accordingly, using the ANSII/BPI-2400-S-2015 standard.
- The results of these activities were combined to produce the Verified Gross Savings and attendant Verified Gross Savings Realization Rates. The adjustment for misapplied baselines was removed from the calculation of an Alternative Prospective Realization Rate

3.2.1 Impact Evaluation Context

The evaluation of the New Construction Program is scheduled to cover all three sectors of program activity over a three-year contract, including single-family (this effort), multifamily, and commercial. The Market and Impact Evaluation Team reviewed activity in all three sectors at contract outset to determine the evaluation schedule. At that time, there was sufficient single-family facticity (2,529 projects) to support an evaluation. Multifamily and commercial projects, however, were found to have low project completion rates at the time but were anticipated to have many more complete before 2023. The Market and Impact Evaluation Team decided to focus on the impacts in the single-family sector in 2021 and 2022 as it had ample participant activity to study with a representative sample. The impacts of the multifamily and commercial sectors are staged for evaluation in 2022 and 2023 as they are projected to have substantial activity to support a fuller sample of program activity.

3.2.2 Program Delivery Details

Per PON 4337 and the New Construction chapter of the CEF Investment Plan, "The Low-Rise Residential New Construction Program (LR NCP) offers technical support and incentives to developers of single-family, low-rise multi-unit, and low-rise multifamily new construction, as well as gut rehabilitation projects." The incentives and technical support offered also spans other sectors, including commercial and multifamily, however, single-family is the focus of this portion of the study. The LR NCP was merged with the multifamily program to become the New Construction Housing Program.

> "The Low-Rise Residential New Construction Program (LR NCP) offers technical support and incentives to developers of single-family, low-rise multi-unit, and low-rise multifamily new construction, as well as gut rehabilitation projects."

Eligible buildings in the single-family sector include single-family homes, multifamily buildings less than three stories high with no more than four units, and townhouses. Applications for participation can be done before or after a home is built. In the Single-Family New Construction program, builders hire Home Energy Raters (HERs) to perform audits that validate the characteristics, systems, and efficiencies of each newly built home eligible for program participation.[15] These HERs must be affiliated with a RESNET-accredited Rating Quality Assurance Provider that is accepted by NYSERDA. The raters are responsible for developing a REM/Rate or Ekotrope model to confirm HERS certification and calculate electric and gas energy savings achieved from home performance above New York State code (and amendments)[16]. The Home Energy Ratings are performed in accordance with industry standards, most notably "Mortgage Industry National Home Energy Rating System Standards" and EPA's ENERGY STAR Certified Homes Program technical standards and requirements.

These models are from either REM/Rate or Ekotrope, both of which are well-known platforms that are considered industry standards for HERs ratings and home energy analysis. NYSERDA receives batched outputs from REM/Rate and savings from Ekotrope that are entered into the Salesforce project tracking database. Homeowner names are not regularly gathered as participation is typically directly with the builder, often before the home is purchased. Builder information and participating addresses are gathered and stored as part of tracking program activity.

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[15] The program requires the buyer to purchase Energy Star qualified appliances in the future when they are not installed at the time of the rating/audit.

[16] An amended version of IECC 2015 was in effect for homes permitted in New York State after October 3, 2016. Those permitted after May 12, 2020, are mandated to comply with an amended version of IECC 2018.

3.2.3 Acquisition of Data

Billing Data. The impact work began with an effort to acquire consumption data for participating homes. A push to web letter was sent by NYSERDA to all identified homeowners of completed single-family homes requesting authorization for NYSERDA to request both electric and gas consumption data from the serving utility company. Since nearly all participating homes went through the program before being purchased for the first time, the Market and Impact Evaluation Team used tax records to map homeowner names to the addresses in Salesforce for use in this solicitation. A $15 Amazon gift card offer was given to each participant that provided consumption data consent. The letter used in this effort is included in Appendix B. Survey responses were gathered in Qualtrics.

The Market and Impact Evaluation Team received 175 data release consents from the 1,289 letters delivered. This represents a 13.6% response rate. The use of both QR codes and an abbreviated URL were particularly useful in producing this response rate, as 55% of them used the QR code and 45% used the URL to access the survey. The utility account numbers provided by respondents were not always successful in matching the account numbers in the request to the serving utility, as shown in Table 3-6. Roughly 6 in 10 electric and half of gas accounts were able to have consumption data successfully delivered and available for the analysis.

Table 3-6. Valid utility account numbers

Result	Electric	Gas
Total respondents	175	175
Valid Unique Account Numbers	103	90
Invalid Account Numbers	72	85
% Success	58.8%	51.4%

The Market and Impact Evaluation Team processed the consumption data from the valid account numbers above for use in the calibration process. Table 3-7 shows the attrition and final disposition of accounts with valid account numbers presented above. As part of this process, the Market and Impact Evaluation Team found several accounts with billing data but no models available. Many of these were determined to have not been completed. A handful were complete but did not have a model available. The Market and Impact Evaluation Team was able to receive PV data for three sites just prior to this report and were not able to incorporate them into the analysis. Seventy-seven electric and 65 natural gas/propane sites were included in the final calibration analysis.

Table 3-7. Final account billing calibration disposition

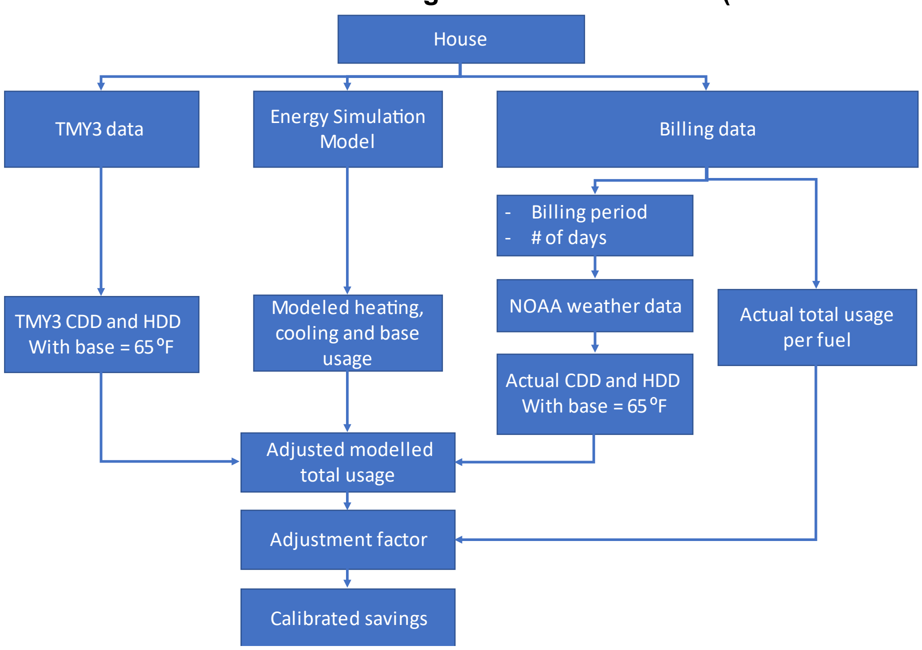
Disposition	Electric	Natural Gas/Propane
All sites (Valid Accounts)	103	90
No model	20	23
Incomplete #Days	5	3
PV (not able to be incorporated)	4	N/A
Final Data in calibration	77	65

Files, models, and reference models. The Market and Impact Evaluation Team worked with NYSERDA to gather available REM/Rate and Ekotrope models from Salesforce and the Ekotrope platform. REM/Rate models were downloaded as needed to exercise them for savings and consumption values when able. Ekotrope models were run via their online platform. NYSERDA provided UDRs to complement the REM/Rate models and enable them to produce energy impacts, although not all could be run successfully, as discussed in Section 2.2.3.2.

3.2.4 Model and Savings Calibration

The monthly consumption data provided by the utilities, described earlier, was the foundation for this analysis. The method used to calibrate the modeled savings follows ANSII/BPI-2400-S-2015 standard. Figure 3-1 illustrates the methodology.

Figure 3-1. Overview of model and savings calibration methods (ANSI/BPI Methodology)



The methodology was applied to each home eligible for the analysis (Table 3-7). Each step of the calibration process is described in the following paragraphs.

Modeled energy usage disaggregation: The modeled energy usage from Ekotrope or REM/Rate, is disaggregated into weather-dependent heating and cooling and a weather-independent baseload for each fuel among natural gas or electricity. If a fuel is not used or there is no billing data, then the weather-dependent component is not computed.

Typical and actual heating and cooling degree days: Weather normalization depends on determining the ratio of the actual degree days that occurred during the billing period and the model assumption of degree days.

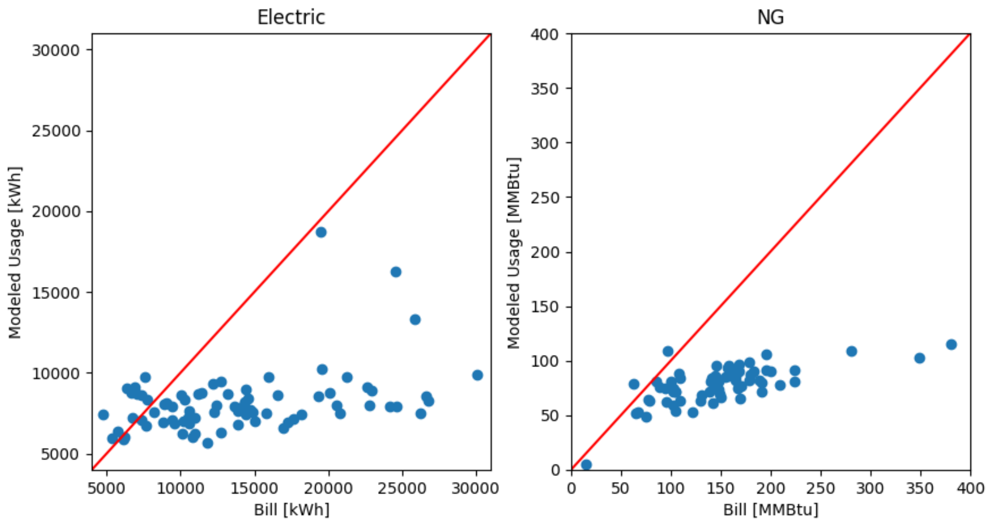
To be able to compare the actual to the modeled total home energy consumption, for each fuel, the modeled energy consumption was weather normalized based on the heating and cooling degree days (HDD and CDD) calculated from the weather data that each simulation software uses. Both Ekotrope and REM/Rate software use the Typical Meteorological Year version 3 (TMY3) weather data in their annual hourly simulations. The home zip code was used as a proxy to identify the closest location for which TMY3 weather data is available. The Python tools package, EEweather,[17] was used to calculate the HDD and CDD for a one-year period with a base temperature equal to 65°F.

To adjust the weather-normalized modeled energy consumption to the actual weather and billing data time frame, the total HDD and CDD from the historical actual weather data must be calculated, as well. The source of the historical weather data was from National Oceanic and Atmospheric Administration (NOAA) weather archives. Here as well, EEweather was used to calculate the actual HDD and CDD with the NOAA data over the billing period.

Determining the Billing Usage: The actual total energy consumption for each fuel, the number of days within the total billing period and its start and end dates was determined for each of the billing accounts received from the utility. The monthly utility billing data for most homes spanned a period of more than 600 days vs the fixed 365 days for the software simulations, which is apparent in Figure 3-2. The figure shows the scatter plot of the total modeled usage from the software versus the actual usage for the billing period for all the retained homes.

[17] https://eeweather.readthedocs.io/en/latest/

Figure 3-2. Modeled usage versus actual usage scatterplots (electric and natural gas/propane)



<u>Calibrated modeled energy consumption</u>: The calibration step adjusts for the actual number of days in the billing period, weather conditions, and other unknown operational factors that occur within the home.

The procedure employed to calculate the "Adjusted Modeled Energy Consumption" (AMEC) was based on the simplified calibration procedure described in ANSI/BPI-2400-S-2015 standard.[18] The adjusted modeled energy consumption is the estimated home energy consumption in the same weather zone as the billing data and for the same period. It is given by the equation below:

$$AMEC_{j,i} = B_{j,i} \cdot \frac{d_{j,i}}{365} + H_{j,i} \cdot \frac{HDD65_{aw,i}}{HDD65_{TMY3,i}} + C_{j,i} \cdot \frac{CDD65_{aw,i}}{CDD65_{TMY3,i}}$$

Where:

i denotes a specific home$_i$.

j denotes a specific fuel$_j$.

$B_{j,i}$ is the modeled baseload annual usage for the considered fuel. $B_{j,i} = 0$ if the fuel is not used for baseload.

$H_{j,i}$ is the modeled heating annual usage for the considered fuel. $H_{j,i} = 0$ if the fuel is not used for heating.

[18] ANSI/BPI-2400-S-2015: Standard Practice for Standardized Qualification of Whole-House Energy Savings Predictions by Calibration to Energy Use History

$C_{j,i}$ is the modeled cooling annual usage for the considered fuel. $C_{j,i} = 0$ if the fuel is not used for cooling.

$d_{j,i}$ is the number of days in the considered billing period.

$HDD65_{aw,i}$ and $CDD65_{aw,i}$ are respectively the total HDD and CDD from the actual weather data for the considered billing period with a 65°F base temperature.

$HDD65_{TMY3,i}$ and $CDD65_{TMY3,i}$ are respectively the total HDD and CDD from the one-year TMY3 weather data with a 65°F base temperature.

Figure 3-3. Calibrated model usage versus actual usage scatterplots (electric and natural gas/propane)

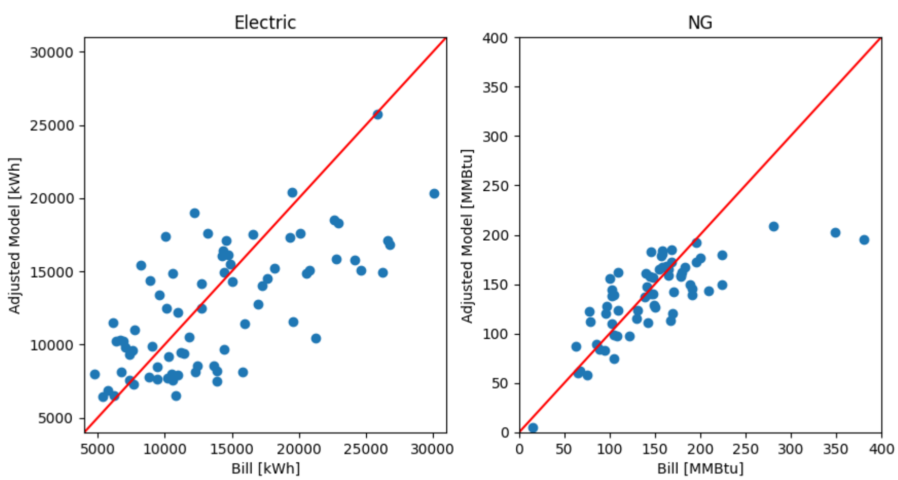


Figure 3-3 shows the scatter plot of the software adjusted modeled usage versus the actual usage for the billing period for all the retained homes. The differences between the actual and modeled energy consumptions can now be attributed to all the possible factors since the normalization adjusts for weather and the length of the billing period. These factors would include, for example, the customer specific preferences for heating and cooling setpoints.

Adjustment factor and savings calibration: The adjustment factor used to calibrate the Scorecard savings is calculated as:

$$Fuel\ Adjustment\ Factor\ (FAF)_{i,j} = \frac{ATU_{i,j}}{AMEC_{i,j}}$$

Where:

$ATU_{i,j}$ is the actual total energy usage gathered from the bills for a given $home_i$ and $fuel_j$.

$FAF_{i,j}$ is the adjustment factor for a given $home_i$. and $fuel_j$.

Figure 3-4. Calculated adjustment factor distribution

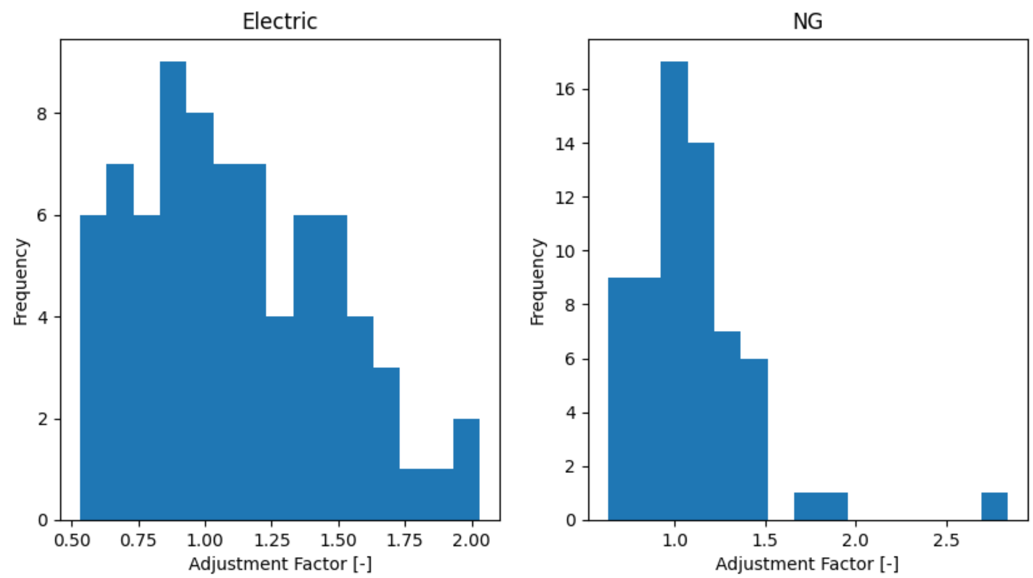


Figure 3-4 shows the calculated adjustment factors distribution for each fuel. It is noticeable that the gas adjustment factor distribution is centered around $F_{adj,j,i} = 1$, which means that generally the gas modeled usage reflects the actual usage. However, the distribution is flatter for electricity which suggests that there are more discrepancies between the modeled electric usage and actual usage. It is uncertain the reasons for these discrepancies.

The following equation is employed to calculate the adjusted savings:

$$S_{adj,i,j} = F_{adj,i,j} \cdot S_{m,i,j}$$

Where:

$S_{adj,i,j}$ is the adjusted savings by $home_i$ and $fuel_j$.

$S_{m,i,j}$ is the modeled savings by $home_i$ and $fuel_j$.

Figure 3-5. Scorecard adjusted savings versus modeled Scorecard savings

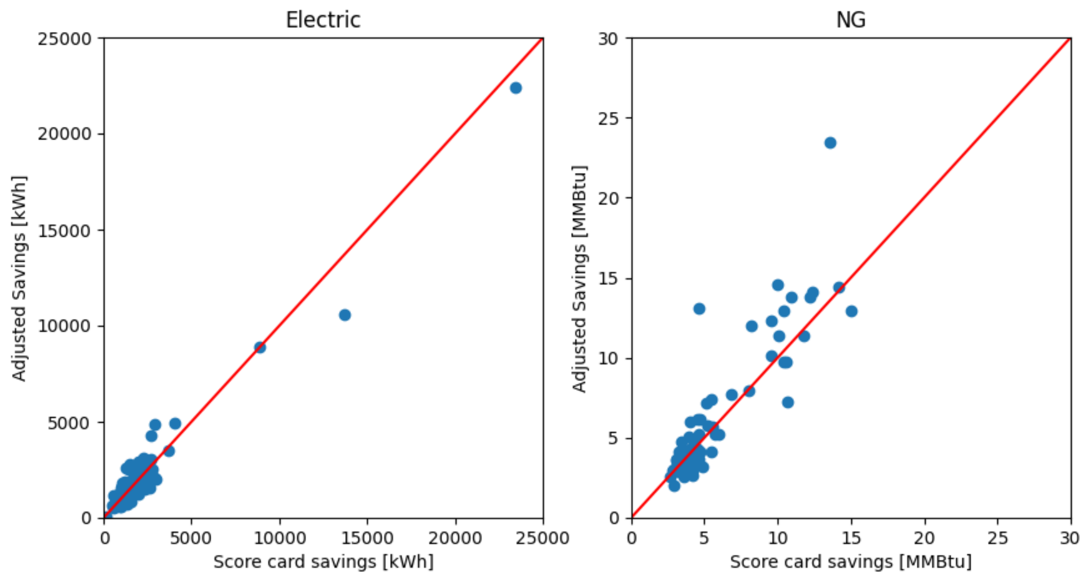


Figure 3-5 shows the scatter plot of the Scorecard adjusted savings versus the modeled Scorecard savings for all the retained homes. The Scorecard adjusted savings reflect the estimated actual savings compared to the energy consumption of the baseline.

Adjustment factor per end use and fuel: The Market and Impact Evaluation Team also explored an alternative method to adjust the software energy consumption per usage and fuel in place of adjusting the total consumption per fuel, but the challenges encountered made the method based on the ANSI/BPI standard practice a better fit. The alternative method requires disaggregating the billing data into baseload, heating, and cooling loads. The commonly used approach to do so consists of fitting multiple linear models with a range of cooling and heating base temperatures, then selecting the model with the best fit. The cooling and/or heating base temperature of the optimal model varies from house to house and can be significantly different from 65°F, the commonly used value for weather normalization. Because of this significant difference, the total CDD and/or HDD calculated from the actual historical data for the billing period could be significantly different from those calculated using TMY3 data with a 65°F base temperature, and thus lead to unrealistic adjustment factors.

For certain houses, it was not possible to calculate the cooling adjustment factor, although the identified model may have been reasonably accurate with a reasonable base temperature. In these cases, the electricity billing data may indicate some cooling energy consumption even though no cooling system was modeled in the Ekotrope or REM/Rate house model. This could signify that the occupants installed a window AC unit.

3.2.5 Review of Baseline and Baseline Adjustment

The Market and Impact Evaluation Team gathered available models for the sample to explore the baselines used to determine program impacts. The program baseline is meant to be code at the time of permitting. Two potential misapplications of code were examined and are included in the results section of this report.

1. The first is the actual baseline home characteristics not conforming to NYS code and amendments. To assess this, the Market and Impact Evaluation Team reviewed the Ekotrope reference home and REM/Rate 2016 reference home (UDR) and concluded that they conformed to the appropriate amended version of IECC 2015 that was in effect for homes permitted after October 3, 2016. This baseline was determined to be appropriate for evaluating the sample, which, based on their completion date, appeared to fall during the period that the 2016 code was in place.
2. The second is the application of the correct code to the savings baseline. To assess this, the evaluation Market and Impact Evaluation Team exercised the available Ekotrope models and REM/Rate models and reviewed the reference homes and UDRs used. This effort revealed moderate use of the 2010 IECC code among some of the REM/Rate modeled homes, where the 2016 IECC code should have been used. The impact of the savings adjustment due to this finding is discussed in Section 2.2.3.2.

3.2.6 Aggregate Results

The site-level findings from the baseline adjustment and the calibration adjustment were applied to the Scorecard savings for each site in the final calibration sample. This was done for electric and natural gas/propane savings independently. It was done in two stages, allowing the calculation of a realization rate with only the calibration adjustment and one with both the calibration and baseline adjustment. This was done to provide a calibration-only realization rate for consideration as an alternative prospective realization rate in the event the baseline issues observed in the study are validated as rectified.

Precisions were calculated around the verified gross electric and gas savings. These calculations used the standard error of the ratio between the scorecard savings and the final calibration and baseline adjusted savings estimate for each site. The actual formulas used are contained in Appendix C.

3.3 Performance Tier Metric Methodology

This section discusses the analysis approach adopted to quantify the site-level and organization-level savings estimates based on measure information from participant and non-participant property surveys. The method was used to develop a performance tier metric for each property, which allowed the Market and Impact Evaluation Team to compare energy performance of surveyed participant and non-participant properties.

The Market and Impact Evaluation Team chose not to use the impact findings to qualify performance because the impact findings reflected only the single-family participant sample—no multifamily or commercial findings—and the impact methodology only focused on the participant properties. The method described in this section was selected to compare participant to non-participant survey responses and to assess the mix of measures deployed in newly constructed buildings and was not designed to be a predictor of savings. The Market and Impact Evaluation Team used pre-existing prototype energy models from the DOE along with the OpenStudio energy modeling tool to create a framework for quantifying performance tier site savings based on measure-specific responses.

3.3.1 DOE Prototype Model Framework

The Market and Impact Evaluation Team used OpenStudio to update standard prototypical models produced by the DOE. The idea behind this was to start with an IECC 2015 (International Energy Conservation Code) compliant prototype as the baseline model. The Market and Impact Evaluation Team then updated building systems in this model with inputs from the surveys, to estimate the savings realized by each measure. This approach neglected interactivities and isolated each measure effect as an independent upgrade form the code-compliant baseline.

Survey responses were collected by sector. The Market and Impact Evaluation Team used a "Medium Office" DOE prototype model as representation for the commercial sector and "Mid-Rise Multifamily" DOE prototype model as representation for the multifamily sector. The DOE prototype did not cover single-family homes. For this, the Market and Impact Evaluation Team used the mid-rise multifamily model with a weighting factor of 0.2 for all consumption and savings values. Additionally, all baseline prototypes were made in compliance with IECC 2015, with weather station "Buffalo Niagara Falls" to account for upstate facilities.

Within these prototype baseline models, the Market and Impact Evaluation Team independently updated the following main end uses to estimate savings for each measure upgrade: Building Shell, Domestic Hot Water, Lighting, HVAC – Heating, and HVAC – Cooling.

3.3.2 Energy Use Intensity Metric

The code-compliant DOE prototype models provide energy consumption by end use. Since all the survey responses were for sites with their own, independent facilities of different areas, the Market and Impact Evaluation Team chose to extract the EUI (Energy Use Intensity) value from the corresponding end use consumption values. The EUI is expressed as:

$$EUI_{enduse} = \frac{Consumption_{enduse}}{Facility\ Area}$$

Where:

EUI_{enduse} = Energy use intensity (kBtu/sq ft)

$Consumption_{enduse}$ = Annual energy consumption corresponding to that end-use (kBtu)

$Facility\ Area$ = Total area of modeled prototype facility (sq ft)

The Market and Impact Evaluation Team obtained the baseline EUI by end use by sector from the DOE prototype models (Table 3-8).

Table 3-8. EUI values (kBtu/sq ft) by end use from DOE baseline prototype models

Facility Type	Interior Lighting	Exterior Lighting	Domestic Hot Water	Space Heating	Space Cooling	Ventilation Fans	Pumps	Misc. Equipm-ent	Total
Single-Family/ Townhouse	1	0	3	2	1	1	0	3	11
Multifamily	4	1	13	8	3	7	0	14	50
Commercial	6	2	2	10	3	2	0	14	38

Next, the Market and Impact Evaluation Team conducted independent parametric runs on the models to account for each measure upgrade. The resultant EUIs gave an estimate of energy use by end use in each sector for each measure upgrade, when compared to the baseline. To setup the parametric runs, the baseline model inputs were changed by measure, and the model simulation was run. For example, to see the effect of a high-efficiency envelope, the baseline model's wall, roof, and floor insulation, and fenestration were improved. The resultant EUIs from this model when compared to the baseline EUI run showed the reduction in EUIs for each end use for a high efficiency envelope. Table 3-9 shows consumption values for EUIs based on all parametric runs for a mid-rise multifamily DOE prototype.

Table 3-9. EUI reductions (kBtu/sq ft) by measure for mid-rise multifamily prototype

Measures	Heating	Cooling	Interior Lighting	Exterior Lighting	Interior Equipment	Fans	Heat Recovery	Water Systems	EUI Total	% Reduction from Baseline
Baseline	8	3	4	1	14	5	2	13	50	0%
Heating LowE	7	3	4	1	14	5	2	13	49	2.7%
Heating MidE	6	3	4	1	14	5	2	13	48	4.0%
Heating HighE	5	3	4	1	14	5	2	13	48	5.2%
Cooling LowE	8	3	4	1	14	5	2	13	50	0.4%
Cooling MidE	8	3	4	1	14	5	2	13	50	0.7%
Cooling HighE	8	2	4	1	14	5	2	13	50	1.0%
LTG LED	9	3	2	1	14	5	2	13	49	1.9%
DHW HighE	8	3	4	1	14	5	2	13	50	0.0%
Shell High	5	3	4	1	14	5	2	13	47	6.7%

A summary of EUI reduction for each measure is summarized in Table 3-10, for all three sectors. Note that the multifamily and single-family sectors show the same reduction in EUI, because DOE does not provide a model for single-family homes, hence, the Market and Impact Evaluation Team used the multifamily model as a proxy.

Table 3-10. EUI reduction percentage by sector

End Use	Commercial	Multifamily	Single-Family
Heating LowE	1.5%	2.7%	2.7%
Heating MidE	2.2%	4.0%	4.0%
Heating HighE	2.9%	5.2%	5.2%
Cooling LowE	1.1%	0.4%	0.4%
Cooling MidE	1.4%	0.7%	0.7%
Cooling HighE	1.5%	1.0%	1.0%
LTG LED	2.5%	1.9%	1.9%
DHW HighE	0.6%	0.0%	0.0%
shell High	4.8%	6.7%	6.7%

Heating and Cooling Efficiency Tiers: As seen in Table 3-10, the Market and Impact Evaluation Team split the heating and cooling end uses into three tiers: Low Efficiency, Mid Efficiency, and High Efficiency. The idea behind this was to capture variances between different levels of measure efficiencies. The Market and Impact Evaluation Team was able to use the text responses provided in the surveys to classify the different cooling and heating technologies installed in each sector. For example, a text response "96% Efficient Burner" would be classified as a "Heating HighE" measure. Each measure's efficiency was obtained through online research and compared to the baseline value.

Non-Modeled Measures: The survey data include a few measures that were not parametrically altered in the DOE prototypes due to low granularity of DOE models. These were: "Lighting - Controls," "Exhaust Heat Recovery," and "Other." The "Lighting - Controls" and "Exhaust Heat Recovery" measures were assigned a 2% EUI reduction value based on consulting the in-house engineering team. The "Other" text responses included mentions of individual measures to claiming Passive House/LEED certifications. The Market and Impact Evaluation Team parsed the responses and came up with scoring criteria based on the text response (Table 3-11).

Table 3-11. EUI reduction for "Other" measures based on text field

"Other" Category	% EUI reduction
Passive House, near net zero	40%
Solar + 1 Measure, All-electric	30%
Only Solar or 2 measures	20%
Single measure	10%
Non-Saving Measure	0%

3.3.3 Calculating Performance Tier Metric

The Market and Impact Evaluation Team used measure-specific responses from each survey and applied EUI reduction as discussed above for the following list of measures: building shell, domestic hot water, lighting, lighting – controls, exhaust heat recovery, HVAC – heating, HVAC – cooling, and other.

Each survey response included a site-specific response and an organization-level response. The site-specific response would address the measure installations for a particular site, while the organization-level response would encompass all other projects under the same owner/developer. For example, a particular site would get high-efficiency geothermal heat pumps, leading to a high reduction in EUI, but for all the other projects done by the same owner/developer, the best heating they installed was 85%, which would be a EUI reduction of 15% to 25% in heating end use.

The Market and Impact Evaluation Team aggregated the measure-level EUI reductions for both the site-level and the organization-level and assigned them specific tiers shown in Table 3-12. These tiers are used in the regression analysis, discussed in Section 2.1.3.1 of this report.

Table 3-12. Tier classification based on EUI reduction

New Tier Name	% EUI Reduction	Definition
Close To Code	<5%	Facility is code compliant
EUI Reduction 5-15%	Between 5% and 15%	Facility is more efficient than a code compliant facility, but is under program eligibility threshold (15% above code)
EUI Reduction 15.1% to 25%	Between 15.1% and 25%	Facility is mid-tier efficient according to program requirements
EUI Reduction >25%	>25%	Facility EUI is low enough that it can qualify as low-carbon or near net zero facility

3.4 Indirect Savings Methodology

The indirect savings methodology follows NYSERDA's indirect savings framework described in the "Indirect Benefits Evaluation Framework" (Framework). The Framework outlines a methodological approach for evaluating indirect savings. In addition to the Framework, NYSERDA prepared a "Budget and Benefits Assumptions Impacts and Fuel Neutrality" Excel workbook (or "BAB") that documents the direct and indirect savings estimates presented in the CEF Investment Plan (IP) for NCP.

The NCP program theory and logic were reviewed to theorize linkages and causality between program activities and expected outcomes. Table 3-13 lists program activities and outcomes from the CEF IP and proposed metrics and their role on achieving savings.

Table 3-13. Indirect savings causation analysis for achieving direct and indirect energy savings

Program Activities	Expected Outcomes	Evaluation Metric	Savings impact
Standard offer	Continued support for NCP projects through resource acquisition projects	Savings MMBtu developed in the impact evaluation for participants	Increases direct and NOMAD savings
	Participants gain confidence and extend the practices to NP construction	Participating developer, owner, and design professionals reporting adoption and influence	Increases indirect savings
Buildings of Excellence and the NZEED competitions	Showcases successful projects for replication by the new construction community	Savings MMBtu developed in the impact evaluation for participants	Increases direct and NOMAD savings
	Participants gain confidence and extend the practices to NP construction	Participating developer, owner, and design professionals reporting adoption and influence	Increases indirect savings
	Nonparticipants become aware of the success of the program	Non-participating developers, owners and design professionals report adoption and influence of NYSERDA	Increases indirect savings
Performance Analysis (Not launched)	Showcases successful projects for replication by the new construction community	Non-participating developers, owners and design professionals report adoption and influence of NYSERDA	Not assessed
Simplified Design and Tools (Not launched)	Support reduces design risk. Methods and tools reduce the cost of implementation.	Participating developers, owners, design professionals, and code officials reported adoption and influence of NYSERDA	Not assessed
Third-Party Standards Development (Not launched)	Support reduces design risk. Methods and tools reduce the cost of implementation.	Participating owners reported adoption and influence of NYSERDA	Not assessed Direct – for participants receiving other program incentives Indirect – for participants receiving no other incentives

3.4.1 Segmentation of the Market

The indirect savings is calculated by segmenting the total new construction market defined as the gross interior area of all buildings built in NYS between 2016 and 2019. The two main segments are the adopters consisting of all new construction built with advanced clean energy features (ACE features) and all new construction built without ACE features. The adopters are further differentiated by participants or non-participants and whether incentives were received by the project or not. A participant is defined as the gross interior space associated with participation in the standard offer, BOE, or Net Zero EED (NZEED) subprograms.

The segment associated with indirect savings was multiplied by the average savings per square foot yielding the indirect savings for electricity and natural gas.

Appendix A: Number of New Construction Projects by Sector

Table 3-14 shows the number of new construction properties in NYS by sector and by square footage.

Table 3-14. New construction properties by sector in NYS

Sector	Non-Participant New Construction (Source: Tax Lot Data, Built 2016 Through 2020)			Participants (Program & Survey Data, Built 2016 Through Mid-2021)		
	Number	Sq. Footage	% Sq. Footage	Number	Sq. Footage [a]	% Sq. Footage
Single-Family	32,618	66,708,879	11%	2,529	6,919,714	33%
Multifamily	4,082	227,465,084	36%	149	9,340,080	44%
Commercial	3,835	329,313,499	53%	40	4,879,166	23%
Total	42,920	623,487,462	100%	2,603	21,138,960	100%

[a] The program data included limited (hardly any) square footage data. Thus, the Market and Impact Evaluation Team used the collected square footage data from the surveys to extrapolate and derive the total square feet by sector for participant properties.

Table 3-15 shows the number of newly constructed advanced clean energy housing units in NYS by sector and by square footage. This information is provided to support NYSERDA's estimates of (1) the number of advanced clean energy housing units in NYS and (2) the number of advanced clean energy commercial buildings in NYS.

Table 3-15. New construction advanced clean energy property units by sector in NYS [a]

Sector	Non-Participants (Tax Lot Data and Survey Data)	Participants (Program Data)
	Number	Number
Single-family properties (Note, single-family properties are adequate approximation for the housing units)	1,631	2,529
Multifamily housing units (not properties/buildings)	TBD	62,448
Commercial buildings	575	40
Total		2,603

[a] To estimate this number for non-participant properties, the Market and Impact Evaluation team took the totals from Table 6-15 and applied the percent of properties in the survey that were binned into either EUI Reduction >25% or EUI Reduction 15%-25% – two categories indicating advanced clean energy property units. The Market and Impact Evaluation Team counted all participant properties as advanced clean energy properties.

Appendix B: Data Collection Instruments

Participant consent to access consumption solicitation letter

Dear [NAME],

According to our records, your home at [Insert Property Street Address] in [Insert Property City], was built with assistance from the New York State Energy Research and Development Authority's (NYSERDA) New Construction Program. This means the builder of your home received incentives from NYSERDA to ensure it would be comfortable and energy efficient. NYSERDA is conducting an evaluation of this program and has hired DNV, an independent contractor, to help us gain an understanding of how successful this program has been in reducing homeowner energy usage. Evaluations such as this are required of all NYSERDA programs. To evaluate this program, DNV will compare the energy usage of your energy efficient home to minimum energy efficiency code standard building practices. To do this, NYSERDA needs your permission to acquire your utility consumption data from your electricity and/or natural gas provider. We are offering a $15 gift card if you agree to authorize the release of your electric and fuel usage and provide the account numbers for those services.

To provide this authorization as well as your utility account numbers, please have your electric and gas bills for [Insert Property Street Address] available and use this link to complete a short online survey:

https://tinyurl.com/NYNCSFI

Or you can access the survey by scanning this code with your mobile phone (recommended in the event you would like to upload a picture of your account number(s):

Once you get to the survey landing page, please enter in your code: **[Insert Code]**.

You will also be asked to provide the name and email of the person that will receive the gift card.

Please note that all of this information, including electric and gas account numbers will be kept secure, and DNV's analyses and report will not identify your home individually. Your home's energy savings will be compiled with the savings from other homes that participated in the program. Should you have any questions, or if you prefer to authorize the release of your electric and fuel usage over the past year over the phone, please call me.

NYSERDA greatly appreciates your participation in this important study that will inform NYSERDA's future program offerings. Thank you in advance for your help.

All other instruments will be included in the final report.

Appendix C: Precision Calculation Detail

Using the case weight, the Market and Impact Evaluation Team defined the combined ratio estimator of B by the equation:[19]

$$b = \frac{\sum_{i=1}^{n} w_i \, y_i}{\sum_{i=1}^{n} w_i \, x_i}$$

Then the population mean or total of y is estimated as b times the population mean or total of x, known from the Scorecard data. Using case weights, the Market and Impact Evaluation Team calculated the relative precision at the 90% level of confidence in three steps:

1. Calculate the sample residual $e_i = y_i - b\,x_i$ for each unit in the sample.
2. Calculate[20]

$$se(b) = \frac{\sqrt{\sum_{i=1}^{n} w_i \left(w_i - 1\right) e_i^2}}{\sum_{i=1}^{n} w_i \, x_i}$$

.

3. Calculate

$$rp = \frac{1.645 \; se(b)}{b}$$

.

[19] This equation gives the same result as the conventional stratum-weighted equation: $b = \frac{\sum_{h=1}^{L} N_h \, \overline{y}_h}{\sum_{h=1}^{L} N_h \, \overline{x}_h}$.

[20] The conventional equation is $se(b) = \frac{1}{\sum_{h=1}^{L} N_h \, \overline{x}_h} \sqrt{\sum_{h=1}^{L} N_h^2 \left(1 - \frac{n_h}{N_h}\right) \frac{s_h^2(e)}{n_h}}$ where $s_h^2(e) = \frac{1}{n_h - 1} \sum_{i=1}^{n_h} \left(e_i - \overline{e}\right)^2$. Our equation assumes that $\frac{1}{n_h - 1} \sum_{i=1}^{n_h} \left(e_i - \overline{e}\right)^2$ is approximately equal to $\frac{1}{n_h} \sum_{i=1}^{n_h} \left(e_i\right)^2$ in each stratum.

Appendix D: Single-Family Desk Review

Final Single Family New Construction Baseline Desk Review Methods and Results

In 2022, DNV performed an electric and gas direct energy savings impact evaluation of the single-family sector of the New Construction Program. This Phase 1 impact analysis produced Verified Gross Savings Realization Rates (VGSRRs) for application to single family program activity from quarter 3 of 2016 through quarter 2 of 2021. The VGSRR rates from this study were 76.5% for electric and 88.9% for gas. The VGSRRs had two components in their calculation. The first was a model calibration component that used post occupancy consumption data to true up model estimated consumption and savings estimates. The second was a baseline component that adjusted for any observed use of incorrect baselines in the savings estimates. The primary driver of the VGSRRs being below 100% was the misapplication of savings baselines; specifically, the misapplication of 2010 code as baseline in participant savings models that should have used the 2016 code as the baseline.

At the time of reporting, it was noted that program changes were implemented to ensure the use of a correct baseline, which made the continued application of the VGSRR beyond the period studied inappropriate. DNV provided an Alternative Prospective Realization Rate (APRR) for application that assumed a correct application of baseline code. This APRR also effectively assumed that only adjustments due to modelling calibration activities drove the realization rate and that the baseline issues observed would be rectified. Per the NYS DPS guidance on gross savings verification, the APRR is available for application for a period of 18 months, after which a study to ensure the conditions for application are verified or the prior VGSRRs must be applied. An updated impact study, consisting of a desk review, was commissioned to fulfill this obligation by drawing a sample of recent program activity to verify correct baseline application and ensure application of a correct and defensible realization rate for single family projects going forward. The table below summarizes the VGSRRs, APRRs, and periods of application used by NYSERDA prior to the findings of the updated analysis.

Table 1. Single Family New Construction VGS and APRR Application Summary

Period of Application	Realization Rate	Electric	Natural Gas
Q3 2016 – Q2 2021	Verified Gross Savings (VGS)	76.5%	84.9%
Q3 2021 – Q4 2022	Alternative Prospective (AP)	100%* (104.5%)	100%* (112.8%)

*DPS VGS guidance does not allow APRRs to be greater than 100%. For reporting purposes, NYSERDA uses 100% during the APRR application period.

Sample Design

DNV received a population of single-family new construction program activity for all of 2022. This data included project description, electric and gas savings, and other initiative and project level information.

DNV targeted a sample size of 46 sites, which targets a precision of ±10% at the 90% confidence interval around the portion of sites using correct baselines. One sample site was dropped as it was a duplicate with another site and a second site was dropped as it was an older site with a 2014 permit date that was not representative of current baseline application activities. DNV stratified the remaining 44 single-family sites based on site type (single-family residential vs. town homes), initiative (market rate vs. low-moderate income), and program (Low-rise Residential New Construction vs New Construction - Housing) to ensure representation within the various program groups. Table 2 shows population activity by project count and savings along with where the final sample of 44 projects fell by program.

Table 2. Summary of 2022 Program Year Activity

Program	Total MMBtu savings (electric and gas)	Savings (%)	Pop (N)	Sample (n=44)
Low Rise New Construction	7,717.7	60%	141	28
New Construction – Housing Program	5,106.5	40%	103	19
Total	12,824.2	100%	244	44

DNV acquired permit data for all sample points, REM/Rate and Ekotrope libraries and models where available. Permit data was used to determine the code appropriate for baseline use. Consistent with NYS regulations, a grace period allowing permitting under a previous code for a period of time was not allowed, and the 2020 baseline was applied starting May 12, 2020. Table 3 shows how codes in effect were determined.

Table 3. Summary of Codes and Application Dates

Date of Permitting	Code in effect
Before May 12, 2020	2016 Energy Conservation Construction Code of New York State (2015 IECC with NYS amendments)
May 12, 2020-Present	2020 Energy Conservation Construction Code of New York State (2018 IECC with NYS amendments)

Verification of Project Baselines

DNV reviewed the models in Ekotrope and REM/Rate separately as they each had their own set of available information and conditions.

There were 32 **Ekotrope** home models in the sample. DNV logged into the Ekotrope platform to run these models against the baseline period based on permit data. The eight sample points with 2016 baselines were run and their modelled savings matched those provided by NYSERDA, indicating these sites used the correct baseline. As part of this process, DNV compared the referenced home library values to the 2016 ECC of New York State to confirm its adherence to code. There were 24 sample points that were reviewed for application of a 2020 baseline, though a 2020 baseline model was not available on the

Ekotrope platform. When DNV ran 17 of the participant models in this group against the 2016 baseline, the modelled savings matched with the tracking estimates provided by NYSERDA. This indicates that these sites incorrectly used the 2016 baseline. Seven other sites in the Ekotrope group determined to require the 2020 baseline had per unit estimates established by NYSERDA . These per unit estimates did not have a formal code-based baseline.

There were 12 **REM/Rate** home models in the sample. A 2020 REM/Rate baseline reference home was not available for observation and use. DNV was unable to run the two participant models that should have used 2016 code baseline, due to inaccessible library files. These sites were categorized as having savings based on an unknown baseline code, because they had unique savings estimates (not per unit estimates). Five sites in the REM/Rate group determined to require the 2020 baseline based on permitting date had per unit estimates established by NYSERDA using the same methodology as for Ekotrope described above. The last five REM/Rate sites, which were permitted after May 12, 2020 were determined to have used 2016 code in lieu of 2020.

Table 4. Application of Baseline Findings Summary

Model	Permit Date Code	Total	Correct used code (n)	Incorrectly used code (n)	Unknown	Used Per-unit estimates
Ekotrope	2016	8	8	0	0	0
Ekotrope	2020	24	0	17	0	7
REM/Rate	2016	2	0	0	2	0
REM/Rate	2020	10	0	5	0	5
	Total	44	8	22	2	12

DNV reviewed the per unit estimates used by NYSERDA for the 7 Ekotrope projects by running models for those projects against the available 2016 baseline. These per unit estimates are 2.09 MHW for electricity and 46 MMBTU for natural gas. The savings from the Ekotrope models with the 2016 baseline was found to be lower than these assumptions. Since use of a 2020 baseline would further lower energy savings from the 2016 baseline, DNV concludes that the per unit estimates currently in use by NYSERDA are producing program savings estimates that are higher than that being achieved.

REVISION OF THE VGSRR

As described above, during the analysis of the 44 sites' data DNV observed many participant models with an incorrect application of code, an unknown baseline, or the use of per-unit estimates without a clear code-based baseline. This precipitates the need for a new code-based adjustment that can be coupled with the DNV established model calibration impacts that drove the APRR. As discussed in the original single family VGSRR study, the design of the evaluation included a model calibration adjustment factor and a baseline adjustment factor that were combined to produce the VGSRR. The following list describes when and how savings were recalculated to inform a new baseline adjustment for different scenarios that arose during the evaluation. This adjustment uses the sum of the tracking savings estimates divided by the sum of the baseline adjusted savings estimate. Table 5 summarizes these results and final impact of the observed baseline issues on savings.

- Where baselines were correctly applied, the baseline adjusted savings is 100% of the tracking estimate (8 sites). These are shown in row A in Table 5.
- Where baseline consumption was known for an Ekotrope site that incorrectly used 2016 code in lieu of 2020 or that had a per unit estimate, that baseline electric and/or gas consumption is decreased by 2% and a new baseline adjusted savings value is calculated as the difference between the new baseline consumption estimate and the as-built model consumption. This method was applied to all 24 Ekotrope models shown in row B in Table 5.
- For the two REM/Rate models with permit dates that identified a 2016 baseline, but the baseline was unknown, the tracked savings is 100% of the tracking estimate This assumes that since a 2020 baseline was not available, a 2016 baseline was likely appropriately used. These are shown in row C in Table 5.
- Three of the five REM/Rate baseline models that incorrectly used 2016 code in lieu of 2020 ran successfully. In these cases, DNV applied a 2% reduction in baseline consumption to recalculate baseline adjusted electric and gas savings, as described in the second bullet above. This method is applied to 3 of the sites in row D in Table 5.
- The remaining seven REM/Rate models whose baseline incorrectly used 2016 code in lieu of 2020 were not able to be run successfully or had a per unit estimate that did not have an explicit code. In these instances, DNV used weighted average electric and gas savings per square foot from the Ekotrope models as the baseline adjusted savings estimate. This method is applied to 7 of the sites in row D in Table 5.

Table 5 summarizes the sample, its tracking savings, and the estimated savings after adjusting for the baseline issues observed with the methods discussed above. The overall baseline adjustment is calculated as the sum of the tracking savings estimates divided by the sum of the baseline adjusted savings estimate. This analysis results in an overall baseline adjustment of 82.3% ±11.9%at the 90% confidence interval for electric savings and 92.5% ±11.6%at the 90% confidence interval for gas savings.

Table 5. Summary of Baseline Adjustment Results and Realization Rates from 2022 Sample

Row	Model	Permit Date Code	Count of Projects	Tracking Savings		Baseline Adjusted		Baseline Adjustment Realization Rates	
				Electric (MWh)	Gas (MMBTU)	Electric (MWh)	Gas (MMBTU)	Electric	Gas
A	Ekotrope	2016	8	8.2	211.8	8.2	211.8	100%	100%
B	Ekotrope	2020	24	39.3	867.4	32.1	814.7	81.7%	93.9%
C	REM Rate	2016	2	3.5	51.8	3.5	51.8	100%	100%
D	REM Rate	2020	10	17.9	420.0	13.0	356.9	72.6%	85.0%
		Total	**44**	**68.9**	**1,551.0**	**56.7**	**1,435.2**	**82.3%**	**92.5%**
							Precision at 90% confidence	**±11.9%**	**±11.6%**

In the New Construction Program Market Assessment and Single-Family Impact Evaluation Phase 1 Report, the adjustment, or APRR, is described. This was estimated by only taking model calibration into account resulting in an APRR of 104.5% ±5.9% at the 90% confidence interval for electric energy savings (kWh) and 112.8% ±10.7% at the 90% confidence interval for gas energy savings (MMBTU). This model calibration impact rested upon the standards established in ANSII/BPI-2400-S-2015. This factor effectively adjusts savings estimates based upon differences observed between predicted consumption in the home models versus actual consumption from post occupied billing data. Combining the baseline adjustment and the model calibration results provides a new overall VGSRR estimate for NYSERDA use.

Combining the model calibration results from the previous study with the new baseline results from this desk review process provide VGSRRs of 86.1% ±11.9% at the 90% confidence interval for electric and 104.4% ±11.6% at the 90% confidence interval for gas.

Table 6. VGSRR Summary by Fuel

Fuel	VGSRR	Precision at 90% Confidence
Electric	86.1%	±11.9%
Gas	104.4%	±11.6%

Findings and Recommendations

Below are the conclusions and recommendations for NYSERDA consideration.

Finding 1. Although DNV found a high rate of baseline misapplication in the sample reviewed, the difference in energy consumption between the 2016 baseline (based on IECC 2015) and the 2020 baseline (based on IESS 2018) represents a comparably small difference in energy savings (2%) compared to the difference in energy consumption between the 2016 baseline and the 2010 baseline. This results in an overall adjustment due to baseline misapplication that is smaller than that observed in the first impact evaluation performed on the single-family sector of the New Construction Program. This results in higher VGSRRs than observed in the first study.

Recommendation 1. The VGSRR rates in Table 6 are recommended for use for program savings claims beginning Q1 2023.

NYSERDA Response to Recommendation: Implemented. NYSERDA will accept these updated realization rates, applying the new VGSRR starting in Q1 2023.

Finding 2. This review of 2022 single family sites found that 12 out of 44 sites examined were using a per unit value for electric and gas savings for participating homes. DNV's analysis suggests that these per unit estimators are likely overestimating impacts. If NYSERDA continues to regularly use these values, it is likely to produce a lower realization rate when actual savings are reviewed against estimated savings in the future.

Recommendation 2. It is recommended that NYSERDA develop a 2020 baseline home to base savings on for both Ekotrope and REM/Rate models. This will help facilitate the use of appropriate baselines and improved realization rates in future evaluations.

NYSERDA Response to Recommendation: Pending. NYSERDA is reviewing the methodology used for estimating and verifying savings, and what tools would be most useful for future analyses.