

New Construction Program Impact Evaluation (2012–2013)

Final Report

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ABSTRACT

NYSERDA's New Construction Program (NCP or the Program) is funded through the Systems Benefits Charge (SBC) and Energy Efficiency Portfolio Standard (EEPS). NCP provides technical assistance and financial incentives to business customers who are building new facilities or undertaking extensive renovations of existing buildings. The businesses served by NCP include commercial, multifamily, institutional, industrial, agriculture, government, and nonprofit operations. This report describes an impact evaluation of the NCP projects completed for the calendar years 2012–2013 and is the third impact evaluation of the Program.

The Impact Evaluation Team performed measurement and verification of energy savings for a statistically valid sample of projects completed between January 1, 2012, and December 31, 2013. Projects completed during this period enrolled in the Program between 2002 and 2013. The Program's electric realization rate (RR) for this period, defined as the evaluated gross savings divided by the program-reported savings, is 89%. The demand reduction RR is 70%. For the 2009–2011 period RRs were determined as an average of the prior evaluation for 2007–2008 and the 2012–2013 results.

This report also presents potential opportunities for consideration during future Program design and implementation discussions. The evaluation focuses on information that could support the Program's evolution under the Clean Energy Fund.

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1 EXECUTIVE SUMMARY

This report describes the impact evaluation of the New Construction Program (NCP or the Program) for the period of January 2009 through December 2013. The objectives of this impact evaluation were as follows:

- Estimate the evaluated gross savings for the Program (electric energy and demand savings).
- Provide input to NYSERDA on current projects by conducting preconstruction reviews to review baseline assumptions and modeling approach.
- Provide information that will be useful to NYSERDA in planning future new construction offerings.

The 2012 to 2013 evaluated gross savings are based on project-specific measurement and verification (M&V) performed on a statistically valid sample of 63 participant projects from that period. The primary evaluation population included 392 projects completed in 2012 and 2013 with project enrollment dates ranging from February 2002 through April 2013. The results are shown in Table 1-1 below.

Table 1-1. NCP Program-Reported Savings Evaluation Results 2012–2013

Parameter	Program-Reported Savings	Realization Rate	Evaluated Gross Savings	Relative Precision
Electric energy (MWh/yr) 2012–2013	115,862	89%	103,117	9%
Peak demand (MW) 2012–2013	37	70%	26	13%

The evaluation derived realization rates (RRs) for the period from January 2009 through December 2011 with the results shown in Table 1-2.

Table 1-2. NCP Program-Reported Savings Evaluation Results 2009–2011¹

Parameter	Program-Reported Savings	RR	Evaluated Gross Savings
Electric energy (MWh/yr) 2009–2011	153,204	84%	128,692
Peak demand reduction (MW) 2009–2011	42	61%	26

¹ RRs reflect the average of RRs for the years immediately prior to and after the 2009–2011 period.

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RRs improved significantly from the prior evaluation – increasing from 71% to 89% for electric energy savings and 52% to 70% for electric demand savings for the period from 2007–2008. This report focuses on the rigorous impact evaluation conducted for projects completed in 2012 and 2013.²

The evaluation commenced in fall 2014 and was completed in mid-2016. The duration of the evaluation period resulted from the need for a full year of building energy consumption data after building occupancy and a six month on-site metering period, both of which were required to support accurate modeling of measures and impacts across all seasons.

1.1 Program Overview

The NCP serves commercial, industrial, agricultural, and multifamily new construction projects providing a range of services and incentives designed to achieve cost-effective savings and the transformation of new construction practices. The NCP addresses a multifaceted and technically sophisticated market, including building developers, owners, design firms, and contractors. It has been in existence since 2000 and has changed considerably since its inception and over the period receiving evaluation. The Program continues to change, enabling it to maintain influence in this challenging market.

1.2 Approach

This section describes the Impact Evaluation Team’s approach to the scope of work, including the impact evaluation, participant research, and preconstruction review.

1.2.1 Retrospective Impact Evaluation

The Impact Evaluation Team conducted an in-depth study of participant savings for a statistical sample³ of new construction projects that were completed in 2012 and 2013 to determine the RR for program-reported electricity and demand savings. All projects in the sample received a high level of evaluation rigor including on-site metering and calibrated modeling at the measure or whole-building level.

The RR was applied to the program-reported savings, resulting in the evaluated gross savings estimates. The RR adjusts the program-reported savings upward or downward to account for savings differences found in the evaluation. Quantifying free ridership and spillover was not in the study scope.

Additional analysis was conducted to provide information on the reasons that evaluated gross savings varied from program-reported savings. This investigation was conducted for each significant variance at the

² The RR for 2009 – 2011 was developed using an average of the RR from 2007-2008 and from 2012-2013. This is detailed in Section 3.2.3.

³ The statistical sample was developed based on program-reported kWh savings for each project that received electric incentives.

end use level (lighting, HVAC,⁴ refrigeration, building envelope, etc.). Variances were categorized with adequate detail to identify potentially actionable drivers for differences in savings.

1.2.2 Participant Surveys

In addition to the on-site participant research described in Section 1.2.1, participant surveys were administered to a statistical sample of 82 owners and designers associated with the projects in the impact evaluation sample. The purpose of the surveys was to inform planning under the Clean Energy Fund (CEF) by providing information on the following areas:

- The mechanisms by which the Program interacts with the market and the effectiveness of those mechanisms at advancing energy efficiency
- Participant views on energy efficient practices in the broader new construction market

1.2.3 Preconstruction Review

The impact evaluation also provided preconstruction review of seven projects in the design phase to identify potential issues with or vulnerabilities of project savings before the project analysis was finalized while this input was highly actionable. The process included a high-level review of project models, a memo summarizing findings to Program staff, and conference calls with the project technical assistance (TA) provider, Program staff, and the evaluator to discuss findings. These projects will be constructed in the future. Therefore, the preconstruction review projects had no overlap with the retrospective impact evaluation population. Future evaluations will need to consider the projects that received preconstruction review separately in the sampling strategy.

1.2.4 Findings and Considerations

A key finding of this evaluation is the significant improvement in realization rates since the previous evaluation. The Program is widely recognized by participants as impacting the energy efficiency of new buildings and advancing the practice and quality of energy modeling. The Program is achieving significant natural gas savings (180% of the reported electric savings when comparing site MMBTU for gas and electricity), most of the gas measures were not funded through NYSERDA incentive programs.

The NCP is expected to operate in its current configuration in the near-term. The long-term design of NYSERDA's new construction market investments is not yet defined. The CEF and Reforming the Energy Vision frameworks suggest significant changes to NYSERDA's programs. What is clear is that NYSERDA is committed to the commercial new construction market and future efforts will place emphasis on market transformation and animation, which have been components of the NCP for the period of study.

⁴ HVAC – heating, ventilating and air conditioning

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Considerations for the Program are offered below based on the findings from this evaluation and the experience of the Impact Evaluation Team in the new construction market⁵.

Under the current Program, continue to improve program RRs by considering the following opportunities:

- The evaluation found significant market recognition of the value of energy modeling and NYSERDA's support for that work. Continue to use, improve and promote the energy modeling guide⁶ developed by the Program; the guide appears to be increasing the accuracy and consistency of building energy models.
- The evaluation found that in some cases operating assumptions used in Program energy models were inconsistent with the expected operations for the applicable building types. Examples of such discrepancies include underestimation of operating hours for manufacturing, overestimating hours and demand coincidence for seasonal fruit storage, and overestimation of occupied hours for schools⁷. While it is not expected that exact predictions of operating hours for equipment in new buildings will be achieved, improvements in estimates and in the documentation thereof will result in further increases in the RR.

The Impact Evaluation Team has identified areas that could be considered as NYSERDA explores new approaches to garnering energy efficiency in the new construction market under the CEF. These areas for possible consideration, depending on the direction and objectives of future strategies, are described below.

- Increase efficiency from building automation systems (BAS) - effectively controlling equipment to minimize energy consumption while meeting occupant needs is a complex but essential element of energy efficiency in new construction.
 - Even when large projects received commissioning, BAS measures did not always perform as expected. There may be an opportunity to more effectively ensure the commissioning provider verifies the efficient control strategies that are receiving incentives by fostering a new paradigm of engagement between the TA provider, the design engineer, the commissioning provider and the controls contractor.
 - Operators may not realize that changes they make to the BAS impact energy use. Consider incorporating key performance indicators (KPIs) for energy into building automation systems to enable operators and managers to understand when systems are not operating at target efficiency levels and enabling them to correct operational issues as they occur.

⁵ These concepts are described in more detail in Section 4.7.2.

⁶ *NYSERDA New Construction Program (NCP) Simulation Guidelines*, version 1.2a. July 30, 2012.

⁷ Examples of opportunities to improve are included in Section 3.

- Including performance measurement and verification (performance verification)⁸ as part of the project delivery is another avenue to ensure savings materialize for complex controls measures. The use of performance verification could enable market transformation by demonstrating the results of project investments and providing feedback to energy modelers and building designers so that they continuously improve their ability to deliver accurate savings estimates and high performing projects.⁹
- Large repeat and institutional customers tend to participate regularly with the Program and report less impact from the regular Program offerings than first time participants report. Consider finding new ways to engage regularly participating larger customers such as performance verification and Net Zero Energy (NZE) building demonstration projects.

⁸ Performance verification is an increasing focus of Leadership in Energy and Environmental Design (LEED) V4 and is of interest to building owners and investors because it provides direct feedback on the performance of energy efficiency investments made during design and construction.

⁹ NYSERDA 2012 Industrial Process Efficiency Impact Evaluation found that projects that received a preconstruction (termed concurrent for this program) EM&V review (similar to what is described for the NCP) all had realization rates near 1.0 while the Program as a whole had a kWh RR of 0.91.

2 INTRODUCTION

This section presents an overview of the Program, the evaluation goals, and a summary of results from the previous New Construction Program (NCP or the Program) evaluation.

2.1 Program Description

The NCP has evolved continuously since its inception in 2000. The following paragraphs describe the Program offerings available during the period being evaluated; projects were completed under nine different Program Opportunity Notices¹⁰ (PONs) during the evaluation period, the majority of which are significantly different than the current Program offerings.

The Program serves commercial, industrial, agricultural, and multifamily¹¹ new construction projects providing a range of services and incentives designed to achieve cost-effective savings and the transformation of new construction practices. The NCP addresses a multifaceted and technically sophisticated market including building developers, owners, design firms, and contractors. It provides participants with technical assistance (TA) services¹² and/or financial support for implementing energy efficiency measures in new construction and substantial renovation projects. NYSERDA contracts with TA providers who work with building owners and their design teams to identify energy efficiency opportunities, quantify the estimated incremental costs and savings of the improvements, and summarize the findings in a TA study. TA providers use energy use simulation software such as eQUEST¹³ and custom spreadsheets to estimate the savings from efficient measures.

Whole building incentives are tiered and custom incentives are established at a fixed rate per kWh and kW. Greater financial assistance is provided to customers with projects achieving higher levels of energy savings. Prequalified incentives (PQ, standardized incentives for specific equipment) were also available to participant projects.¹⁴

¹⁰ NYSERDA issues new PONs to reflect new funding, changes in code and changes in program requirements. The projects in the study population were completed under the following PONs: 495, 593, 815, 913, 1035, 1501, 1222, 1155, 1601. The current Program is being offered under PON 1601rev which includes some changes from PON 1601.

¹¹ Multifamily projects in the NCP are mixed use projects that include commercial and residential usage. The multifamily buildings in this study did not meet the current program threshold of 50% commercial space (i.e. the multifamily buildings included more residential square footage than commercial in most cases.)

¹² Under the current program design, these services are referred to as technical support by Energy Modeling Professionals. This evaluation addresses the prior iteration of the Program which used the language Technical Assistance (TA) provider.

¹³ eQUEST is building energy simulation software that uses a DOE-2 engine. DOE-2 was developed by the US Department of Energy, <http://www.doe2.com/equest/>.

¹⁴ The NCP ceased offering prequalified incentives for new construction projects in March 2015.

While the efficiency measures funded under the Program often impact fossil fuel use,¹⁵ the Program has not historically focused on providing incentives for fossil fuel impacts. During the period addressed in this evaluation, fossil fuel impacts were typically included in TA studies and quantified in the NYSERDA database when whole building models were completed for projects; these project typically received incentive funding only for the electric efficiency measures. Funding of fossil fuel energy efficiency in new construction has increased recently, enabling the Program to further advance practices related to saving natural gas.

In 2013 the American Council for an Energy Efficient Economy (ACEEE) recognized the NYSERDA NCP as an Exemplary Energy Efficiency Program¹⁶ demonstrating leading program design for commercial new construction.

2.1.1 Program-Reported Savings

The Program completed 397 projects consisting of more than 50 million square feet of new construction in 2012 and 2013 with 392 of them receiving incentives for electric energy efficiency¹⁷. Figure 2-1 shows the distribution of electrical savings reported by the Program for the study period by project analysis approach. Project analysis approaches include:

- Whole building – includes the use of whole building energy modeling provided by a NYSERDA funded Technical Assistance (TA) provider and a single incentive for a comprehensive package of electric efficiency measures. Can include some prequalified measures.
- Custom – includes the use of measure specific energy modeling provided by a TA of measure level savings. Incentives are offered for individual measures. Can include some prequalified measures.
- Prequalified (PQ) – includes standard incentives for measures with deemed savings values. No engineering analysis of savings is provided. NYSERDA no longer offers PQ incentives in the Program.

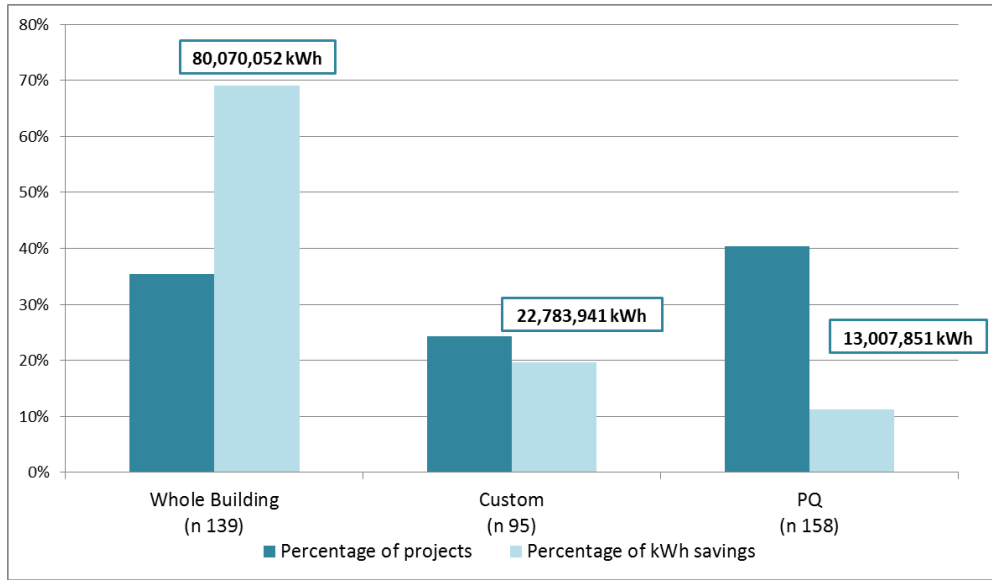
While whole building model projects comprised 68% of reported savings, they were 28% of the population.

¹⁵ The reported fossil fuel impacts of the program are on natural gas.

¹⁶ ACEEE 3rd National Review of Exemplary Energy Efficiency Programs, June 2013, <http://aceee.org/research-report/u132>.

¹⁷ All projects in the evaluated population received electric incentives. A small portion also received some incentives for natural gas measures.

Figure 2-1. NCP Project Count and Savings by Analysis Approach



Whole building and custom projects include some prequalified measures and savings.

2.2 Evaluation Objectives

The objective of this impact evaluation was to estimate the evaluated gross electric energy and demand savings for the NCP. The evaluated gross savings were based on project-specific measurement and verification (M&V) and calculation of representative realization rates (RRs) from a statistically valid sample of projects from the population. The sample was randomly selected by stratum from the population of completed projects during the analysis period, and the sample size was designed to meet the 90/10 confidence/precision target based on using stratified ratio estimation.

This report complies with the M&V savings-related requirements listed in *New York Evaluation Plan Guidance for EEPS Program Administrators*,¹⁸ issued by the DPS and is intended to provide robust, timely, and transparent results. The methods align with the guidelines of the *National Action Plan for Energy Efficiency (NAPEE) Model Energy Efficiency Program Impact Evaluation Guide*.¹⁹

The overall evaluation scope and objectives are described in Table 2-1.

¹⁸

[https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/766a83dce56eca35852576da006d79a7/\\$FILE/NY_Eval_Guidance_Aug_2013.pdf](https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/766a83dce56eca35852576da006d79a7/$FILE/NY_Eval_Guidance_Aug_2013.pdf)

¹⁹ https://www4.eere.energy.gov/seeaction/system/files/documents/emv_ee_program_impact_guide_0.pdf

Table 2-1. NCP Evaluation Scope and Objectives

Objectives	Outputs	Method Used
Evaluated energy savings	Annual evaluated electric (kWh) energy savings at the customer meter(s)	On-site M&V for projects using on-site logging, custom engineering assessments, billing analysis, and building simulation modeling of a representative sample of program-participant projects
Evaluated demand savings	Peak electrical demand ¹ impacts calculated consistent with New York Technical Manual (NYTM) definitions	
RR	Ratio of the sum of the weighted evaluated gross savings divided by the sum or the weighted program-reported savings ²	
Targeted level of confidence and precision	The sample design targeted a 10% relative precision or better for program-evaluated energy savings variables at 90% confidence.	Stratified ratio estimation sample design
Participant research	Information on NCP influences and on participant views of the broader new construction market to inform planning under the Clean Energy Fund (CEF).	Participant surveys

¹ Peak demand is defined as the impact at the customer meter on the peak day (defined in the NYTM by location) during the hour from 4 p.m. to 5 p.m. on a weekday or non-holiday. This is not necessarily the highest demand that any individual customer will experience.² Evaluated and reported project savings were weighted based on the number of projects in each stratum.

2.3 Previous Evaluations

An impact evaluation of the NCP was completed in 2012. The results are summarized in Table 2-2.

Table 2-2. 2007-2008 NCP Impact Evaluation Findings

Parameter	Program-Reported Savings	Realization Rate	Evaluated Gross Savings	Relative Precision¹
Electric energy (MWh/yr) 2007–2008	82,941	71%	58,888	14%
Peak demand reduction (MW) 2007–2008	23	52%	12	12%

¹ Relative precision for the 2007–2008 was determined for the net savings analysis and was not presented in the final report for the evaluated gross savings portion of the study. The relative precision was obtained from the analysis files used for the 2007-2008 evaluation.

The NCP has implemented several improvements since the last impact evaluation; some early results from these changes were expected to be captured in this evaluation. The level of participation has increased as well. Comparing the above reported results with the 2012–2013 activity, the number of program participants increased 68%, from 236 to 397, and the energy savings increased by 40%.

3 METHODS

The scope of work for this impact evaluation was to estimate the evaluated gross savings of the New Construction Program (NCP or Program). This evaluation consisted of the following components:

- Retrospective measurement and verification (M&V) based impact evaluation of completed NCP projects to develop program realization rates (RRs)
- Preconstruction review of NCP projects in the modeling and analysis phase
- Participant research

The methods used to conduct this study are discussed in the following sections and the Appendices.

3.1 Evaluation Methods

A critical component of the evaluation is the development of rigorous estimates of the realization rates for program-reported electricity and demand savings, which includes verifying the installation of efficiency measures and an independent savings analysis. The RR is calculated as shown in Equation 3-1 and represents an adjustment – upward or downward – to the program-reported savings to account for savings differences found in the evaluation.

Equation 3-1: Realization Rate Calculation

$RR = \frac{Savings_{Evaluated}}{Savings_{Reported}}$	
where,	
RR	= Realization rate
$Savings_{Evaluated}$	= Savings as per measurement and verification (M&V) evaluation
$Savings_{Reported}$	= Savings as reported by the Program

Each project in the sample received the highest level of rigor. Project level data collection and analysis addressed at least 90% of the program-reported electric energy (kWh savings) and at least 85% of the program-reported demand savings for each site in the sample. Analysis was conducted using site-measured data and utility billing data to develop calibrated energy consumption models for each project using International Performance Measurement and Verification Protocol (IPMVP) Options B and D. Analysis tools included custom spreadsheets to develop hourly load profiles and energy modeling software such as eQUEST.²⁰ Analysis methods and data sources are detailed in Appendix B: Evaluation Data Sources and Appendix C: M&V Approach Details.

The baseline used for the savings evaluation was the applicable energy code at the time the building was permitted. This was largely consistent with the baselines established by the Program, which set the baseline code as that

²⁰ The modeling software used in this evaluation included eQuest, DOE2, Trane Trace and custom spreadsheets.

prescribed in the Program Opportunity Notice (PON) in effect at the time of enrollment. The Impact Evaluation Team documented the baseline assumptions for control measures where the code allows more than one control approach for compliance. This matrix was reviewed by Program staff at the inception of the evaluation.

The project as-built and code baseline models were compared to determine the evaluated gross savings for each project. Savings were calculated using whole-building models to capture the interactions between measures for comprehensive design projects while custom and prescriptive projects were analyzed at the measure level.

Results were analyzed for variances to provide the Program with actionable information on why evaluated project savings varied from reported savings. The Impact Evaluation Team analyzed variances to identify areas where there is potential for the Program to further influence savings achievement and to understand where variances are beyond the Program's influence.

Net savings impact analysis was originally included in the NCP evaluation plan but efforts were terminated during the course of the evaluation. Termination occurred due to the changing landscape for the Program and NYSERDA under the CEF, which resulted in an increased focus on providing actionable information that NYSERDA can use to inform Program changes under the CEF.

3.2 Sample Design

The sample was developed using stratified ratio estimation because it typically requires a lower sample size for a targeted level of precision when there is a strong correlation between the program-reported savings and the evaluated gross savings. The sample frame included all completed projects that received electric measure incentives from January 1, 2012 through December 31, 2013 (the NCP sample unit is a newly constructed or renovated commercial or industrial building; each building is a project). Table 3-1 presents a summary of the sampling plan.

Table 3-1. New Construction Program Sample Plan Overview of On-Site Sampling

Sampling Content	Sampling Approach	Comments
Sample frame	Program-reported data; all projects completed between January 1, 2012 and December 31, 2013	Program-reported data provided by NYSERDA.
Method	Stratified ratio estimation	Correlation between program-reported and evaluated gross savings was expected to be moderate; the kWh error ratio from the previous PY2007/2008 evaluation was greater than 1.0.
Variable to estimate	RR for annual electric energy and demand savings	M&V to establish evaluated gross savings and RR is calculated as the ratio of the evaluated gross savings to the program-reported savings.

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Primary sampling unit	Project	A “project” refers to any newly constructed or renovated building that participated in the NCP during the period of study.
Primary stratification variable	Size	Size was determined by the annual electric energy savings (kWh)
Post-hoc stratification variables	Upstate/downstate, project analysis approach and PON ¹	Post hoc stratification and analysis was conducted to estimate RRs by location, analysis approach and program offering.

¹ PON – Program opportunity notice; the NCP issues updated PONs to reflect the adoption of new codes and other changes in program design and funding. Due to the varied duration of new construction projects, a substantial number of PONs was included in the population and the sample.

3.2.1 Sample Stratification

Project size, defined as the value of the program-reported energy savings in kWh, was the stratification variable.

Four size strata were defined, based on the magnitude of the program-reported electric kWh savings, as shown below in Table 3-2.

Table 3-2. 2012 and 2013 Stratification Results

Stratum	Sampling Method	# of Projects	kWh Savings	% of Total kWh Savings in the Stratum	Sample Size ²
0	None	149	3,443,149	3%	0
1	Random	168	28,452,273	25%	22
2	Random	55	36,551,097	32%	22
3	Census ¹	20	47,415,326	41%	20
Total		392	115,861,845	100%	64

¹ The census stratum includes 13 large 2012 projects, which were sampled in the spring of 2013 to enable evaluation to commence closer to project completion.

² One project in stratum 3 could not be recruited. Because there were only 20 projects of that size in the overall population (see Table 3-3), the final sample included 19 projects in the stratum 3 census sample. Response rates are discussed in Section 4.1.

Strata boundaries were established following methods described in the 2004 California Evaluation Framework²¹ as shown in Table 3-3.

²¹ Stratified ratio estimation as it applies to impact evaluation is thoroughly described in the California Evaluation Framework: TecMarket Works, et. al. The California Evaluation Framework. Project Number: K2033910. Prepared for the California Public Utilities Commission and the Project Advisory Group. June, 2004. Pages 327 to 339 and 361 to 384.

Table 3-3. 2012 and 2013 Size Strata Boundaries

Stratum	Minimum kWh	Maximum kWh	kWh savings	Percent kWh Savings	Number of Projects
0	(26,199)	54,856	3,443,149	3%	149
1	55,054	372,263	28,452,273	25%	168
2	386,018	1,084,157	36,551,097	32%	55
3	1,092,274	11,546,691	47,415,326	41%	20

3.2.2 Post Hoc Stratification

Through discussions with NYSERDA, the Impact Evaluation Team selected three variables for post hoc stratification: location (upstate/downstate), program opportunity notice (PON), and analysis type (prequalified, custom, and whole building). RRs were estimated separately for each of the post hoc strata. The rationales behind these choices are presented in Table 3-4.

Table 3-4. Rationale for Post Hoc Stratification

Post Hoc Stratification Variable	Definition	Why the RRs Might Vary by the Stratification Variable
Location	Upstate/downstate	Downstate projects tend to be larger and more complex than upstate projects.
Program offering	PON	A PON is a proxy for project start date. Projects initiated as long ago as 2002 and as recently as 2012 were completed during the sample frame's 2012–2013 period. Program approaches, market practices, and NYSERDA activity changed significantly over this period.
Analysis type	Prequalified, custom and whole building	The methods for estimating savings are different for prequalified, custom, and whole-building analyses.

3.2.3 Approach to Estimating Realization Rates for 2009–2011

The RR to be applied to the 2009–2011 NCP savings was developed by combining the evaluation results for 2007–2008 and 2012–2013. Three approaches were assessed:

- A simple average of the RRs for program years (PYs) 2007–2008 and PYs 2012–2013
- Applying the post hoc stratification results by PON for PY 2012–2013
- Applying the post hoc stratification results by analysis type; possibly combining the RRs from the two evaluation cycles

The third option was eliminated as there were very few 2012–2013 projects in the custom/prequalified category and the 2007–2008 evaluation noted inconsistencies in the use of prequalified savings and whole-building analysis for the same project. The advantages and disadvantages of options 1 and 2 are shown in Table 3-5 below.

Table 3-5. Post Hoc Stratification Summary

Post Hoc Stratification Method	Advantages	Disadvantages
Simple average of the two evaluation cycles	Simplicity, good precision	Potential for bias: RRs have been improving over time. PY 2009–2011 projects could be more similar to either the earlier or the later evaluation, which could bias the results.
Use PY 2012–2013 stratification by PON ¹	Accounts for changes over time, less likely to introduce bias	Poor precision due to the small sample sizes

¹ PON – Program Opportunity Notice; the NCP issues updated PONs to reflect the adoption of new codes and other changes in program design and funding. To compare RR over time, and analysis was performed based on stratification of projects by PONs.

Comparing the results for the simple average and the post hoc stratification produced RRs of similar magnitude. As the results were similar and the precision of the simple average was better, the final RR’s are based on the simple average.

3.3 Participant Survey

Surveys of participant owners and design firms were administered to gain information in the following areas:

- Project decision-making
- Energy modeling practices
- Program influences on energy efficiency decisions
- Energy efficiency practices in the broader new construction market

The focus of the research was to gain information that could inform the development of new initiatives in the market under the CEF. Interviews were conducted starting in fall 2013. Projects enrolled in the Program from 2002 – 2013 and incentives were encumbered (design complete) from July 2009 – July 2013.

The research was conducted by review engineers trained in survey techniques and familiar with the projects. The review engineers prepared customized survey instruments that explored the general practices of the participants and their peers as well as decisions specific to the project under investigation. We attempted to interview all of the owners and designers associated with the sampled projects within each stratum described in Section 3.2. Response rates are discussed in Section 4.3.

3.4 Preconstruction Review

Preconstruction reviews were conducted to help Program staff identify areas of baseline assumption and/or analysis vulnerability²² with the objective of improving program savings RRs²³. Reviews were completed after the technical assistance (TA) firm provided the NCP with the list of building model assumptions and before incentives were offered to the customer. Projects included in the preconstruction review process were identified by Program staff based on the presence of at least one of the following characteristics:

- Large buildings where whole-building analyses were being undertaken using simulation modeling
- Buildings with unique equipment, such as absorption chillers, ground source heat pumps, variable refrigerant volume systems, and radiant cooling
- Buildings with unique or unknown operating characteristics, such as industrial process and laboratories
- Projects with uncertain baselines

All of the projects identified by the Program included at least one of these characteristics. The sample for Preconstruction review was not random, but was determined by Program staff with the purpose of providing insights specific to selected projects. There is no overlap between the projects receiving preconstruction review and the population of projects receiving impact evaluation from 2009-2013. Future NCP Impact Evaluations will need to sample projects that received preconstruction reviews separately from the general population of projects which did not receive the review.

The review process consisted of a detailed analysis of the design drawings and specifications, modeling inputs, baseline and efficiency measure assumptions, and TA models. Where baseline and operation characterization questions arose, Cx Associates contacted the TA firm to obtain details on the design parameters. Upon completion of this interchange, Cx Associates developed a memo stating the recommended baseline and operating characteristics, the analysis findings, a description of any issues, and potential areas for improvement observed during the review.

²² Baseline assumption and/or analysis vulnerability indicates areas where the assumptions or analysis approach are likely to have a significant impact on the project realization rate if not estimated correctly. In new construction projects, the variables used to estimate savings (such as schedules and loads) must also be estimated. Variables and baselines with significant impact on the savings were identified as potential “vulnerabilities” and were assessed in the Preconstruction Review.

²³Even with this review it is possible that future third party evaluators could find different baseline assumptions to be applicable (for instance if a project is put on hold and not built until after a new code has gone into effect) which could affect evaluated savings.

4 RESULTS, FINDINGS, AND CONSIDERATIONS

This section presents the results and findings from the savings evaluation and includes considerations that could inform the Program as it is changed under the CEF. The majority of the discussion focuses on the impact evaluation and research completed for 2012–2013 projects. Section 4.5 addresses the findings for the 2009–2011 realization rates (RRs).

4.1 Electric Energy Savings Results 2012–2013

This section summarizes the results of the measurement and verification (M&V) activities for electric energy savings projects.

The impact evaluation sample included 64 projects; rigorous evaluation was completed for 63 projects. One census stratum project was dropped due to non-response. Thirteen projects in the original sample were replaced due to non-response in the small and medium strata. The most common reason for projects being dropped is the Impact Evaluation Team was unable to reach the appropriate person. One project was dropped after an initial site visit due to lack of facility management staff time available to support the evaluation (typically 8-12 hours for large projects). One project was dropped because the tenant occupying the space that was served by the Program did not participate directly in the Program. In new construction determining the performance of the building in comparison with the baseline and identifying savings is complex and expensive²⁴. Most building owners do not know how their buildings are performing in comparison to design estimates which makes it is unlikely that non-response was driven by concern about energy savings or lack thereof. The Impact Evaluation Team does not have reason to suspect non-response bias in the results of this study.

4.1.1 Program Electrical Energy Savings and Realization Rates

The reported and evaluated gross savings and the electric energy savings RR for projects completed in 2012 and 2013 are reported in Table 4-1.

Table 4-1. Reported and Evaluated Electric Energy Savings

Parameter	Program-Reported Savings	RR	Evaluated Gross Savings	Relative Precision	Error Ratio
Electric energy (MWh/yr)	115,862	89%	103,117	9%	0.6

²⁴ The typical method for determining savings in new construction projects is through IPMVP Option D as used in many projects in this evaluation. Such studies typically cost between \$20,000 and \$50,000.

RRs improved significantly from the prior evaluation – increasing from 71% to 89% for kWh savings and 52% to 70% for electric demand savings for the period from 2007–2008.

4.1.1.1 Electric Energy Savings by Project Size

RRs were developed using stratified ratio estimation for each stratum in order to calculate the program-level RR. The results of the analysis by project size stratum are shown in Table 4-2.

Table 4-2. Realization Rate by Size Category

Size Stratum ¹		Total Number of Projects in Population	Number of Evaluated Projects in Sample ²	Stratum RR
1	Small	168	22	87%
2	Medium	55	22	98%
3	Large	20	19	83%

¹ Size ranges are as follows: Small 55,054 – 372,263 kWh; Medium 386,018-1,084,157 kWh; Large 1,092,274-11,546,691 kWh.

² The large stratum size was originally 20 projects, which was a census of all the projects in that strata. One of these projects was unresponsive and could not be evaluated, which is why the final sample size for the large strata is 19 projects.

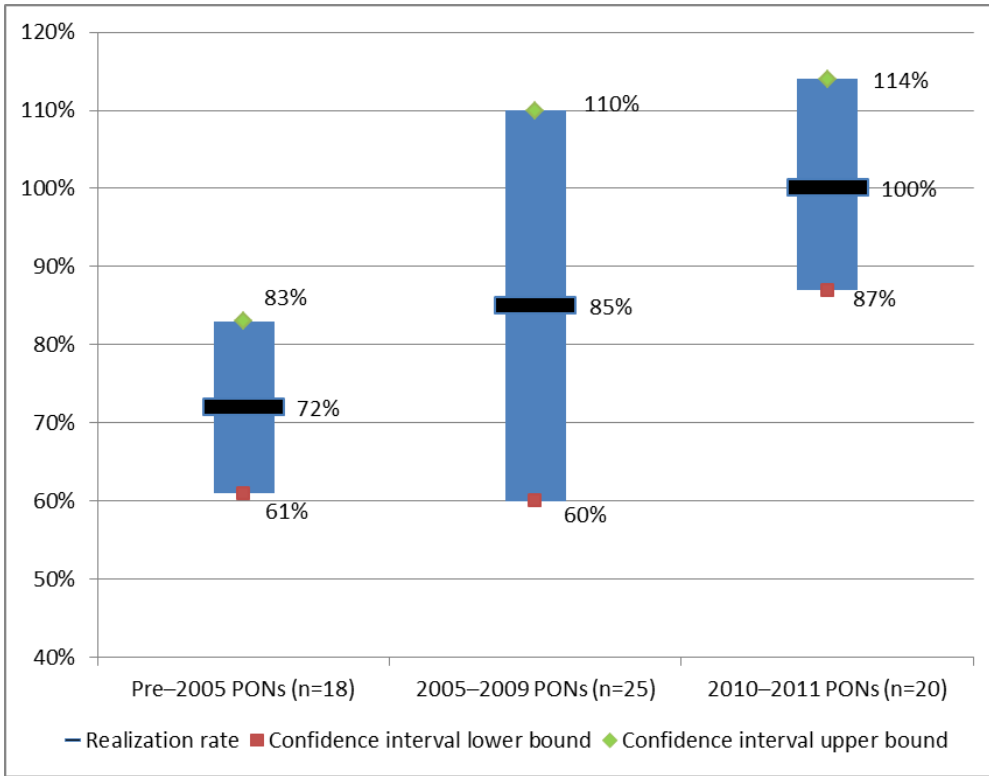
The distribution of RRs by size strata differs from the 2007-2008 evaluation, which found that the largest projects had markedly lower realization rates than the small and medium projects. The 2007–2008 RRs were as follows: Large: 57%; medium: 74%; small: 94%. Note that these results are not directly comparable since the strata boundaries in the two evaluations were not the same. The project population for 2012–2013 included significant whole-building modeled projects with comprehensive energy efficiency measures in each size stratum whereas in the 2007–2008 study relatively few small projects used whole-building modeling.

4.1.1.2 Post Hoc Stratification Analysis

Post hoc stratification of the 2012-2013 sample of 63 projects was conducted on additional variables of interest including location (upstate/downstate), program opportunity notice (PON), and analysis type (prequalified, custom, and whole building). RRs for electric energy savings that were developed for these additional stratification variables have lower relative precision because the sample was not specifically designed for this analysis and the sample sizes in some cells are necessarily smaller.

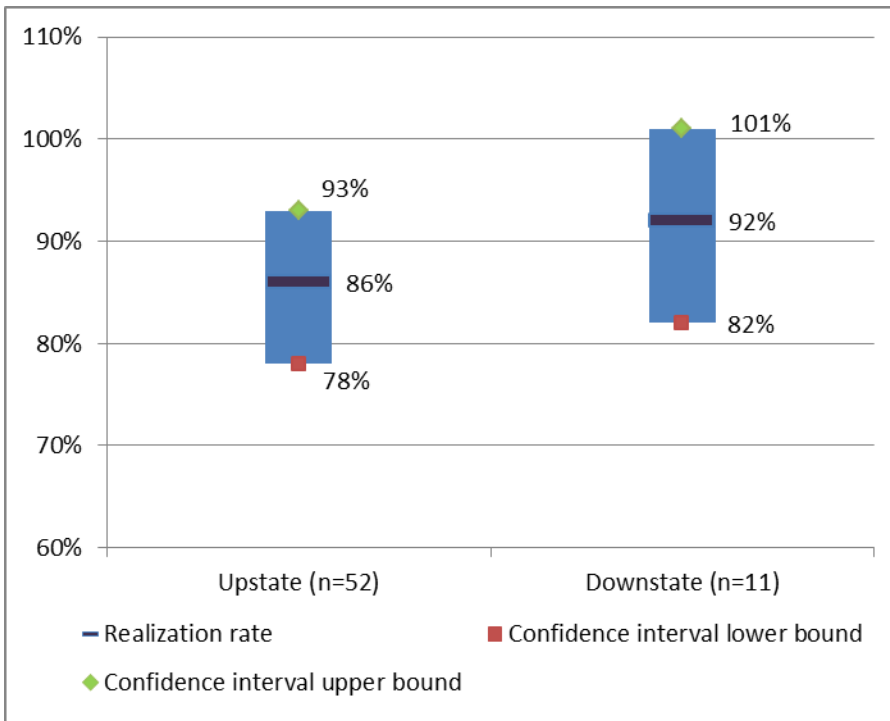
The analysis by PON provided the most significant results, as shown in Figure 4-1. Changes in the Program are incorporated as new PONs are issued; therefore, realization rates by PON may serve as a proxy for understanding how the Program changes are affecting project outcomes. The RRs for the pre-2005 are significantly smaller than those for the 2010–2011 PONs. The mean values for each period indicate a potential trend toward improving RRs over time, though the 2005–2009 period had a relative precision of 30%.

Figure 4-1. Realization Rates and 90% Confidence Intervals, by PON



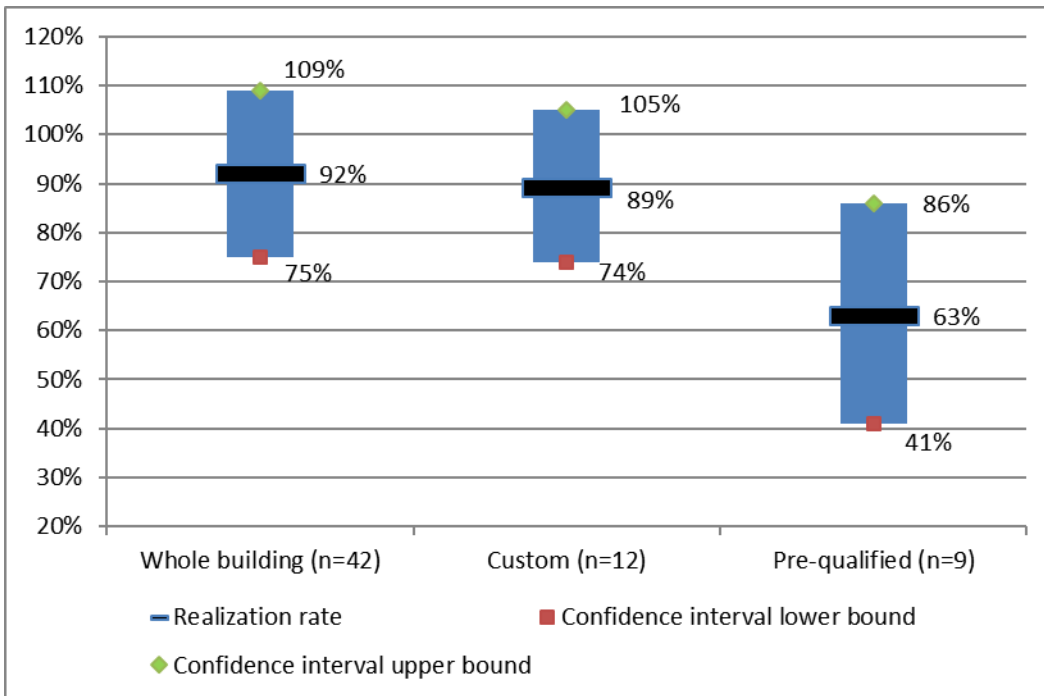
Post hoc stratification by region is shown in Figure 4-2. The downstate sample size is small, resulting in a relative precision of 28%. This analysis indicates that there are no significant differences between realization rates for upstate and downstate projects.

Figure 4-2. Realization Rates, and 90% Confidence Intervals, by Region



The analysis by project type shown in Figure 4-3 indicates that prequalified measures with deemed savings have a significantly lower RR than custom and whole-building modeled projects. However, the whole-building and custom results are only marginally different from each other.

Figure 4-3. Realization Rate and 90% Confidence Intervals, by Analysis Type



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The NCP stopped offering prequalified measures in March 2015. The whole-building and custom projects include some prequalified measures, but these projects were categorized as either whole building or custom to ensure mutually exclusive grouping for post hoc stratification.

4.1.1.3 Ancillary Natural Gas Savings

The evaluation was not designed to report statistically valid RRs for natural gas savings because they were not the primary focus of the Program during the period being evaluated. Overall, the Program reported 180% more natural gas savings than electric savings for the population on a site MMBTU basis. 94% of the reported gas savings were ancillary (gas impacts that result from either an electric efficiency measure such as increased heating due to more efficient lighting or whole building projects that affected both gas and electric efficiency levels and received only electric incentives).

Fifty-nine projects in the sample included ancillary natural gas impacts. Table 4-3 shows the evaluation results for the projects in the sample with ancillary gas impacts.

Table 4-3. Ancillary Gas Savings for NCP Sample

Natural Gas Savings	Number of Projects from Sample	Program Reported MMBTU Savings	Evaluated MMBTU Savings
Positive Impacts	36	555,467	775,208
Negative Impacts ¹	23	-8,243	-117,526
Total	59	547,224	657,682

¹ Negative impacts are for measures like lighting that increase heating loads and for fuel switching measures such as absorption chillers.

4.1.2 Program Electrical Demand Savings and Realization Rates

The Program historically has reported the peak customer demand impact²⁵ (i.e., the reduction of the customer's maximum demand due to energy efficiency, regardless of when that would occur). The evaluation used the New York Technical Manual (NYTM) which defines peak demand as the impact of energy efficiency at the customer meter on the peak day for each location during the hour from 4 p.m. to 5

²⁵ The Program modified its analysis protocols to include the NYTM peak demand after the previous impact evaluation. The projects in the population for this evaluation were predominantly analyzed under earlier PONs and used the peak customer demand method.

p.m. on a weekday or non-holiday.²⁶ The NYTM definition is not necessarily the highest demand impact that any individual customer will experience. The evaluation developed a RR for electric demand savings using the NYTM definition, as shown in Table 4-4.

Table 4-4. Reported and Evaluated Electric Demand Savings NYTM Definition

Parameter	Program-Reported Demand Savings	RR	Evaluated Gross Demand Savings	Relative Precision	Error Ratio
Peak demand reduction (MW)	37	70%	26	13%	1.06

The Impact Evaluation Team completed an additional demand analysis to assess the RR for project-level demand savings using the peak customer demand impact. The results are shown in Table 4-5. The evaluation found less variation in demand savings and an improved realization rate when calculating demand using the same method as the Program for the majority of projects.

Table 4-5. Reported and Evaluated Electric Demand Savings Building Peak Definition

Parameter	Program-Reported Savings	RR	Evaluated Gross Savings	Relative Precision	Error Ratio
Peak demand reduction (MW)	35	78%	28	11%	0.64

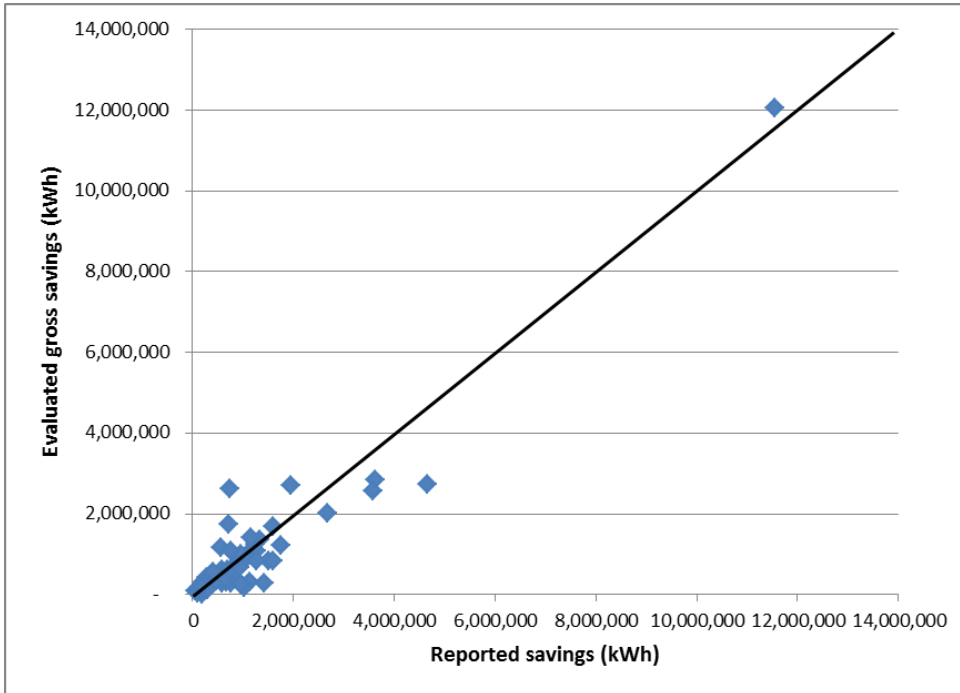
4.1.3 Differences between Reported and Evaluated Project Savings

While the Program electric energy RR is 89%, substantial deviations between program-reported and evaluated gross savings occurred at the project level. Figure 4-4 illustrates the evaluated annual electric energy savings compared with the program-reported savings for each project in the sample. For a project level RR of 1, the evaluated gross savings would equal the program-reported savings; this is shown as a solid black line on the graph. Project savings are plotted as blue squares.

²⁶ Link:

[http://www3.dps.ny.gov/W/PSCWeb.nsf/ca7cd46b41e6d01f0525685800545955/06f2fee55575bd8a852576e4006f9af7/\\$FILE/TRM%20Version%202%20December%2010,%202014.pdf](http://www3.dps.ny.gov/W/PSCWeb.nsf/ca7cd46b41e6d01f0525685800545955/06f2fee55575bd8a852576e4006f9af7/$FILE/TRM%20Version%202%20December%2010,%202014.pdf)

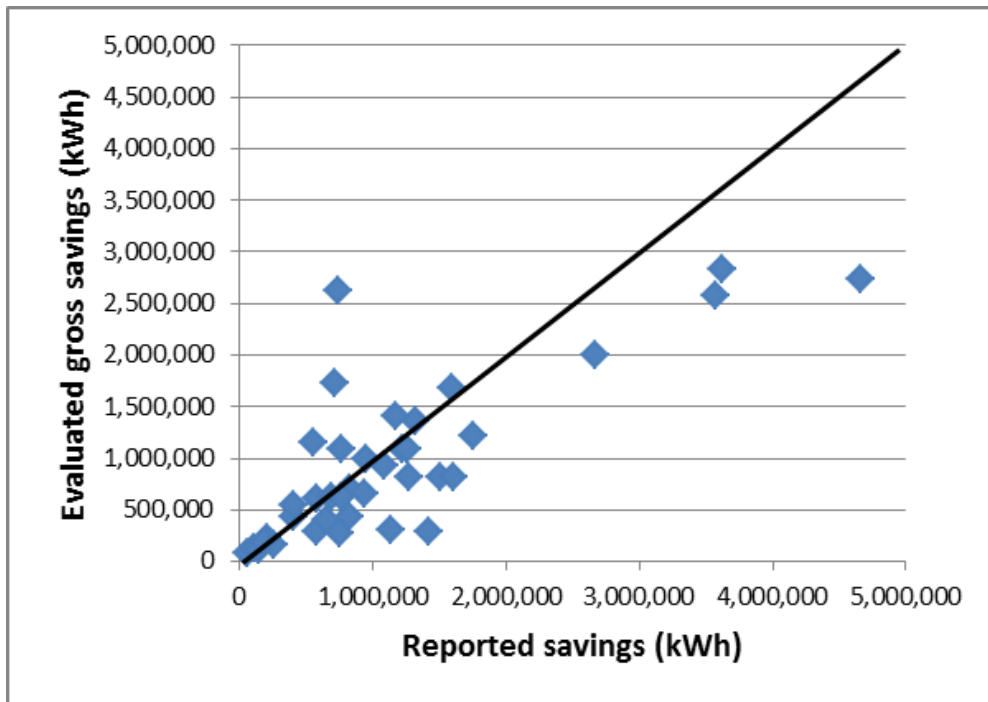
Figure 4-4. Evaluated vs. Reported Project kWh Savings



A pattern of points below the black line illustrates projects with RRs less than 1; points above the line illustrate those with RRs greater than 1. The error ratio is a measure of the degree of variance between the program-reported savings estimates and the evaluated estimates. The higher the error ratio, the greater the amount of scatter between points. The error ratio improved from greater than 1 in the prior evaluation to 0.6 in this evaluation indicating significant improvement in the accuracy of project level program reported savings.

Figure 4-5 presents the same information as shown in Figure 4-4, with the largest project excluded. This provides a more granular view of the results for the majority of the projects in the sample.

Figure 4-5. Evaluated vs. Reported kWh Savings (Largest project excluded)



4.2 Reasons for Savings Differences

The differences in evaluated and reported savings were analyzed at the end-use level to provide actionable information to Program staff. Differences were organized into three types:

- Equipment – Variations between what was physically found and what was reported
- Building – Variations in building loads and operations
- Data and analysis – Variations in data, analysis, and baselines



The differences between evaluated and reported savings are shown by type and discrepancy category in Table 4-6. The impacts on RRs are weighted using the weights for each size stratum.²⁷

²⁷ Sample weights were calculated based on the ratio of the total number of projects over the number of verified sample projects in each stratum.

Table 4-6. Summary of kWh Savings Differences

Discrepancy Category	Discrepancy Subcategory	Counts	Positive and Negative % Impact on RR ¹	Overall % Impact on RR ¹	Total kWh Impact
Equipment	Claimed measures not installed	5			-448,515
	Difference in quantity	2			112,321
	Installed equipment is more efficient	12			1,884,505
	Installed equipment is less efficient	21			-3,954,372
Building	Load differed	19			4,825,428
	Operations differed	127			-3,172,637
Data and analysis	Database entry issues	3			307,500
	Differences in modeling approach	5			-135,332
	Analysis issues (non-lighting)	12			-2,487,950
	Lighting analysis issues	10			-3,875,433
	Baseline differences	30			-6,467,293

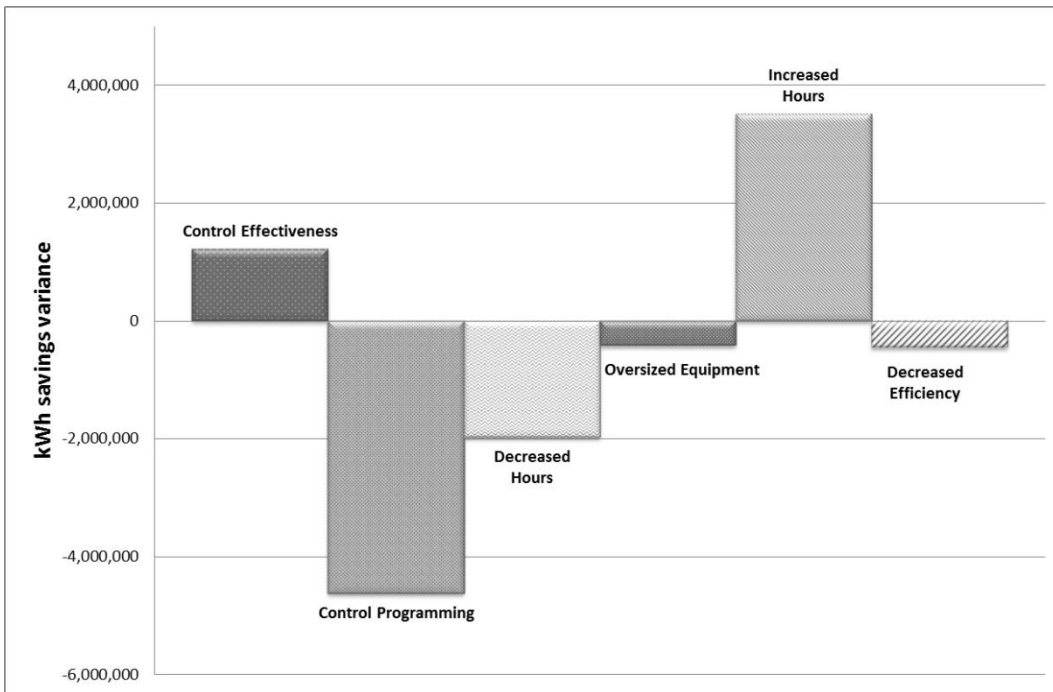
¹Legend

 Red bars are to the left of the zero impact axis and indicate negative impacts (more energy used than claimed)
 Blue bars are to the right of the axis and indicate positive impacts (less energy used than claimed)

The evaluation found significant differences between the installed and reported equipment that resulted in both positive and negative impacts with an overall negative impact on project savings. Load differences are expected in new construction projects in which the baseline building is not available to inform the energy analysis. Load differences typically result from differences in building plug and process loads, which are estimated during the project design.

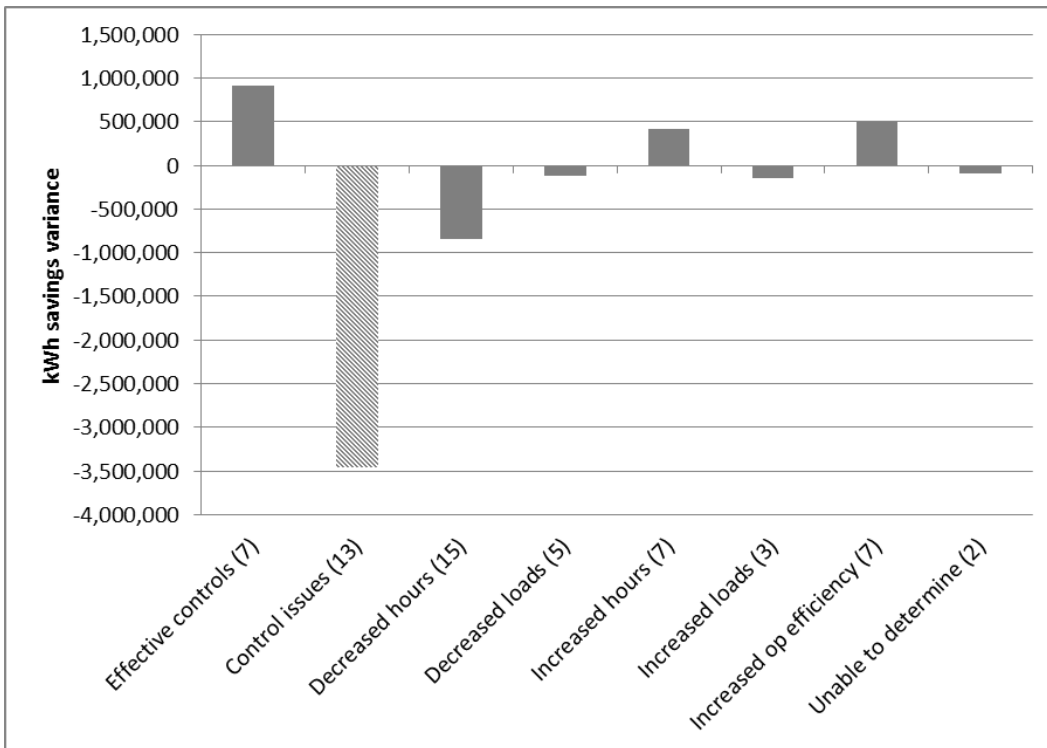
In the following discussion of differences, the kWh impacts and percentages are derived from unweighted project level data. Figure 4-6 shows the results of closer examination of building operational differences for all measure types (HVAC, lighting, envelope, refrigeration and other measures). Increased and decreased operating hours reflect the impact of more efficient equipment running longer (resulting in more evaluated savings than reported) or running less (resulting in lower evaluated savings). In some projects where the controls were working correctly, the evaluated savings were greater than reported. However, failure of controls to operate resulted in a significant reduction in the evaluated savings.

Figure 4-6. Savings Variances due to Operational Differences (All End Uses)

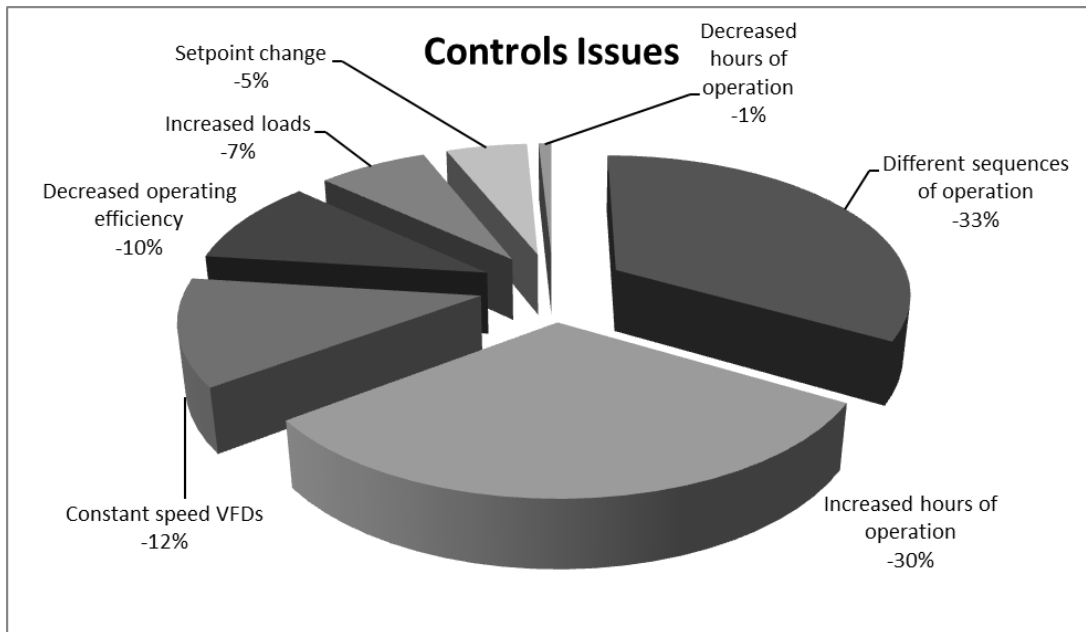


The evaluation analyzed building operational differences for HVAC systems to understand how these differences impacted savings for this important end use. Figure 4-7 shows that HVAC system control issues in 13 projects resulted in nearly 3.5 million kWh of reported savings that were not realized in the evaluation. Effective HVAC controls and increased operating efficiency of installed equipment resulted in smaller positive savings variances (more evaluated savings than reported).

Figure 4-7. Savings Variances due to HVAC System Operating Differences



As shown in Figure 4-7, control programming issues were the primary driver of operational differences in evaluated HVAC savings compared to program-reported savings and these issues had a significant overall impact on HVAC savings realization. Figure 4-8 details the control issues shown in Figure 4-7. “Increased hours of operation” in Figure 4-8 are different than those shown in Figure 4-6 because in this case, savings were claimed for equipment being controlled off and the equipment was found to be running, resulting in lost savings. “Different sequences of operation” indicates instances where the necessary programming was not installed, such as air temperature reset schedules not programmed. Variable frequency drives (VFDs) vary the speed of motors serving HVAC functions (such as fans and pumps); in some cases, VFDs were found to be installed but not programmed, so motors were running at full speed. Decreased operating efficiency was the result of no unoccupied schedule programmed for a 24/7 laboratory that was typically not in use during the night hours resulting in lower overall system efficiency.

Figure 4-8. Project Savings Impacts of HVAC Control Programming Issues

Lighting operational differences were dominated by variances in hours of operations with one very large positive impact due to 24/7 operations for a large facility where the program analysis had not assumed continuous operation. Lighting control programming issues also had a significant impact and included daylighting controls found to be programmed so that they did not dim the lights as much as expected and daylighting controls and occupancy sensors found to be inoperative.

4.2.1 Data and Analysis Variances

There were significant differences resulting from variances in baseline equipment and efficiencies. Both the NCP and the evaluation used the applicable codes to establish baseline. The differences came from the following areas:

- Code mandates that some efficiency measures, such as variable frequency drives and economizers, are required for equipment above specific size thresholds. In some cases, the Program reported savings for measures on equipment that was above the code specified size threshold. In these cases, the efficiency measure was determined by the evaluators to represent the code baseline.
- The Program makes adjustments to baselines to account for code changes in the middle of a PON. These adjustments are not exact representations of the code changes and result in some savings variances.
- The code stipulates what types of baseline systems should be used in estimating savings for efficiency measures. In some cases, the Program baseline system was not the system required in ASHRAE 90.1's Appendix G which is the accepted baseline reference document for the Program.

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- In some cases, the energy efficiency characteristics of baseline equipment used in the technical assistance (TA) model differed from that found in the code. In some cases, the models used above code efficiency levels and in other cases they used below code efficiency levels.

The evaluation identified differences in analysis including double counting of savings, a model that was not updated to reflect the project characteristics documented in the TA study, and inaccuracies in the characterization of energy recovery ventilation measures that resulted in overestimation of savings for those measures.

4.3 Participant Survey Results

The Impact Evaluation Team conducted participant surveys with building owners, architects, and engineers. The surveys provide information on the new construction efficiency market and on how the program interacts with the market. The Impact Evaluation Team attempted 124 interviews and completed 82. The completed interviews represented 47 of the 63 projects in the sample and included surveys of 43 owners, 18 architects, and 21 engineers.

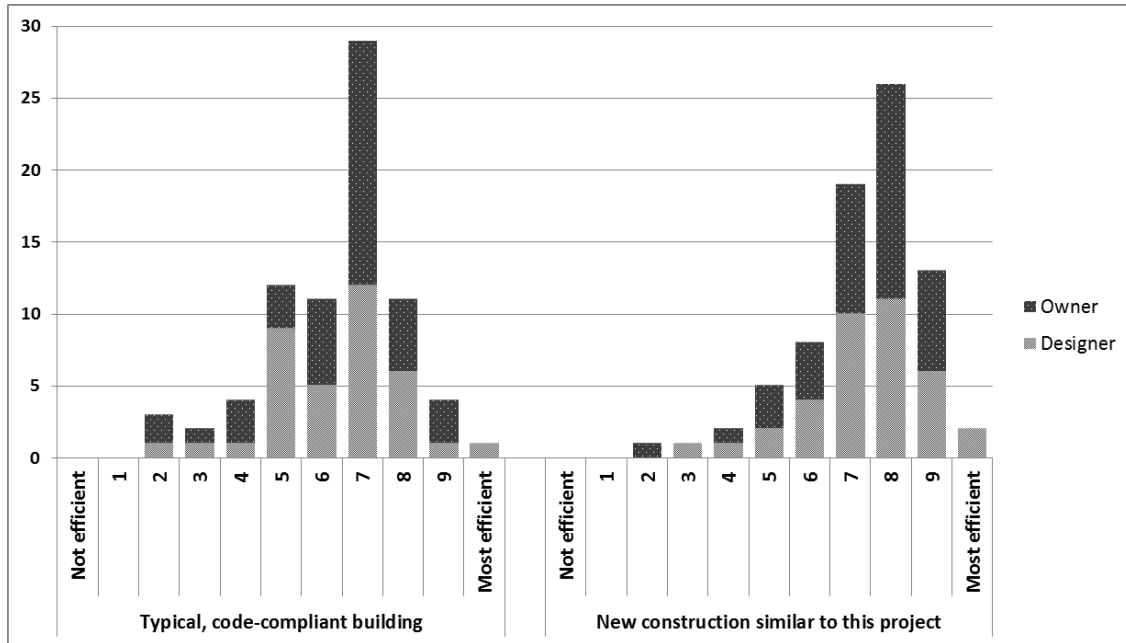
4.3.1 Participants Rate Peer Buildings as More Efficient Than Code

A notable finding from the participant surveys was the participants' perception of the energy efficiency level of peer buildings relative to code compliant buildings. When asked how efficient a typical, code-compliant building was on a scale from zero to 10 with 10 being most efficient and zero being not efficient, participant results show a median and peak in responses at a seven. When asked about the efficiency of new construction similar to the participant project, responses shifted upward to an eight. This shift is shown in Figure 4-9 below²⁸. This means that, in general, participants characterized the baseline for peer buildings in the market as better than code. While the January 2012 New York Energy Code Compliance Study²⁹ found C&I new construction to have a compliance rate of less than 100% using the approved compliance methodology, it also found that medium and large non-participant projects overall used less energy than a code compliant building, even when they included elements that were not in full compliance with the code. The code study also found that these projects complied with the code when using the energy cost budget method to assess compliance. However, this code compliance study did not include participant projects.

²⁸ n=77; 37 designers and 40 owners. The mean response shifts from 6.37 to 7.32. Standard error is .189 and .173 for these two questions. The difference in the two means is statistically significant.

²⁹ Link:
http://cdn2.hubspot.net/hubfs/416421/pdf/nyserda_code_compliance_final_report_with_appendices_sm.pdf?t=1461677468441

Figure 4-9. Participant Perceptions of Code and Market Efficiency Levels



The participant responses to this question represent a potential issue for the program, which is that participants see the baseline for construction in their market sector as better than a code-compliant building.

4.3.2 Large Customers Report Relatively Low Program Influence

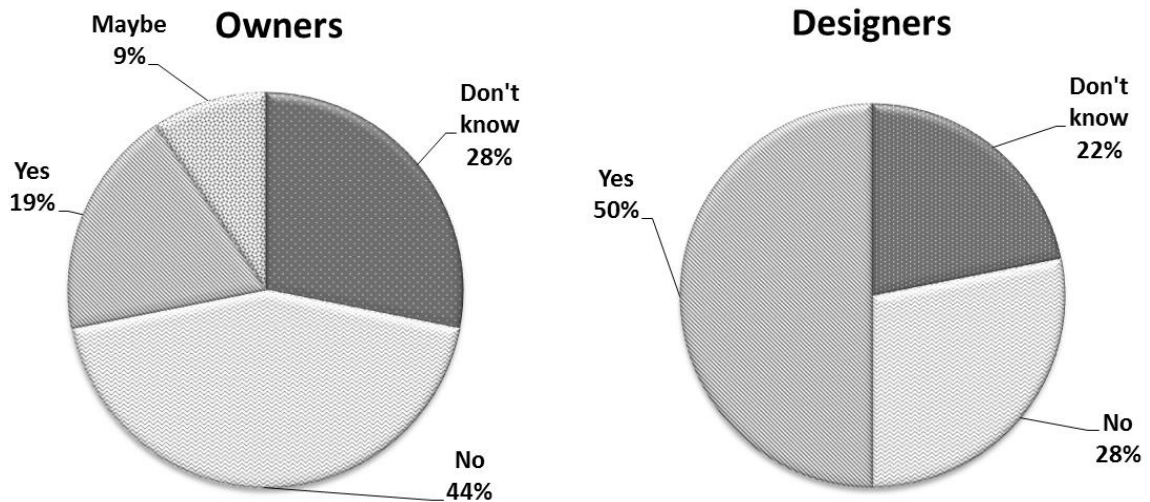
The evaluation found that many of the architects, engineers, and owners associated with the largest buildings in the sample work for companies that are repeat participants in the NCP. The respondents associated with large projects attributed fewer energy efficiency decisions to the NCP. Some of these participants had multiple projects in the sample and reported minimal influence from the Program. While the NCP may have influenced energy efficiency decisions on earlier large participant projects (prior to the current sample), the Program influence associated with repeat participants was reported to be very limited.

4.3.3 Use of Energy Models Significantly Influenced by the Program

The participant surveys revealed that the use of whole-building energy models was highly influenced by the NCP. Based on the data displayed in Figure 4-10 below,³⁰ 28% of designers and 44% of owners associated with participant projects did not plan to use a whole-building energy model prior to NYSEERDA’s influence. This is important because whole-building modeling projects showed an improved RR over the other analysis approaches.

³⁰ Designers: n=32; Owners n=32

Figure 4-10. Planned Use of a Whole-Building Modeling Prior to Program Participation



"Yes" responses indicate that whole building modeling was planned prior to NCP engagement. "No" responses indicate that modeling was not planned prior to NCP engagement. All projects represented in these graphs undertook whole building modeling.

4.4 Preconstruction Review Findings

Cx Associates completed seven preconstruction reviews: three projects included review of ground source heat pump analyses and four projects had questions regarding applicable baselines and/or operating characteristics³¹.

In nearly all of the projects evaluated as part of preconstruction review, project-specific assumptions surrounding operating schedules presented potential vulnerabilities³² to the savings estimates. The diverse building types that were evaluated as part of the preconstruction review process had a wide range of annual hours. Examples of findings that are relevant to improving estimates of operating hours include the following:

- Assumptions of daily classroom occupancy of 60% at 5:00 a.m. and 90% at 7:00 a.m. would likely result in overstatement of lighting system operating hours and lighting savings.

³¹ The sample for preconstruction review was not random and was selected by Program staff. There is no overlap between the projects receiving preconstruction review and the population receiving impact evaluation from 2009-2013. The projects receiving preconstruction review will complete construction in the future.

³² Baseline assumption and/or analysis vulnerability indicates areas where the assumptions or analysis approach are likely to have a significant impact on the project realization rate if not estimated correctly. In new construction projects, the variables used to estimate savings (such as schedules and loads) must also be estimated. Variables and baselines with significant impact on the savings were identified as potential "vulnerabilities" and were assessed in the Preconstruction Review.

- Assumptions of 90% occupancy from 8:00 a.m.–5:00 p.m. in conference rooms overstated lighting fixture, lighting control, and HVAC system measure energy savings while understating savings attributable to the demand controlled ventilation.

As shown in the current evaluation, differences in building occupancy schedules can have a significant impact on project savings. While it isn't feasible to exactly estimate the operations of a facility yet to be built, there are opportunities to reflect more typical operations of specific spaces within each building type.

In addition to the building operating profile issues, the Impact Evaluation Team identified several issues such as:

- oversized equipment,
- an approach to chilled water system design that could result in increased energy use,
- insufficient documentation,
- incorrect analysis of energy recovery savings, and
- incentives paid for the lowest first cost (typically baseline) approach.

Evaluator findings were shared with Program staff and TA providers who considered the input and made adjustments as they deemed appropriate to the affected projects. The issues identified in these reviewed projects are representative of issues seen in this evaluation. Increased attention to operating profiles, equipment sizing, system design for operating efficiency, documentation, and modeling energy recovery systems will help the NCP continue to improve its RR.

4.5 Realization Rates for 2009–2011

The reported and evaluated gross savings and the electric savings and peak demand RR for projects completed in PY 2009–2011 are reported in Table 4-7.

Table 4-7. Realization Rates for 2009–2011

Analysis Type	Program-Reported Savings	Realization Rate	Evaluated Gross Savings	Relative Precision
Electric (kWh)	153,204,345	80%	123,907	8%
Peak Demand (kW)	42,114	61%	23,687	9%

4.6 Program Considerations

The Impact Evaluation Team has identified potential opportunities to improve documentation, analysis and building operations for Program consideration.

4.6.1 Documentation and Analysis

While program documentation was found to be considerably more complete than that found in the 2007–2008 evaluation, the lack of documentation in some cases resulted in different evaluator assumptions and affected savings. Opportunities to improve project documentation include:

- Baseline development and documentation
 - While the energy code is the source of most baselines for new construction projects, differences between Program and evaluation baselines resulted in significant savings variances. Opportunities exist to increase consistency of TA model baselines with code, such as including a baseline checklist as part of the TA-provided project documentation.
- Analysis methods
 - Savings estimates for energy recovery ventilation (ERV) methods were calculated using a constant efficiency over all temperatures which overestimated savings values; a standardized protocol for ERV modeling and analysis could improve accuracy. In some cases, operating hours used in models did not reflect the known operations of the building type; guidelines for hours of operation by space type and building end use could improve accuracy.
 - Consider standardizing the use of space-by-space lighting power density (LPD) analysis instead of whole-building LPD to increase the accuracy of how lighting schedules are applied in developing lighting energy savings.
- File retention of early project documentation
 - Consider making a practice of retaining documentation of NCP impacts on the project design (such as minutes from charrettes and basis-of-design narratives and early drawings) to support future process and impact evaluations.

4.6.2 Concepts for Consideration in Future Program and Evaluation Planning

The NCP is recognized as one of the leading programs in the country. The opportunities presented below are new ideas developed from the research conducted for this study and the market expertise of the Impact Evaluation Team. Because the new construction market evolves rapidly, it is useful to consider potential new innovations that have not been proven or even used elsewhere as the Program evolves under the CEF.

Energy efficiency is increasingly a result of optimized system control. This is particularly true in new construction where the code is continuously updated to reflect increasing baseline equipment efficiencies. The correct programming and persistence of control-based energy efficiency measures are issues that affect all programs and had a notable impact on the NCP RR. There is no silver bullet fix for these issues because addressing them requires fundamental changes in control design, construction, and operational practices.

The following considerations could contribute to driving the necessary changes:

- Design³³ – ASHRAE Guideline 36: High Performance HVAC System Sequences of Operations (GL 36) could be used to advance more efficient sequences of operation than those that are often employed even in energy efficient buildings. Advancing industry knowledge of this guideline (currently available in draft format) could support continued improvement of energy performance in new buildings. The following approaches could be considered:
 - Provide training to the technical support providers, members of the design community, and controls contractors on GL 36.
 - Incorporate discussion of GL 36 into charrettes and in meetings with design engineers so that it is cited as a project reference in the basis-of-design documents and project specifications.
 - Work with New York State ASHRAE chapters to normalize the expectation that control sequences should be designed to GL 36.
 - Model example buildings with standard controls and GL 36-compliant controls to develop estimates of the savings associated with better controls and demonstrate the benefits to the market.
- Construction – There are two major opportunities to influence the control programming that is implemented during construction. Issues with control programming can result in lost savings due to operational efficiency issues. The NCP could foster improved controls by advancing the following activities during the controls submittal process and functional performance testing:
 - Consider adding a controls pre-submittal meeting as a standard part of the commissioning provider and TA scopes of work.³⁴ In the pre-submittal meeting, the commissioning provider, design engineer, TA provider, and controls contractor would review the specified sequences of operations and agree on how the sequences will be translated and implemented. The results would then be reflected in the control submittal, which should be reviewed by the design engineer and the commissioning provider. This approach has been found to improve control system effectiveness³⁵.
 - Consider including specific documentation of the control sequences necessary to generate project savings as part of the commissioning-provider scope of work to ensure functional

³³ This recommendation comes from the recent emergence of this new guideline which provides a unique resource that design professionals and controls contractors can use to improve the efficiency of HVAC designs and the ability to implement those designs so they work as intended. Failure of control strategies to work as intended was a source of significant unrealized savings.

³⁴ This recommendation is a result of the fact that while many of the evaluated projects included commissioning, the control sequences necessary to achieve the reported savings were not always programmed. In the Impact Evaluation Team's direct experience working on new construction projects, these pre-submittal meetings significantly improve the outcome of the commissioning process.

³⁵ These findings have been on an anecdotal basis by commissioning providers.

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performance testing provided as part of the commissioning process includes the energy savings sequences.

- Key performance indicators (KPIs) that relate to energy use at the system and building level can help address persistence of control measures. Many participants were interested in receiving data on their buildings from this evaluation, consistent with increasing market interest in feedback on building performance. In some cases, participant buildings did not include any building-level metering, which is now a prerequisite for Leadership in Energy and Environmental Design (LEED) Version 4. The NCP could consider the following actions to advance the use of energy-related KPIs in the market.
 - Consider requiring building-level metering of all fuels including chilled water and steam from central plants at the building level as a prerequisite for NCP participation.³⁶
 - Consider promoting key performance indicators and feedback systems such as dashboards that participants can use to monitor and improve the performance of buildings and systems.
 - For larger projects, consider including performance verification as part of the Program's offering. Incorporating performance verification into project development and delivery will increase market familiarity with the benefits of verifying energy savings, improve program RRs by verifying measure performance, and increase energy efficiency as building operators and owners review and improve building performance.
- In order to better understand the Program's influence over time, we recommend that the Program work with large repeat customers to document both the planned levels of energy efficiency and the stretch levels of efficiency that are driven by the Program. Adoption of a stretch efficiency measure, such as use of separate systems for space conditioning and ventilation (a strategy that has been repeatedly shown to reduce building energy consumption) could be advanced and supported by the Program early on. Once documented as successful, the measure could be standardized as a customer minimum requirement for new construction on future participating projects.

4.7 Additional Evaluation Considerations

The following approaches can be considered opportunities to refine evaluation methods and improve the actionable feedback generated by future evaluation efforts.

- Consider integrating M&V into the NCP for large or complex projects. There are two different ways this could be accomplished.

³⁶ The affected buildings tend to be on campuses and associated with customers that report lower program influence. The addition of minimum requirements, beyond what the projects currently include could also increase participant recognition of program influence.

1. Have the Program support M&V and work with customers to specify M&V systems in the building and plan to undertake M&V to verify building performance. Evaluators would then access the data and analysis from the Program M&V to inform impact evaluation.

2. Include evaluation components such as the preconstruction review as an ongoing feature.

The benefits of Program supported M&V include (1) increased investor confidence in energy efficiency due to measurement-based validation of project-specific savings, (2) an active feedback loop that will result in better design, implementation, and savings estimates over time as engineers, architects, and program implementers learn how measures perform in the real world, (3) building owners and operators making adjustments to put their buildings on track to generate the expected savings and (4) improved participant engagement and responsiveness to the demands of rigorous M&V. Evaluation sample design will need to account for M&V efforts to minimize the potential for bias in the program RR due to the effect of the prospective M&V. In other Programs a separate sample and realization rate has been developed for projects receiving M&V. If the M&V is part of Program delivery the sample design could result in a single program level RR.

- Find ways to understand and quantify long-term market impacts of the Program. As noted above, large and institutional customers were found to participate regularly and to be less likely to attribute program-incented efficiency measures to the Program. Consider methods for documenting program impacts and informing the Program of industry needs such as a Delphi panel of leaders from long-term participant institutions to provide feedback on program impacts and forecasts of the areas in which future interventions will have the greatest impacts on energy use.