FINAL REPORT

IALC4 NRNC Whole Building Impact Evaluation Report PY-2013

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1. *EXECUTIVE SUMMARY*

This report presents findings of the impact evaluation of California program administrators' (PAs)[1] 2013 Non-Residential New Construction (NRNC) programs.[2] This NRNC project impact evaluation is one of multiple California Public Utilities Commission (CPUC) evaluations of the PAs 2013-2014 efficiency programs. This evaluation primarily focused on non-residential new construction (NRNC) Whole Building projects and was conducted under the Industrial Agricultural Large Commercial (IALC) roadmap.

The evaluation addresses non-residential new construction (NRNC) Whole Building projects that received incentives under the statewide Savings by Design (SBD) program. The scope of work for this new construction evaluation includes an independent estimation of gross and net savings and development of findings and recommendations that can be used to improve program, project, and measure effectiveness. Primarily, three main evaluation activities support the findings and recommendations in this report:

1. M&V activities for estimating gross impacts for 25 projects across all PAs,
2. Professional telephone survey data collection supporting net-to-gross (NTG) estimation for the 25 gross sample points, and
3. Engineering reviews of the 25 gross sample points to support the qualitative project practices assessment (PPA).

NRNC Whole Building Impact Evaluation Portfolio Context and Sample Sizes

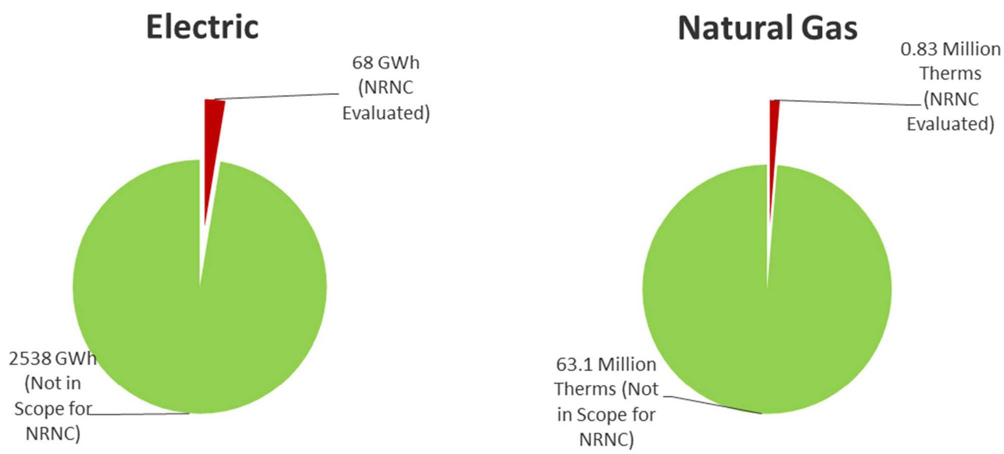
This NRNC impact evaluation covers Whole Building projects that received incentives under the SBD program in PY2013. This population of 239 projects is very diverse with regards to project size, measures installed, and amount of savings claimed. The most common building types evaluated under this impact study were schools, universities, healthcare facilities, grocery stores, refrigerated warehouses, laboratories and office buildings.

[1] California energy efficiency program administrators include PG&E, SCE, SCG, SDG&E, Marin Clean Energy, the Bay Area Regional Energy Network (REN), and the Southern California REN. However, this evaluation only addresses programs under the administration of PG&E, SCE, SCG and SDG&E.

[2] This effort was completed for CPUC under the direction of staff responsible for evaluation of utility energy efficiency programs.

Figure 1 shows the energy savings claims associated with this evaluation compared to the total savings portfolios energy efficiency programs, accounting for about 2.6 % percent of statewide electric savings claims and 1.3 % percent of statewide gas savings claims for PY2013. For 2013, the PA tracking data for the program portfolio has thousands of entries with statewide savings claims totaling 2,606 GWh and 436 MW for the first year. Statewide first year's gas savings claims from measures total 64 million therms.

Figure 1: NRNC Whole Building Evaluation Share of Statewide PY2013 PA Claims



The overall project approach followed standard evaluation protocols. A sample of project population was selected as gross and net evaluation points. These sampled projects were evaluated to obtain gross realization rates (GRRs) and net-to-gross (NTG) ratios for project. The sample results were then statistically expanded to generate statewide program-level results.

The primary constraints on the sample size were the budget limit and the relatively high cost per sample point for this study. The desired high-level of rigor for estimating savings for large and complex whole building projects in the non-residential new construction sector comes with significantly increased cost per sample point. This high-level of rigor reflects the objective of reducing measurement error (which requires extensive project review, on-site visits, and varying amounts of short and mid-term measurements) at the expense of sampling error.

Given these constraints, a total of 25 M&V points were planned for this study, which allowed reporting meaningful estimation of GRR only on the overall statewide population. With 25 gross impact points, the 2013 sample was expected to support a 25 percent relative precision at the 90 percent confidence level. The total sample sizes by PA for each activity are shown in

Table 1 below. This sample accounts for 20% of the total NRNC Whole Building ex ante statewide source MMBTU savings.

Table 1: Summary of NRNC Whole Building Evaluation Sample Sizes for PA

Utility Sampling	Number of Completed Surveys (n)			
	Gross Impact (M&V)	NTG	PPA	Sample % of Population MMBtu
PG&E	15	15	15	20%
SCE	5	5	5	22%
SDG&E	5	5	5	18%
Total	**25**	**25**	**25**	**20%**

Since all of the sample points were whole building projects, PA’s used building simulation models for estimating the ex ante savings for kWh, kW and therms, for each project. The ex ante models were acquired from the PA’s by the evaluation team for each project in the sample. These models were reviewed along with PA’s submitted project documentation to develop on-site data collection.

Site visits were performed for each sampled project. During the site visit, installed energy efficiency measures were verified, buildings were surveyed to determine operational conditions, and short-term metering with data loggers was performed where feasible and helpful to the evaluation. End-use trend data logged through participant energy management systems was acquired when available. These data, along with the whole-premise 15-minute interval data from the billing meter were used to more accurately assess the actual savings being realized by the projects.

To estimate the ex post savings, the ex ante energy simulation models were altered to reflect as-found conditions such as control methods, temperature set points, occupancy levels, building schedules and material properties when strong evidence was available. After these changes to models were performed, the models were calibrated with end-use and/or whole premise data where feasible. Table 15 in Chapter 5 (Gross Impact Results) indicates sites where energy models were calibrated to building load and/or utility interval data. This table also shows pre-calibration savings, post-calibration savings and the percentage of the impact on these sites due to calibration.

High-Level NRNC Whole Building Gross Impact Results

In Figure 2 below, we summarize the life cycle gross impact realization rates (LC GRRs) across all PAs. Realization rates are calculated for each sampled project as the ex post, evaluation-based estimate of impacts divided by the PA’s ex ante estimate of impacts. Case weights are used to extrapolate the evaluation results to the population. The population sample frame and the total number of completed gross impact points are also in Table 2 for each energy metric, along with the resulting error ratio (ER), which is a measure of the statistical variation in the gross realization rates, and the 90 percent confidence intervals for the GRRs. With all the sample points included, the mean statewide realization rates were 0.92 for kWh, 0.79 for kW and 0.57 for therms. Although the kWh GRRs for the sampled projects ranged from -0.46 to 2.28, the resulting overall kWh GRR of 0.92 is little bit above the 0.9 default ex ante GRR adjustments for the SBD program. However, the overall program therm GRR of 0.57 was significantly below the default 0.9 ex ante GRR adjustments for the SBD program.

Figure 2: Project Lifecycle Gross Realization Rates by Energy Metric (kWh, kW, and Therms)

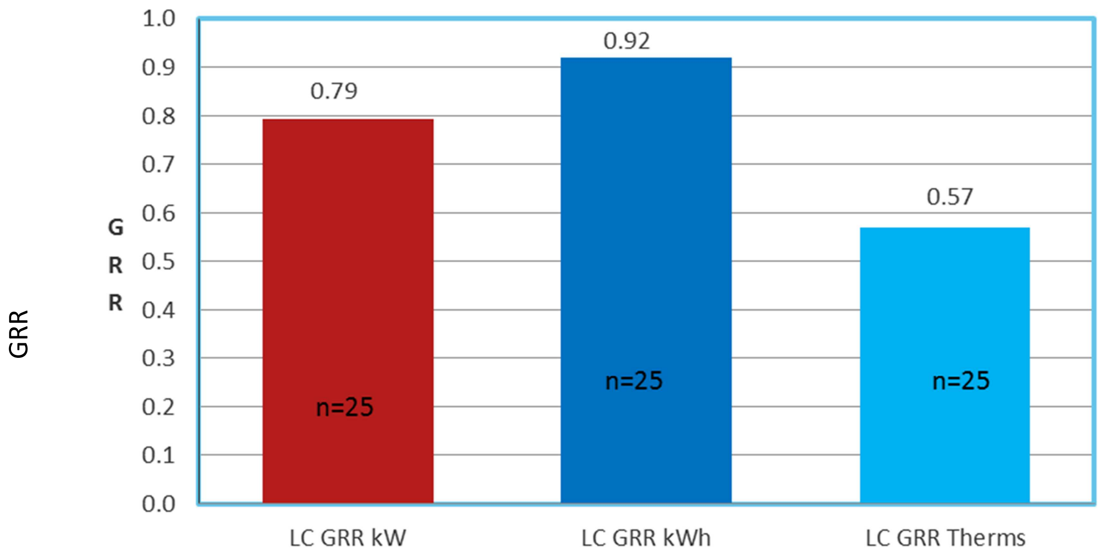


Table 2: Project Lifecycle Gross Realization Rates by Energy Metric

Energy Metric	Sample Size (n)	LC Gross Realization Rate	Population (N)	Error Ratio*	90% Confidence Interval	Relative Precision
PA Statewide						
kWh	25	0.92	239	0.79	0.88 - 0.97	24.7%
kW	25	0.79	239	0.91	0.75 - 0.84	28.2%
Therms	25	0.57	239	1.44	0.52 - 0.62	44.8%
Source MMBTU	25	0.84	239	0.72	0.8 - 0.87	22.5%

In an effort to provide more specific and actionable findings, GRR results for the program samples were examined in detail. The difference in the savings between the ex ante estimate and the ex post results were primarily, due to the differences in modeling assumptions, calculation methods and baseline assumptions.

The four principal reasons that ex ante gross impacts differ from ex post results are as follows:

- Differences in operating conditions, where the evaluation field visit revealed differences in the building's operational conditions that warranted adjustment to the building energy models
- Differing baselines, where the evaluation team determined a different baseline than the one used by the PA was more appropriate
- Differing calculation methods, where the evaluator used a different modeling approach

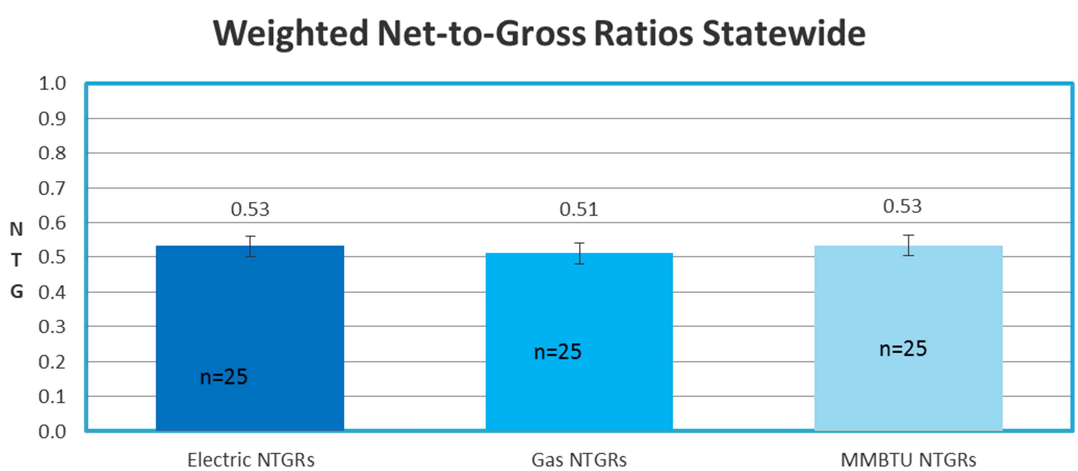
- Model calibration[3], where models were adjusted to calibrate model energy using billing-meter or end-use data

These four discrepancy factors explain most of the differences in ex ante savings and ex post results. A detailed investigation of all eight discrepancy factors is found in Chapter 5.

High Level Custom Net-to-Gross Results

Statewide NTG results are presented in Figure 3 and Table 3. Evaluation net-to-gross ratio (NTGR) results reveal that a moderate level free ridership has persisted into this program cycle. On a statewide basis, the NTGR for Whole Building program is estimated at 0.53 for kWh and 0.51 for therms and 0.53 based on source MMBTU which was the basis of sample design.

Figure 3: Weighted Net-to-Gross Ratios by Fuel Type Statewide



[3] This discrepancy is primarily due to calibrating the model with either end-use or/and billing data.

Table 3: Weighted Net-to-Gross Ratios by Fuel Type

Results	Electric NTGRs	Gas NTGRs	Source MMBTU NTGRs
	Statewide	Statewide	Statewide
Weighted NTGR	**0.53**	**0.51**	**0.53**
90 Percent Confidence Interval	0.51 - 0.56	0.49 - 0.54	0.51 - 0.55
Relative Precision	24%	25%	20%
n NTGR Completes	25	25	25
N Sampling Units	239	239	239
Final NTGR	**0.53**	**0.51**	**0.53**

Net Evaluation Realization Rate Results

Statewide first year net evaluation realization rates are presented in Table 4 for each of the energy metrics. Net realization rates are the product of the GRRs and the NTGRs and thus portray the combined evaluation impact as compared to unadjusted PA ex ante gross impact claims. This table also provides a comparison of the ex post net savings to the PAs' claimed net savings.

Table 4: PA Statewide First Year Net Realization Rate Estimates and Comparisons

	Electric Savings		Gas Savings
Impact Element	**kWh/year**	**Average Peak kW**	**Therms/year**
Tracking			
a. Claimed Gross Savings	67,909,049	21,886	828,183
b. Claimed GRR*	0.9	0.9	0.9
c. Claimed Adjusted Gross Savings	61,183,615	19,710	745,328
d. Claimed NTGR	0.65	0.65	0.64
e. Claimed Net Savings (e = c x d)	39,564,196	12,746	476,312
f. Claimed Net Realization Rate (f = b x d)	0.58	0.58	0.58
Evaluation			
g. Evaluation GRR	0.94	0.79	0.57
h. Evaluated Gross Results (h = a x g)	63,903,109	17,397	474,104
i. Evaluation NTG Ratio	0.53	0.50	0.51
k. Evaluated Net Results (k = h x i)	33,986,798	8,765	242,122
l. Evaluation Net Realization Rate (l = g x i)	0.50	0.40	0.29
m. Evaluated Net Savings as a Fraction of Claimed Net Savings (m = k / e)	0.86	0.69	0.51

*1 site had a claimed of ex ante GRR of 100%. This site is an ex ante review (EAR) overlap point in which CPUC participated in the final adjustment to the claimed savings. According to the CPUC policy surrounding EAR activities, this site is a frozen point and receives ex ante GRR of 1.0 instead of the 0.9 default ex ante GRR

Summary of Findings and Recommendations

This report provides a range of findings and recommendations aimed at improving NRNC Whole Building program performance and supporting CPUC and PA program and policy enhancements for this important element of the PAs' energy efficiency portfolios. Findings and recommendations were developed from each of the primary analysis activities. Extensive overarching findings and recommendations are presented in Chapter 7 (Net to Gross) and Chapter 8 (Findings and Recommendations) of this report. At a summary level, the detailed recommendations in this report fall into the following primary areas:

- To better align ex ante and ex post savings, the PAs should:
  - Use appropriate calculation methods, apply as-built building operating conditions, use applicable Title-24 baseline or Industry Standard Practice (ISP) to improve the savings estimation, and perform better quality control of the projects.
  - Improve adjustments to project savings based on post-installation inspections and M&V.
- Significant improvements in PA project documentation and tracking data are required to increase consistency between project files and tracking data and minimize errors in reporting project claims.
- To reduce continued moderate free ridership, PAs should design, implement, and test program features and procedural changes focusing on increasing program-induced savings.

2. *INTRODUCTION AND BACKGROUND*

This report presents the final results from the impact evaluation of 2013 Non-residential New Construction Savings by Design (SBD) Program administered by Pacific Gas and Electric (PG&E), Southern California Electric (SCE), San Diego Gas and Electric (SDG&E) and Southern California Gas (SCG). These program administrators (PAs) implement the SBD programs within their respective service territories. This evaluation study focuses specifically on non-residential new construction (NRNC) Whole Building projects. This study is managed by CPUC Energy Division (ED) staff. The study is referenced as the IALC4 work order and is being conducted under the Industrial Agricultural Large Commercial (IALC) roadmap. The IALC4 NRNC Whole Building Research Plan was finalized and posted on ED public document website.[4]

This chapter provides background information and introduces the reader to the SBD Program and whole building projects evaluated under the IALC4 work order. This chapter also references the research plan and evaluation architecture at a very high level. In the following subsections, we provide additional study background, highlight the percentage of portfolio-claimed savings associated with this IALC4 evaluation effort, and present the study objectives and issues researched.

Background

This impact evaluation focuses on high priority evaluation objectives for the NRNC Whole Building Programs and projects, and includes independent estimation of program and measure impacts, provision of recommendations to improve programs, and feedback to support cost-effectiveness analyses, program planning, and strategic planning.

SBD is the NRNC program administered by the PAs. SBD project savings are estimated via two separate approaches, the “systems” approach and the “Whole Building” approach. Although interactive effects are taken into account, the systems approach provides individual system estimates for energy efficiency measures installed in building systems such as lighting, HVAC, and building shell. Alternatively, the “Whole Building” approach utilizes building energy simulation models to forecast project-level estimates. This evaluation was focused solely on the SBD projects that used the Whole Building approach. Systems approach SBD projects were included in the custom impact evaluation under IALC2.[5]

[4] http://www.energydataweb.com/cpuc/#

[5] The Industrial, Agriculture and Large Commercial 2013 Impact Evaluation Report is available at http://www.energydataweb.com/cpuc/.

More than 200 hundred new Whole Building projects were completed and claimed by the PAs in the PY 2013 under the NRNC SBD Program. The Whole Building projects implemented within the non-residential new construction group were very diverse. The size of the projects, the types of installed energy efficiency measures, and the energy savings of the projects are highly variable across the population.

This evaluation effort investigates NRNC Whole Building claims to be evaluated, identifies those data sources that were used, estimates the program gross realization rates, determines net-to-gross scores, and provides qualitative assessments of sampled projects via project practice assessments(PPA).

The NRNC Whole Building gross impact assessment utilized standard M&V approaches to the extent appropriate and practical, including on-site data collection, monitoring, and analysis for a representative sample of Whole Building projects. The gross impact analysis: (a) developed ex post estimates of the energy and demand savings for each project in the sample, and (b) applied those findings back against the full participant population to obtain population estimates of program impacts. The evaluation team utilized PA and implementer-collected site-specific information, including M&V data, supplemented by data collected specifically for this evaluation. The site-level M&V rigor was "enhanced," and projects were evaluated with IPMVP option D, Whole Building simulation models that were calibrated to end use and billing data where feasible.[6]

In addition, a net-to-gross assessment was conducted using telephone surveys and self-report methods to derive net program impacts. More information regarding the net-to-gross assessment is found in Section 7 of this report.

The proposed sample sizes for the PY 2013 NRNC Whole Building evaluation are discussed in Section 7. In brief, a total sample size of 25 gross impact sample points was planned for PY 2013. Project specific M&V was slated for 25 points. All sample points were included in the gross impact and NTG samples. With 25 gross impact points, the 2013 sample the expected relative precision was 25% at 90% confidence interval, but the achieved precision for the overall estimate across all three PAs for the PY 2013 cycle was 23% at the 90% confidence level.

This evaluation assessed the NRNC Whole Building projects within SBD program. The energy savings claims associated with the scope of this evaluation account for about 2.6% percent of the total portfolio electric savings claims and 1.3 % percent of total portfolio gas savings claims during PY2013. For 2013, the PA tracking data for the program portfolio has thousands of entries with state-wide savings claims totaling 2,606 GWh and 436 MW for 2013. Statewide gas savings claims total 64 million therms in 2013.

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[6] From 25 projects, 10 projects were calibrated. Please refer to Table14 in the M&V chapter for calibration details.

Table 5: Claimed Energy Savings by PA for 2013 Projects in the NRNC Work Order below reports the claimed energy savings included in the NRNC Whole Building evaluation using the current measure group mapping[7] to impact evaluation work order.

Table 5: Claimed Energy Savings by PA for 2013 Projects in the NRNC Work Order

Energy Savings Claims by PA[8]			
PA	**Electric Energy (GWh)**	**Electric Demand (MW)**	**Gas Energy (Million Therms)**
NRNC WB Savings Claim			
PG&E	35	12	0.65
SCE	22	7	0.14
SDG&E	10	3	0.03
Total	**68**	**22**	**0.83**
Portfolio Savings Claim			
PG&E	1,490	242	35
SCE	786	142	1
SCG	8	6	26
SDG&E	322	47	2
Total	**2,606**	**436**	**64**
NRNC WB Percentage of Portfolio Claim			
PG&E	2%	5%	2%
SCE	3%	5%	14%
SDG&E	3%	6%	2%
Total	**2.6%**	**5.0%**	**1.3%**

Study Objectives and Researchable Issues

The overarching goals of this impact evaluation of non-residential new construction Whole Building projects were to verify and validate the energy efficiency savings claims reported from the SBD program; to provide

[7] CPUC Energy Division created these measure groups to facilitate the aggregation of like measures for the purposes of dividing the evaluation responsibilities by work order and to enable evaluation reporting by measure, where feasible.

[8] In the program year 2013, PG&E, SCE and SDG&E completed 135, 74 and 30 NRNC Whole Building projects respectively.

feedback on how well program procedures and savings methods comport with energy efficiency policies, requirements, and expectations; and to provide recommendations on how NRNC Whole Building programs can be further improved or refined to support overall and NRNC-related energy efficiency goals and objectives. Gross energy savings, free ridership levels, and net energy savings (in kWh, kW and therms) are estimated and compared to PA savings claims using evaluation-based realization rates and NTG ratios.

More details on the evaluation priorities[9] and the researchable issues for this effort are contained in the *IALC4 NRNC Whole Building Impact Evaluation Plan 2013.*[10]

The priorities for this evaluation effort and the researchable issues that this evaluation examined are described as follows:

- Estimating the level of achieved gross impact savings, determining what factors drive gross realization rates, and, as necessary, assessing how realization rates can be improved; the evaluation will identify issues with respect to impact methods, inputs, and procedures and make recommendations to improve PA savings estimates and realization rates.
- Estimating the level of free ridership, determining the factors that characterize free ridership, and, as necessary, providing recommendations on how free ridership might be reduced.
- Providing feedback to PAs to facilitate program design improvements.
- Determining whether the impact estimation methods, inputs, and procedures used by the PAs and implementers are consistent with the CPUC's policy directives, decisions, and best practices.
- Determining whether project baseline modeling approaches and simulation tools are appropriate with respect to California Title 24 building code and industry standard practice where no code is applicable.
- Collecting data and information to assist with other research or study areas, which could include measure cost estimation, cost effectiveness, updates to DEER, strategic planning, and future program planning.

In order to better answer these research questions and extract the greatest value from this study, the evaluation effort used a combination of approaches that included a gross impact sample supplemented with desk review (the latter desk reviews are part of what is referred to as the *project practice assessment* effort) for all the sample points. Thus, in addition to the M&V-oriented gross impact work described in Chapters 3, 4, and 5, additional project-level evaluation efforts included site-specific project practice assessment efforts.

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9 These priorities include energy savings, net to gross ratios and program assessments.

10 http://www.energydataweb.com/cpuc/search.aspx

Project practice assessment methods are described in greater detail in Chapter 7. Sample points were analyzed to:

- Examine and comment on conformance with program procedures (including measure eligibility and other rules);
- Analyze strengths and weaknesses of project applications; and
- Provide feedback on impact estimation processes.

For example, the project reviews and project practice assessment (PPA) examined whether the Title24 building codes were appropriate and program eligibility rules were consistent with overarching regulatory guidance and program rules and whether calculation methods and inputs were appropriate. Some other assessment categories included whether the PAs use appropriate incremental costs and incentive caps for the project and whether the measure EULs were appropriately assigned to each project. PPA forms are structured in a manner consistent with claims review requirements that are part of ESPI.

Given the expected range of error ratios (coefficient of variation for a ratio estimator) for the gross realization rates (roughly 0.6 to 1.0 based on the 2010-2012 custom impact evaluation), and the small number of impact (M&V) and NTG points implemented, no sampling sub-domains could be supported for the 2013 study. Since the IALC4 NRNC evaluation was expected to provide results at the statewide level, M&V and NTG samples were designed and implemented at the statewide level.

To allow evaluation of both electric and gas projects in a single domain, all the PAs electric savings (kWh) and gas savings (therms) at the project level were converted into source energy (MMBtu) savings for stratification and sampling purposes.[11]

Structure of the Report

Table 6 shows the overall organizational structure of this report. The findings and recommendations from this evaluation have been summarized in Chapter 8, and explained in more detail in Chapters 5, 6 and 7. Readers seeking a more comprehensive assessment of opportunities for program improvement are therefore encouraged to read these particular chapters.

[11] Conversion rates obtained from "*2001 Energy Efficiency Standards for Residential and Non-residential Buildings, California Energy Commission*," June 2001: 1 kWh = 10,239 Btu source energy; 1 Therm = 100,000 Btu source energy. 1 MMBtu =1,000,000 Btu.

Table 6: Overall Organizational Structure of Report

Section #	Title	Content
1	**Executive Summary**	Summary of results and high level findings
2	**Introduction and Background**	Evaluation objectives, research issues, and savings claims
3	**Sample Design**	Sampling design and associated issues
4	**Methods**	Approaches to gross impact determination, on-site M&V activities, NTG surveys, and lower rigor assessment (desk review) activities
5	**Gross Impact Results**	Gross impacts and realization rates, measure and program differentiation, new construction highlights
6	**Net Impact Results**	Net of free ridership ratios and results, spillover results, net realization rates and NTG result drivers
7	**PPA Results**	Program assessments based on project documentation review using the lower rigor desk review approach
8	**Detailed Findings and Recommendations**	Presented by topic area, including operating conditions, baseline issues, calculation methods, cross-cutting, net-to-gross/program influence, and lower rigor program related assessments

3. SAMPLE DESIGN

This chapter presents an overview and summary of the sample design used for the IALC4 NRNC Whole Building impact evaluation. For the program year 2013, 25 whole building projects were sampled for this study. These 25 projects were evaluated for gross and net savings and there were no other assessments of gross or net set savings outside of this 25 project sample.

According to the sample design, the 2013 population was divided into three strata using the total source MMBtu savings of each sampling unit (defined as a project). For this sample design, Stratum 1 contains the largest projects and Stratum 3 contains the smallest projects. Projects were selected randomly from each strata to achieve the proposed precision. The strata boundaries were set to optimize the relative precision for the total source energy savings (MMBtu) estimate of the entire NRNC whole building 2013 population across all PAs. As is typical in model-based statistical sampling, larger projects are oversampled. Of the 25 M&V points planned for 2013, 16 were allocated to large projects (Strata 1 and 2), and 9 to small projects. Table 7 below shows the disposition of the 2013 population and the final sample by PA. Roughly 20% of energy savings for each PA's NRNC Whole Building projects for 2013 were evaluated for this study.

Table 7: Summary of NRNC WB Impact Population and Sample by PA

PAs	Sample Points	Sampled Source MMBtu	NRNC Source MMBtu	Sample % of Population MMBtu	Sample Points Stratum 1	Sample Points Stratum 2	Sample Points Stratum 3
PG&E	15	83,081	424,316	20%	4	5	6
SCE	5	54,680	244,823	22%	3	2	0
SDG&E	5	19,450	109,001	18%	1	1	3
Total	**25**	**157,211**	**778,140**	**20%**	**8**	**8**	**9**

There were no changes or adjustments made to the initial sample design during the course of this evaluation. That is, 25 sample sites initially planned for this study were evaluated. Although some sites from the initial sample were dropped due to recruiting issues, these dropped sites were replaced with back-ups sites within the same stratum. Thus, no post stratification was required to the final sample frame. Table 8 shows a side by side comparison between the initial sample design and the final sample frame of this evaluation. The four rows highlighted in red in the table below show the four sites (E067, E093, E057 and E071) that were replaced with four back-up sites(E028, E011,E014 and E050) within the same stratum.

Table 8: Comparison between Initial Sample Design and Final Sample Frame

Initial Sample Design			Final Sample Frame		
DNV_GL_ID	IOU	Stratum	DNV_GL_ID	IOU	Stratum
E027	PGE	3	E027	PGE	3
E004	PGE	3	E004	PGE	3
E088	PGE	3	E088	PGE	3
E019	PGE	3	E019	PGE	3
E013	PGE	3	E013	PGE	3
E067	PGE	3	E028	PGE	3
E041	PGE	2	E041	PGE	2
E112	PGE	2	E112	PGE	2
E026	PGE	2	E026	PGE	2
E093	PGE	2	E011	PGE	2
E057	PGE	2	E014	PGE	2
E025	PGE	1	E025	PGE	1
E046	PGE	1	E046	PGE	1
E071	PGE	1	E050	PGE	1
E016	PGE	1	E016	PGE	1
F043	SCE	2	F043	SCE	2
F014	SCE	2	F014	SCE	2
F024	SCE	1	F024	SCE	1
F072	SCE	1	F072	SCE	1
F020	SCE	1	F020	SCE	1
H011	SDGE	3	H011	SDGE	3
H017	SDGE	3	H017	SDGE	3
H004	SDGE	3	H004	SDGE	3
H021	SDGE	2	H021	SDGE	2
H024	SDGE	1	H024	SDGE	1

Table 9 shows the sample points and populations by stratum. As a general principle, the ratio estimation approach optimizes statistical precision by oversampling larger projects. This is performed by stratifying the population by energy savings, and selecting a higher proportion of projects in the strata with larger energy savings. In this case, sampled projects comprised 52% of the energy savings in stratum 1, the stratum with the largest energy saving projects. Conversely, the sampled projects comprised only 3% of the energy savings in stratum 3, the stratum with the smallest energy saving projects.

Table 9: Sample Points and Population by Stratum

Stratum	Sample Points	Sampled Source MMBtu	NRNC Source MMBtu	Sample % of Population MMBtu	Sample Points PG&E	Sample Points SCE	Sample Points SDG&E
1	8	103,482	199,365	52%	4	3	1
2	8	46,309	259,377	18%	5	2	1
3	9	7,420	319,398	2%	6	0	3
Total	**25**	**157,211**	**778,140**	**20%**	**15**	**5**	**5**

Net-to-Gross (NTG) Sample. The net-to-gross sample utilized the gross impact sample for the IALC_4 NRNC whole building impact evaluation.

The details of sample design considerations and constraints, and confidence and targeted relative precision are discussed in the Sample Design Section of the IALC4 NRNC Whole Building research plan.[12]

[12] http://www.energydataweb.com/cpucFiles/pdaDocs/1186/DRAFT%20ED_IALC4%20NRNC%20Research%20Plan_Posted.docx.

4. METHODS

This chapter addresses the methods used for the gross impact, net impact, and PPA efforts including an examination of data sources and constraints associated with the evaluation methodology.

This NRNC Whole Building Impact Evaluation study was guided by the California Energy Efficiency Evaluation Protocols: Technical, Methodological, and Reporting Requirements for Evaluation Professionals.[13] The following protocols were primarily used, along with other guidance provided by the CPUC:

- Impact Evaluation Protocol
- Gross Energy Impact Protocol
- Gross Demand Impact Protocol
- Participant Net Impact Protocol or Net-to-Gross Guidance Document if Applicable
- Measurement and Verification Protocol
- Sampling and Uncertainty Protocol
- Evaluation Reporting Protocol

The evaluation approaches were consistently applied. However, given the heterogeneity of the projects, specialized and unique approaches were also utilized on a project-specific basis where necessary.

The NRNC Whole Building gross impact assessment involved standard M&V approaches to the extent appropriate and practical, including on-site data collection, monitoring, and analysis for a representative sample of Whole Building projects. The gross impact analysis: (a) developed ex post estimates of the energy and demand savings for each project in the sample, and (b) applied those findings back against the full participant population to obtain population estimates of program impacts. The evaluation team utilized PA and implementer-collected site-specific information, including project-implementer's submitted project files/documentation, supplemented by data collected for this evaluation. The site-level M&V rigor was "enhanced," and projects were evaluated with IPMVP option D, Whole Building simulation models calibrated to end use and billing data where feasible.

In addition, a net-to-gross assessment was implemented using telephone surveys and self-report methods to derive net program impacts.

[13] Available at http://www.calmac.org/events/EvaluatorsProtocols_Final_AdoptedviaRuling_06-19-2006.pdf.

Also, project-level assessments were conducted using the PPA approach developed for all gross sample points. The PPA approach provides cost-effective, impact-oriented findings and feedback on the NRNC Whole Building program.

The details of gross and net evaluation methodologies, M&V activities, development of data collection instrument, end-use metering, assessment of baseline, evaluation rigor levels, reliability, bias, uncertainty and data sources and constraints are discussed in M&V Chapter of the IALC4 NRNC Whole Building research plan.[14]

[14] http://www.energydataweb.com/cpucFiles/pdaDocs/1186/DRAFT%20ED_IALC4%20NRNC%20Research%20Plan_Posted.docx.

5. GROSS IMPACT RESULTS

This chapter presents quantitative and qualitative gross impact results for the 2013 IALC4 NRNC Whole Building impact evaluation. Gross impact realization rates (GRRs) are presented in this chapter using statewide and strata combinations of electric energy (kWh), electric demand (kW), gas energy (therms) and source energy (MMBTU) metrics.[15]

Program-Level Gross Impact Summary

Weighted gross impact results are presented in this section by stratum. Gross impact evaluation results are supported by 25 M&V sample points.

Table 10: Statewide First Year Weighted Gross Realization Rate Estimates and Comparisons and Table 11 show the first year and lifecycle PA Statewide ex ante claimed gross realization rate (GRR) estimates and comparisons to the ex post evaluated GRR. Table 12 and Table 13 present the evaluated statewide first year and lifecycle gross realization rates (GRR) with statistical boundaries. The life cycle savings are calculated by multiplying the first year savings by the estimated useful life (EUL) of the whole building measure(s). Note that the evaluated first year and life cycle GRR[16] values are different because the ex ante (tracking) EULs are different from the ex post (evaluated) EULs.

[15] Conversion rates obtained from "*2001 Energy Efficiency Standards for Residential and Non-residential Buildings, California Energy Commission*," June 2001: 1 kWh = 10,239 Btu source energy; 1 Therm = 100,000 Btu source energy. 1 MMBtu =1,000,000 Btu.

[16] PG&E did not submit EUL values in the tracking data. Hence, the evaluation team used the program EUL from the PY2013 Savings By Design E3 Calculator to estimate life cycle ex ante savings for PG&E projects.

Table 10: Statewide First Year Weighted Gross Realization Rate Estimates and Comparisons

	Electric Savings		Gas Savings	Source Energy Savings
Impact Element	**kWh/year**	**Average Peak kW**	**Therms/year**	**MMBTU/year**
Tracking				
a. Claimed Gross Savings	67,909,049	21,886	828,183	778,139
b. Claimed GRR*	0.9	0.9	0.9	0.9
c. Claimed Adjusted Gross Savings	61,183,615	19,710	745,328	700,992
Evaluation				
g. Evaluation GRR	0.94	0.79	0.57	0.85
h. Evaluated Gross Results (h = a x g)	63,903,109	17,397	474,104	663,454

*1 site had a claimed of ex ante GRR of 100%. This site is an ex ante review (EAR) overlap point in which CPUC participated in the final adjustment to the claimed savings According to the CPUC policy surrounding EAR activities, this site is a frozen point and receives ex ante GRR of 1.0 instead of the 0.9 default ex ante GRR

Table 11: Statewide Life Cycle[17] Weighted Gross Realization Rate Estimates and Comparisons

	Electric Savings		Gas Savings	Source Energy Savings
Impact Element	**kWh**	**Average Peak kW**	**Therms**	**MMBTU/year**
Tracking				
a. Claimed Gross Savings	1,072,032,790	346,431	13,026,360	12,279,180
b. Claimed GRR*	0.9	0.9	0.9	0.9
c. Claimed Adjusted Gross Savings	965,863,066	312,000	11,723,152	11,061,783
Evaluation				
g. Evaluation GRR	0.92	0.79	0.57	0.85
h. Evaluated Gross Results (h = a x g)	987,494,279	274,327	7,428,262	10,266,156

* 1 site had a claimed of ex ante GRR of 100%. This site is an ex ante review (EAR) overlap point in which CPUC participated in the final adjustment to the claimed savings According to the CPUC policy surrounding EAR activities, this site is a frozen point and receives ex ante GRR of 1.0 instead of the 0.9 default ex ante GRR.

[17] Life cycle gross realization rates vary slightly from first-year realization rates due to the variation of effective useful lives across projects

Table 12: Statewide First Year Weighted Gross Realization Rates

Energy Metric	Sample Size (n)	Gross Realization Rate	Population (N)	Error Ratio*	90% Confidence Interval	RR > 1.5	RR = 0	RR < 0**
PA Statewide								
kWh	25	0.94	239	0.81	0.89 - 0.99	4	0	1
kW	25	0.79	239	0.90	0.75 - 0.84	3	0	2
Therms	25	0.57	239	1.38	0.52 - 0.62	3	5	5

*A measure of the statistical variation in the gross realization rates.
** For three sites with RR<0 the ex ante savings estimates were negative but, the ex post results showed positive savings. Reporting a site-specific GRR in such cases would be meaningless. Positive ex post savings were used while extrapolating savings.

Table 13: Statewide Life Cycle Weighted Gross Realization Rates

Energy Metric	Sample Size (n)	LC Gross Realization Rate	Population (N)	Error Ratio *	90% Confidence Interval	RR > 1.5	RR = 0	RR < 0**	LC GRR Mean
PA Statewide									
kWh	25	0.92	239	0.79	0.88 - 0.97	3	0	1	0.94
kW	25	0.79	239	0.91	0.75 - 0.84	3	0	2	0.79
Therms	25	0.57	239	1.44	0.52 - 0.62	3	5	5	0.57

*A measure of the statistical variation in the gross realization rates
** For three sites with RRs <0 the ex ante savings estimates were negative, but the ex post results showed positive savings. Reporting a site-specific GRR in such cases would be meaningless. Positive ex post savings were used while extrapolating savings.

Figure 4, Figure 5, Figure 6, and Figure 7 graphically display *weighted* ex ante versus ex post savings estimates for the statewide sample. These figures present the weighted ex ante (tracking system) claimed savings and the weighted ex post evaluated savings for the M&V sample points for kWh, kW, therms, and source MMBTU, respectively. The charts also include a unity line, which divides the results into those in which the project-specific gross realization rates (GRR) were above one (sites above the line) and below one (sites below the line).

Figure 4: First Year Weighted Ex-Ante and Ex-Post Electric Savings (kWh) for Sampled Projects

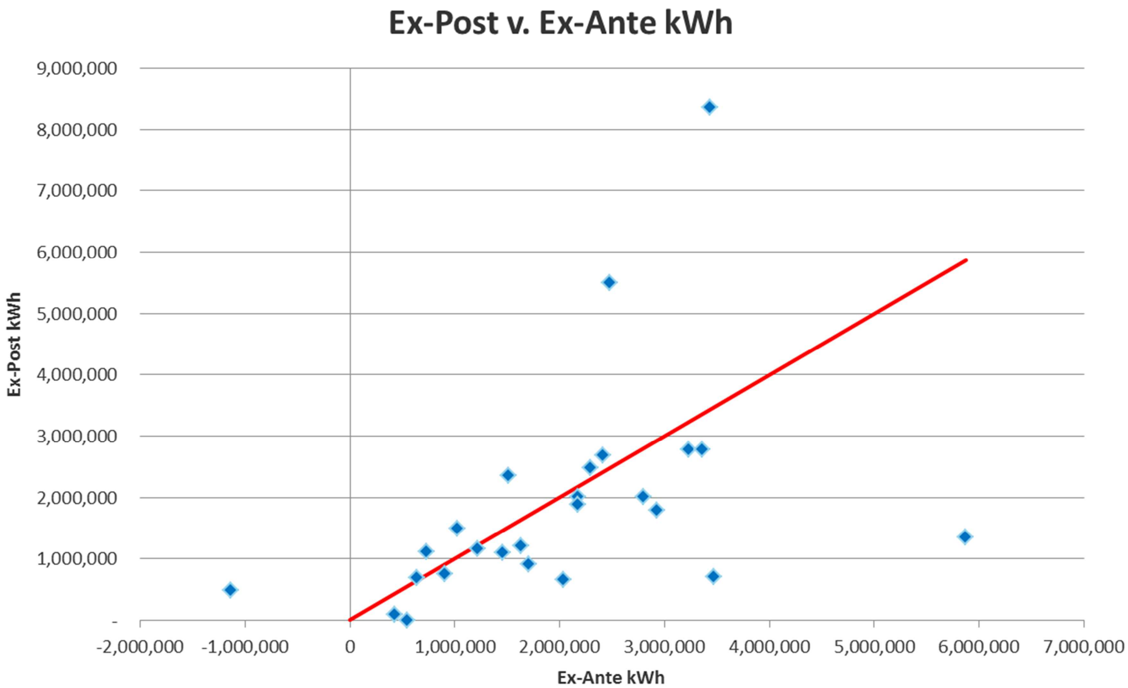


Figure 5: First Year Weighted Ex-Ante and Ex-Post Electric Demand Savings (kW) for Sampled Projects

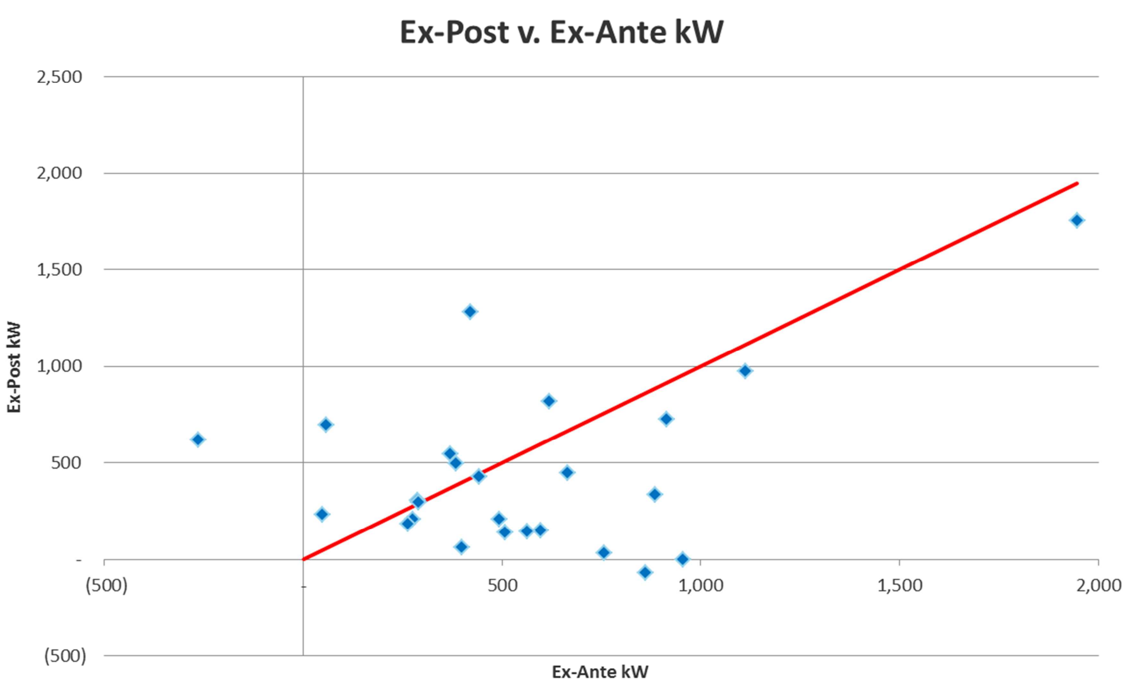


Figure 6: First Year Weighted Ex-Ante and Ex-Post Gas Savings (Therms) for Sampled Projects

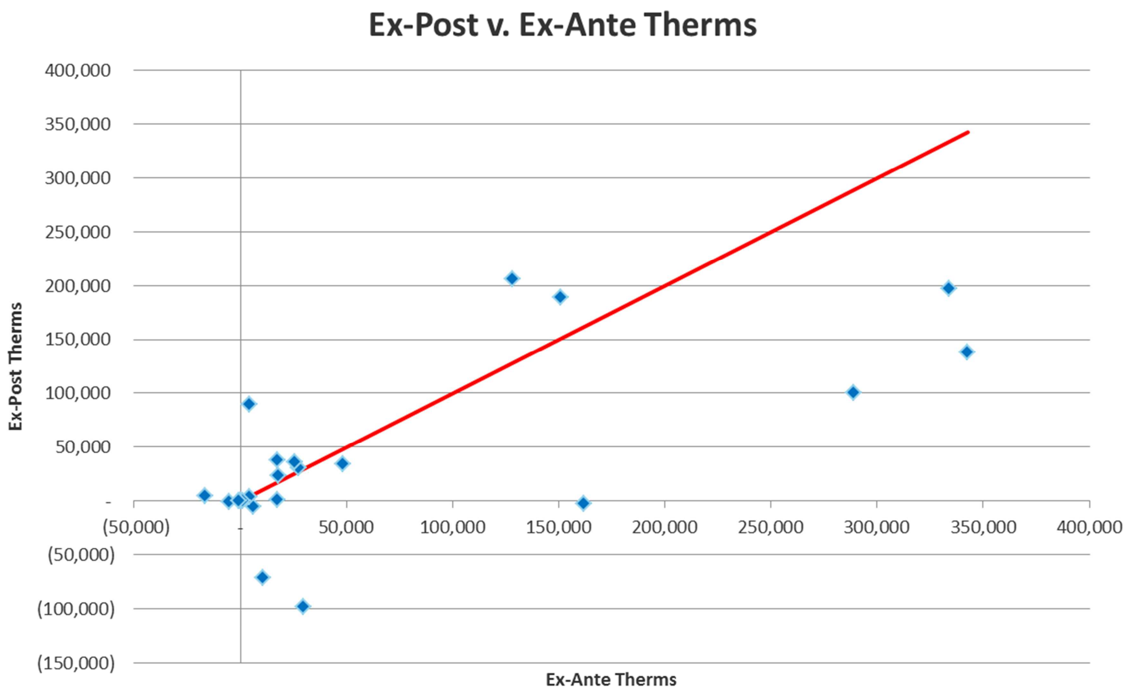
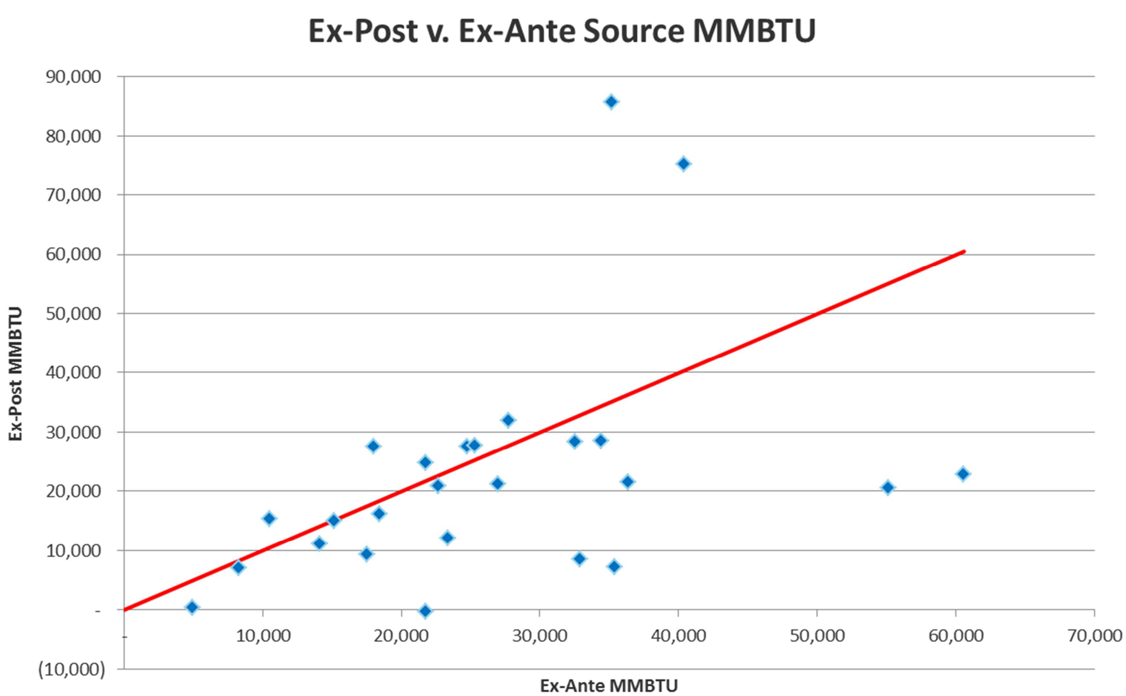


Figure 7: First Year Weighted Ex-Ante and Ex-Post Source MMBTU Savings for Sampled Projects



As the figures above show, the GRRs are scattered above and below the unity line for all energy metrics. No statistical correlation was discovered attributing specific project characteristics (e.g., building type, measure type, project size, etc.) to its respective GRR. The majority (19 out of 25) of sampled sites had kWh GRRs less than one. Ten sampled sites had weighted kW GRR greater than one. Gas energy GRRs appear the most erratic with about half of the sampled sites having a weighted GRR greater than one. Site-specific discussion regarding GRR and associated discrepancies are discussed in the next section.

Project-Specific Gross Impact Summary

This section covers site-specific gross impact findings for the 25 M&V sample points. The total ex ante (tracking) savings claimed for the 25 sampled NRNC sites was 12,372,105 kWh, 3,068.3 kW, and 305,330 therms. The total evaluated (ex post) savings for these 25 sites was 10,333,755 kWh, 2,050.2 kW, and 221,126 therms. The un-weighted[18] gross realization rates for the NRNC sites are 84 percent for electric energy (kWh), 67 percent for electric demand (kW), and 72 percent for gas energy (therms).

Table 14: Evaluated Un-weighted Site Specific Ex-Post Savings and GRR Results presents ex ante savings, ex post savings, and GRRs for each fuel metric and all sample points. The table also shows each sample point's stratum and unique site ID.

[18] The un-weighted gross realization rate is the average realization rate across the evaluated 25 NRNC sites

Table 14: Evaluated Un-weighted[19] Site Specific Ex-Post Savings and GRR Results[20]

			Ex-Ante Savings			Ex-Post Savings			Gross Realization Rates		
Site ID	Sample Stratum	Building Type	kW	kWh	Therms	kW	kWh	Therms	kW	kWh	Therms
E004	3	Assembly	46.2	61,519	1,377	36.8	58,994	1,565	0.80	0.96	1.14
E011	2	Educational - Secondary School	201.1	343,384	3,630	0.2	253,034	7,937	0.00	0.74	2.19
E013	3	Library	(13.3)	36,695	14,614	31.3	56,521	5,054	-2.35	1.54	0.35
E014	2	Educational - University	78.1	723,149	-	114.8	1,761,043	-	1.47	2.44	0.00
E016	1	Educational - Community College	95.9	708,222	119,204	72.0	230,236	47,987	0.75	0.33	0.40
E019	3	Healthcare building	13.3	27,699	8,179	9.2	256	(139)	0.69	0.01	-0.02
E025	1	Refrigerated Warehouse	99.7	839,826	-	106.4	935,795	-	1.07	1.11	0.00
E026	2	Office	181.4	(239,321)	70,310	(14.8)	102,617	41,539	-0.08	-0.43	0.59
E027	3	Office	19.4	45,790	2,440	25.0	37,987	1,714	1.29	0.83	0.70
E028	3	Educational - Community College	20.2	21,569	298	3.2	4,620	(255)	0.16	0.21	-0.86
E041	2	Healthcare building	88.5	520,532	31,787	269.5	1,159,155	39,706	3.05	2.23	1.25
E046	1	Office	387.0	1,123,102	(1,785)	339.3	965,574	(369)	0.88	0.86	0.21
E050	1	Office	231.6	507,353	44,537	156.2	383,391	71,755	0.67	0.76	1.61
E088	3	Storage - Conditioned	2.9	51,768	-	35.2	75,699	10	12.14	1.46	0.00
E112	2	Grocery retail store	61.0	456,985	893	62.0	422,537	830	1.02	0.92	0.93
F014	2	Office	410.0	483,172	3,783	369.0	522,762	4,842	0.90	1.08	1.28
F020	1	Storage - Refrigerated Warehouse	153.9	1,169,772	-	149.3	969,438	145	0.97	0.83	0.00
F024	1	Hospital	263.7	2,043,581	1,429	12.0	472,371	31,135	0.05	0.23	21.79
F043	2	Manufacturing - Light Industrial	186.4	615,927	6,223	70.4	376,611	(20,746)	0.38	0.61	-3.33
F072	1	Large retail store	177.1	972,491	(5,760)	48.4	701,672	1,644	0.27	0.72	-0.29
H004	3	Educational - Primary	30.2	86,166	54	7.7	46,023	12	0.25	0.53	0.23
H011	3	Educational - Community College	2.4	32,444	880	11.8	34,666	37	4.92	1.07	0.04
H017	3	Museum	31.3	76,510	1,289	41.3	118,826	1,797	1.32	1.55	1.39
H021	2	Educational - University	104.1	457,953	2,253	44.0	397,248	(15,074)	0.42	0.87	-6.69
H024	1	Office	196.2	1,205,817	(305)	50.0	246,679	-	0.25	0.20	0.00
Total			**3,068.3**	**12,372,105**	**305,330**	**2,050.2**	**10,333,755**	**221,126**	**0.67**	**0.84**	**0.72**

[19] The un-weighted gross realization rate is the average realization rate across the evaluated NRNC sites and is for informational purposes only.

[20] The GRR metric is defined as (ex post results) / (ex ante results) and remains consistent throughout the report. Individually, some GRR results may appear counter-intuitive. For example, E013 claimed negative kW impact yet the evaluation found a positive kW impact. This condition would lead one to intuitively assume a greater than 1 GRR (i.e., project performed better than claimed). Yet by definition of the GRR metric, this condition results in a negative project-level GRR (similarly with E026 and F072). There are also instances (e.g., E046) where the ex ante value is negative and the ex post value is less negative. In this case one would expect a greater than 1 GRR (project performed better than claimed). Yet the GRR is calculated as being a positive number less than 1, an indication typically acknowledged as under-performing. Finally, there are instances (H024, F020, E088, E025, E014) where GRR is reported as zero when the claimed impact is 0 but the evaluated impact is not zero. In these cases, the project must be assessed on an individual basis and not on reported GRR. Please note that the individual project-level GRR values are not used when rolling up results to the aggregate level; individual energy metrics (e.g., MMBTU, kWh, kW, Therms) are used to calculate aggregate program level results.

Of the 25 NRNC sample points, 13 of the sample points involved two building occupancy types – education and office (7 education building types and 6 office building types). The remaining 12 sample points were distributed among a variety of building types: 1 assembly, 1 grocery retail store, 2 healthcare buildings, 1 hospital, 1 large retail store, 1 library, 1 museum, 1 light industrial building, 2 refrigerated warehouses, and 1 conditioned storage building.

The evaluation team investigated whether there were any meaningful patterns in GRRs among similar building types. The small number of sample points, especially for a given building type, limited this assessment. One noteworthy observation involved sample points with refrigeration measures (Site IDs F020, E025, and E112). These three projects had relatively tight GRR ranges with kWh GRR ranging from 0.83 to 1.11 and kW GRR ranging from 0.97 to 1.07.[21] No other significant patterns were observed among the sample points.

Site E026 has a negative kWh GRR of -0.43; this is actually a result of negative ex ante kWh savings and positive ex post kWh savings. We found similar results with the Site E013 kW GRR and the Site F072 therm GRR. These sites had negative ex ante kW and therms and positive ex post kW and therms, respectively.[22]

The figures below graphically illustrate GRRs using the horizontal axis to show the magnitude of the project's ex ante savings relative to the total sampled ex ante savings. The vertical axis represents the project's GRR percentage and the green horizontal line represents 100% GRR (the horizontal axis represents 0% GRR). These figures clearly illustrate each sample point's GRR using the vertical axis as GRR magnitude. In Figure 8, the points that are close to the vertical axis have relatively small kWh savings compared to the total sample population kWh savings. The sample points that are farther from the vertical axis have kWh savings that account for a larger percentage of the total sample population kWh savings.

For example, Figure 8 has four dark green points above the horizontal green line. They represent the four sites that had GRRs greater than 150%. From these four dark green points, the two points closer to the vertical axis are sites with lower ex ante savings (<1% of the total ex ante sample savings) whereas the other two points farther from the vertical axis are sites that had higher ex ante savings (5-7% of the total ex ante sample savings).

Figure 9 and Figure 10 show the results (kW and therms, respectively) with observations associated with extreme GRRs removed. This was done for graphical comparison purposes only; evaluation savings include all 25 sampled M&V points.[23]

[21] Only E112 had Therms savings with a therms GRR of 0.93.

[22] See footnote 20, above, for clarification on why site-specific GRR is reported with a consistent definition and how aggregate GRR is calculated.

[23] Figure 8, Figure 9, and Figure 10 do not include points where the ex ante metric is negative and the corresponding ex post metric is positive (which results in a negative GRR).

Figure 8: kWh GRR for Sampled NRNC Whole Building Projects

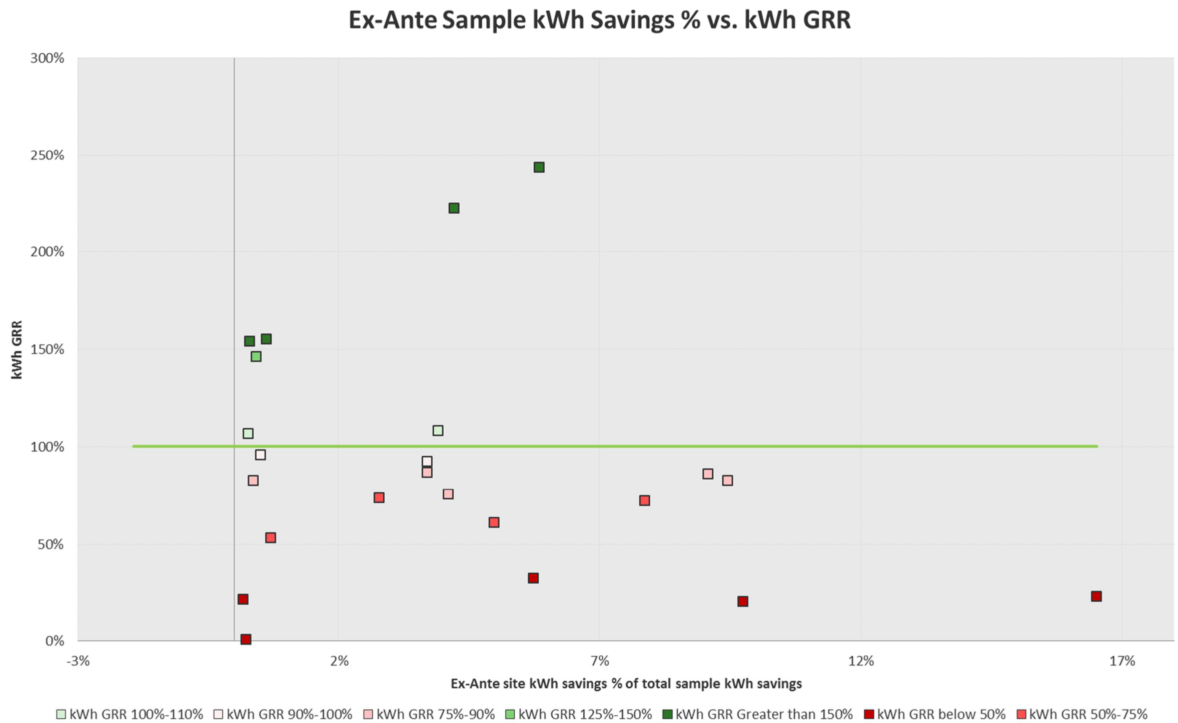


Figure 9: kW GRR for NRNC Whole Building Sampled Projects (Cropped)

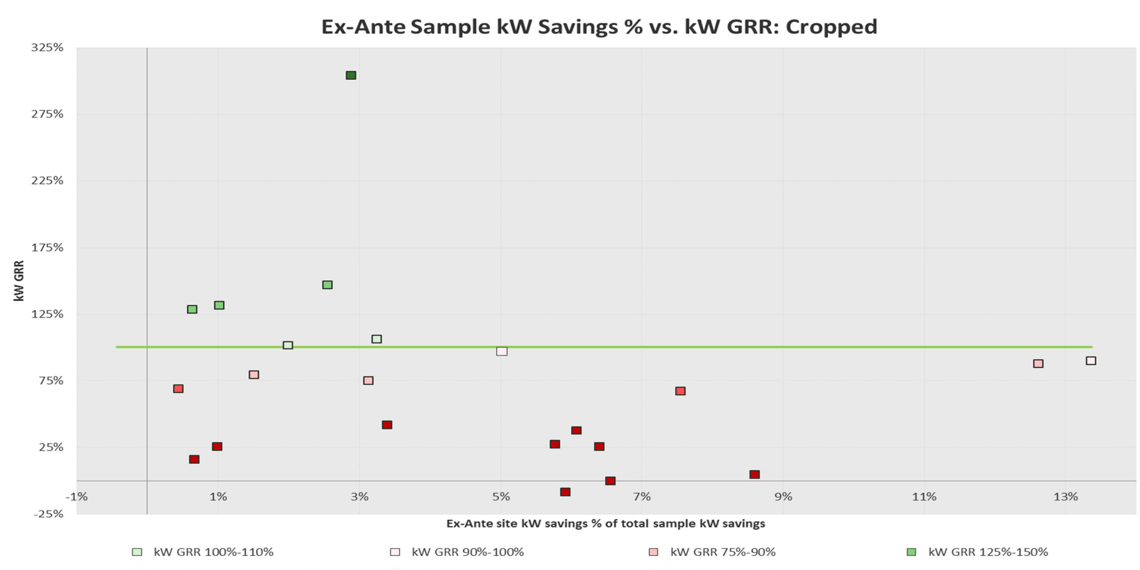
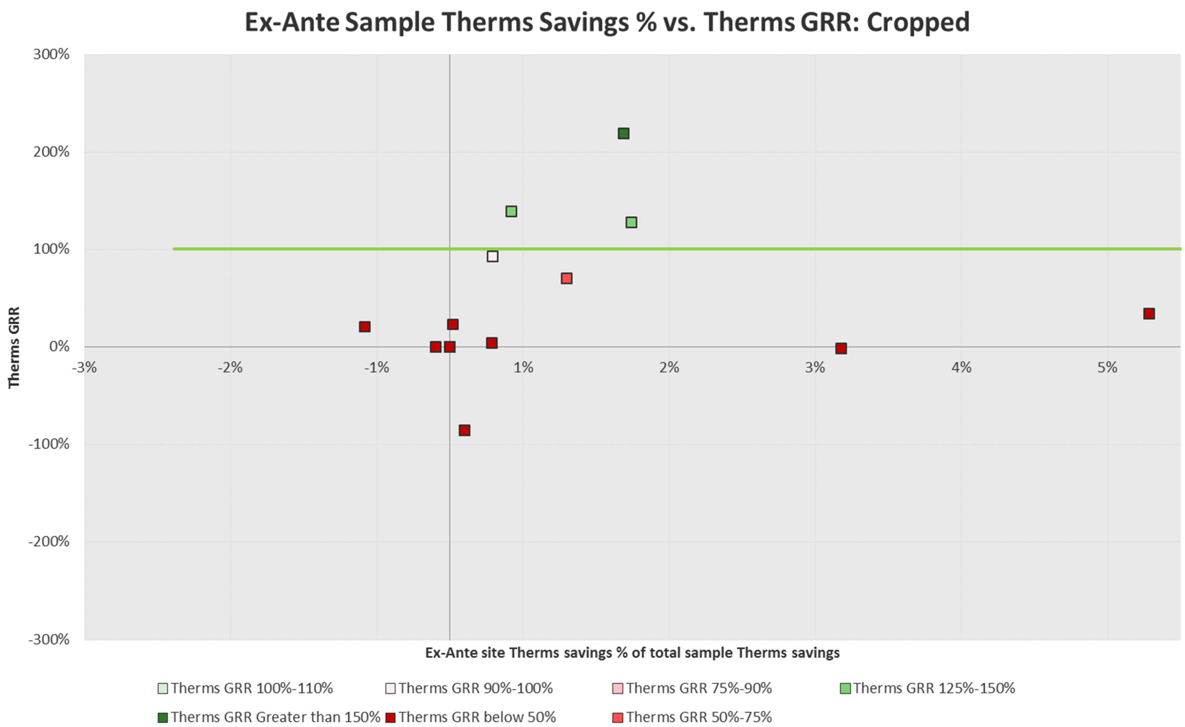


Figure 10: Therms GRR for NRNC Whole Building Sampled Projects (Cropped)[24]



The next three bar charts show the distribution of GRR values categorized in to four bins relative to a 100% realization rate: ± 10%, ± 25%, ± 50%, and more than ± 50%. The relatively large number of sample points that were more than ± 50% away from the 100% realization rate suggests that these points had evaluation findings that significantly affected the ex post results and caused them to vary considerably from ex ante estimates. However, the mix of positive and negative GRRs and the randomness of sample point savings magnitudes within each bin allowed the un-weighted average GRR values for each energy metric to remain relatively moderate compared to the extreme GRR values.

[24] The points with negative percentage values on the horizontal axis indicate that the ex post savings value was negative (i.e., negative therms savings). Points with negative horizontal axis and negative vertical axis values indicate that the evaluated (ex post) savings was positive.

Figure 11: kWh GRR Distribution for NRNC Whole Building Sample Projects

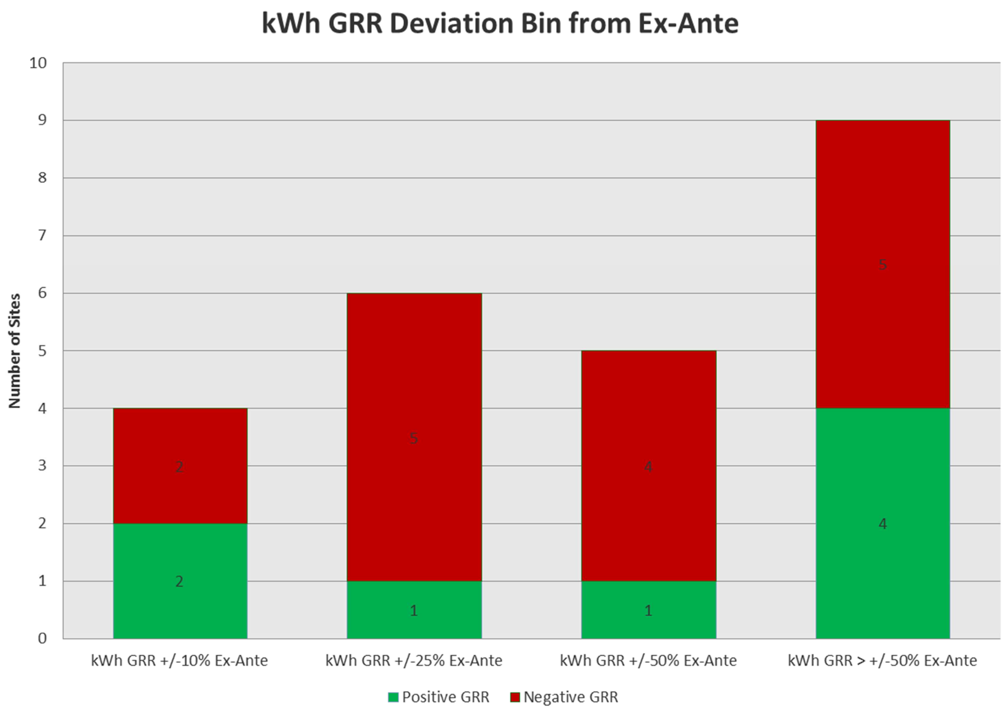


Figure 12: kW GRR Distribution for NRNC Whole Building Sample Projects

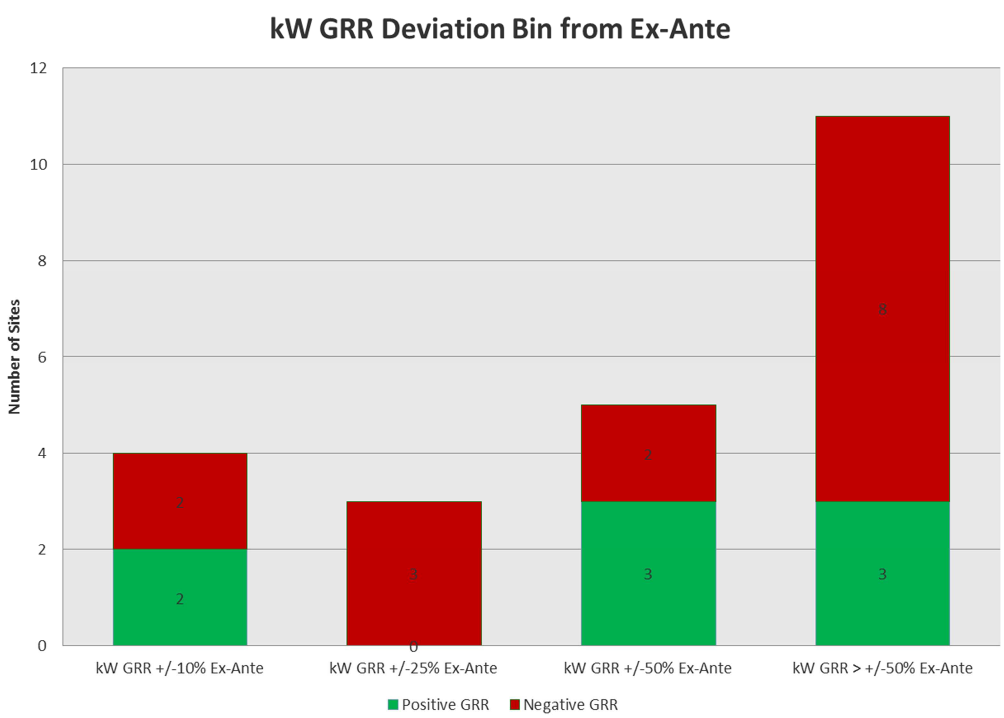
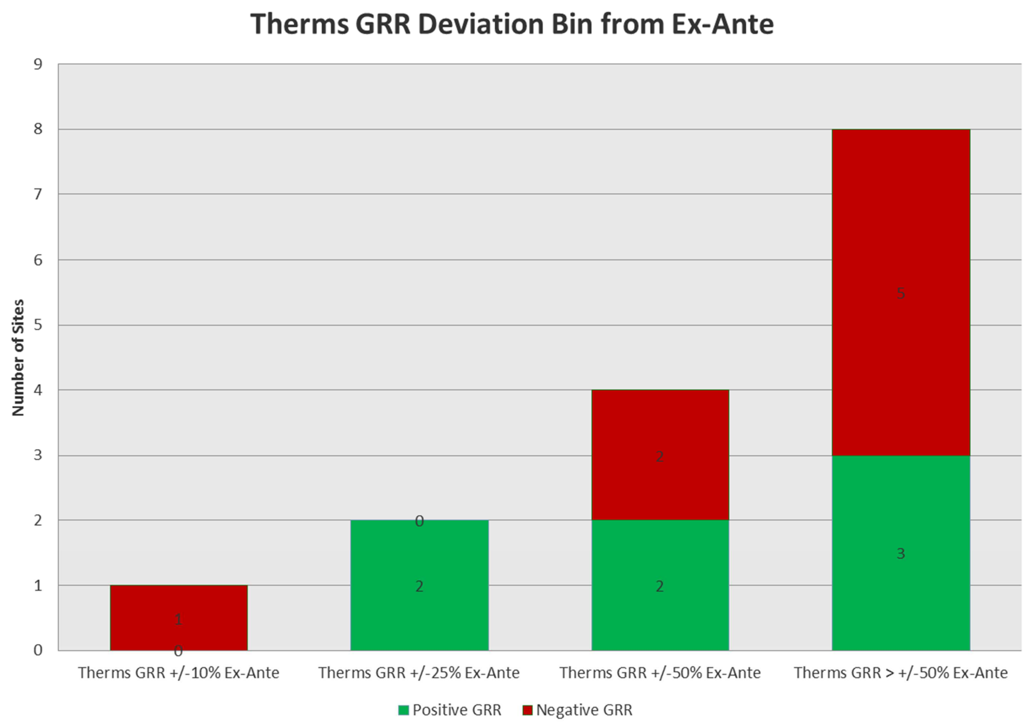
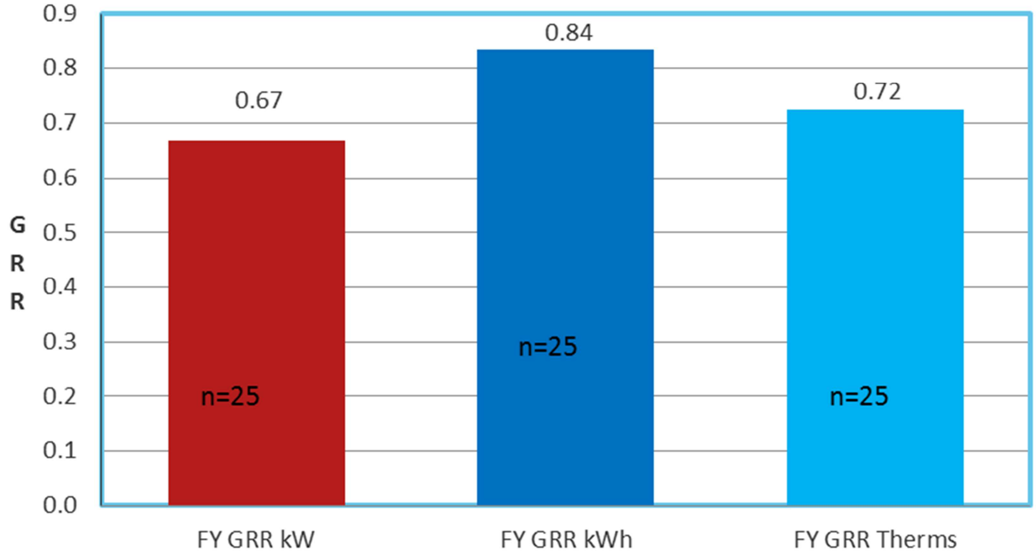


Figure 13: Therms GRR Distribution for NRNC Whole Building Sample Projects



Un-weighted gross realization rates for all sample points for the appropriate energy metrics (kW, kWh, and therms) are presented graphically in Figure 14. Gas energy (therms) savings were impacted most significantly among the energy metrics, mostly due to Calculation Method and Uncontrollable (model calibration) discrepancies. These findings are explained in greater detail in the Discrepancy Analysis section below.

Figure 14: First Year Unweighted Gross Realization Rate (GRR) by Sample Domain



Discrepancy Analysis

This section presents an analysis of the discrepancies that account for the difference between ex ante and ex post savings for the NRNC Whole Building sampled projects. This discrepancy analysis is based on discrepancies associated with first year impacts and gross realization rates.

5.1.1 Discrepancy Factor Definitions

The evaluation team categorized discrepancies between the NRNC Whole Building projects' ex ante and ex post impacts into two distinct categories: Controllable and uncontrollable. "Control" refers to whether the PAs had potential control over the discrepancies between the ex ante and ex post savings estimates, i.e., could the PAs have identified and rectified controllable issues discovered in the ex post models such that the evaluation only finds uncontrollable discrepancies.

A prime example of an uncontrollable discrepancy is the difference between ex ante and ex post savings as a result of model calibration to utility billing data. When the PAs perform post inspections to verify building completion, measure installation and operation, and to true up models to observed conditions, they often perform the inspections in the very early stages of building occupancy. Not enough time has elapsed for PAs to gather sufficient data related to building operations, including: building/energy management system (EMS) trend data, utility electric & gas interval data, and in some cases, cogeneration or site-generated (e.g., PV, wind) interval data. The building occupancy and equipment schedules must reach a steady state relative to the expected normal operating conditions, operating seasonality, and regional weather seasonality before the PAs could legitimately calibrate building models to building EMS (e.g., chiller/boiler load) and utility interval data. Because of these circumstances, discrepancies related to building load and model calibrations are categorized as uncontrollable. Hence, this is a discrepancy that is beyond PAs control unless PAs decide to wait a few months after the building completion and collect billing or/and end-use data and then calibrate the models to update the ex ante savings.

Ex ante savings would likely change significantly in the hypothetical situation where PAs could reasonably calibrate building models to building load and/or utility interval data; however, that change in ex ante savings could increase or decrease depending on project and building circumstances.[25] Uncontrollable discrepancies therefore cannot be considered strictly a negative impact on ex ante savings.

The controllable discrepancy category is sub-categorized into seven factors in order to increase discrepancy resolution and identify key problem areas. The following seven distinct controllable discrepancy factors are described below:

- Tracking Data
- Ineligible Measure
- Measure Count
- Inappropriate Baseline
- Inoperable Measure
- Operating Conditions
- Calculation Method

Tracking Data

This discrepancy category captured instances when the final ex ante building model results from project documentation did not match the final claimed ex ante savings as reported in the tracking data. These discrepancies are typically random administrator error (e.g., final model is revised after tracking values have been approved and tracking savings are not updated) and rounding errors, and no systemic patterns were observed. However there may be site-specific exceptions where this category was considered to be the most appropriate given the fixed discrepancy categories.

Ineligible Measure

When the evaluated building/measure was determined to be ineligible based on program rules or policy, the discrepancy between ex ante and ex post energy impacts are assigned to this category. An example of an ineligible measure involved Site E112 where the efficiencies of the installed HVAC packaged units did not exceed the Title 24 standard efficiency. Note that if there were other additional measures that used the ineligible measure as a means to define baseline conditions or efficiency, then the other measures' discrepancies would be assigned to the inappropriate baseline discrepancy category as well.

[25] There is no strong statistical correlation between building calibration and change in estimated energy savings. Table 15 lists projects whose models were calibrated to utility data and/or building load data. The results show that savings could increase or decrease with varying magnitudes and explanations for the change.

Measure Count

The "Measure Count" category is used when the observed number of measures (e.g., number of air compressors, number of supply fan motors, number of identical buildings, calculated LPD based on fixture count) does not match the number of respective measures incentivized in the ex ante project documentation. An example of this discrepancy was observed for Site E004 where the calculated ex ante lighting power density (LPD) was revised because the observed fixture count was different than what was described in the ex ante project documentation.

Inappropriate Baseline

This discrepancy category is applied to instances where the baseline model does not reflect 2008 Title 24 or Alternative Calculation Method (ACM) guidelines for establishing standard/baseline model characteristics. An example of this discrepancy would be if the baseline model of a two story office building was created with a built-up single zone HVAC system with a central plant (defined as System #5 in the ACM guidelines). The ACM manual states that a low-rise nonresidential building (three stories or less) should use System #1 through #3, depending on whether the proposed system is single or multiple zone and gas or electric heat. A specific example of this discrepancy was observed for Site E019 where a medical office baseline model was inappropriately simulated using the SBD healthcare ISP which dictated constant volume HVAC systems. This building was an out-patient clinic and didn't have any special pressurized zones that require the HVAC System to be constant volume. Therefore, the baseline should have been based around Title-24 building code with variable volume HVAC systems.

Inoperable Measure

The Inoperable Measure category is assigned when the impact discrepancy is due to a measure that was not observed to be operating as intended. For example, if glycol pumps were proposed to be fitted with variable speed drives (VSDs) and operate between 30% and 90% speed and if during the site visit the drives were observed to be installed but disabled such that the motors were running full speed, then the discrepancy associated with this finding would be assigned to the Inoperable Measure category. There was only one occurrence of this discrepancy in the sampled projects; Site E112 had gas savings associated with a heat reclaim tank. The tank was installed as proposed; however, the valve allowing make-up flow to the tank was closed, effectively zeroing the measure savings.

Operating Conditions

This discrepancy category is chosen for discrepancies that arise from differences in building or HVAC operation between the ex ante model using assumed conditions and the ex post model using observed operations. For example, the AHU supply fan brake horse power input value in one site's building model may be 20.0 hp at the design airflow based on the AHU specifications. Site visit findings may have indicated the actual fan brake horse power was only 12.5 hp at the design airflow, due to a more efficient duct design. The savings change due to the fan design brake horse power difference is counted as an Operating Conditions discrepancy. Another example of this type of discrepancy may involve the difference between the observed refrigeration load and the load that was estimated in the ex ante model. The ex ante model may have assumed a continuous full design refrigeration load while the evaluated (ex post) model used the observed refrigeration load based on trend/metered data or production/operating schedules. In this case, the difference in refrigeration load and load schedule is a discrepancy in the operating conditions of the building.

Calculation Method

The Calculation Method discrepancy category accounts for savings differences due to different modeling methods used between the ex ante and ex post savings estimates. This can include differences between ex ante and ex post load estimate, weather normalization, savings normalization, peak demand calculation methods and modeled equipment design. For example, an ex ante model may have been modeled with an AHU with heating hot water (HHW) heating coils at the air handler. The site visit may have observed that the AHU did not have HHW coils at the air handler but rather had reheat coils downstream at the VAV boxes. This difference between AHU configurations is a Calculation Method discrepancy. Another example had ex ante peak demand reduction estimated using all annual hours lying between 2-5 P.M. whereas the ex post estimate was estimated using only hours falling within the DEER peak periods for the site's climate zone. Differences between the ex ante and ex post model's simulation year (standardized model savings uses 1991 as the calendar year) is another example of a Calculation Method discrepancy. As a final example, projects that used Energy Pro had final ex post savings estimated using the (noncompliance) Nonresidential Performance module rather than the (compliance) Title 24 Nonresidential Performance module that ex ante savings estimates were modeled with. This Calculation Method discrepancy was encountered on nearly every sampled project using Energy Pro (except for Site E046). This modeling discrepancy was also noted as a prominent issue in the previous evaluation of 2010-2012 NRNC projects. This issue is discussed further in the "Issues and Recommendations" section of this chapter.

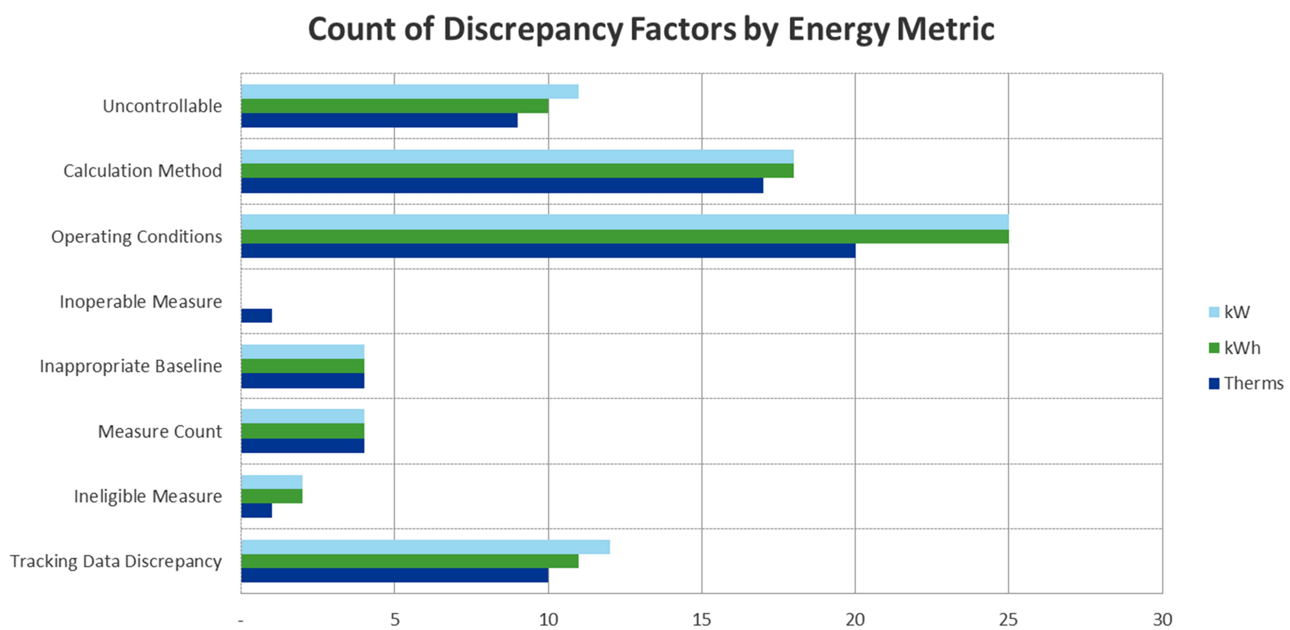
Uncontrollable Discrepancies

A total of eight discrepancy categories were used in this evaluation (seven controllable factors and the uncontrollable factor).The uncontrollable discrepancy could potentially be sub-categorized into the same seven factors as the controllable discrepancy factor; however, this evaluation used the uncontrollable category primarily to identify discrepancies regarding model adjustments and calibration performed due to change in building load, use of end-use data, and utility billing data.

5.1.2 Frequency of Discrepancy Factors

The energy metric (kWh, kW, and therm) discrepancies of a given sample point are categorized using the eight discrepancy factors (seven controllable and one uncontrollable) defined above. The discrepancy factor occurrences were then tallied up to assess the frequency that the discrepancy factors were used. Figure 15 shows the frequency of each discrepancy factor.

Figure 15: Frequency of Discrepancy Factors by Energy Metric



Each energy metric for a given sample point can have multiple discrepancy factors assigned to it. For example, Site E041 has a kW discrepancy of 181 kW, or ~205% of the ex ante kW value of 88.5 kW. Of that total ~205%, -5.7% (or -5.04 kW) was assigned to the Tracking Data discrepancy, 89% was assigned to the Operating Conditions discrepancy, 52.4% was assigned to the Calculation Method discrepancy, and 68.8% was assigned to Other discrepancies.

This disaggregation was possible because the evaluation team performed several iterations of revisions to the ex ante energy models for each site. For each iteration (i.e., for each Energy Pro or eQUEST model run), the team would attempt to group revisions with common discrepancy factors so that individual iterations could be assigned one discrepancy category.

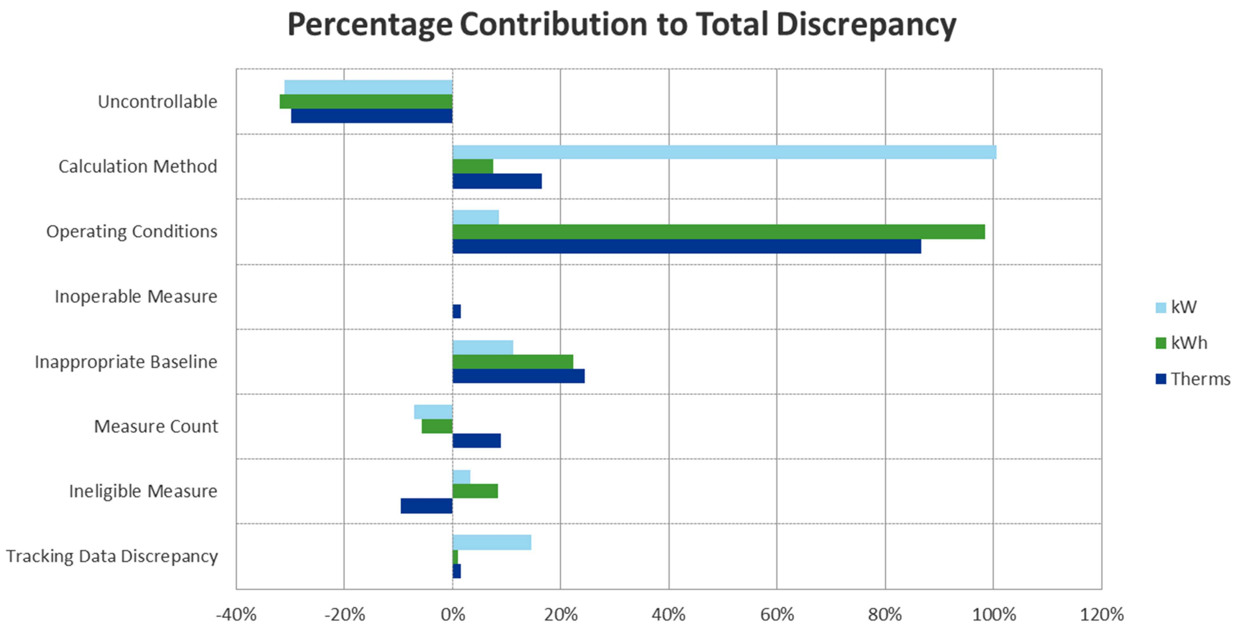
Based on the figure above, the four discrepancy factors with the highest frequency of occurrence are Operating Conditions, Calculation Method, Tracking Data, and Uncontrollable (i.e., model calibration). The next section will report on whether there are correlations between the frequency and energy impact of the discrepancy factors.

5.1.3 Discrepancy Effect on Ex-Ante Savings Claims

From the overall annual ex ante savings and the GRR values cited in Table 14 above, the discrepancies of all 25 sample points total -2,038,350 kWh, -1,018 kW, and -84,204 therms.

Figure 16 shows the percentage of savings discrepancy that the discrepancy factors are responsible for in each energy metric (kWh, kW, and therms) for all the sample points. Note that a category can have a discrepancy contribution greater than ± 100% and that the sum of all eight category discrepancy contributions for a given energy metric totals 100%.

Figure 16: Factor Contribution to Total Discrepancy by Energy Metric



The figure illustrates that the Calculation Method discrepancy factor accounts for the largest impact for the kW metric (100.6%) while the Operating Conditions discrepancy factor accounts for the largest impact for the kWh and therm energy metrics (98.4% for kWh and 86.6% for therms).

The following examples illustrate the major contributors that led to the significant Calculation Method discrepancy for the kW metric. The Site E011 ex ante peak demand reduction was calculated using the maximum peak demand of the entire year (i.e., maximum peak kW of all 8,760 hours) rather than the DEER peak definition. This led to a -98% (-196.7 kW) demand impact for the specific project. The ex ante model for Site E050 was run using the NR T-24 Performance module while the ex post model was run using the NR Performance module. Additionally, there were issues discovered with fan energy consumption that were attributed to the Energy Pro program not properly calculating fan power for the particular zone and schedule period. This discrepancy caused a -84.1% (-194.8 kW) demand impact for the specific project.

The kW metric had moderate discrepancy impacts (14.5%) from the Tracking Data discrepancy category. This category is used when the ex ante (tracking) savings claim is different from the final ex ante energy model results i.e., the savings that the energy model reports when the evaluation team simulated the final ex ante model. When the evaluation team attempted to reproduce the ex ante savings claim (specifically the electric demand reduction) using the final ex ante energy model, the team used the appropriate climate zone and DEER peak demand definition as described in the research plan.

Of the 14.5% (-147.1 kW) peak demand impact from the Tracking Data Discrepancy factor, one sample point had a significant impact on the discrepancy factor's total contribution. Site F014 used an eQUEST model and a custom workbook to calculate hourly TDV for program eligibility and ex ante savings. The evaluation team reproduced the eQUEST model savings by running the model under the appropriate climate zone and calculated peak demand reduction using the DEER peak definition. This led to a peak demand discrepancy of -164 kW which was categorized under the Tracking Data Discrepancy. Although this discrepancy could be construed as a Calculation Method discrepancy, the evaluation team believed this particular issue would be better described using the Tracking Data discrepancy category.

The Uncontrollable discrepancy factor, used primarily for discrepancies due to model calibration, contributed negatively toward all energy metrics (-31.9% for kWh, -31.0% for kW, and -29.9% for therms). This finding is coincidental however since individual sample point discrepancies assigned to the Uncontrollable category were both positive and negative for all energy metrics. The "negative" connotation in this case can be misleading; a negative percent contribution to the total discrepancy *reduces* the magnitude of the energy metric's discrepancy.

The evaluation team disaggregated the impact that uncontrollable discrepancies had on GRR from controllable discrepancies. Table 15 shows the sub-set of sites whose energy models were calibrated to building load and/or utility interval data. Pre-calibration and post-calibration results are shown[26]. The intent of the table is to illustrate the significant (and site-specific) impact that building load and/or utility billing data calibration can have on estimated savings.

Table 15: Site Specific Model Calibration Impact Comparison

	Pre-Calibration Savings			Post-Calibration Savings			Calibration Impact (%)		
Site ID	**kW**	**kWh**	**Therms**	**kW**	**kWh**	**Therms**	**kW**	**kWh**	**Therms**
E004	33.9	70,881	1,516	36.8	58,994	1,565	9%	-17%	3%
E025	106.7	931,501	-	106.4	935,795	-	0%	0%	-
E026	-23.4	52,517	32,473	-14.7	101,425	40,410	-37%	93%	24%
E041	208.6	886,589	41,032	269.5	1,159,155	39,706	29%	31%	-3%
E112	55.4	414,185	(113)	62.0	422,537	830	12%	2%	-835%
F014	252.0	466,693	3,582	369.0	522,762	4,842	46%	12%	35%
F020	120.6	879,511	98	149.3	969,438	145	24%	10%	48%
F043	54.2	242,676	28,467	54.5	215,534	25,424	1%	-11%	-11%
H017	18.0	70,591	6,571	41.4	118,214	4,087	130%	67%	-38%
H024	20.4	384,280	(20,635)	28.1	320,351	(29,990)	38%	-17%	45%
Total	**846.4**	**4,399,424**	**92,991**	**1,102.3**	**4,824,205**	**87,019**	**30%**	**10%**	**-6%**

As the total calibration impacts show, model calibration had an overall positive impact (increased savings) on kWh and kW and a negative impact on therms. Note however, that these findings cannot be correlated to

26 Note that post-calibration results shown in the table are not the final ex post savings for all the listed sites. There were some additional revisions after calibration for E026, F043, H017, and H024

project characteristics (e.g., project size, building type, measure types, etc.) because each site has unique conditions that affect model calibration. Trends could possibly be determined with larger samples that contain similar building types or occupancies (e.g., chain restaurants or retail stores).

Issues and Recommendations

In California, Energy-Pro was a state-approved energy simulation tool that was used to demonstrate performance compliance for new construction buildings and eligibility for the statewide SBD program. Since Energy Pro has not been certified by the CEC for use in assessing compliance with the 2013 T24, the IOUs should use a software package that can provide results in the T-24 compliance mode as well as-built performance mode (non-compliance).

The issues discussed below not only cover modeling related concerns but also go over other key issues such as use of inappropriate baseline, applying default operating schedules and set points to the models, not using appropriate weather files in simulations. These issues will still be relevant irrespective of software used for simulation. Therefore, the evaluators believe that these issues and recommendations will be relevant for future program years, regardless of the software choice made by the PAs.

The certified version of Energy-Pro that was used by PAs for the program year 2013 projects. The EP tool was either (1) inappropriately used to estimate ex ante savings, or (2) limitations of the tool led to inappropriate baseline characteristics in the standard model.

The ACM Manual clearly states the modeling rules for standard and proposed design to demonstrate compliance with Title-24. However, there is no official document (e.g., the SBD Program Manual) to articulate the modeling rules for standard and proposed design to estimate ex ante energy savings. This limitation has led to inconsistencies in the interpretation of the ACM among different program implementers.

Energy-Pro uses two calculation modules related to the SBD program: (1) NR T-24 Performance and (2) NR Performance. Both modules create standard and proposed building description files and estimate annual building energy performance using the DOE-2.1E building energy simulation program. However, there are distinct differences between these two modules that have been ignored or misunderstood by some SBD program sponsors and administrators. The NR T-24 Performance module uses T-24 standard schedules in both the baseline and post-retrofit models while the NR Performance module uses the current year as the run period and as-built mechanical systems in the baseline model. As proposed in this section: as-built design schedules should be used in *both* the baseline and post-retrofit models; the baseline mechanical systems should be specified in accordance with the Title-24 ACM manual; and the run period should have been the calendar year 1991 (to be consistent with the defined DEER peak periods which use standardized CTZ weather data and the 1991 reference year). This problem has contributed to the inaccuracy of energy savings estimates for this program. The significant difference in peak demand savings between the ex ante estimate and the ex post results were largely due to the use of inappropriate calculation method in the ex ante estimate.

In addition, neither of the standard building models created by the two modules is appropriate for use as the baseline model for the SBD program. The NR T-24 Performance module uses T-24 standard schedules in both the standard and proposed models while the NR Performance module uses the current year as the run period and as-built mechanical systems in the baseline model.[27]

As proposed in this section: (1) program eligibility should be determined using the NR T-24 Performance module and ex ante savings should be determined using the NR Performance module; (2) as-built design schedules should be used in both the baseline and post-retrofit models when calculating savings; (3) the baseline mechanical systems should be specified in accordance with the Title-24 ACM manual; and (4) the run period should be consistent with the defined and applicable DEER peak periods.

Issue #1: Ex-Ante Energy Pro Model Schedules Do Not Match As-Built Design Schedules

For some of the whole building sites with energy savings simulated with Energy-Pro, the ex ante annual energy savings were determined based on standard T-24 schedules instead of the building's as-designed schedules. "As- designed" schedules are based on full design occupancy and typical planned building schedules. As-designed is usually different from the "standard" or "reference" T-24 schedules that this issue describes.[28] The as-designed schedules are also different from the "as-built" schedules, which are observed once the building is completed and occupied, and "as-evaluated" schedules which are collected during evaluation and used for calibration purposes.

The difference in building schedules can have a significant impact on the ex ante savings, especially for seasonal buildings such as schools and recreation centers where as-built design schedules can typically have larger variations, compared to T-24 schedules, than other high occupancy buildings like hospitals or large office buildings.

Some ex ante Energy Pro models had "undefined" schedules which default to T-24 schedules in the NR T-24 Performance module but require definition in the NR Performance module. This can also have a significant impact when the evaluation team runs the energy model using the NR Performance module to estimate energy savings[29].

Recommendation #1: Use As-Designed or As-Built Schedules

Generally speaking, the annual TDV energy use should be simulated using standard T-24 schedules to determine the percentage of annual energy use below Title-24 and subsequent program eligibility. After

[27] The "current" run year is dictated by the computer date that the Energy-Pro program and model was simulated on. So for example, if the computer's calendar year was changed from 2015 to 1991 the Energy Pro program running the NR Performance module would simulate the model based on the 1991 calendar year.

[28] There were instances where the T-24 schedules were reasonably similar to the as-designed schedules

[29] Adjusting the model to use the NR Performance module instead of the NR T-24 Performance module is a necessary step in order to adjust the building schedules to actual conditions. However, the schedule change could not be isolated completely from other factors because when the modeler changes from NR T-24 Performance (compliance module) to NR Performance (non-compliance module) several other inputs for the "standard" base case model (equipment and thermostat set points, artificial loads, and run period) are automatically changed by the EnergyPro software. An isolated comparison to quantify the difference in savings due to a change in schedules from the T-24 schedules to actual schedules must be performed outside of EnergyPro; this task requires significant effort that was not within the planned scope of the evaluation. This "bundled" adjustment introduces some uncertainty around discrepancy assignment and discrepancy magnitude around change in building schedule(s).

eligibility is determined, the annual energy savings should be simulated using as-designed schedules to estimate the ex ante savings.

This adjustment means the NR T-24 Performance module should first be selected to develop the baseline model and conditions (e.g., baseline equipment types, equipment controls, equipment efficiencies, etc.), and to determine the eligibility of the building. The post-retrofit TDV energy should be lower than the baseline TDV energy by the program-required percentage to be eligible for SBD incentives.

If the project/building is eligible for incentives, the software package should then be switched from NR T-24 Performance to NR Performance in order to perform the ex ante pre-installation savings estimation. At this point, as-designed schedules would be applied to both the baseline and post-retrofit models for the ex ante savings estimation. Thus, the as-designed schedules are reflected in the baseline and proposed conditions and savings are attributed only to the equipment/building design enhancements.

When the building construction is complete and the project is ready for the post-verification visit, the inspector would verify that the as-built schedules are consistent with as-designed schedules. If not, further adjustments should be made to the manually entered schedules in the post model; these adjustments will also be automatically applied to the baseline model. The revised ex ante models are then re-simulated to true-up the ex ante savings estimation based on the as-built conditions observed during the post-construction inspection.

The recommended modeling process detailed above is currently manual, and might sometimes become labor intensive. We suggest the PAs explore modifications to the PA selected software tool in order to automate the recommended modeling process and automatically generate appropriate energy savings. Alternatively, PAs can elect for additional training so that modelers are proficient with both the compliance and non-compliance modules.

Issue #2: Ex-Ante Models are not trued-up to Physical As-built Conditions

Some of the ex ante energy models were not trued up (i.e., "physical calibration") to reflect actual as-built equipment specifications, sequencing, and controls. The system configuration modeled in the building simulation did not always match the observed system configuration found by the evaluator during the site visit.

For example, the ex ante proposed model for Site E013 had a HVAC system type that did not match the actual observed HVAC system. The ex ante model utilized a VAV system with chilled and hot water coils; the evaluator site visit determined that the HVAC system was actually VRF. This had a significant impact on all energy metrics (kW by -324%, kWh by 57%, and therms by -66%). For another site, the HVAC systems' heating hot water (HHW) coils were modeled as being packaged within the AHU, while the evaluator's site visit determined that the HHW coils were actually installed downstream before the VAV boxes. These discrepancies in the modeled system configuration often have negative implications for the site's GRR.

Recommendation #2: Require Title-24 Acceptance Test Submittal & Site Visits to Verify Key ECMs and Revise Model to Physical "As-Built" Conditions

NRNC whole building projects are inherently unique because they do not involve any sort of pre-implementation "verification." Furthermore, building plans are often used by technical reviewers to "verify" installation of particular energy conservation measures (ECMs) (e.g., efficient HVAC components, high performance glazing or insulation, lighting controls). The importance of visual verification may be considered less important for NRNC projects largely because the building is new and building plans are readily available - there is less perceived risk for discrepancy.

However, based on the examples provided above, this form of verification is not adequate; PAs should require their inspectors and engineers to perform on-site visits to visually verify that the proposed ECMs have been installed and are operating as intended *and as simulated in the building model*. It is recommended that the PA's perform post inspection site visits and model true ups on all projects, regardless of size, due to diversity of the NRNC projects. It should be noted that the smaller projects tend to take less PA resources as compared to the larger projects, in terms of performing the site inspections and trueing up the models, so performing these tasks on smaller projects most likely this will not have a disproportionately large impact on the cost effectiveness of the projects.

It is also recommended that the program administrator should make it mandatory for program participants to submit a Title-24 Acceptance Test Report before being paid an incentive. Title-24 acceptance tests involves inspection checks and performance tests to determine whether specific building systems conform to the criteria set forth in the standards and to the proposed building specifications and controls. The acceptance test reports can also be used to true-up building models to as-built conditions.

It is recommended that the final approved model should be adjusted to physical "as-built" conditions observed during the verification site visit. "As-built" conditions include observed construction & equipment efficiencies and observed HVAC controls and sequencing. This effort should be performed in conjunction with revising the standard schedules with as-built building schedules.

Issue #3: Ex-Ante Savings do not account for Cogeneration or Site-generated Power

There were multiple sites in the sample where cogeneration or other self-generated power (e.g., PV) was not assessed by the PA for estimating eligible ex ante savings. The CPUC policy requires that the program participants pay the Public Good Charge (PGC) for Public Purpose Programs (PPP). New construction projects may not necessarily have had an active service account at the time of application but projects are typically eligible if the buildings are built within the respective PA service territory and the participant intends to purchase energy from the PA.

For NRNC projects where it is known by the PA that cogeneration or self-generation is planned and the building design incorporates the design load of the cogeneration/site-generation, then the PA should assess whether the magnitude of the ex ante savings for the project, for each fuel, exceeds the likely energy purchases from the PA. Demonstrating the grid/system impact on an hourly basis is the CPUC policy requirement to qualify for incentives.

Likewise for sites with cogeneration, the claimed ex ante electric (kWh) savings must be apportioned according to the impacts on the grid (electric)/system (natural gas), depending on the fuel saved and its coincidence with the timing of energy purchase profiles (hourly for electric and monthly for gas). In the case where the cogeneration source fuel is purchased from the same PA as electric grid purchases, a portion of kWh savings may need to be converted to therm savings during the periods electricity is not being purchased from the PA.

Site H024 involves a campus with a 450 MW cogeneration plant. Natural gas is purchased from a third-party and the campus also has PV generation on site. The evaluation team confirmed that the ex ante savings were not appropriately accounting for the cogeneration and PV generation by claiming full kWh savings and peak kW reductions without assessing the cogeneration fuel (therms) savings and PV-generated source electricity. This issue affected all energy savings metrics (kWh, kW, and therms), reducing kWh savings by 14%, peak kW by 16%, and increasing therms savings by -2,668%.[30]

Recommendation #3: Clearly Assess Impact of Cogeneration or Other Site-generation on Ex-Ante Savings Claims

NRNC projects that have planned design for cogeneration or other site-generation should have their modeled energy savings and demand reductions scrutinized and appropriately allocated and capped, if necessary. Design loads and load shapes for cogeneration and site-generation equipment should be collected and incorporated into the energy savings calculations. Assessment of the expected peak site generation (and cogeneration) relative to the estimated source fuel savings is critical in order to reduce discrepancies related to cogeneration and/or site-generation.

[30] The percentage is very large and negative because ex post therms savings were relatively small and negative at -305 therms.

6. NTG RESULTS

The methodology used to develop the individual, site-specific net-to-gross estimates is summarized in the Evaluation Plan provided previously.[31] Here, we present the weighted results for the population.

Number of Completed Surveys

For this effort, twenty-five (25) NTG surveys were completed in total using the same sample of projects as the gross savings sample. Across the three participating PAs, the ex ante combined gas and electric (source MMBtu[32]) savings for projects with completed surveys was roughly 20% of the population savings of completed NRNC Whole Building projects for each PA. Table 16 below reports the number of completed surveys by utility.

Table 16: Completed Surveys by PA

PA	Number of Completed Surveys (n)
PG&E	15
SCE	5
SDG&E	5
Total	**25**

Weighted NTG Results

Weighted results are presented in this section for each fuel domain; see Table 17 below. To produce an estimate of the net-to-gross ratio (NTGR), the individual NTGRs for each of the applications in the sample were weighted by the size of the ex post gross impacts associated and the proportion of the total sampling domain impacts represented by each sampling stratum. The sample of Whole Building projects was developed based on combined, source MMBtu, however the varying proportion of kWh, and therm savings across the sample produced slightly different NTGRs by fuel domain.

[31] http://www.energydataweb.com/cpucFiles/

[32] Conversion rates obtained from "2001 Energy Efficiency Standards for Residential and Non-residential Buildings, California Energy Commission," June 2001: 1 kWh = 10,239 Btu source energy; 1 Therm = 100,000 Btu source energy. 1 MMBtu =1,000,000 Btu

Table 17: Weighted Net-to-Gross Ratios by Fuel Type

Results	Electric NTGR	Gas NTGR	MMBTU NTGR
	Statewide	Statewide	Statewide
Weighted NTGR	0.53	0.51	0.53
90 Percent Confidence Interval	0.51 - 0.56	0.49 - 0.54	0.51 - 0.55
Net Savings Relative Precision	24%	25%	20%
n Survey Completes	25	25	25
N Sampling Units	239	239	239
Final NTGR	**0.53**	**0.51**	**0.53**

Prior to this study, NTGR for SBD Whole Building projects had not been evaluated separately, so there is no real historical trend to be obtained for this metric. In the 2010-12 program cycle, SBD was evaluated with other programs as part of the Custom Evaluation group, Work Order 33. While net-to-gross ratios were calculated by PA and fuel domain, there was no specific SBD NTGR. In the 2006-08 program cycle, the NTGR for the SBD Program electric energy domain was 0.62; however this included systems projects as well as Whole Building analyses and NTGRs for Whole Building projects were not tabulated separately. While the combined NTGR of 0.53 is likely not viewed as favorable, and it is below the PA claim of 0.65, it cannot be determined if the free ridership trend is changing for this component of the program.

Weighted Net Savings Results

The following charts show the net savings results of the sampled projects against the ex ante net savings estimates for each project. The ex ante net savings for all projects are 58% of the ex ante gross savings since the ex ante net savings are estimated by assuming a 0.9 gross realization rate and applying 0.65 net-to-gross ratio to the assumed GRR. The red line across the chart is where the sampled project result equals forecast. Data points above the line indicate projects have greater net savings than forecasted and points below indicate where the forecast overestimated the net savings. Note that many more projects are below the line than above in all fuel domains, which explains the program net savings results shown below in Table 18.

Figure 17: Weighted Source MMBtu Net Savings Project Results

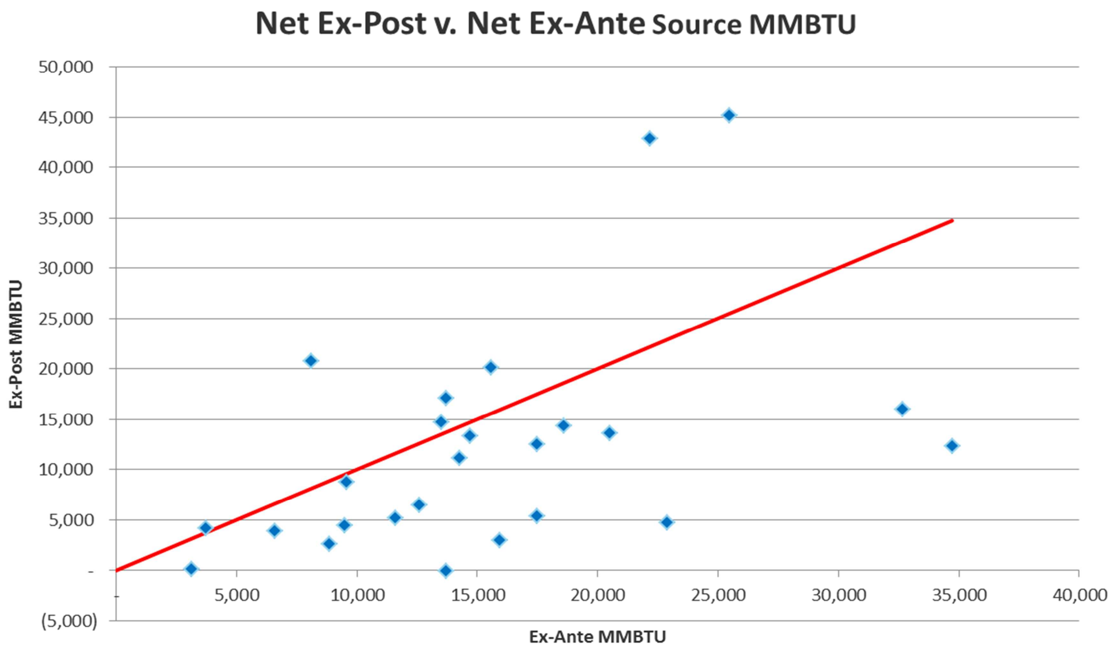


Figure 18: Weighted kWh Net Saving Project Results

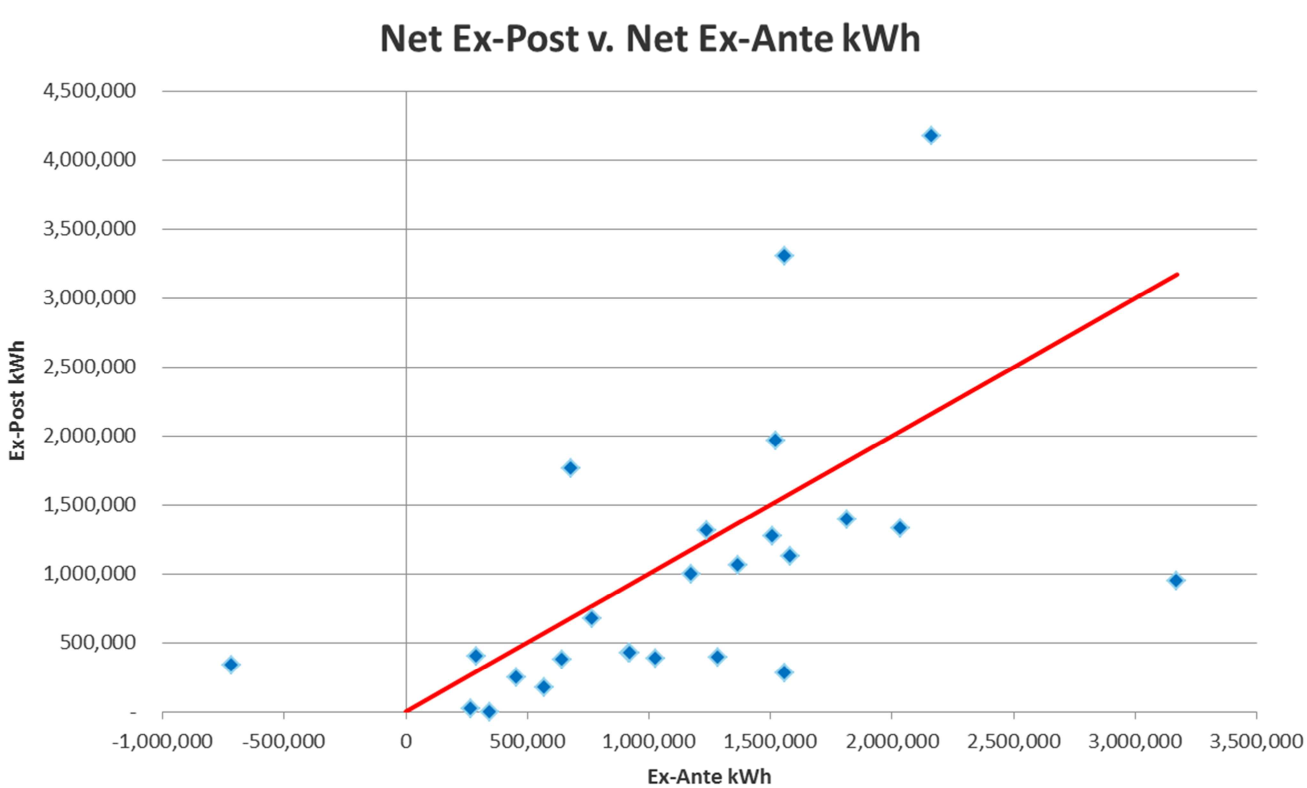


Figure 19: Weighted Therm Net Saving Project Results

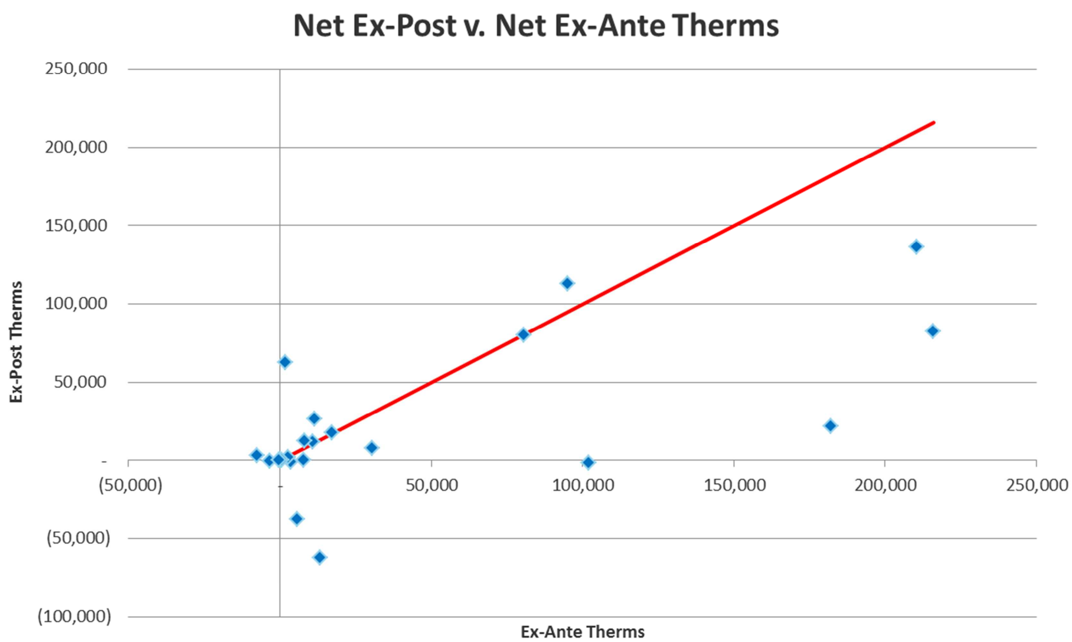


Figure 20: Weighted Peak kW Net Saving Project Results

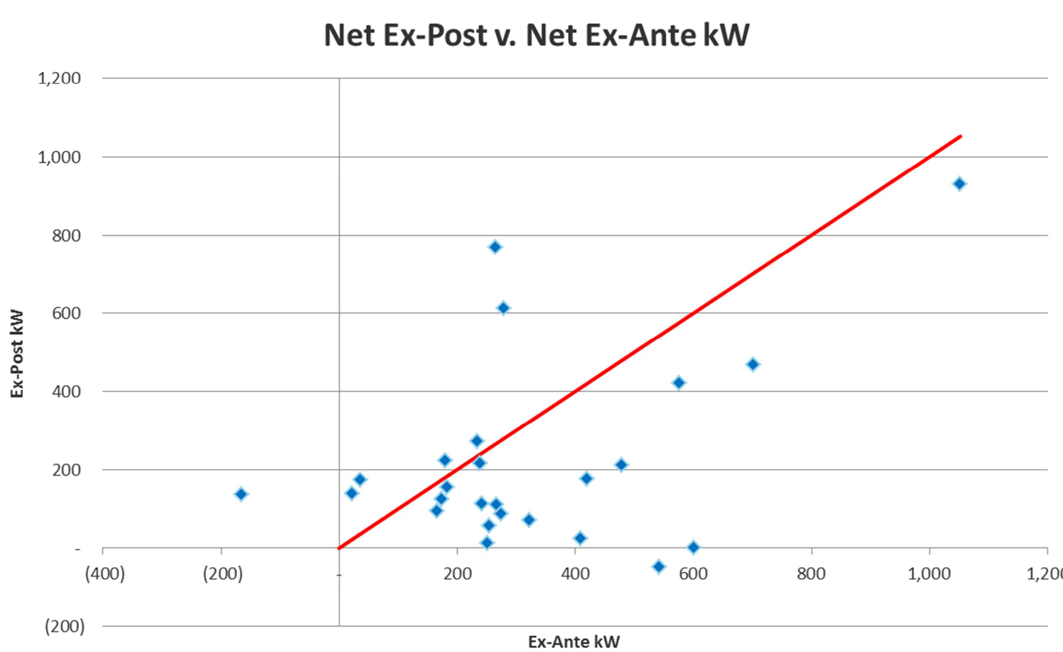


Table 18: PA Statewide Net Realization Rate Estimate and Comparisons

	Electric Savings		Gas Savings	Source Energy Savings
Impact Element	**kWh/year**	**Peak kW**	**Therms/year**	**MMBTU/year**
Tracking				
a. Claimed Gross Savings	67,909,049	21,886	828,183	778,139
b. Claimed GRR*	0.9	0.9	0.9	0.9
c. Claimed Adjusted Gross Savings	61,183,615	19,710	745,328	700,992
d. Claimed NTGR	0.65	0.65	0.64	0.65
e. Claimed Net Savings (e = c x d)	39,564,196	12,746	476,312	453,116
f. Claimed Net Realization Rate (f = b x d)	0.58	0.58	0.58	0.58
Evaluation				
g. Evaluation GRR	0.94	0.79	0.57	0.85
h. Evaluated Gross Results (h = a x g)	63,903,109	17,397	474,104	663,454
i. Evaluation NTG Ratio	0.53	0.50	0.51	0.53
k. Evaluated Net Results (k = h x i)	33,986,798	8,765	242,122	353,595
l. Evaluation Net Realization Rate (l = g x i)	0.50	0.40	0.29	0.45
m. Evaluated Net Savings as a Fraction of Claimed Net Savings (m = k / e)	0.86	0.69	0.51	0.78

** 1 site had a claimed of ex ante GRR of 100%. This site is an ex ante review (EAR) overlap point in which CPUC participated in the final adjustment to the claimed savings According to the CPUC policy surrounding EAR activities, this site is a frozen point and receives ex ante GRR of 1.0 instead of the 0.9 default ex ante GRR

Key Factors Influencing NTGRs

Behind the NTGR calculation for each project is a host of contextual factors that may have influenced the project, directly or indirectly. The contextual factors were examined for each project primarily within three main categories described as follows:

- Program service: This includes design assistance, analysis, and information and support, energy design resources and training courses
- Program incentives: This category relates to Whole Building approach, design team and kicker incentives (e.g. LEED, enhanced commissioning and end use monitoring)
- Non-program factors: This comprises eleven possible influences including non-energy benefits, payback on the investment or ROI, recommendation from a consultant, standard practice, corporate guidelines, prior measure experience and prior program influence

The intent was to look holistically at the energy-efficiency drivers including isolating the relative importance of the program (services and incentives) compared to non-program factors and the likelihood the project would have been built exactly the same without the program. The numerical responses feed into the NTGR algorithm, which include three calculations to develop the final score. Across all program groupings analyzed, financials were the most significant driver. Evaluating project drivers or influences on a ten point scale with 10 being the most important, design team and Whole Building approach incentives scored the highest at 8.75 and 8.32 and return on investment (ROI) and lifecycle cost almost exactly the same at 8.6 and 8.5. Design analysis was also rated very high at 8.5. The second most important grouping with averages in the 7's included recommendations from a consultant, compliance with organizations normal maintenance or equipment policies, corporate policy or guidelines, followed by non-energy benefits. Less important factors included industry standard practice, and prior experience with the measure(s) and program and the lowest score was recommendation from a vendor or manufacturer.

Additionally there are some possibly helpful responses to open-ended survey questions:

- Certain factors can contribute to **a lower level of program influence**, and include:
    - Documentation requirements are onerous and not worth the incentives
    - Enhanced commissioning requirement is confusing and/or not considered valuable by some respondents
    - The incentives are too small to provide influence
    - Long wait time for incentive check cuts into program participation value
- Other factors that can contribute to **higher program influence** at the project level include:
    - Incentives help to offset higher first cost of energy efficiency enhancements
    - Energy modeling reinforces the values proposition of EE measures
    - Incentives reduce measure payback periods
    - Secondary peer-review of projects is valued by survey respondents
    - Design team incentives provide motivation for energy efficiency enhancements
- There are several factors that add uncertainty to the NTG survey results:
    - The survey relies primarily on human memories of events that happened years prior. Construction delays may increase the lag time between energy efficiency decision-making and survey completion beyond a decade in extreme cases.
    - Decision maker may have moved on to other employment or retirement, and the remaining decision-makers may not have been as well-informed
    - Some primary decision makers are unresponsive, so secondary (and possibly sub-optimal) decision-makers are left to complete the survey

The evaluation team is cognizant of these factors, and uses all means available to mitigate these uncertainties using veteran and qualified surveyors. In the case of failing memories, the surveyor will discuss project details in order to precipitate recall and will move on to another decision-maker or design team member if the designated decision maker can't remember the decision. Similarly, we have located decision-makers to the current employer when they have moved on, and have even called them after retirement. We monitor the quality, consistency and confidence in the survey responses and will ask for a more informed individual, such as a design team member, if the designated decision-maker answers inconsistent or a disinterested fashion. The evaluation team believes that this provides the most valid and defensible surveys results as possible.

Recommendations

Medium high NTGR is an issue for the program.

Since many design features and equipment choices are established in the early stages of whole building new construction projects, it follows that the earlier the involvement with the program, the greater the potential influence that the program has on the project. For example, the average NTGR of 17 projects in the sample that reported that initial contact with the program was during or before the design phase was 0.53. The six projects that indicated initial contact with the program was after the design phase had an average NTGR of 0.45.

One possible solution to reduce free ridership is to shift program delivery to attract earlier project involvement. One suggestion is to reduce incentive payments or disqualify projects that have completed and committed designs before program interactions began. Conversely, greater incentives could be extended to projects that get involved with the program in the early design stages. This scenario would require some sort of "litmus test" to determine whether participants could be influenced by the program or not. This approach could separate out the projects that are "applying for an incentive for a pre-determined design" from those that are willing to consider better design alternatives.

The PAs should verify the decisionmakers are still with the organization as part of post-installation verification or incentive payment. This way the most recent contact information can be recorded in the project files, reducing the difficulties evaluators may face in locating decisionmakers(s) if they have moved on.

7. PROJECT PRACTICE ASSESSMENT RESULTS

Introduction

This chapter discusses the results of the Project Practice Assessment (PPA) effort. The goal of the PPAs is to provide qualitative, cost-effective, program-specific, impact-oriented findings and feedback to the NRNC Whole Building program. PPAs are largely an application review process. Each claim review evaluated conformity with policy guidance, with an emphasis on program administrator (PA) NRNC Whole Building ex ante gross impact development methods. Furthermore, all M&V and application review/verification points were reviewed for ESPI requirements for project EUL assessments.

The PPA process was conducted on all the gross impact sample points. This process entailed a "desk review" of project application paper work received from the PAs as part of the evaluation data request.

Project Practice Assessment Results

The following subsections present un-weighted PPA result for the 25 NRNC whole building projects[33]. The PPA process, intended to group categories for comparison, is generally done by PA and by customer agreement date (pre-2013 or 2013+). This segregation is meant to capture any effects of the policy guidance issued based on precedents established in the EAR process (CPUC's Decision D. 11-07-030 and subsequent ex ante-review-related decisions[34]). The evaluation team assumed that guidance issued by ex ante reviews may take some time to get fully adopted by the PAs. Therefore, a system wide impact of guidance from ex ante reviews would not likely get reflected in projects committed before 2013.[35] Some of these results are displayed but due to a small sample size it was not possible to draw conclusions from the groupings. Only 3 of the 25 projects had customer signature dates from 2013+, however the results by time period are still displayed in the following tables. All but

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[33] One whole building site was split into two measures which totals to 26 measures sampled.

[34] http://docs.cpuc.ca.gov/published/FINAL_DECISION/139858.htm. Decision 11-07-030
The EAR process involves an M&V-level of review for PA projects that are under development, prior to claims. CPUC staff and their contractors participate in these reviews and seek to actively influence the outcome of associated ex ante project savings estimates, as well as PA within-program engineering processes and procedures more generally. Importantly, D. 11-07-030 features detailed baseline requirements that were hypothesized to have significant influence on PA project results, including remaining useful life/effective useful life (RUL/EUL) treatment and the need to demonstrate and document all associated early replacement (ER) claims.

[35] Ex ante reviews commenced from September 2011 through February 2012 and reached a steady state in 2013 when review processes were largely settled.

one site had customer agreement dates missing from PA tracking data. The missing customer agreement date was estimated for the PPA based on the project application and installation date based on similar project patterns for that PA.

7.1.1 Overview of the Project Practice Assessment

The PPA is broken down into several main categories. The discussion below summarizes recommendations from the following subsections of the PPA. Each subcategory contains findings listed in tables and written form along, with recommendations based on evaluator and PA comparison. The categories addressed are:

- Project eligibility
- Baseline selection and documentation
- EUL/RUL
- Cost and incentive documentation and calculations
- Calculation methods; models/methods, inputs, and assumptions

These categories were assessed based on documentation provided by the PA's along with the quality and appropriateness of the ex ante methods and results. Assessments were ranked on a scale from 1 to 5, with 1 indicating the ex ante conclusion did not meet expectations and 5 indicating the ex ante conclusion consistently exceeded expectations. A score of 3 means the ex ante approach meets expectations for a given PPA This scoring scale was derived from ex ante ESPI scoring criteria identified in Attachment 5 of CPUC Decision R.12-01-005.

7.1.2 Project Eligibility Considerations

This section of the PPA form addresses relevant project eligibility considerations such as program rules, CPUC decisions/guidance, and ex ante review (EAR) guidance. The evaluator reviewed PA project documentation to determine which eligibility considerations were taken into account during the claim review process for a given measure. Project Eligibility assessment entails reviewing PA-provided documentation such as calculation results, spreadsheets, energy models, project documents, etc. to determine if the program criteria are met for the project to be eligible for incentive. Then, the evaluator indicated which eligibility requirements should have been examined for that measure type and application based on their own review.

Findings

Table 19 shows the summary of eligibility considerations. Overall, PA and evaluator conclusions all matched in this category

Recommendations

The evaluator does not see a need for further recommendations in this category.

Table 19: Comparison of PA and Ex-Post M&V Eligibility Considerations by Customer Agreement Date

Parameter Examined	PA	Ex-Post M&V
Pre-2013 Customer Agreement Date		
Number of measures evaluated (N)	23	
Number of measures with eligibility considerations documented (N)	23	23
Frequency of eligibility considerations documented (N)		
Program rules	100%	100%
Normal maintenance	0%	0%
Operating practice change	0%	0%
CPUC decisions	0%	0%
CPUC guidance	0%	0%
Requirement that measures exceed baseline	100%	100%
Previous EAR guidance	0%	0%
Previous evaluation findings	0%	0%
Project boundary condition	0%	0%
EE Policy Manual	0%	0%
Multiple PA fuels (includes cogeneration and fuel switching)	0%	0%
Three prong test	0%	0%
Non-PA fuels and ancillary impacts (i.e., cogen, refinery gas, waste heat recovery, etc.)	0%	0%
Other	0%	0%
2013+ Customer Agreement Date		
Number of measures evaluated (N)	3	
Number of measures with eligibility considerations documented (N)	3	3
Frequency of eligibility considerations documented (N)		
Program rules	100%	100%
Normal maintenance	0%	0%
Operating practice change	0%	0%
CPUC decisions	0%	0%
CPUC guidance	0%	0%
Requirement that measures exceed baseline	100%	100%
Previous EAR guidance	0%	0%
Previous evaluation findings	0%	0%
Project boundary condition	0%	0%
EE Policy Manual	0%	0%
Multiple PA fuels (includes cogeneration and fuel switching)	0%	0%
Three prong test	0%	0%
Non-PA fuels and ancillary impacts (i.e., cogen, refinery gas, waste heat recovery, etc.)	0%	0%
Other	0%	0%

7.1.3 Project Eligibility Ratings

The two primary objectives of this portion of the PPA are to rate the *Quality* of the documentation supporting measure eligibility and then to rate the *Appropriateness* of the PA assessment of eligibility requirements. Quality of the documentation is the extent in which details are specified relative to the scope of the project and its key parameters. Appropriateness is the how pertinent the provided documentation was in relation to the measure or project.

Findings

Table 20 addresses the assessment of eligibility documentation and appropriateness. Overall each PA provided adequate information that met expectations for examining eligibility. Based on PA documentation the evaluator determined that all ex ante measures were eligible except one. For this one project the ex ante chosen baseline was inappropriate and didn't follow the appropriate building use type which resulted in the savings that were less than 10% of Title-24 building TDV standard which is below the SBD program's eligibility requirements. The ranges of appropriateness ratings were 2.8 to 3. Two of twenty-six measures received ratings below expectations and one measure had a rating of four, exceeding expectations. Whereas the range for the documentation quality category ratings were slightly higher, from 3.0 to 3.2, consisting of 3 measures receiving ratings of 4 where documentation quality exceeded expectations.

Recommendations

In order to continue to minimize this eligibility discrepancy, PAs should carefully review the model baseline and make sure that the baseline equipment and conditions meet the applicable Title-24 code and ACM manual.

Table 20: PA Eligibility Ratings by Customer Agreement Date

Parameter Examined	PA Eligibility Ratings (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Number of Measures Assessed	13	6	4	2	0	1
Assessment of PA Eligibility Appropriateness Rating						
Number of Measures with Eligibility Appropriateness Ratings (N)	13	6	4	2	0	1
Mean Eligibility Appropriateness Rating	2.8	3.0	3.0	3.0	-	3.0
Number of ELIGIBLE Measures (N)	12	6	4	2	0	1
Mean Eligibility Appropriateness Rating for ELIGIBLE Measures	3.0	3.0	3.0	3.0	-	3.0
Number of INELIGIBLE Measures (N)	1	0	0	0	0	0
Mean Eligibility Appropriateness Rating for INELIGIBLE Measures	1.0	-	-	-	-	-
Assessment of PA Quality of Eligibility Documentation Rating						
Number of Measures with Quality of Eligibility Documentation Ratings (N)	13	6	4	2	0	1
Mean Quality of Eligibility Documentation Rating	3.0	3.2	3.0	3.0	-	3.0
Number of ELIGIBLE Measures (N)	12	6	4	2	0	1
Mean Quality of Eligibility Documentation Rating for ELIGIBLE Measures	3.0	3.2	3.0	3.0	-	3.0
Number of INELIGIBLE Measures (N)	1	0	0	0	0	0
Mean Quality of Eligibility Documentation Rating for INELIGIBLE Measures	3.0	-	-	-	-	-

7.1.4 Project Types

Project Type Assessment is an overview of the PA versus ex post project type designations. Project Type may be defined as early replacement, natural replacement, replace-on-burnout, capacity expansion, new construction, add-on measure, or system optimization.

Findings

The NRNC Whole Building Program consisted of 25 projects (26 measures). Twenty two of these measures were listed as a New Construction project type and 4 were listed as Major Renovations. All Major Renovation project types had a listed customer agreement date pre-2013. In all cases the evaluator agreed with PA conclusion for project type.

Recommendations

The evaluator does not see a need for further recommendations in this category.

7.1.5 Project Baselines

This section presents an overview of the PA versus ex post project baseline designations. Baseline designations are crucial when computing savings from the proposed energy models. The baseline is defined based on the building type and scope of the project.

Findings

NRNC PA designations were primarily Title 24 code and Industry Standard Practices (when applicable). Examples of Industry Standard Practice documents applicable for Whole Building projects include refrigerated warehouses, laboratories, grocery store refrigeration measures, and hospital baselines. For project baseline designations in the NRNC Whole Building Program, the evaluator and PA conclusion were identical with the exception of one case. A PA designated baseline for one project was indicated as a healthcare facility when in fact the evaluator deemed this project as a clinic/office building that did not need to comply with healthcare specific ISP. Table 21 displays these findings. The reason evaluator’s findings display 8 ISP measures as compared to PA’s ex ante claim of 9 ISP measures is due to the fact that one of the PA’s ISP claimed project didn’t meet the ISP criteria for the healthcare facility. As stated above, this project should have used T-24 building standard as baseline because this building is a medical clinic with no special pressurization requirements that could have triggered to use healthcare ISP as baseline. In all but one industrial related project, which used ISP baselines, Title 24 was a part of the project baseline for whole building.

Recommendations

To avoid this discrepancy PAs should thoroughly review healthcare-related building projects and determine the occupancy categories of these projects. If the building occupancy is subjected to review and approval by the Office of Statewide Health Planning and Development (OSHPD), the building is not required to comply with the Title 24 standards but should be covered by the SBD Healthcare Modeling Procedures. Any other types of hospital buildings that are not subject to the OSHPD requirements must use the appropriate Title 24 baseline. For example, medical office buildings that are not subject to any specific design requirements dictated by OSHPD and therefore should be approached using conventional Savings by Design procedures and occupancies that are already in place in Title -24.

Table 21: Comparison of PA and Ex-Post M&V Project Baseline Conclusions

Ex-Post Evaluation Project Baseline			PA-Specified Project Baseline							
			Existing equipment	Title 24	Industry standard practice	Title 20	Customer /facility standard practice	Local AQMD/ other code	Federal regulations	Miscellaneous other
Pre-2013 Customer Agreement Date										
Number of measures evaluated (N)			23							
Frequency of PA-Specified Project Baseline (N)			0	22	9	0	0	0	0	0
Frequency of Evaluation-Specified Project Baseline	Frequency of Measure-Level Observations (N)									
	Existing equipment	0	0	0	0	0	0	0	0	0
	Title 24	22	0	22	0	0	0	0	0	0
	Industry standard practice	8	0	0	9	0	0	0	0	0
	Title 20	0	0	0	0	0	0	0	0	0
	Customer/facility standard practice	0	0	0	0	0	0	0	0	0
	Local AQMD/other code	0	0	0	0	0	0	0	0	0
	Federal regulations	0	0	0	0	0	0	0	0	0
	Miscellaneous other	0	0	0	0	0	0	0	0	0
2013+ Customer Agreement Date										
Number of measures evaluated (N)			3							
Frequency of PA-Specified Project Baseline (N)			0	3	2	0	0	0	0	0
Frequency of Evaluation-Specified Project Baseline	Frequency of Measure-Level Observations (N)									
	Existing equipment	0	0	0	0	0	0	0	0	0
	Title 24	3	0	3	0	0	0	0	0	0
	Industry standard practice	2	0	0	2	0	0	0	0	0
	Title 20	0	0	0	0	0	0	0	0	0
	Customer/facility standard practice	0	0	0	0	0	0	0	0	0
	Local AQMD/other code	0	0	0	0	0	0	0	0	0
	Federal regulations	0	0	0	0	0	0	0	0	0
	Miscellaneous other	0	0	0	0	0	0	0	0	0

7.1.6 Project Baseline Documentation Quality

Baseline documentation includes the code year, equipment detail, project use type, and other parameters defining the standard project type defined by appropriate code. Assessment of the quality presents how clear data pertaining to establishment of the baseline was presented in PA's submitted documents.

Findings

Table 22 outlines the summary of the PA documentation quality used for establishing project baselines. In projects pre-2013 and 2013+, applicable codes were documented and the mean scores by PA ranged between 2.5 and 3.0. In the NRNC Whole Building Program the Title 24 code would be the baseline in most cases due to the nature of whole building new construction projects. There were also a few cases where ISP determined the baseline. The evaluator confirmed the correct baseline documentation in the ex post comparison.

Two projects used additional baseline information as listed in the table. The SCE project was an industrial based measure that needed to factor in other equipment and facility baseline parameters. For one of the PG&E 2013+ sites, the implementer-provided ISP documents were not available in the ex ante review and had to be requested for the ex post analysis, as noted in the first source line item in Table 22. The industrial SCE site took into consideration some other baseline information seen in Table 22. Most NRNC Whole Building Projects rely on whole building simulation software that generates the baseline to the appropriate Title 24 standards, which is evident in 100% of baselines sources utilizing this code. There are several places within PA documentation in which the Title 24 Standards compared to the proposed design are referenced which meets expectations and received a rating of 3. More granular Title-24-specific details related to equipment or design scope were sometimes absent, but this will be discussed further in baseline ratings. Circumstances where specifics within the Title 24 documentation were missing or unclear are what caused the ratings to fall below expectations.

Recommendations

The evaluator recommends making sure any relevant baseline documents and any ISP documents are included.

Table 22: PA Baseline Documentation Ratings by Customer Agreement Date

Parameter Examined	Quality of PA Baseline Documentation (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Number of Measures Evaluated	13	6	4	2	0	1
Percent of All Measures Evaluated	100%	100%	100%	100%	-	100%
Mean Rating	2.77	2.67	2.75	2.5	-	3.0
Distribution of Ex-Ante Application-Based Baseline Documentation Sources						
Sources						
OTHER: Implementer provided ISP documents	0%	0%	0%	50%	0%	0%
Not documented	0%	0%	0%	0%	0%	0%
Age of existing equipment	N/A	N/A	N/A	N/A	N/A	N/A
EUL of equipment	0%	0%	0%	0%	0%	0%
Assessment of RUL	N/A	N/A	N/A	N/A	N/A	N/A
Condition of existing equipment	N/A	N/A	N/A	N/A	N/A	N/A
Capability of existing equipment to meet service requirements	N/A	N/A	N/A	N/A	N/A	N/A
Capability of baseline equipment to meet service requirements	0%	17%	0%	0%	0%	0%
Equipment replacement schedule	N/A	N/A	N/A	N/A	N/A	N/A
Efficiency level(s) available	N/A	N/A	N/A	N/A	N/A	N/A
Maintenance records examined	N/A	N/A	N/A	N/A	N/A	N/A
Other equipment choices considered	0%	17%	0%	0%	0%	0%
Other equipment choices documented from vendor or designer	0%	0%	0%	0%	0%	0%
Normal facility practices examined	0%	17%	0%	0%	0%	0%
Standard industry practices examined	0%	17%	0%	0%	0%	0%
Standard industry practices researched	0%	0%	0%	0%	0%	0%
Applicable codes or regulations examined	100%	100%	100%	100%	0%	100%
Written facility plans if "no program"	0%	0%	0%	0%	0%	0%
Stated facility plans if "no program"	0%	0%	0%	0%	0%	0%
NTG project screening interview completed	0%	0%	0%	0%	0%	0%
Miscellaneous other	0%	0%	0%	0%	0%	0%

7.1.7 Project Baseline Ratings

To determine Project Baseline Ratings the evaluator reviews the relevant documentation, baseline appropriateness scores reflect whether or not the PA correctly identified the project baseline. Baseline description scores capture the extent to which PAs described the baseline equipment / efficiency rating.

Findings

Table 23 summarizes scores for baseline appropriateness and the baseline description, based on our documentation review. The scores indicate whether or not the PA baseline conclusion was correctly identified. In most cases the appropriateness rating met expectations. The appropriateness of the baseline was on average higher than the documentation rating. Only 1 site received a rating of 1 or 2 for appropriateness, but for documentation rating, 7 of the 26 measure received a score of either 1 or 2 for reasons listed in Table 23.

In several instances, provided baseline documentation did not necessarily match the type of equipment being modeled. One example involves ex ante documentation indicating a Variable Speed Air Handling Unit serving VAV and CAV boxes in a lab zone, but in the ex ante model all zones were VAV. The correct baseline could not be determined until ex post inspection because of contradictory information. Ex-post verification provides this insight, but the documentation alone what not clear enough to resolve the discrepancy. In other cases it was not clear which parameters or models were intentionally revised, and there were no details accompanying documentation. This resulted either in more PA data requests, reaching out to implementers for baseline related documents, or in-depth investigating simulation software files.

Recommendations

The evaluator recommends including more details on any project baseline changes and updating documentation if the project scope changes over the course of construction.

Table 23: PA Baseline Ratings by Customer Agreement Date

Parameter Examined	PA Baseline Ratings (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Percent of Measures with PA Baseline Documented in the Project Application File	13	6	4	2	0	1
Assessment of PA Baseline Appropriateness Rating						
Number of Measures with Baseline Appropriateness Ratings (N)	13	6	4	2	0	1
Mean Baseline Appropriateness Rating	3.00	3.50	3.00	3.00	N/A	3.00
Number of Measures with Baseline Appropriateness Ratings of 1 or 2 (N)	1	0	0	0	0	0
Reasons for Ratings of 1 or 2						
OTHER: Incorrect T24 baseline year and did not model existing central plant correctly	1	0	0	0	0	0
Assessment of PA Baseline Documentation Rating						
Number of Measures with Baseline Documentation Ratings (N)	13	6	4	2	0	1
Mean Baseline Documentation Rating	2.54	2.83	3.00	2.50	N/A	N/A
Number of Measures with Baseline Documentation Ratings of 1 or 2 (N)	4	2	0	1	0	0
Reasons for Ratings of 1 or 2						
OTHER: Incorrect T24 baseline year and did not model existing central plant correctly	1	0	0	0	0	0
OTHER: Baseline documentation does not provide source and/or details of key parameters	2	2	0	1	0	0
OTHER: Baseline documentation did not detail T24 to SBD changes per ACM manual	1	0	0	0	0	0

7.1.8 EUL Assessment

EUL assessment provides a comparison of the EUL values that were documented in the PA tracking data, project application, and the ex post site reports and provides a summary of the EUL sources. EUL is used in lifecycle savings calculations on the whole building projects. Since these are newly constructed whole building projects RUL (remaining useful life) and dual baseline considerations in lifecycle savings are not relevant.

Findings

Table 24 summarizes EUL comparisons from PA tracking data and project documentation. The most prominent differences between PA EUL data and evaluator ex post EULs were the fact that PG&E tracking data did not include any EUL values. All site EULs were populated with zeroes. In addition, not one single project had an EUL documented in the project documents. This shortcoming resulted in large differences between PA and evaluator conclusions. Projects that had an EUL included in tracking data, but no EUL in project documents received a rating of 2. Projects with no EUL reported anywhere, received a rating of 1. For analysis, we had to extract PG&E EUL values from the PG&E's 2013 SBD E3 calculator.

Since all NRNC Whole Building projects fall under New Construction or Major Renovation baselines, there is no applicability for RUL values in the savings calculations, and there were no RUL data to be assessed. All lifecycle savings are computed with EULs alone.

Ex-post EUL values were created from end-use savings-weighted 2014 DEER EUL values. The SCE and SDG&E EUL values that existed in the tracking data were not accompanied by a source, therefore the evaluator was not able to determine how the PA's calculated project EUL values. It was not possible to further investigate EUL differences without this data. There was no distinction between these patterns between pre-2013 and 2013+ EUL documentation.

Recommendations

EUL is crucial for lifecycle savings calculations, and the evaluator recommends collecting EULs for each measure of the Whole Building project from DEER and calculating the project EUL by weighting them by measure savings. Then this weighted average EUL should be assigned to the project level for the Whole Building projects to estimate project life cycle savings. Additionally, it is recommended to include EUL as a required field on the utility incentive worksheet or on project application.

Table 24: Comparison of PA and Ex-Post EUL Assessment by Customer Agreement Date

Parameter Examined	PA EUL Documentation (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Number of Measures Assessed	13	6	4	2	0	1
Percent of Measures with PA Tracking System EUL Populated	0%	100%	100%	0%	-	100%
Percent of Measures with PA EUL Documented in the Project Application Files	0%	0%	0%	0%	-	0%
Mean PA EUL Documentation Score	1.00	2.00	2.00	1.00	-	2.00
Summary of PA EUL Treatment						
Number of Measures with PA Tracking System EUL Populated (N)	0	6	4	0	0	1
Mean PA Tracking System EUL	-	15.67	15.00	-	-	15.00
Number of Measures with PA EUL Documented in the Project Application Files	0%	0%	0%	-	-	0%
Mean PA Application File-Based EUL	-	-	-	-	-	-
Source of EUL						
OTHER: Not provided	100%	100%	100%	100%	100%	100%
Summary of Evaluation EUL Treatment						
Number of Measures with Evaluation EUL Populated (N)	13	6	4	2	0	1
Mean Evaluation EUL	15.37	15.35	15.25	15.00	-	16.00
Source of EUL						
DEER	100%	100%	100%	100%	-	100%
Summary of EUL Differences						
Number of Measures with Evaluation EUL Different Than PA Tracking EUL (N)	13	5	2	2	0	1
Mean Evaluation EUL (where differences exist)	15.37	15.42	15.50	15.00	-	16.00
Mean PA Tracking System EUL (where differences exist)	0	15.80	15.00	0%	-	15.00
Reason for EUL Differences						
OTHER: No PA EUL data	100%	0%	0%	100%	0%	0%
OTHER: EUL using DEER, weighted based on energy savings category	0%	100%	100%	0%	0%	100%

7.1.9 Incremental Cost Ratings Assessment

The incremental cost ratings for each measure, the appropriateness, the quality, and the documentation were rated. In order for a given measure to obtain appropriateness score of 3 (meets expectations) the incremental cost data must be provided and must be relevant for the chosen baseline. The incremental cost quality rating is a measurement of the reliability of the cost data sources. Reliable sources would include invoices, price quotes from manufacturers, and etc. Finally, the documentation score reflects the level of detail included in the cost data sources. A documentation quality score of 3 would indicate that costs were itemized by measures and include some level of detail on the measure specifications.

Findings

PA cost documentation was provided for all 26 assessed measures. Some measures included both full cost data and incremental cost data, but for this assessment of the NRNC Whole Building Program, only an incremental cost assessment was applicable. Incremental cost findings are presented in Table 25. Evaluator examination of the cost documents indicate that while incremental cost data existed, it did not always meet quality or appropriate expectations. This is evident in the fact that 17 of 26 measures received a score of 1 or 2 for the incremental cost documentation rating. These low ratings of 1 or 2 were usually due to unreferenced sources or unclear cost data, i.e. not separated out by measure but just a total reported incremental cost. Some of the referenced sources were the names of previous implementer project documents, which were not provided, nor did documentation contain any links to referenced documents to verify the incremental cost claims.

Program rules indicate incentive caps relative to incremental cost, which makes these pieces of data crucial to other aspects of the project. In several projects incremental cost documentation was provided at various project stages while the scope or equipment types were still changing. Having a final sheet listing incremental cost by equipment type or a traceable category to match with equipment and the final savings model and incentive would make the final PA conclusion more prominent and increase project cost/incentive transparency.

Recommendations

The evaluator recommends standardizing incremental cost documentation where both the baseline and the installed measure cost data should be provided along with their reference sources to validate the incremental cost estimates.

Table 25: PA Incremental Cost Ratings by Customer Agreement Date

Parameter Examined	PA Incremental Cost Ratings (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Number of Measures Assessed* (N)	13	6	4	2	0	1
Assessment of PA Incremental Cost Appropriateness Rating						
Number of Measures with Incremental Cost Populated (N)	13	6	4	2	0	1
Number of Measures with Incremental Cost Appropriateness Ratings (N)	13	6	4	2	0	1
Mean Incremental Cost Appropriateness Rating	2.15	3.00	2.25	2.50	-	3.00
Number of Measures with Incremental Cost Appropriateness Ratings of 1 or 2 (N)	9	2	3	1	0	0
Source of PA Incremental Cost Data						
Price quotes	0	0	0	0	-	0
Letter certifying proportion of full cost	1	0	0	0	-	0
Manufacturer or contractor quotes	3	0	0	0	-	0
Certified engineering estimates	1	0	0	0	-	1
Industry cost guide	3	0	1	0	-	1
Miscellaneous Other	8	6	4	2	-	1
Assessment of PA Incremental Cost Quality Rating						
Number of Measures with Incremental Cost Quality Ratings (N)	13	6	4	2	0	1
Mean Incremental Cost Quality Rating	2.15	2.17	2.00	2.50	-	3.00
Number of Measures with Incremental Cost Quality Ratings of 1 or 2 (N)	9	5	3	1	0	0
Assessment of PA Incremental Cost Documentation Rating						
Number of Measures with Incremental Cost Documentation Ratings (N)	13	6	4	2	0	1
Mean Incremental Cost Documentation Rating	2.46	2.17	2.00	2.00	-	3.00
Number of Measures with Incremental Cost Documentation Ratings of 1 or 2 (N)	7	5	3	2	0	0

7.1.10 Incentives Assessment

Incentive assessment provides the percentage of measures for which the PA tracking system and the PA project application files documented measure-level incentive amounts. It also provides the frequency in which the tracking system and application files had the same incentive value populated. The assessment also includes an incentive calculation appropriateness rating. A full description of this appropriateness score is included below because, unlike other scores, ratings of 4 or 5 are necessary to ensure that all of the necessary information is captured accurately in the tracking data.

1. Incentives incorrectly calculated or incorrect cap applied or tracking data incentives do not match project documentation

2. Incentives correctly calculated but incorrect incentive cap applied or tracking data incentives do not match project documentation
3. Incentive and cap correctly calculated but tracking data incentives do not match project documentation
4. Incentives correctly calculated, appropriate cap used and the tracking data incentives match the project calculations
5. Incentives correctly calculated, appropriate cap used and the tracking data incentives match the project calculations for both full and incremental measure costs for an ER measure.

Findings

Table 26 outlines incentive assessment findings. Overall the PA incentive calculation methods and incentive caps agreed with evaluator findings. The table first outlines the percentage of measures with incentive amounts documented in the tracking data and then the project documentation. Tracking data and project documents for every project scored a 100% for including incentive details. Based on information from project documents, all of the appropriate incentive caps were applied when necessary, resulting in all the incentives assessments receiving passing approval.

However there were some large discrepancies between the tracking data incentive amount and the project document's incentive amount for some PG&E and SCE sites. To account for rounding errors, the evaluator documented that tracking data incentives matched the project documents if the values were within ± $5. The sum of differences between tracking data incentives and project documents for the 26 measures was -$148,661. There were 3 projects in particular that made up more than 90% of this difference. These discrepancies between project documents and tracking data ranged from -$70,850 to -$21,825. Having no further insight into the tracking data incentive values, it appears there could be some significant inconsistencies in how design team incentives and other incentives, such as LEED and Commissioning kickers, could be documented. It is also possible that improper data calculation and entry occurred.

The approximately 5% difference in incentive amounts between project documents and tracking data (just for the sampled projects) indicates there is uncertainty around tracking incentives associated with various projects.

Recommendations

The evaluator recommends having more transparency and thoroughness when documenting incentive data. Incentive amounts in the project documents should be verified to match what is listed in the tracking data.

Table 26: PA Incentive Calculation Assessment by Customer Agreement Date

Parameter Examined	PA Incentive Calculation Appropriateness Ratings (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Number of Measures Assessed	13	6	4	2	0	1
Percent of Measures with PA Incentive Level Documented in the Tracking System	100%	100%	100%	100%	-	100%
Mean Tracking System Incentive Amount	$ 97,783.12	$ 185,127.79	$ 39,651.50	$186,002.94	-	$ 150,000.00
Percent of Measures with PA Incentive Level Documented in the Project Application File	100%	100%	100%	100%	-	100%
Percent of Measures with Matched PA Incentive Level in the Tracking System and Project Application File	54%	17%	100%	50%	-	100%
Assessment of PA Incentive Calculation Appropriateness Rating						
Number of Measures with Incentive Calculation Appropriateness Ratings (N)	13	6	4	2	0	1
Mean Incentive Calculation Appropriateness Rating	3.00	3.00	3.00	3.00	-	3.00
Assessment of PA Use of Incentive Caps						
Number of Measures with PA Incentive Caps Assessed (N)	13	6	4	2	0	1
Incentives capped at 50% of the total project cost	0	0	0	0	0	0
Incentives capped at 50% of the incremental cost	1	0	0	1	0	0
Incentives capped at 75% of the incremental cost	2	0	0	0	0	0
Incentives capped at 100% of the incremental cost	0	0	0	0	0	0
Incentive capped at program allowed maximum	0	1	0	0	0	1
Miscellaneous other	10	5	4	1	0	0
Number of Measures with PA Incentive Caps Verified (N)	13	6	4	2	0	1
Appropriate incentive cap applied	100%	100%	100%	100%	-	100%
Mean Incentive Calculation Appropriateness Rating	3.00	3.00	3.00	3.00	-	3.00
Inappropriate incentive cap applied	0%	0%	0%	0%	0%	0%
Mean Incentive Calculation Appropriateness Rating	-	-	-	-	-	-

7.1.11 Calculation Considerations Assessment

Calculation Considerations Assessment is a measure by measure comparison of PA versus evaluator calculations along with the frequency in which the PA uses different methods of savings calculations.

Findings

Table 27 displays the calculation considerations used by the PAs and the ex post evaluators. Findings from the Calculation Considerations assessment indicate an overall good match between the PA and evaluator considerations. As a result of whole building modeling, both the PA and evaluator considerations for all 25 projects included the following:

- CPUC policy and guidance
- Weather Normalization
- Seasonality considerations
- Interactive effects (all but one measure)
- Facility-based custom elements/inputs
- DEER inputs and assumptions

The main difference between PA and evaluator considerations was that PA post-installation activities included only verification, while evaluator considerations included post-installation measurement and verification. In addition 10 of the 25 projects underwent model calibration following evaluator M&V. See Table 27 below for details. The one measure using PA calculation tools was part of an industrial measure on a whole building project.

Recommendations

The evaluator does not see a need for further recommendations in this category.

Table 27: Comparison of PA and Ex-Post M&V Calculation Considerations by Customer Agreement Date

Parameter Examined	PA	Ex-Post M&V
Pre-2013 Customer Agreement Date		
Number of measures evaluated (N)	23	
Number of measures with calculation considerations documented (N)	23	23
Frequency of calculation considerations documented (N)		
CPUC policy and guidance	23	23
Previous relevant EAR guidance	0	0
Standard evaluation practices	1	0
Model calibration	0	8
PA calculation tools	1	1
Production normalization	0	0
Stable period of measured performance	0	0
Weather normalization	23	23
Seasonality considerations	23	23
Interactive effects	22	22
Facility-based custom elements/inputs	23	23
DEER inputs and assumptions	23	23
Pre-installation M&V	0	0
Post-installation M&V	0	23
2013+ Customer Agreement Date		
Number of measures evaluated (N)	3	
Number of measures with calculation considerations documented (N)	3	3
Frequency of calculation considerations documented (N)		
CPUC policy and guidance	3	3
Previous relevant EAR guidance	0	0
Standard evaluation practices	0	0
Model calibration	0	2
PA calculation tools	0	0
Production normalization	0	0
Stable period of measured performance	0	0
Weather normalization	3	3
Seasonality considerations	3	3
Interactive effects	3	3
Facility-based custom elements/inputs	3	3
DEER inputs and assumptions	3	3
Pre-installation M&V	0	0
Post-installation M&V	0	3

7.1.12 Calculations Assessment

Calculation Assessment provides an assessment of the appropriateness, the documentation quality, and the accuracy of the PA models in determining measure savings. The assessment also indicates if the evaluator used the PA provided model, a similar model, or a different model for savings calculations.

Findings

Table 28 provides Calculation Consideration comparison between PA and the evaluator. Findings show that the PA and evaluator may have been in agreement, but the proper implementation of the calculations was more inconsistent. Whole building energy simulation software was used in calculations, but the correct modes, inputs, and assumptions were not always correct. Only 1 of the 25 projects was calculated in noncompliance mode using actual building schedules. Model calibration for sites where it was applicable had significant impact on ex post results.

Mean scores for this assessment category ranged at mostly 2.0 - 2.5 due to the lack of using or updating site specific parameters such as actual buildings schedules to run in noncompliance simulation mode.

Recommendations

If PA post-installation verification could become measurement and verification focused, model accuracy could increase using more accurate facility inputs, regardless of whether there is enough data for calibration.

Table 28: Assessment of PA Calculation Methods by Customer Agreement Date

Parameter Examined	PA Calculation Method Ratings (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Number of Measures Assessed	13	6	4	2	0	1
Assessment of Appropriateness of PA Savings Model						
Number of Measures with PA Model Appropriateness Ratings (N)	13	6	4	2	0	1
Mean PA Model Appropriateness Rating	2.31	2.33	2.25	3.00	-	2.00
Median PA Model Appropriateness Rating	2.00	2.50	2.00	3.00	-	2.00
Assessment of Quality of PA Model Documentation						
Number of Measures with PA Model Documentation Quality Ratings (N)	13	6	4	2	0	1
Mean PA Model Documentation Quality Rating	2.23	2.00	1.75	3.00	-	2.00
Median PA Model Documentation Quality Rating	2.00	2.00	2.00	3.00	-	2.00
Assessment of Accuracy of PA Model						
Number of Measures with PA Model Accuracy Ratings (N)	13	6	4	2	0	1
Mean PA Model Accuracy Rating	2.08	1.83	2.00	2.50	-	2.00
Median PA Model Accuracy Rating	2.00	2.00	2.00	2.50	-	2.00
Assessment of Evaluation Use of PA Models						
Number of Measures with an Assessment of Evaluation Use of PA Models (N)	13	6	4	2	0	1
Evaluation used a different model	0%	0%	0%	0%	-	0%
Evaluation used a similar model	0%	0%	0%	0%	-	0%
Evaluation adjusted PA model	100%	100%	100%	100%	-	100%

7.1.13 PA Inputs and Assumptions Assessment

Input and Assumptions Assessment summarizes the comprehensiveness, documentation, and accuracy ratings for the PAs' calculation methods' inputs and assumptions and provides and assessment of the evaluation's use of the PAs' inputs and assumptions. The evaluation team documented whether they used different, similar, or adjusted inputs and assumptions compared to those used in the PAs' calculation methods.

Findings

Table 29 summarizes the comparison of calculation input and assumptions scores. PA and evaluator inputs varied at some level in most projects. The majority of changes involved adjusting the PA inputs, but a significant portion also used different PA inputs as seen below in the table. As shown, the mean comprehensiveness, documentation, and accuracy ratings for each PA are below average indicating the PA did not meet the evaluation team's expectations.

Numerous savings models were not trued up to site findings even though the PA post verification indicated differences between initial model assumptions and the verified findings. Calculating savings using incorrect simulation modes, not using as built schedules, and not adjusting the as-found measure count in the PA inspections are some of the reasons for lower calculation method scores. These parameters significantly affect model accuracy and savings.

Recommendations

The evaluator recommendations that the PAs conduct more post-installation measurement and more detailed post-installation verification, and include the updated inputs into their energy savings models and calculations so that the ex ante claims appropriately reflect as-found parameters.

Table 29: Assessment of PA Calculation Inputs and Assumptions by Customer Agreement Date

Parameter Examined	PA Calculation Input and Assumption Ratings (1 = Does not meet basic expectations, 5 = Consistently exceeds expectations)					
	Pre-2013 Customer Agreement Date			2013+ Customer Agreement Date		
	PG&E	SCE	SDG&E	PG&E	SCE	SDG&E
Number of Measures Assessed	13	6	4	2	0	1
Assessment of Comprehensiveness of PA Inputs and Assumptions						
Number of Measures with Ratings for Comprehensiveness of PA Inputs and Assumptions (N)	13	6	4	2	0	1
Mean PA Input and Assumption Rating	2.15	2.17	2.00	3.00	-	2.00
Median PA Input and Assumption Rating	2.00	2.00	2.00	3.00	-	2.00
Assessment of Documentation of PA Inputs and Assumptions						
Number of Measures with PA Input and Assumption Documentation Ratings (N)	13	6	4	2	0	1
Mean PA Input and Assumption Documentation Rating	2.15	2.33	1.75	3.00	-	2.00
Median PA Input and Assumption Documentation Rating	2.00	2.00	2.00	3.00	-	2.00
Assessment of Accuracy of PA Inputs and Assumptions						
Number of Measures with PA Input and Assumption Accuracy Ratings (N)	13	6	4	2	0	1
Mean PA Input and Assumption Accuracy Rating	2.08	1.83	2.00	2.50	-	2.00
Median PA Input and Assumption Accuracy Rating	2.00	2.00	2.00	2.50	-	2.00
Assessment of Evaluation Use of PA Inputs and Assumptions						
Number of Measures with an Assessment of Evaluation Use of PA Inputs (N)	13	6	4	2	0	1
Evaluation used different inputs	23%	17%	50%	0%	-	0%
Evaluation used similar inputs	8%	17%	0%	0%	-	0%
Evaluation adjusted PA inputs	69%	67%	50%	100%	-	100%
Number of Measures with an Assessment of Evaluation Use of PA Assumptions (N)	13	6	4	2	0	1
Evaluation used different assumptions	0%	0%	0%	0%	-	0%
Evaluation used similar assumptions	0%	0%	0%	0%	-	0%
Evaluation adjusted PA assumptions	100%	100%	100%	100%	-	100%

8. *SUMMARY OF EVALUATION FINDINGS AND RECOMMENDATIONS*

In this chapter we present key findings, drawn from the previous results chapters of this report and associated recommendations. Findings and recommendations are organized into the following sections:

- 8.1 Gross impact-related findings and recommendations
- 8.2 Net-to-gross-related findings and recommendations
- 8.3 Program findings and recommendations based on PPA results

As summarized in Chapter 5 across all PAs, the mean life cycle ex post gross impact realization rates were 0.92 for kWh and 0.57 for the therms. The average electricity ex post GRR was a little above the program calculated default ex ante GRR (0.9) whereas the ex post gas GRR was significantly below the default 0.9 ex ante GRR adjustments for the 2013 program year. On a statewide basis, the net-to-gross ratio was estimated at 0.53 for kWh and 0.51 for therms. At a summary level, the detailed recommendations in this chapter fall into the following primary areas:

- To better align ex ante and ex post savings, the PAs should:
    - Use appropriate calculation methods, apply as-built building operating conditions, use applicable Title-24 baselines or Industry Standard Practices (ISPs) to improve the savings estimation, and perform better quality control of the projects
    - Improve adjustments to project savings based on post-installation inspections and M&V.
- Improvements in PA project documentation and tracking data are required to increase consistency between project files and tracking data, and minimize errors of project claims.
- To reduce continued moderate to high free ridership, PAs should test program features and procedures changes focused on increasing program-induced savings.

Gross Impact Findings and Recommendations

This subsection presents gross impact issues and recommendations associated with the 2013 NRNC Whole Building program. As presented in Chapter 5, the four primary discrepancy factors that contributed to impact related differences between evaluated ex post savings and PA estimated ex ante savings were Operating

Conditions, Calculation Method, Inappropriate Baseline, and Uncontrollable factors.[36] The following sub sections summarize these discrepancy factors, issues pertaining to these discrepancy factors, and recommendations that, if implemented, could reduce the impact these controllable discrepancy factors have on PA-estimated ex ante savings. The issues and recommendations discussed below are based on the site specific discrepancy analyses that were performed on the 25 M&V sample points.

8.1.1 Operating Conditions – Issues and Recommendations

This discrepancy category represents the differences in building or HVAC operation between the ex ante model assumed conditions and the ex post observed conditions. The discrepancies categorized as Operating Conditions contributed a total negative impact of -2,061,209 kWh, -87.2 kW, and -73,062 therms on evaluated ex post non-weighted project-level savings or -2.8% of ex ante kW, -16.7% of ex ante kWh, and -23.9% of ex ante therm savings of the sample savings.

The primary issue regarding the Operating Conditions discrepancy involved ex ante models that are not properly trued-up to match physical as-built conditions. Some of the ex ante energy models were not trued up (i.e., "physical calibration") to reflect actual as-built equipment specifications, sequencing, and controls. The evaluation team believes there is room for improvement regarding the true-up of the ex ante models' equipment specifications, sequences, and controls to the as-built conditions observed during the PA verification site visit.

PAs should require their inspectors and engineers to perform on-site visits to visually verify that the proposed ECMs have been installed and are operating as intended *and as simulated in the building model*. The latter point is very important because if the ex ante model is not revised based on site inspection notes, collected building characteristics, and observed operating conditions then these impact discrepancies will continue to be substantial, regardless of whether comprehensive site verifications were conducted. It is recommended that the final approved model should be adjusted to physical "as-built" conditions observed during the verification site visit. "As-built" conditions include observed construction and equipment efficiencies and observed HVAC controls and sequencing. This effort should be performed in conjunction with revising the standard schedules with as-built building schedules.

It is also recommended that the program administrator should make it mandatory for program participants to submit a Title-24 Acceptance Test Report before being paid an incentive. Title-24 acceptance tests

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[36] The first three primary discrepancy factors – Operating Conditions, Calculation Method, and Inappropriate Baseline – are controllable discrepancy factors. The evaluation team categorized discrepancy factors in to two distinct categories: controllable and Uncontrollable. "controllable" refers to whether the PAs had potential control over correcting the discrepancies that contribute to the difference between the ex ante and ex post savings estimates, i.e., could the PAs have identified and rectified controllable issues discovered in the ex ante models such that the ex post evaluation needs to assess the impact of only uncontrollable factors.

involve inspection checks and performance tests to determine whether specific building systems conform to the criteria set forth in the standards and to the proposed building specifications and controls. The acceptance test reports can also be used to true-up building models to as-built conditions.

8.1.2 Calculation Method – Issues and Recommendations

The Calculation Method discrepancy category accounts for savings differences due to different modeling methods used between the ex ante and ex post savings estimates. This discrepancy can include differences between ex ante and ex post load estimate, weather normalization, savings normalization, peak demand calculation methods and modeled equipment design. The discrepancies categorized as Calculation Method contributed a total negative impact of -156,060 kWh, -1,021.5 kW, and -13,918 therms on evaluated ex post savings or -33.3% of ex ante kW, -1.3% of ex ante kWh, and -4.6% of ex ante therm savings.

The primary issue regarding the Calculation Method discrepancy involves how the Energy Pro model is used in the SBD Program to both assess eligibility of the NRNC projects and to estimate ex ante savings.

Energy-Pro uses two calculation modules related to the SBD Program: (1) NR T-24 Performance and (2) NR Performance. Both modules create standard and proposed building description files and estimate annual building energy performance using the DOE-2.1E building energy simulation program. However, there are distinct differences between these two modules that have been ignored or misunderstood. This problem has contributed to the inaccuracy of energy savings estimates for this program. The significant difference in peak demand savings between the ex ante estimate and the ex post results were due to the use of inappropriate calculation method in the ex ante estimate.

To develop more accurate ex ante energy savings estimates, the evaluators recommend that: (1) when using Energy-Pro, program eligibility should be determined using the *NR T-24 Performance* module and ex ante savings should be determined using the *NR Performance* module; (2) as-built design schedules should be used in both the baseline and post-retrofit models; and(3) the run period should be consistent with the defined and applicable DEER peak periods.

8.1.3 Inappropriate Baseline – Issues and Recommendations

The Inappropriate Baseline discrepancy category is applied to instances where the baseline model does not reflect 2008 Title 24 or ACM guidelines for establishing standard/baseline model characteristics. The discrepancies categorized as Inappropriate Baseline contributed a total negative impact of -469,036 kWh, -113.2 kW, and -20,571 therms on evaluated ex post savings or -3.7% of ex ante kW, -3.8% of ex ante kWh, and -6.7% of ex ante therm savings of the total non-weighted sample savings.

The primary issue regarding the Inappropriate Baseline discrepancy is similar to the issue discussed for the Calculation Method discrepancy – how Energy Pro is used in the SBD Program to create the standard/baseline model[37]. Neither of the standard building models created by the two Performance modules in Energy Pro is appropriate for use as the baseline model for the SBD Program. The NR T-24 Performance module uses T-24 standard schedules in both the standard and proposed models while the NR Performance module uses the current year as the run period and as-built mechanical systems in the baseline model[38].

It is recommended that the PA modelers verify that the baseline model, specifically the mechanical and HVAC systems, is in accordance with the Title-24 ACM manual. This recommendation and the recommendation given in the Calculation Method section above are the most critical improvement areas that could be used to improve ex ante savings estimation. This adjustment requires proficient modeling experience, with the modeler able to work outside of the Energy Pro program, using the DOE-2 input files (e.g., .doe files) and the ACM manual to verify that the standard model generated by Energy Pro applies the Title 24 and ACM rules correctly. Furthermore, buildings that are modeled within Energy Pro but do not have baseline requirements stipulated in Title 24 (i.e., hospitals, data center, labs, and other buildings requiring special ventilation, pressurization, or process-related provisions) need extra scrutiny to assess whether Energy Pro produces a reasonable standard/baseline model.

The recommended modeling adjustment process detailed above is a manual, labor intensive process and can be very tedious at times. If the PAs desire to continue to use Energy-Pro in the future for energy savings estimation (as opposed to T24 compliance), we suggest the PAs explore modifications to the Energy-Pro or any other PA selected software tool in order to automate the recommended modeling process and automatically generate appropriate energy savings.

8.1.4 Uncontrollable – Comments

The uncontrollable discrepancy category was used primarily to identify discrepancies regarding model adjustments and calibration performed due to changes in building load, use of end-use data in building, and utility billing data. However, the Uncontrollable discrepancy category covers all discrepancies that PAs have no potential control over.

[37] Issues involving Inappropriate Baseline have also been discovered with projects that used eQUEST but projects using Energy Pro to estimate savings are relatively unique because Energy Pro automatically creates the baseline model based on the proposed model inputs. This is distinctly different from how eQUEST models are typically developed. eQUEST modelers typically create the baseline model first, based on ACM guidelines, Title 24 defaults imbedded in the program, and ISP guidelines where appropriate. Then, the proposed model is developed with the baseline model as the starting point.

[38] The "current" run year is dictated by the computer date that the Energy-Pro program and model was simulated on. So for example, if the computer's calendar year was changed from 2015 to 1991 the Energy Pro program running the NR Performance module would simulate the model based on the 1991 calendar year.

The discrepancies categorized as uncontrollable contributed a total positive impact of 669,053 kWh, 314.9 kW, and 25,193 therms on evaluated ex post savings or 10.3% of ex ante kW, 5.4% of ex ante kWh, and 8.3% of ex ante therm savings of the total sample savings.

These positive impacts of the uncontrollable discrepancy are considered to be coincidental and no statistical correlation has been determined between the process of model calibration and positive impacts on GRR. In fact, the WO033 evaluated results for 2010-2012 SBD Whole Building projects showed that model calibration had a negative impact on the site-specific GRR for that sample – the opposite effect from the current sample.

Net-to-Gross Findings and Recommendations

This subsection presents findings and recommendations related to net-to-gross and program influence. Detailed NTG evaluation results are discussed in Chapter 6 of this report.

The net-to-gross ratios (NTGRs) discussed here are strictly "net-of-free ridership" as no spillover is considered in this analysis. The NTGRs were estimated at 0.50 to 0.53 across fuel domains based on 25 sites. These NTGRs indicate a moderate level of free ridership.

The evaluation team has noticed evidence suggesting that the earlier the involvement with the program, the greater influence that the program has on the project. One possible solution to reduce free ridership is to shift program delivery to attract earlier project involvement. One suggestion is to reduce incentive payments or even disqualify projects that have completed and committed designs before program interactions began. Conversely, greater incentives could be extended to projects that get involved with the program in the early design stages. This scenario would require some sort of "litmus test" to determine whether participants could be influenced by the program or not. This approach could separate out the projects that are "applying for an incentive for a pre-determined design" from those that are willing to consider design alternatives.

Program Findings and Recommendations Based on PPA Results

This subsection presents PPA findings and recommendations associated with 2013 NRNC Whole Building program. As presented in Chapter 7, the PPAs rate project documentation and provide recommendations to improve the PA assessment and documentation of the following categories:

- Project Eligibility
- Baseline selection and documentation
- EUL/RUL
- Cost and Incentive Documentation and Calculations
- Calculation methods; models/methods, inputs, and assumptions

Each aspect was rated on a 1 to 5 where a 3 was given where the documentation was considered acceptable. Ratings of 4 or 5 were for documentation with more detail than expected, and ratings of 1 or 2 were for given for missing or inadequate documentation. Summary findings and recommendations from each PPA subsection are listed below.

Project Eligibility Considerations

After reviewing the PA project documents regarding eligibility requirements and program documentation, the evaluator eligibility conclusions were almost identical to PA conclusions, and the evaluator provides no recommendations to change eligibility considerations.

Project Eligibility Ratings

The two primary objectives of this portion of the PPA are to rate the quality of the documentation supporting measure eligibility and then to rate the Appropriateness of the PA assessment of eligibility requirements. Overall each PA provided adequate information that met expectations for examining eligibility. Based on PA documentation the evaluator determined that all ex ante measures were eligible.

To continue to minimize this eligibility discrepancy, PAs should carefully review the model baseline and make sure that the baseline equipment and conditions meet the applicable Title-24 code and ACM manual.

Project Types

Project Type Assessment is an overview of the PA versus ex post project type designations. In all cases the evaluator agreed with PA conclusion for project type designation and has no further recommendation.

Project Baselines

For the NRNC Whole Building projects, baseline designations are usually based on either Title 24 code or Industry Standard Practices, and this designation, which is driven by type of building, will affect estimated savings. For project baseline designations in the NRNC Whole Building Program, the evaluator and PA conclusions were identical with the exception of one case. A site designated by the PA as a healthcare facility was in fact deemed ex post as a medical office building that did not need to comply with healthcare specific ISP, but rather the Title-24 building code. This baseline change from healthcare ISP to T-24 building code had a drastic impact on the GRR of this site.

The evaluator recommends reviewing baseline building use type selection and confirming that it is the most appropriate option while generating the energy model.

Project Baseline Documentation Quality

Applicable codes were documented by the PAs and the mean scores by PA ranged between 2.5 and 3.0. In the NRNC Whole Building Program, the Title 24 code is the baseline for most projects, and the evaluator confirmed this correct code documentation in the ex post review.

One SCE and one PG&E project used additional baseline information. The SCE project was an industrial based measure that needed to factor in other equipment and facility baseline parameters. For one of the PG&E sites, implementer-provided ISP documents were not available in the ex ante review and had to be requested for the ex post analysis. Most NRNC Whole Building Projects rely on whole building simulation software that generates the baseline to the appropriate Title 24 standards.

The evaluator recommends including all baseline documentation files such as implementer ISP files used in the project design in the project file.

Project Baseline Ratings

The baseline rating indicates whether or not the PA baseline conclusion was correctly identified. In most cases the appropriateness rating met expectations. The appropriateness of the baseline was on average higher than the documentation rating. Only 1 site received a rating of 1 or 2 for appropriateness, but 7 of the 26 measures received a score of either 1 or 2 for documentation. In several instances baseline documentation provided did not necessarily match the type of equipment being modeled. In other cases it was not clear which parameters or models were intentionally revised, and there was no detailed accompanying documentation.

The evaluator recommends including more details from any project equipment changes and updating documentation if project scope changes over the course of construction in the project file.

EUL Assessment

The EUL assessment is an examination of PA tracking data and project documentation on EUL values. The most notable difference between PA EUL data and evaluator EUL findings was the fact that PG&E tracking data did not include any EUL values. All site EULs were populated with zeroes. In addition not a single project had the EUL documented in the project documents. This resulted in large differences between PA and evaluator EUL designations. For our analysis, PG&E EUL values were obtained from PG&E 's 2013 SBD E3 calculator. The SCE and SDG&E EUL values that existed in the tracking data were not accompanied by a source, therefore the evaluator was not able to determine how the PAs calculated project EUL values. It was not possible to further investigate EUL differences without this data.

EUL is crucial for lifecycle savings calculations, and the evaluator recommends collecting EULs for each measure of the Whole Building project from DEER and calculating the project EUL by weighting them by measure savings. Then this weighted average EUL should be assigned to the project level for the Whole Building projects to estimate project life cycle savings. Additionally, it is recommended to include EUL as a required field on the utility incentive worksheet or on project application.

Incremental Cost Ratings Assessment

PA cost documentation was provided for all 26 measures. For this assessment only incremental costs are relevant. Program rules identify incentive caps relative to incremental cost, which makes this cost element crucial for appropriate incentive calculations.

Evaluator examination of the cost documents indicate that while incremental cost data existed, it did not always meet quality or appropriate expectations. This is evident in the fact that 17 of 26 measures received as score of 1 or 2 for incremental cost documentation rating, usually due to unreferenced sources or unclear cost data (i.e. not separated out by measure, but just a total reported incremental cost). Some referenced sources were the names of previous implementer project documents, which were not accessible to evaluators to verify the incremental cost claims.

We recommend standardizing incremental cost documentation where both the baseline and the installed measure cost data should be provided along with their reference sources to validate the incremental cost estimates.

Incentives Assessment

Overall the PA incentive calculation methods and incentive caps agreed with evaluator findings. Tracking data and project documents for every project scored a 100% for including incentive details. Based on information from project documents, all of the appropriate incentive caps were applied when necessary. Consequently, all PAs received a rating of 3.0 which is meeting the expectations for documentation for the incentive assessment category.

However there were some large discrepancies between the tracking data incentive amount and the project documents incentive amount for some PG&E and SCE sites. Having no further insight into the tracking data incentive values it appears there could be some significant inconsistencies in how design team incentives and other incentives such as LEED and Commissioning kickers were documented. It is also possible that improper data calculation and entry occurred.

The evaluator recommends having more transparency and thoroughness when documenting incentives. Incentive amounts in the project documents should match what was listed in the tracking data.

Calculation Considerations Assessment

Findings from the Calculation Considerations Assessment indicate that the PA and evaluator considerations have an overall good match. The main difference between PA and evaluator considerations was that PA post-installation activities included verification only and evaluator considerations included post-installation measurement and verification.

Calculations Assessment

Calculation considerations between the PA and the evaluator may have been in agreement, but the proper implementation of the calculations was inconsistent. Whole building energy simulation software was used in calculations, but the simulation modes, inputs, and assumptions were not always correct. Only 1 of the 25 projects was calculated in noncompliance mode using actual building schedules. Model calibration for sites where it was applicable had significant impact on ex post results.

If PA post-installation verification could become measurement and verification focused, model accuracy could increase using more accurate facility inputs, regardless of whether there is enough data for calibration.

PA Inputs and Assumptions Assessment

Numerous savings models were not trued up to site findings even though the PA post verification indicated otherwise. Calculating savings using incorrect simulation modes, not using as built schedules, and not adjusting the as-found measure count in the PA inspections are some of the reasons for lower calculation method scores. These parameters significantly affect model accuracy and savings.

The evaluator recommendations that the PAs conduct more post-installation measurement and more detailed post-installation verification, and include the updated inputs into their energy savings models and calculations so that the ex ante claims appropriately reflect as-found parameters.