DNV·GL

PY2016 Rhode Island Commercial and Industrial Small Business Initiative Impact Evaluation

National Grid

Final Report
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1 EXECUTIVE SUMMARY

This Executive Summary provides a high-level review of key findings from the Impact Evaluation of the 2016 program year of the Rhode Island Commercial and Industrial (C&I) Small Business (SB) Initiative, conducted by DNV GL for National Grid. In this section, we state the study objectives, summarize the evaluation approach, and present results, conclusions, and recommendations.

1.1 Background

The Rhode Island SB initiative is one of the delivery methods used by National Grid to increase the market penetration of energy-efficient technologies among small commercial customers. The initiative leverages contractors to provide turnkey services for recruiting customers, identifying and implementing energy efficiency opportunities, processing incentives, and estimating energy and demand savings per project.

The initiative's efficiency measure offerings for electric customers primarily consist of retrofits to facility lighting systems, such as replacing fixtures and ballasts and installing lighting controls, but also include measures for refrigeration, HVAC systems, motor/drives and other custom offerings. National Grid also offers on- and/or off-bill financing options to help customers finance their share of the cost of installing improvements. National Grid offers incentives up to 70% of the total project costs.

In 2016, the SB initiative contributed 6% of the state-wide annual electric energy savings as reported in the RI Energy Efficiency Resource and Management Council 2017 Annual[1] Report.

The SB initiative offers both custom and prescriptive measures. In 2015 SB lighting projects installed in the 2013 Program Year (PY), were evaluated. Only 4% of the total savings came from Non-lighting measures in this initiative in 2016 and therefore this impact evaluation studied prescriptive and custom lighting measures only.

1.2 Overview of objectives

The primary objective of this impact evaluation was to provide verification or re-estimation of electric energy and demand savings estimates for a sample of custom and prescriptive electric lighting SB projects through site-specific inspection, monitoring, and analysis. These site-specific results were aggregated to determine energy and demand realization rates for National Grid's SB initiative in RI by combining them with results from the 54 sites included in the recently finalized Massachusetts (MA) sample (National Grid territory) SB initiative. As savings from lighting measures represent a significant majority of SB savings (~96%), only lighting measures have been assessed in this evaluation.

The evaluation team also developed additional RRs and factors that are described in forthcoming sections of this report:

- Connected kW RR
- Installation rate RR
- Delta watts RR
- Hours of use RR
- Summer and winter on-peak hours and coincidence factors
- % on-peak kWh

[1] Per annual reports found on the RI Energy Efficiency & Resource Management Council website, http://www.rieermc.ri.gov/documents/annual/7_2017%20EERMC%20Annual%20Report.pdf. Please note that savings shares reflect for 2016 only.

- kWh and summer and winter kW HVAC interactive effects
- Gas heating penalty

There was some discussion regarding the difference between prescriptive and custom lighting projects in the MA study; the evaluation team consulted implementers from National Grid to inquire about their tracking methods and treatment of prescriptive and custom lighting measures. National Grid confirmed that the majority of their custom SB lighting projects were similar to prescriptive in how the savings are estimated. For the most part, lighting projects that get tracked as custom do so because they do not have the exact product codes (often LED) in their prescriptive measure lists. The measure lists were planned to be updated in 2017, so that their vendors can more consistently enter all products into the prescriptive applications.

The evaluation team also reviewed a very small sample of custom lighting project files to confirm the savings calculations match the prescriptive lighting calculations. In this preliminary assessment of a selection of 13 projects (in MA) and 5 projects (in RI), no significant differences in savings calculation methods were observed. For these reasons, the evaluation sample was designed to develop results for custom and prescriptive lighting projects combined in the sample design.

1.3 Summary of Approach

The evaluation team's approach and methodology were consistent with the procedures and protocols developed during the previous round of SB impact evaluation last conducted in 2015. The impact evaluation completed on-site visits and metering of lighting hours-of-use for a randomly selected sample of projects at participating 30 small businesses in Rhode Island. In addition to on-site metering, the evaluation team confirmed installation and operability and investigated baseline issues on a per-project basis.

This study required onsite visits and metering of lighting hours-of-operation ("HOU") for a randomly selected sample of 84 customer facilities that participated in the Initiative in PY2016. In addition to onsite metering, our team investigated baseline issues, collected a comprehensive inventory of lighting and HVAC characteristics, and gathered additional information related to the objectives identified in the previous section. A high-level synopsis of the evaluation approach is as follows:

Sample design. Our team investigated Initiative changes since the PY2015 evaluation and determined the customer sample frame to develop a sample design that meets the desired statistical precision targets for key savings parameters such as energy and peak demand savings, as well as other factors such as peak coincidence factors and HVAC interactive effects.

Data collection and analysis. Data collection for this impact evaluation included a physical inspection and inventory of installed products, interviews with facility personnel, observation of site operating conditions and equipment and short-term metering of lighting HOU.

1.4 Findings

Table 1-1 presents the initiative's final state-wide realization rates for kWh, summer and winter peak kW, and connected kW savings, as well as the relative precisions at the specified confidence intervals.

Table 1-1 Final SB Initiative lighting realization rates achieved by savings type

Savings	MA+RI		MA only		RI only	
	RR	RP	RR	RP	RR	RP
Annual kWh (90% confidence interval)	102.5%	±7.1%	101.7%	±8.4%	105.8%	±11.4%
Summer peak kW (80% confidence interval)	90.6%	±6.8%	93.2%	±7.1%	79.3%	±20.0%
Winter peak kW (80% confidence interval)	80.8%	±19.5%	73.2%	±22.9%	124.7%	±14.9%
Connected kW (80% confidence interval)	97.0%	2.0%	96.3%	±2.6%	100.0%	±1.7%

Evaluators determined that lighting measures in the Small Business Initiative achieved approximately 103% of the reported electric energy savings for MA and RI combined and 106% of the reported electric energy savings in RI. Demand savings results achieved lower evaluated savings than reported for both summer kW and winter kW in MA and RI combined. Table 1-2 also illustrates that the evaluation team achieved the statistical targets considered in the sample design: ±10% relative precision at the 90% confidence interval for kWh but did not achieve ±10% relative precision at the 80% confidence interval for winter peak kW in MA and RI combined.

Table 1-2 further examines the kWh RR, dissecting it among five discrepancy categories considered across all site analyses. The discrepancy categories are further defined in Section 1.6. Please note that tracking and reported gross savings are comprehensively defined in APPENDIX A. In summary, tracking gross savings are defined as the base savings based on fixture quantity, wattage, and operation values (hours of use, coincidence factors). Tracking gross savings are the savings recorded at the completion of a project. Tracking savings do not incorporate HVAC interactive effects or other final adjustment factors. Net savings, which are calculated by National Grid's internal database, include HVAC interactive effects and are the savings ultimately claimed by National Grid. Adjusted gross (evaluated) savings in Table 1-2 includes HVAC interactive adjustment. The kWh realization rate of 102.5% referred to throughout this report is based on tracking gross savings as it is intended to be used prospectively to adjust tracking gross savings.

Table 1-2. Examination of overall and state-level energy realization rate for SB lighting measures

Savings Parameter	Energy MA+RI		Energy MA		Energy RI	
	kWh	% Gross	kWh	% Gross	kWh	% Gross
Tracking Gross Savings (without HVAC adjustment)	54,611,479		42,247,374		12,364,104	
Documentation Adjustment	-326,620	-0.6%	-265,333	-0.6%	-58,724	-0.5%
Technology Adjustment	-907,134	-1.7%	-871,915	-2.1%	-768	0.0%
Quantity Adjustment	-1,815,692	-3.3%	-1,812,987	-4.3%	79,975	0.6%
Operational Adjustment	3,206,660	5.9%	2,942,960	7.0%	170,103	1.4%
HVAC Interactive Adjustment	1,213,501	2.2%	727,070	1.7%	529,291	4.3%
Adjusted Gross Evaluated Savings (with HVAC Adjustment)	55,982,194	102.5%	42,967,170	101.7%	13,083,981	105.8%

Gross Realization Rate	102.5%		101.7%		105.8%	
Relative Precision	±7.1%		±8.4%		±11.4%	
Confidence Interval	90.0%		90.0%		90.0%	
Error Ratio	0.32		0.32		0.35	

Section 1.4 examines the key contributors to energy and demand discrepancies by the five categories in Table 1-2. Notable contributors in RI include:

- For some projects, insufficient tracking data led evaluators to attribute savings differences to the **documentation** category.
- There was positive overall (electric heating and cooling) HVAC interaction effect in RI when compared with MA.
- **Operating hours were higher** than anticipated by the implementation vendors.
- Coincidence factors for both summer and winter in RI were found to be lower than MA. It could be due to the lower operation hours during the peaks.

Table 1-3 presents the overall, state-level savings factors determined in this study. Sections 1.5 and 1.6 further explain the evaluation team's recommendations for applying the results of the evaluation.

Table 1-3. Overall and state-level factors for SB lighting measures

Savings Parameter	MA+RI		MA		RI	
	Value	Precision at 80% Confidence	Value	Precision at 80% Confidence	Value	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW)	99.4%	±1.1%	99.0%	±1.2%	101.7%	±2.8%
Delta Watts (Technology Adjustment - kW)	99.0%	±0.7%	98.8%	±0.9%	100.3%	±0.8%
Connected kW Realization Rate	97.1%	±2.0%	96.3%	±2.6%	100.7%	±1.7%
Summer kW Realization Rate	90.6%	±6.8%	93.2%	±7.1%	79.3%	±20.0%
Winter kW Realization Rate	80.8%	±19.5%	73.2%	±22.9%	124.7%	±14.9%
kW Factors (Precision at 80% confidence)						
Summer Coincidence Factor	45.7%	±15.4%	48.3%	±18.9%	35.6%	±18.3%
Winter Coincidence Factor	49.7%	±16.0%	48.3%	±20.0%	54.9%	±14.7%
Summer kW HVAC Interactive Effect	114.5%	±1.4%	113.9%	±1.6%	117.3%	±2.6%
Winter kW HVAC Interactive Effect	99.8%	±0.2%	100.0%	±0.0%	99.2%	±0.7%
kWh Factors (Precisions at 90% confidence)						
kWh HVAC Interactive Effect	102.2%	±0.6%	101.7%	±0.5%	104.2%	±1.6%
Hours of Use Realization Rate	106.2%	±6.1%	107.5%	±7.0%	101.4%	±11.0%
% On Peak kWh	63.3%	±11.7%	67.8%	±14.1%	45.4%	±15.0%
Non-Electric						
Heating HVAC Interaction Effect (MMBtu/kWh)	-0.00091		-0.00094		-0.00078	

1.5 Conclusions

Overall, the lighting measures installed through National Grid Rhode Island's SBS initiative are performing well relative to tracking estimates and generating substantial energy (kWh) savings. The study achieved the designed target of 90% confidence with ±10% precision interval for summer demand kW in MA and RI combined.

The energy realization rate of 102.5% is similar to those from previous lighting impact evaluations, which are typically at or above 100%. The primary drivers for the higher evaluated gross savings estimates are the HVAC interactive and operational adjustments (8.1% of the tracking savings) as shown in Table 1-4. As mentioned in the previous section, the tracking savings used in this report were used to calculate the gross realization rate and did not include HVAC interactive effects, but National Grid does account for HVAC interactive effects in their net-tracking savings estimates.

The higher operational adjustment primarily comes from MA, and the HVAC adjustment in MA and RI combined is 8.1% (Table 1-2). The decrease in savings due to documentation, technology and quantity adjustments sum up to a total of -5.6% of the total tracking savings value.

Only 3 out 30 sites in RI had occupancy controls installed (through this program) with one site (RI193, retail) showing a 114% HOU realization rate and the other two sites RI376 (religious facility) and RI648 (retail) with 38% and 0% HOU realization rates respectively. For RI193 and RI376, DNV GL installed loggers in rooms of similar space types with and without occupancy sensors to capture post-retrofit and

baseline/pre-retrofit HOU respectively. For example, if an occupancy has been installed in a bathroom, DNV GL installed loggers in bathrooms with and without sensors to capture both pre- and post-retrofit hours of use. In RI648, no occupancy sensors were installed, therefore 0% HOU RR.

Table 1-4. Examination of energy realization rate for SB lighting measures in MA+RI

Savings Parameter	kWh	% Gross
Tracking Gross Savings (without HVAC adjustment)	54,611,479	
Documentation Adjustment	-326,620	-0.6%
Technology Adjustment	-907,134	-1.7%
Quantity Adjustment	-1,815,692	-3.3%
Operational Adjustment	3,206,660	5.9%
HVAC Interactive Adjustment	1,213,501	2.2%
Adjusted Gross Evaluated Savings (with HVAC adjustment)	55,982,194	102.5%
Gross Realization Rate	102.5%	
Relative Precision	±7.1%	
Confidence Interval	90.0%	
Error Ratio	0.32	

The following are some observations and recommendations specific to each of the adjustments presented above.

1.6 Observations and recommendations

Overall RI SB initiative is working very well with a realization rate of 103% for RI and MA combined and 106% for RI sites alone. DNV GL recommends National Grid to use those results from MA and RI combined for prospective application because the study was designed to reach the target precisions of ±10% with 90% confidence for energy savings (kWh) at combined level and was then achieved at the completion. The higher RR for the program suggests that the program is working well as its run currently but there are some minor adjustments that DNV GL recommends below for it run more effectively. MA specific recommendations are listed in the MA report[2].

Documentation Adjustment: The overall documentation adjustment resulted in a decrease in savings of ~0.6% in the combined MA+RI result. In RI: twenty-five of the thirty sites in the sample had the documentation to support the savings estimates provided in the tracking system. Four other sites (in RI) had documentation which provided savings estimates that were only slightly different (~3%) from those in the tracking system. One site had a reduction of about 22% in fixture savings compared to tracking. Overall, National Grid does a good job with the tracking database used for the SB Initiative and with the documentation that supports those savings estimates.

Recommendation: We recommend that National Grid continue to track savings and supporting documentation consistent with its current system.

Technology Adjustment: The lower technology savings in the combined MA+RI result are primarily coming from MA with some minor savings adjustment in RI. In RI, two sites in the sample had slightly

[2] http://ma-eeac.org/wordpress/wp-content/uploads/P69-Impact-Eval-of-MA-Small-Business-Initiative-Phase-I-Lighting_Report_FINAL.pdf

higher installed wattages than reported in the tracking system, which results in a 1% and 3% decrease in savings, respectively. One site had a discrepancy of 7.5-watts/fixture (22 fixtures in total) lower than what was used in tracking; increasing the savings by 3% of the site savings.

Quantity Adjustment: The higher quantity adjustment in RI was essentially penalized by lower savings adjustment in MA. In RI, one sampled site had a discrepancy in the number of occupancy sensors installed, decreasing the savings. This reduction was essentially compensated by another site's fixture quantity increasing the savings overall.

Operational Adjustment: There was positive operational adjustment in both MA and RI and therefore also in the MA and RI combined result. In RI: all thirty sampled sites experienced an operational adjustment, which is understandable given that tracking hours of use are estimated by vendors and/or customers based on building specific inputs. Eighteen sites had evaluation hours that were lower than the tracking estimates and twelve had evaluation hours that were higher but when combined they accounted for a 1.4% increase in savings.

Recommendation: Overall, the tracking system hours of use estimates appear to be reasonable. While there were discrepancies between the tracking and evaluation hours for every site, the average tracking hours were very close to the average evaluation hours. We do recommend that National Grid to more carefully assess the hours-of-use estimates for religious facilities. The two religious facilities in the sample had evaluation hours of use that were approximately 40% lower than their tracking system estimates. Consider using at least seven days of metered data during the pre-retrofit condition.

HVAC Interactive Adjustment: HVAC interaction accounted for 2.2% adjustment to the gross tracking savings in the combined MA and RI. Both the states had positive interactive savings. In RI: Two sampled sites had electric heat (heat pump) which reduced the savings a little bit but sixteen of the remaining sites had a positive effect on the overall savings due to the presence of electric cooling.

Recommendation:

We recommend that National Grid consider including HVAC interaction in their gross savings estimates by calculating it on a site-by-site basis. Currently, HVAC interaction is accounted for in National Grid net savings calculations by applying a factor that represents average HVAC interaction savings to each project. While it was a relatively minor adjustment in this evaluation, interaction may become more influential on program savings should future program installations shift away from exterior fixtures and more toward interior fixtures.

1.6.1 Prospective application of results

Regarding lighting controls, the evaluation team recommends that the results from the prior lighting controls-specific study (2014)[3] continue to be applied by National Grid. The current study's population (PY2016) featured only 1% kWh savings contribution from lighting controls, and the evaluation sample design subsequently did not segment specifically for lighting controls; rather, overall state-wide results were determined for SB lighting measures altogether. Therefore, we do not recommend application of any results from this evaluation study to controls measures moving forward. The factors tabulated in section 1.4 should be prospectively applied to lamp and/or ballast replacement measures only.

[3] Retrofit Lighting Controls Measures Summary of Findings. DNV GL. 2014. http://ma-eeac.org/wordpress/wp-content/uploads/Lighting-Retrofit-Control-Measures-Final-Report.pdf

As mentioned in the sections above, DNV GL recommends National Grid to use the results from MA and RI combined for the prospective application and planning as the study was originally designed at the combined level and has also met the targeted precisions at combined level (MA+RI). The factors calculated at the combined level of MA and RI in section 1.6.1.1 below are to be applied in National Grid's tracking system.

1.6.1.1 Individual factor approach

We recommend that National Grid replace individual factors within their tracking systems factors with evaluated factors in MA and RI combined, as illustrated in the following fixture savings formulae:

$$Evaluated\ Gross\ kWh\ Savings = Conn.kW\ Savings_{Tracking} \times RR_{Conn\ kW} \times HOU_{Tracking} \times RR_{HOU} \times HVAC\ Interactivity_{kWh}$$

$$Evaluated\ Gross\ Peak\ kW\ Savings_{Summer} = Conn.kW\ Savings_{Tracking} \times RR_{Conn\ kW} \times CF_{Summer} \times HVAC\ Interactivity_{skW}$$

$$Evaluated\ Gross\ Peak\ kW\ Savings_{Winter} = Conn.kW\ Savings_{Tracking} \times RR_{Conn\ kW} \times CF_{Winter} \times HVAC\ Interactivity_{wkW}$$

where,

$Conn.kW\ Savings_{Tracking}$ = Connected kW savings claimed by implementer

$HOU_{Tracking}$ = Hours of use (HOU) claimed by implementer

The remaining savings factors are provided in Table 1-5 below: the proposed new peak demand savings factors, HVAC interactive effects factors, and RRs for HOU and connected kW.

Table 1-5. Proposed new savings factors (MA+RI) for prospective use (PY2019 and beyond)

Savings Factor	Formula Term	Prospective Recommended Value	Relative Precision at Specified Confidence Interval
Connected kW RR	$RR_{Conn\ kW}$	97.0%	±2.0% (80% confidence)
HOU RR	RR_{HOU}	106.2%	±6.1% (90% confidence)
kWh HVAC Interactive Factor	$HVAC\ Interactivity_{kWh}$	102.2%	±0.6% (90% confidence)
Summer CF	CF_{Summer}	45.7%	±15.4% (80% confidence)
Winter CF	CF_{Winter}	49.7%	±16.0% (80% confidence)
Summer kW HVAC Interactive Factor	$HVAC\ Interactivity_{skW}$	114.5%	±1.4% (80% confidence)
Winter kW HVAC Interactive Factor	$HVAC\ Interactivity_{wkW}$	99.8%	±0.2% (80% confidence)

2 INTRODUCTION

This document presents the final report for the Impact Evaluation of the Rhode Island Commercial and Industrial (C&I) Small Business (SB) Initiative, also referred to as "the Initiative" in this document.

2.1 Background

The Rhode Island SB Initiative is one of the delivery methods used by National Grid to increase the market penetration of energy-efficient technologies among small commercial and industrial customers. The Initiative leverages vendors under contract with National Grid to provide turnkey services for recruiting customers, identifying and implementing energy efficiency opportunities, processing incentives, and estimating energy and demand savings per project.

The Initiative's efficiency measure offerings for electric customers primarily consist of retrofits to facility lighting systems, such as replacing fixtures and ballasts and installing lighting controls, but also include measures for refrigeration, HVAC, and other systems. Rebates of up to 70% of project costs can be provided to qualifying customers and National Grid further offers to finance the remaining 30% of project costs with a 0% interest loan for 2 years. To be eligible for the initiative, the business must have an average peak monthly demand of 200 kW or less.

The SB initiative offers both custom and prescriptive measures. In 2016, the SB initiative contributed 6% of the state-wide annual electric energy savings as reported in the RI Energy Efficiency Resource and Management Council 2017 Annual[4] Report. Only 4% of the total savings came from Non-lighting measures in this initiative in 2016 and therefore the proposed impact evaluation is being studied for prescriptive and custom lighting measures only.

In 2015 SB lighting projects installed in the 2013 Program Year (PY), were evaluated. Only 4% of the total savings came from non-lighting measures in this initiative in 2016 and therefore this impact evaluation studied prescriptive and custom lighting measures only[4].

2.2 Study objectives

The primary objective of this impact evaluation was to provide verification or re-estimation of electric energy and demand savings estimates for a sample of custom and prescriptive electric lighting SB projects through site-specific inspection, monitoring, and analysis. These site-specific results were aggregated to determine realization rates for National Grid's SB initiative in RI by combining them with results from the 54 sites included in the SB initiative recently finalized Massachusetts (MA) sample (National Grid territory). Two additional sets of realization rates based on RI-only data and MA-only data were produced for comparison purposes. As savings from lighting measures represent a significant majority of SB savings (~96%), only lighting measures have been assessed in this evaluation.

The evaluation team also developed additional RRs and factors that are described in forthcoming sections of this report:

- Energy kWh RR
- Summer and Winter peak demand kW
- Connected kW RR

[4] Per annual reports found on the RI Energy Efficiency & Resource Management Council website, http://www.rieermc.ri.gov/documents/annual/7_2017%20EERMC%20Annual%20Report.pdf. Please note that savings shares reflect for 2016 only.

- Installation rate RR
- Delta watts RR
- Hours of use RR
- Summer and winter on-peak hours and coincidence factors
- % on-peak kWh
- kWh and summer and winter kW HVAC interactive effects
- Gas heating penalty

Prescriptive vs Custom projects**:** In the MA study, the evaluation team consulted implementers from National Grid to inquire about their tracking methods and treatment of prescriptive and custom lighting measures. National Grid confirmed that the majority of their custom SB lighting projects were similar to prescriptive in how the savings are estimated. For the most part, lighting projects that get tracked as custom do so because they do not have the exact product codes (often LED) in their prescriptive measure lists. The measure lists were planned to be updated in 2017, so that their vendors can more consistently enter all products into the prescriptive applications.

The evaluation team also reviewed a very small sample of custom lighting project files to confirm the savings calculations match the prescriptive lighting calculations. In this preliminary assessment of a selection of 13 sets (in MA) and 5 sets (in RI) of project files, no significant differences in savings calculation methods were observed. For these reasons, the evaluation sample was designed to develop results, and custom and prescriptive lighting were combined in the sample design.

2.3 Methodology

The evaluation team's approach and methodology were consistent with the procedures and protocols developed during the previous round of SB impact evaluation last conducted on program year 2013. As described in the next sections, the impact evaluation involved on-site visits and metering of lighting hours of use for a randomly selected sample of projects at participating small businesses.

Originally, the DNV GL started with 2015 participant data but based on a discussion with National Grid, and to be consistent with the MA SB study (P69), the DNV GL updated the population to 2016 SB participant data for both MA and RI.

A total of 2,293 accounts participated in the initiative in 2016, producing an estimated 54,611 MWh of annual energy savings in National Grid's service territory in Massachusetts and Rhode Island. A summary of the 2016 population of projects is presented in Table 2-1. RI projects account for 23% of the total SBS energy savings in the combined (MA+RI) National Grid territory. Table 2-1 also shows peak demand savings by state. The original tracking data does not include winter peak demand (kW) for every account, so DNV GL calculated by taking the product of the tracking connected kW savings estimate and TRM coincidence factor of 0.44 for winter. Summer demand kW was provided in the tracking data by National Grid.

Table 2-1. 2016 PY small business energy savings by end use

State	Accounts	Savings (kWh)	Summer Demand (kW)	Winter Demand (kW)
MA	1,506	42,247,374[5]	9,064	5,463
RI	787	12,364,104[5]	2,220	1,713
Grand Total	**2,293**	**54,611,479[5]**	**11,284**	**7,176**

[5] Lighting Measures only.

In Rhode Island, lighting energy savings dominated SB activity, representing approximately 96% of energy savings when refrigeration[6] lighting is included. The lighting measures include both custom (28% of savings) and prescriptive (68%) measures as shown in Table 2-2. The remaining 4% is represented by non-lighting measures and therefore not included in this evaluation.

Table 2-2. 2016 PY Small Business Energy Savings (RI Only)

End-Use	Savings (kWh)	Percent Savings
Non-Lighting Measures	533,703	4%
Custom Lighting Measures	3,639,866	28%
Prescriptive Lighting Measures	8,724,238	68%
Total SBS	**12,897,807**	**100%**

The primary goal of this sample design was to determine the summer peak demand savings impacts of lighting activity in the 2016 program year at ±10% precision at 80% the confidence interval at the combined RI and MA level. In practical terms, this means that the sample design was stratified and optimized to provide an overall summer peak demand savings estimate.

We used Model Based Statistical Sampling (MBSS) techniques to develop the sample design. We assumed an error ratio of 0.7 in the sample design and defined a sample unit as an account (i.e., a site as opposed to application). Table 2-3 shows the resulting on-site sample design.

Table 2-3. Sample Design for a combined population of National Grid territory in MA and RI

State	Accounts (N)	Summer Demand (kW)	Sample (n)		RR	Expected Relative Precision with 80% confidence interval		Error Ratio	
			Expected	Achieved	Achieved	Expected	Achieved	Assumed	Achieved
MA	1,506	9,064	55	54	93.2%	±12.1%	±7.1%	0.70	0.39
RI	787	2,220	30	30	79.3%	±16.1%	±20.0%	0.70	0.90
TOTAL	**2,293**	**11,284**	**85**	**84**	**90.6%**	**±10.2%**	**±6.8%**	**0.70**	**0.50**

Table 2-4 below shows post stratification and cut-points for the sample in RI population. The first column shows the strata number while the second column shows the maximum site level savings in that strata. Each account was considered a site. The third and fourth columns show the number of Accounts (sites) and sampled accounts (sites) in each stratum. The sample size required to achieve the 80/10 peak demand precision threshold is 30 sites, divided among the five strata. The case weights in the final column reflect the weights that will be used to drive the final savings estimates from the sample.

Table 2-4. On-site (post-stratified) summer kW sample design (RI only)

Stratum	Maximum Savings (Summer kW)	Accounts (N)	Sampled accounts (n)	Case Weight
1	2	480	9	53.33
2	3	106	3	35.33
3	6	118	6	19.67
4	12	52	5	10.4
5	47	31	7	4.43
TOTAL		**787**	**30**	

[6] LED cooler or freezer case lights of various watts and lengths.

Despite optimizing our sample to achieve 80/10 on summer peak demand savings, we estimated energy savings and provided precisions around the 90% confidence interval around those results (savings). Based on this design, the initiative achieved a precision of ±6.8% at the 80% confidence interval, with a 0.50 error ratio for Summer kW.

2.3.1 Rolling/stage evaluation

As the market share of LEDs grows, the SB initiative is a promising candidate for rolling or staged evaluation. As the Initiative has not been evaluated in over three years, this report and the above sample design represent a traditional evaluation approach designed to meet the statistical precision for summer and winter demand required for FCM reporting. However, should the SB initiative be evaluated with a staged approach in the future, future supplementary samples are expected to decrease in size, barring any drastic changes in initiative design or offerings. As the initiative and market evolve, and as the results of Phase I of this traditional evaluation are finalized, evaluators will revisit the staged evaluation approach with National Grid to determine if it will be beneficial for the SB initiative.

2.3.2 Recruitment and sample replacements

Sites were recruited via telephone and email (when available). Judging that advance letters would be more beneficial than participation incentives, we sent an advance letter of introduction prior to recruitment, and did not budget for incentives. Recruitment was limited to five attempts per customer. If after five attempts no contact was made and our phone messages and emails were not returned, the site was replaced by a similar-stratum site from the back-up sample. Table 2-5 presents the final disposition of the recruitment calls based on the disposition.

Table 2-5. Final on-site visit recruitment disposition

Code	Disposition Description	Total
1.1	Complete	30
2.1	Refusal	5
2.2	Non-Contact/Unresponsive	3
Total Customers Called		**38**

2.4 Data collection and analysis

Data collection for the impact work included physical inspection and inventory, interviews with facility personnel, observation of site operating conditions and equipment, and short-term metering of lighting HOU. Evaluators attempted to determine pre-existing fixture characteristics from interviews with facility staff while performing the onsite data collection. Our data calculation method has been shown in 5.

The evaluation team combined the data gathered during the site visit with the tracking data provided by National Grid to estimate gross savings realization rates for annual kWh, annual hours of use, delta watts, HVAC interactive effects, and summer and winter peak coincidence factors. All reporting at this level was sample-weighted and statistically representative of the population or appropriate population sub-groups; post-stratification was performed based on our sample design.

Our overall measurement and evaluation plan is detailed below.

2.4.1 Measurement, verification and analysis methodology

A key task in the onsite engineering assessment was the installation of measurement equipment to aid in the development of independent savings estimates. The type of measure influences the measurement strategy used. In the context of an energy analysis, most efficiency measures can be characterized as either time-dependent or load-dependent. Time-dependent equipment typically runs at constant load according to a time-of-day operating schedule. Mathematically, hour-of-day and day-of-week operation are usually the most relevant variables in the energy savings analysis of these measures.

Lighting is most prevalently a time-dependent measure. Therefore, the evaluation team deployed a variety of time-of-use loggers to characterize the operation of upgraded lighting fixtures, as further detailed in section 5.2.

2.4.1.1 Measurement and verification

During each site visit, DNV GL field staff verified the type and quantity of installed fixtures by consulting with the site contact and comparing their specifications (including locations when available) to those reported in the tracking system. Interviews were conducted with the appropriate site personnel to gather information on holidays, operating hours, seasonal variations in schedules, business cycles or functional area use patterns that could be utilized to annualize the short-term monitoring. When possible, DNV GL field staff verified pre-existing or baseline conditions with site personnel to help with the accuracy of the savings calculations. HVAC equipment was documented to calculate interactive savings and 151 ISO-NE Manual M-MVDR compliant lighting loggers were installed for a minimum of four weeks. No power meters or lumen loggers were used in this study.

2.4.1.2 Site Analysis

Once the loggers were removed, the on and off transition data was downloaded from each logger and annualized/normalized to represent an entire year. In determining lighting schedules from time-of-use data, annual trends such as seasonal effects (e.g., daylight savings), production, and occupancy swings (such as vacations, business cycles, etc.) were accommodated to the extent supported by the data and site contact interviews.

The data gathered from the on-sites were compiled into spreadsheets for analysis using the methods found in Appendix B. The savings were calculated as line-by-line comparisons of pre- and post-retrofit electrical use. Pre- and post-retrofit energy estimates were developed for each line item within each measure. Interactive cooling and heating effects of the installed measures were also calculated, when appropriate, utilizing engineering algorithms. The on-site savings calculations included all relevant information gathered during the on-site. All analyses were conducted in a manner that allowed for the provision of discrepancies between the tracked and evaluated gross savings according to each adjustment phase. This approach is consistent with that taken in all of the C&I lighting studies that DNV GL has performed for National Grid in Massachusetts and elsewhere.

Overall initiative savings impacts are provided for each level of adjustment, including:

- Documentation Adjustment: The Documentation Adjustment reflects any change in savings due to discrepancies in project documentation. Evaluators recalculated the tracking estimates of savings using all quantities, fixture types/wattages, and hours documented in the project file. All tracking system discrepancies and documentation errors are reflected in this adjustment.

- Technology Adjustment: The Technology Adjustment reflects the change in savings due to the identification of a different lighting technology (fixture type and wattage) at the site than represented in the program data estimate of savings, provided that this technology was rebated by the initiative.
- Quantity Adjustment: The Quantity Adjustment reflects the change in savings due to the identification of a different quantity of lighting fixtures installed at the site than presented in the program data system estimate of savings.
- Operation Adjustment: The Operation Adjustment reflects the change in savings due to the observation or monitoring of different lighting operating hours at the site than represented in the program data system estimate of savings.
- Interactive/Heating and Cooling Adjustment: The Heating and Cooling Adjustments reflect changes in savings due to interaction between measures and other systems in the building. These effects take into account the effect of the energy efficient lighting measures on their corresponding heating and cooling systems. Energy efficient lighting serves to reduce the heat gain to a given space and accordingly reduces the load on cooling equipment. But this reduced heat gain has the added consequence of increasing the load on the heating system.

As discussed above, evaluators interviewed facility personnel during the on-site visit to ascertain the cooling and heating fuel, system type, and other information with which to approximate the efficiency of the HVAC equipment serving the space of each lighting installation. The DNV GL team expresses HVAC system efficiency in dimensionless units of Coefficient of Performance (COP), which reflects the ratio of the heating or cooling supplied by the system by the system to the electric energy input of the system.

Table 2-6 details the COP assumptions for general heating and cooling equipment types encountered in this study. Where site specific information yields improved estimates of system efficiency, these were used in place of the general assumptions below.

Table 2-6. General heating and cooling COP assumptions

Cooling system type	COP
Packaged direct expansion (DX)	2.9
Window DX	2.7
Chiller < 200 ton	4.7
Chiller > 200 ton	5.5
Air-to-air heat pump	3.9
Water-to-air heat pump	4.4

Heating system type	COP
Air-to-air heat pump	1.5
Electric resistance	1.0
Water-to-air heat pump	2.8
Hot Water Boiler	0.77
Infrared Heater	0.85
Steam Boiler	0.72
Warm Air	0.74
Unit Heater	0.75

Interactive effects are calculated at all sites where heating or cooling systems are in use, based on typical hourly outdoor air temperature and customer survey data on typical HVAC system operation by month of year and hour of day. Leveraging the 8,760 profile of hourly demand impacts, the evaluation team computed interactive effects during the hours that lighting and HVAC systems are assumed to operate in unison.

DNV GL utilizes Typical Meteorological Year 3 (TMY3) hourly dry-bulb temperatures for Providence, RI as the balance point criteria in this analysis. For each hour in a typical year, DNV GL computes HVAC interaction according to the following equations:

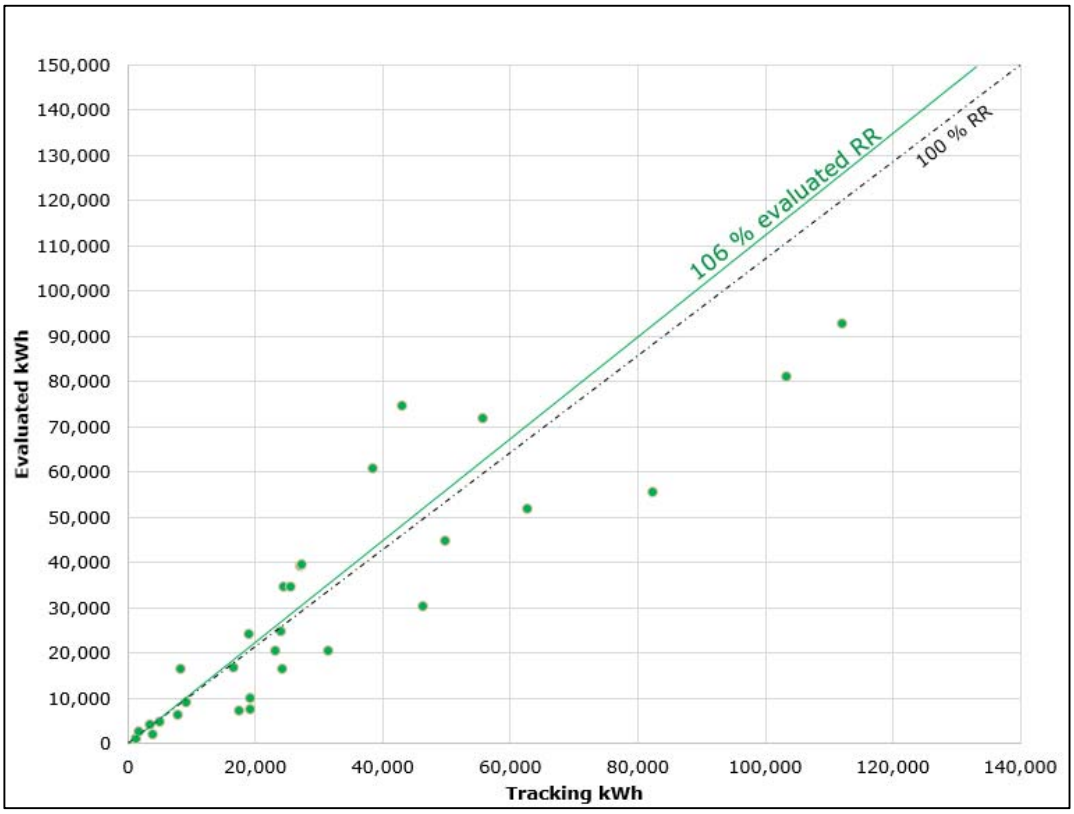
Cooling kW Effects = 80% * Lighting kW Savings / Cooling System COP
Heating kW Effects = -80% * Lighting kW Savings / Heating System COP

The 80% values represent the assumed percentage of the lighting energy that translates to heat which either must be removed from the space by the air conditioning system or added to the space by the heating system during the aforementioned HVAC hours. The HVAC hours account for when the heating or cooling system is on, and when the outdoor air temperature exceeds a certain point for cooling, typically 65°F, or goes below a certain point for heating, typically 55°F. This assumption is consistent with those established and employed in previous impact evaluations of prescriptive lighting measures. Heating factors are negative because heating interaction erodes gross lighting savings, while cooling interactive boosts it.

3 FINDINGS

The results presented in the following subsections include MA, RI and MA+RI level realization rates (and associated precision levels) for annual kWh savings, percent on-peak kWh savings, on-peak demand (kW) and coincidence factors at the times of the winter and summer peaks, as defined by the ISO New England Forward Capacity Market (FCM). Figure 3-1 presents a scatter plot of evaluation results versus tracking savings for annual energy savings (kWh). A one-to-one reference line is plotted as a bolded line on the diagonal of the figure. The annual kWh realization rate is 106% for RI only.

Figure 3-1 Scatter plot of M&V evaluated results of annual energy (kWh) savings (RI Only)



All coincident summer and winter peak reductions were calculated using the following FCM definitions:

- **Coincident summer on-peak kW reduction** is the average demand reduction that occurs during all hours between 1:00 p.m. and 5:00 p.m. on non-holiday weekdays in June, July, and August.
- **Coincident winter on-peak kW reduction** is the average demand reduction that occurs during all hours between 5:00 p.m. and 7:00 p.m. on non-holiday weekdays in December and January.

Table 3-1 presents the National Grid territory-wide (MA+RI) results for Small Business Initiative projects completed in 2016. Please note that tracking and reported gross savings are comprehensively defined in Appendix A. In summary, tracking gross savings are defined as the base savings based on fixture quantity, wattage, and operation values (hours of use, coincidence factors). Tracking savings do not incorporate HVAC interactive effects or other final adjustment factors.

Table 3-1. Summary of state-wide energy realization rate for SB lighting measures

Savings Parameter	Energy MA+RI		Energy MA		Energy RI	
	kWh	% Gross	kWh	% Gross	kWh	% Gross
Tracking Gross Savings	54,611,479		42,247,374		12,364,104	
Documentation Adjustment	-326,620	-0.6%	-265,333	-0.6%	-58,724	-0.5%
Technology Adjustment	-907,134	-1.7%	-871,915	-2.1%	-768	0.1%
Quantity Adjustment	-1,815,692	-3.3%	-1,812,987	-4.3%	79,975	0.5%
Operational Adjustment	3,206,660	5.9%	2,942,960	7.0%	170,103	2.0%
HVAC Interactive Adjustment	1,213,501	2.2%	727,070	1.7%	529,291	4.4%
Adjusted Gross Savings (Evaluated)	55,982,194	102.5%	42,967,170	101.7%	13,083,981	105.8%
Gross Realization Rate	102.5%		101.7%		105.8%	
Relative Precision	±7.1%		±8.4%		±11.4%	
Confidence Interval	90.0%		90.0%		90.0%	
Error Ratio	0.32		0.32		0.35	

The combined MA + RI overall kWh realization rate was 102.5% with a relative precision of ±7.1% at the 90% level of confidence, indicating that the evaluation sample sufficiently achieved the kWh precision target set forth in section 2.2. Additionally, the evaluation results indicated a significantly lower error ratio than predicted (0.7), indicating less variability in site-level results than anticipated. This study's error ratio can be used to inform future evaluation samples, such as possible rolling evaluation samples as the Initiative evolves, barring any major changes in program design or operation.

Appendix B: Site level results (RI only), contains each of the site-level RRs for kWh and kW along with each site's most prevalent difference category.

Table 3-2 presents the state-wide savings factors resulting from this study. All relative precisions were calculated at the 80% confidence interval for demand. The summer on-peak coincidence factor was 45.7%, with a relative precision of ±15.4% at the 80% level of confidence. The on-peak winter coincidence factor was 49.7%, with a relative precision of ±16.0% at the 80% level of confidence. The table also provides savings factors for on-peak summer and winter kW HVAC interactive effects, kWh HVAC interactive effect, HOU realization rate, and percent on-peak kWh.

Table 3-2. Overall and state-level factors for SB lighting measures

Savings Parameter	MA+RI		MA		RI	
	Value	Precision at 80% Confidence	Value	Precision at 80% Confidence	Value	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW)	99.4%	±1.1%	99.0%	±1.2%	101.7%	±2.8%
Delta Watts (Technology Adjustment - kW)	99.0%	±0.7%	98.8%	±0.9%	100.3%	±0.8%
Connected kW Realization Rate	97.1%	±2.0%	96.3%	±2.6%	100.7%	±1.7%
Summer kW Realization Rate	90.6%	±6.8%	93.2%	±7.1%	79.3%	±20.0%
Winter kW Realization Rate	80.8%	±19.5%	73.2%	±22.9%	124.7%	±14.9%
kW Factors (Precision at 80% confidence)						
Summer Coincidence Factor	45.7%	±15.4%	48.3%	±18.9%	35.6%	±18.3%
Winter Coincidence Factor	49.7%	±16.0%	48.3%	±20.0%	54.9%	±14.7%
Summer kW HVAC Interactive Effect	114.5%	±1.4%	113.9%	±1.6%	117.3%	±2.6%
Winter kW HVAC Interactive Effect	99.8%	±0.2%	100.0%	±0.0%	99.2%	±0.7%
kWh Factors (Precisions at 90% confidence)						
kWh HVAC Interactive Effect	102.2%	±0.6%	101.7%	±0.5%	104.2%	±1.6%
Hours of Use Realization Rate	106.2%	±6.1%	107.5%	±7.0%	101.4%	±11.0%
% On Peak kWh	63.3%	±11.7%	67.8%	±14.1%	45.4%	±15.0%
Non-Electric						
Heating HVAC Interaction Effect (MMBtu/kWh)	-0.00091		-0.00094		-0.00078	

Overall, the evaluation team found lower levels of summer coincident kW reduction than assumed by National Grid in RI, but higher levels of winter coincident kW reduction. In RI, the operating hours during the peak hour were lower than the tracking assumptions which could be the reason for low summer coincidence. Evaluator measurement of lighting operation led to an overall, weighted average annual hours of use value 3.8% higher (MA+RI) than that assumed within tracking data.

4 CONCLUSIONS

Overall, the lighting measures installed through National Grid Rhode Island's SBS initiative are performing well relative to tracking estimates and generating substantial savings. The study achieved the designed target of 90% confidence with ±10% precision interval for summer demand kW in MA and RI combined.

The primary drivers for the higher evaluated gross savings estimates are the HVAC interactive and operational adjustments (8.1% of the tracking savings) as shown in Table 1-4. The decrease in savings due to documentation, technology and quantity adjustments sum up to a total of -5.6% of the total tracking savings value.

The energy realization rate of 102.5% is similar to those from previous lighting impact evaluations, which are typically at or above 100%. The higher operational adjustment of 5.9% primarily comes from MA, and HVAC adjustment in MA and RI combined is 2.2% (Table 3-1). Only 3 out 30 sites in RI had occupancy controls installed (through this program) with one site (RI193, retail) 114% HOU realization rate and the other two sites RI376 (religious facility) and RI648 (retail) with 38% and 0% HOU realization rates respectively. For RI 193 and RI376, DNV GL installed loggers in rooms of similar space types with and without occupancy sensors to capture post-retrofit and baseline/pre-retrofit HOU respectively. For example, if an occupancy has been installed in a bathroom, DNV GL installed loggers in bathrooms with and without sensors to capture both pre- and post-retrofit hours of use. In RI648, no occupancy sensors were installed, therefore 0% HOU RR.

Table 4-1.Examination of energy realization rate for SB lighting measures in MA+RI

Savings Parameter	kWh	% Gross
Tracking Gross Savings	54,611,479	
Documentation Adjustment	-326,620	-0.6%
Technology Adjustment	-907,134	-1.7%
Quantity Adjustment	-1,815,692	-3.3%
Operational Adjustment	3,206,660	5.9%
HVAC Interactive Adjustment	1,213,501	2.2%
Adjusted Gross Savings	55,982,194	102.5%
Gross Realization Rate	102.5%	
Relative Precision	±7.1%	
Confidence Interval	90.0%	
Error Ratio	0.32	

The following are some observations and recommendations specific to each of the adjustments presented above.

4.1 Observations and recommendations

Overall RI SB initiative is working very well with a realization rate of 102.5% for RI and MA combined. DNV GL recommends National Grid to use those results from MA and RI combined prospectively because the study was designed to reach the target precision of with 90% confidence for energy savings (kWh) at combined level which was then achieved at the completion of the study. The higher RR for the program suggests that the program is working well as its run currently but there are some minor adjustments that

DNV GL recommends below for it run more effectively. MA specific recommendations are listed in the MA report[7].

Documentation Adjustment: The overall documentation adjustment resulted in a decrease in savings of ~0.6%. In RI: twenty-five of the thirty sites in the sample had the documentation to support the savings estimates provided in the tracking system. Four other sites (in RI) had documentation which provided savings estimates that were only slightly different (~3%) from those in the tracking system. One site had a reduction of about 22% in fixture savings compared to tracking. Overall, National Grid does a good job with the tracking database used for the SB Initiative and with the documentation that supports those savings estimates.

Recommendation: We recommend that National Grid continue to track savings and supporting documentation consistent with its current system.

Technology Adjustment: The lower technology savings are primarily coming from MA with some minor savings adjustments in RI. In RI, two sites in the sample had slightly higher installed wattages than reported in the tracking system, which results in a 1% and 3% decrease in savings, respectively. One site had a discrepancy of 7.5-watts/fixture (22 fixtures in total) lower than what was used in tracking; increasing the savings by 3% of the site savings.

Quantity Adjustment: The higher quantity adjustment in RI was essentially penalized by lower savings adjustment in MA. In RI, one sampled site had a discrepancy in the number of occupancy sensors installed, decreasing the savings. This reduction was essentially compensated by another site's fixture quantity increasing the savings overall.

Operational Adjustment: There was a positive operational adjustment in both MA and RI and therefore MA and RI combined. In RI: all twenty-nine sampled sites experienced an operational adjustment, which is understandable given that tracking hours of use are estimated by vendors and/or customers based on building specific inputs. Seventeen sites had evaluation hours that were lower than the tracking estimates and twelve had evaluation hours that were higher but when combined they accounted for a 1.4% increase in savings.

Recommendation: Overall, the tracking system hours of use estimates appear to be reasonable. While there were discrepancies between the tracking and evaluation hours for every site, the average tracking hours were very close to the average evaluation hours. We do recommend that National Grid to more carefully assess the hours-of-use estimates for religious facilities. The two religious facilities in the sample had evaluation hours of use that were approximately 40% lower than their tracking system estimates. Consider using at least seven days of metered data during the pre-retrofit condition.

HVAC Interactive Adjustment: HVAC interaction accounted for 2.2% adjustment to the gross tracking savings in MA and RI combined. Both the states had positive interactive savings. In RI: Two sampled sites had electric heat (heat pump) which reduced the savings a little bit but sixteen of the remaining sites had a positive effect on the overall savings due to the presence of electric cooling.

Recommendation: We recommend that National Grid consider including HVAC interaction in their gross savings estimates by calculating it on a site-by-site basis. Currently, HVAC interaction is accounted for in National Grid net savings calculations by applying a factor that represents average HVAC interaction savings

[7] http://ma-eeac.org/wordpress/wp-content/uploads/P69-Impact-Eval-of-MA-Small-Business-Initiative-Phase-I-Lighting_Report_FINAL.pdf

to each project. While it was a relatively minor adjustment in this evaluation, interaction may become more influential on program savings should future program installations shift away from exterior fixtures and more toward interior fixtures.

4.1.1 Prospective application of results

Regarding lighting controls, the evaluation team recommends that the results from the prior lighting controls-specific study (2014)[8] continue to be applied by National Grid. The current study's population (PY2016) featured only 1% kWh savings contribution from lighting controls, and the evaluation sample design subsequently did not segment specifically for lighting controls; rather, overall state-wide results were determined for SB lighting measures altogether. Therefore, we do not recommend application of any results from this evaluation study to controls measures moving forward. The factors tabulated in section 1.4 should be prospectively applied to lamp and/or ballast replacement measures only.

As mentioned in the sections above, DNV GL recommends National Grid to use the results from MA and RI combined for the prospective application and planning as the study was originally designed at the combined level and has also met the targeted precisions at combined level (MA+RI). The factors calculated at the combined level of MA and RI in section 4.1.1.1 below are to be used prospectively and for planning purposes.

4.1.1.1 Individual factor approach

We recommend that National Grid replace individual factors within their tracking systems factors with evaluated factors in MA and RI combined, as illustrated in the following fixture savings formulae:

$$Evaluated\ Gross\ kWh\ Savings = Conn.kW\ Savings_{Tracking} \times RR_{Conn\ kW} \times HOU_{Tracking} \times RR_{HOU} \times HVAC\ Interactivity_{kWh}$$

$$Evaluated\ Gross\ Peak\ kW\ Savings_{Summer} = Conn.kW\ Savings_{Tracking} \times RR_{Conn\ kW} \times CF_{Summer} \times HVAC\ Interactivity_{skW}$$

$$Evaluated\ Gross\ Peak\ kW\ Savings_{Winter} = Conn.kW\ Savings_{Tracking} \times RR_{Conn\ kW} \times CF_{Winter} \times HVAC\ Interactivity_{wkW}$$

where,

$Conn.kW\ Savings_{Tracking}$ = Connected kW savings claimed by implementer

$HOU_{Tracking}$ = Hours of use (HOU) claimed by implementer

The remaining savings factors are provided in Table 1-5 below: the proposed new peak demand savings factors, HVAC interactive effects factors, and RRs for HOU and connected kW.

[8] Retrofit Lighting Controls Measures Summary of Findings. DNV GL. 2014. http://ma-eeac.org/wordpress/wp-content/uploads/Lighting-Retrofit-Control-Measures-Final-Report.pdf

Table 4-2. Proposed new savings factors (MA+RI) for prospective use (PY2019 and beyond)

Savings Factor	Formula Term	Prospective Recommended Value	Relative Precision at Specified Confidence Interval
Connected kW RR	$RR_{Conn\,kW}$	97.0%	±2.0% (80% confidence)
HOU RR	RR_{HOU}	106.2%	±6.1% (90% confidence)
kWh HVAC Interactive Factor	$HVAC\ Interactivity_{kWh}$	102.2%	±0.6% (90% confidence)
Summer CF	CF_{Summer}	45.7%	±15.4% (80% confidence)
Winter CF	CF_{Winter}	49.7%	±16.0% (80% confidence)
Summer kW HVAC Interactive Factor	$HVAC\ Interactivity_{skW}$	114.5%	±1.4% (80% confidence)
Winter kW HVAC Interactive Factor	$HVAC\ Interactivity_{wkW}$	99.8%	±0.2% (80% confidence)

5 APPENDIX A

This section presents a listing of realization rate and savings factors that were produced as part of this study. Each entry contains a description of that savings variable.

REALIZATION RATES

Annual kWh – This result is the gross annual kWh realization rate including additional savings due to HVAC interactive effects. This realization rate is the evaluation gross annual kWh savings divided by the tracking gross annual kWh savings. It is used against the tracking gross savings which does not include any adjustment factors, i.e. just delta-watt time hours.

Connected kW – This result is the gross connected kW realization rate, which includes any documentation, quantity, and technology adjustments. This realization rate is the evaluation gross connected kW savings divided by the tracking gross connected kW savings.

Summer On-Peak: average demand reduction realization rates from 1:00-5:00 PM on non-holiday weekdays in June July, and August

Winter On-Peak: average demand reduction realization rates from 5:00-7:00 PM on non-holiday weekdays in December and January

Hours of Use – This result is the hours of use realization rate, which represents the evaluation estimate of weighted hours of use divided by the tracking estimate of weighted hours of use.

5.1 Savings Factors

Coincidence Factor: A coincidence factor adjusts the connected load kW savings derived from the savings algorithm. A coincidence factor represents the fraction of the connected load reduction expected to occur at the same time as a particular system peak period. The coincidence factor includes both coincidence and diversity factors combined into one number, thus there is no need for a separate diversity factor in this TRM. Coincidence factors are provided for both the on-peak and seasonal peak periods as defined by the ISO New England for the Forward Capacity Market ("FCM"), and are calculated consistently with the FCM methodology

Summer Coincidence Factor – Diversity x Coincidence. This is the percentage of the connected kW savings coincident with the summer on-peak period (1pm-5pm on non-holiday weekdays in June, July, and August).

Winter Coincidence Factor – Diversity x Coincidence. This is the percentage of the connected kW savings coincident with the winter on-peak period (5pm-7pm on non-holiday weekdays in December and January).

Summer kW HVAC Interactive Effect – This is an adjustment factor applied to the gross connected kW savings that are due to interactive effects during the summer on-peak period.

Winter kW HVAC Interactive Effect – This is an adjustment factor applied to the gross connected kW savings that are due to interactive effects during the winter on-peak period.

kWh HVAC Interactive Effect – This is an adjustment factor applied to the gross tracking kWh savings that are due to interactive effects.

% On Peak kWh – This is the percentage of energy savings that occur during on-peak hours (non-holiday weekdays from 6am-10pm).

Table 5-1. Summary of Results and Factors

Tracking System Values		Evaluation Values	
(a)	Annual kWh	(j)	Annual kWh
(b)	kWh HVAC Factor	(k)	kWh HVAC Factor
(c)	On-Peak % Annual kWh	(l)	On-Peak % Annual kWh
(d)	Connected kW	(m)	Connected kW
(e)	Summer kW Coincidence Factor	(n)	Summer kW Coincidence Factor
(f)	Summer kW HVAC Factor	(o)	Summer kW HVAC Factor
(g)	Winter kW Coincidence Factor	(p)	Winter kW Coincidence Factor
(h)	Winter kW HVAC Factor	(q)	Winter kW HVAC Factor
(i)	Average Hours of Use	(r)	Average Hours of Use

Realization Rates	
(s)	Annual kWh
(t)	Connected kW
(u)	Hours of Use

Savings Algorithms	
Evaluated Annual kWh Savings	(a) x (s) or (a) x (t) x (u) x (k)
Evaluated Connected kW	(d) x (t)
Evaluated Summer Peak kW Reduction	(d) x (t) x (n) x (o)
Evaluated Winter Peak kW Reduction	(d) x (t) x (p) x (q)

5.2 Calculation Methods

This section serves as a detailed example that illustrates the calculation of all savings and adjustment factors. DNV GL used a single line item from a lighting project to serve as an example of the calculation methods. Table 5-2 presents a summary of all savings parameters for this particular example.

Table 5-2: Calculation Example Result Summary

Parameter	Annual KWH	Difference %	Connected kW	Difference %
Gross (TRACKING) kWh/Connected kW Savings	3,690	N/A	0.74	N/A
Adjustment - Documentation Change	0	0%	0.00	0%
Adjustment - Technology Change	0	0%	0.00	0%
Adjustment - Quantity Change	-410	-11%	-0.08	-11%
Adjustment - Operation Change	543	15%	N/A	N/A
Non-Interactive Savings	3,823	104%	0.66	89%
Adjustment - Cooling Interaction	314	9%		
Adjusted Gross (ONSITE) Savings	4,136	112%		

Parameter	On-Peak Summer kW	Difference %	On-Peak Winter kW	Difference %
Connected Demand Savings	0.66	N/A	0.66	N/A
Adjustment - On-Peak Coincidence	-0.12	-18%	0.00	0%
Non-Interactive Savings	0.54	82%	0.66	100%

Parameter	On-Peak Summer kW	Difference %	On-Peak Winter kW	Difference %
Non-Interactive Savings	0.54	N/A	0.66	N/A
Adjustment - HVAC Interaction	0.14	27%	0.00	0%
Adjusted Gross (ONSITE) Savings	0.68	127%	0.66	100%

Table 5-3 presents the pre-retrofit condition for this space as outlined in the application documentation. The pre-retrofit condition included (18) 2F40SSS fixtures rated at 94 watts each. The application also assumed 5,000 annual operating hours.

Table 5-3: Tracking Pre-Retrofit Condition

Qty	Lighting Fixture Code	Fixture Type	Fixture Description	W/Fixt	Hours of Operation per Year
18	2F40SSS	2L4' STD/STD	Four Foot T12 Systems	94	5,000

Table 5-4 represents the proposed condition according to the tracking system. In this case, the pre-retrofit fixtures were to be replaced with (18) 2F32EEE fixtures rated at 53 watts each. The hours of operation in the proposed condition were also 5,000 annual operating hours.

Table 5-4: Tracking Proposed Condition

Qty	Lighting Fixture Code	Fixture Description	Fixture Type	W/Fixt	Hours of Operation per Year
18	2F32EEE	2L4' T8EE/ELEE	Four Foot T8 HP/RW Systems	53	5,000

The first step of the savings analysis was to recreate the savings calculations based upon project documentation. This was done to isolate any documentation adjustments.

Documentation Adjustments

Documentation adjustments reflect any change in savings due to discrepancies in project documentation. Evaluators recalculated the tracking estimates of savings using all quantities, fixture types/wattages, and hours documented in the project file. All tracking system discrepancies and documentation errors are reflected in this adjustment. The documentation adjustments are calculated according to the following formulae:

DOC KWH ADJ = Recreated Tracking kWh Savings – Tracking kWh Savings = 3,690 - 3,690 = 0 kWh

DOC KW ADJ = Recreated Tracking kW Savings – Tracking kW Savings = 0.74 – 0.74 = 0 kW

Technology Adjustments

TECH KWH ADJ = Recreated Tracking kWh Savings – Tracking kWh Savings = 3,690 - 3,690 = 0 kWh

TECH KW ADJ = Recreated Tracking kW Savings – Tracking kW Savings = 0.74 – 0.74 = 0 kW

Quantity Adjustments

QTY KWH ADJ = Recreated Tracking kWh Savings – Tracking kWh Savings = 3,280 - 3,690 = -410 kWh

QTY KW ADJ = Recreated Tracking kW Savings – Tracking kW Savings = 0.66 – 0.74 = -0.08 kW

Recreated Tracking kWh= (16*94*5000-16*53*5000)/1000=3,280 kWh

Recreated Tracking kW= (16*94-16*53)/1000=0.66 kW

Operational Adjustments

OP KWH ADJ = Recreated Tracking kWh Savings – Tracking kWh Savings = 3,690 - 3,690 = 0 kWh

OP KW ADJ = Recreated Tracking kW Savings – Tracking kW Savings = 0.74 – 0.74 = 0 kW

Recreated tracking kWh= ((16*94*5,827-16*53*5,827)/1000)-3,690-410=-543 kWh

Hours of Use and Coincidence

The first on-site task was establishing the customer's holiday and vacation/shutdown schedule. Table 5-5 shows the input for the site holiday analysis. In this particular case, the site contact informed the evaluating engineer that the facility was closed during six major holidays. He also stated that the facility does not have any long shutdowns.

Table 5-5: Input for Site Specific Holidays

Holiday	Date	Site Observed Holidays
New Year's Day	1/1/2014	Yes
Martin Luther King Day	1/20/2014	No
Presidents Day	2/17/2014	No
Good Friday	4/18/2014	No
Memorial Day	5/26/2014	Yes
Independence Day	7/4/2014	Yes
Labor Day	9/1/2014	Yes
Columbus Day	10/13/2014	No
Veteran's Day	11/11/2014	No
Thanksgiving Day	11/27/2014	Yes
Day After Thanksgiving	11/28/2014	No
Christmas Eve	12/24/2014	No
Christmas Day	12/25/2014	Yes

To determine the annual operating hours from monitoring lighting logger data, engineers examine the hourly percent run time across the entire monitoring period.

For the logger data analysis, an 8x24 profile (Monday through Friday plus Holiday by hour-of-day) is generated using a computer program to represent the average percentage of time that the fixture operated during the monitoring study. Table 5-6 presents the profile of the logger used for this example.

Table 5-6: Logger Profile Summary

Hour Ending	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Hol
1	33	36	49	45	46	53	45	57
2	34	36	42	47	41	49	46	51
3	32	36	50	39	42	39	41	50
4	32	36	41	36	35	37	37	50
5	57	39	40	36	34	37	49	50
6	34	57	54	53	84	50	35	50
7	34	75	89	66	94	66	39	50
8	35	99	100	100	99	99	47	52
9	37	100	100	100	100	100	51	57
10	38	100	100	100	100	100	58	50
11	35	100	100	100	100	100	53	50
12	37	100	100	100	100	100	53	50
13	36	98	100	100	100	100	45	50
14	35	99	100	100	99	100	43	50
15	34	100	100	100	100	100	48	50
16	37	94	92	94	92	90	43	50
17	34	92	86	84	86	81	42	50
18	36	100	100	100	100	100	37	50
19	37	100	100	100	100	100	35	50
20	34	95	89	93	94	97	35	50
21	32	98	96	95	97	97	37	50
22	33	96	92	88	87	73	35	50
23	32	49	43	40	33	37	34	50
24	33	45	42	40	40	49	42	50

This analysis concluded that this fixture operates 5,827 hours per year, of which 67% of these operating hours occur coincide with the defined on-peak period definition. The on-peak summer and winter coincidence factors are 82% and 100%, respectively.

Non-Interactive On-Site Savings

Table 5-7 represents the on-site installed condition as found the evaluation team. For this example, the evaluator identified (16) 2F32EEE fixtures, which was two fewer fixtures than in the project documentation. A schedule identification number ("1" in this example) maps the hours of operation and the summer and winter coincidences into this spreadsheet.

Table 5-7: On-Site Installed Condition

Qty	Lighting Fixture Code	Fixture Description	Fixture Type	W/Fixt	Schedule Number	Hours of Operation per Year	On-Peak Summer Coincidence	On-Peak Winter Coincidence
16	2F32EEE	2L4' T8EE/ELEE	Four Foot T8 HP/RW Systems	53	1	5,827	82%	100%

The on-site pre-retrofit condition, presented in Table 5-8, was established through review of project documents, discussion with facility personnel, and observational inference. This lighting fixture savings analysis presumes that the operating hours did not change between the pre- and post-retrofit conditions.

Table 5-8: On-Site Pre-Retrofit Condition

Qty	Lighting Fixture Code	Fixture Description	Fixture Type	W/Fixt	Hours of Operation per Year
16	2F40SSS	2L4' STD/STD	Four Foot T12 Systems	94	5,827

The fixture counts in pre-retrofit condition will be verified during the onsite interview.

Table 5-9 presents the adjusted gross on-site savings for this example.

Table 5-9: Adjusted Gross On-Site Savings

kW Savings	kW Summer Savings	kW Winter Savings	kWh Savings
0.656	0.536	0.656	3,823

Heating and Cooling Interaction

Heating and cooling interaction was calculated for each line item where applicable based on the specific HVAC systems serving the space. When lighting equipment converts electrical energy to light, a significant amount of that energy is dissipated in the form of heat. Energy efficient lighting measures convert more electrical energy to light and less to heat.

The interactive effects take into account the effect of the energy efficient lighting measures on their corresponding heating and cooling systems. Energy efficient lighting serves to reduce the heat gain to a given space and accordingly reduces the load on cooling equipment. But this reduced heat gain has the added consequence of increasing the load on the heating system.

As part of the on-site methodology, evaluators interviewed facility personnel to ascertain the cooling and heating fuel, system type, and other information with which to approximate the efficiency of the HVAC equipment serving the space of each lighting installation. The DNV GL team expresses HVAC system efficiency in dimensionless units of Coefficient of Performance (COP), which reflects the ratio of work performed by the system to the work input of the system. Table 5-10 details the COP assumptions for general heating and cooling equipment types encountered in this study. Where site-specific information yields improved estimates of system efficiency, these were used in place of the general assumptions below.

Table 5-10: General Heating and Cooling COP Assumptions

Cooling system type	COP
Packaged direct expansion (DX)	2.9
Window DX	2.7
Chiller < 200 ton	4.7
Chiller > 200 ton	5.5
Air-to-air heat pump	3.9
Water-to-air heat pump	4.4

Heating system type	COP
Air-to-air heat pump	1.5
Electric resistance	1.0
Water-to-air heat pump	2.8
Hot Water Boiler	0.77
Infrared Heater	0.85
Steam Boiler	0.72
Warm Air	0.74
Unit Heater	0.75

Electric interactive effects are calculated only at sites where heating and/or cooling systems are in use at the same time the lighting project provides savings. Leveraging the 8,760 profile of hourly demand impacts, the DNV GL team computes electric interactive effects during the hours that lighting and HVAC are assumed to operate in unison.

DNV GL utilizes Typical Meteorological Year 3 (TMY3) hourly dry-bulb temperatures for Providence, RI as the balance point criteria in this analysis. For each hour in a typical year, DNV GL computes HVAC interaction according to the following equations:

Cooling kW Effects = 80% * Lighting kW Savings / Cooling System COP

Heating kW Effects = -80% * Lighting kW Savings / Heating System COP

The 80% values represent the assumed percentage of the lighting energy that translates to heat which either must be removed from the space by the air conditioning system or added to the space by the heating system during the aforementioned HVAC hours. The HVAC hours account for when the heating or cooling system is on, and when the outdoor air temperature exceeds a certain point, typically over 65°F in summer and under 55˚F in winter. This assumption is consistent with those established and employed in previous impact evaluations of custom lighting measures. Also, heating factors are negative because heating interaction erodes gross lighting savings, while cooling interactive boosts it.

6 APPENDIX B: SITE LEVEL RESULTS (RI ONLY)

Table 6-1: Sample Tracking System Savings Estimates

DNVGL ID	Facility Type	Annual kWh	kWh HVAC Factor	On-Peak % Annual kWh	Connected kW	Summer kW	Winter kW
RI376	Religious	19,219	0%	N/A	16.73	14.86	7.36
RI189	Assembly	17,461	0%	N/A	11.30	6.25	4.97
RI396	Restaurant-Fast Food	4,023	0%	N/A	1.18	0.65	0.52
RI118	Office-Small	19,238	0%	N/A	6.12	3.38	2.69
RI435	Office-Large	31,451	0%	N/A	10.36	5.58	4.56
RI134	Assembly	1,463	0%	N/A	0.40	0.22	0.18
RI325	Religious	46,267	0%	N/A	17.47	8.31	7.69
RI728	Other	82,365	0%	N/A	20.45	15.37	9.00
RI724	Other	103,424	0%	N/A	22.90	18.58	10.07
RI169	Manufacturing-Light Industrial	7,915	0%	N/A	2.24	0.91	0.99
RI649	Industrial Warehouse-1-shift	62,776	0%	N/A	21.31	11.29	9.38
RI147	Retail-Mall Department Store	112,187	0%	N/A	24.91	14.29	10.96
RI620	Health/Medical	23,119	0%	N/A	6.79	3.76	2.99
RI141	Other	49,745	0%	N/A	22.11	20.87	9.73
RI193	Retail-Small	5,014	0%	N/A	2.54	1.22	1.12
RI077	Service	9,293	0%	N/A	2.74	1.93	1.20
RI391	Retail-Small	16,728	0%	N/A	2.95	2.42	1.30
RI773	Service	24,033	0%	N/A	8.18	4.44	3.60
RI521	Service	3,494	0%	N/A	0.96	0.53	0.42
RI667	Other	19,144	0%	N/A	9.46	4.96	4.16
RI625	Education-Primary School	55,804	0%	N/A	23.01	12.44	10.13
RI775	Retail-Small	25,629	0%	N/A	6.52	1.65	2.87
RI648	Retail-Small	24,420	0%	N/A	7.64	2.27	3.36
RI138	Other	27,227	0%	N/A	4.40	2.43	1.94
RI238	Retail-Single-Story, Large	27,378	0%	N/A	9.13	8.62	4.02
RI035	Health/Medical	1,800	0%	N/A	0.60	0.06	0.26
RI213	Other	38,506	0%	N/A	9.77	9.15	4.30
RI378	Manufacturing-Light Industrial	43,136	0%	N/A	15.38	14.52	6.77
RI388	Retail-Small	8,345	0%	N/A	4.01	0.42	1.77

Table 6-2: Sample Evaluation Savings Estimates

DNVGL ID	Facility Type	Annual kWh	kWh HVAC Factor	On-Peak % Annual kWh	Connected kW	Summer On-Peak kW Coincidence Factor	Summer On-Peak kW HVAC Factor	Winter On-Peak kW Coincidence Factor	Winter On-Peak kW HVAC Factor	Average Hours of Use
RI376	Religious	7,168	100%	50%	10.03	14%	100%	5%	100%	1,119
RI189	Assembly	7,108	100%	49%	11.26	9%	100%	7%	100%	1,555
RI396	Restaurant-Fast Food	1,874	112%	67%	1.18	32%	126%	40%	100%	3,329
RI118	Office-Small	9,962	91%	46%	6.23	17%	127%	18%	47%	3,117
RI435	Office-Large	20,299	107%	73%	10.34	50%	116%	25%	100%	3,011
RI134	Assembly	951	107%	81%	0.40	72%	120%	8%	100%	3,640
RI325	Religious	30,178	103%	56%	19.11	17%	115%	26%	100%	2,597
RI728	Other	55,442	106%	57%	20.12	42%	116%	39%	100%	3,677
RI724	Other	80,862	107%	56%	22.90	41%	117%	73%	100%	4,855
RI169	Manufacturing-Light Industrial	6,233	95%	34%	2.24	10%	125%	41%	90%	3,227
RI649	Industrial Warehouse-1-shift	51,779	100%	64%	21.31	50%	102%	10%	100%	2,890
RI147	Retail-Mall Department Store	92,686	100%	28%	24.91	0%	100%	95%	100%	4,438
RI620	Health/Medical	20,277	107%	74%	5.91	73%	123%	72%	100%	3,555
RI141	Other	44,755	100%	58%	22.11	0%	100%	100%	100%	2,250
RI193	Retail-Small	3,756	112%	59%	1.82	37%	128%	18%	100%	2,477
RI077	Service	8,872	107%	50%	2.74	33%	129%	71%	100%	3,706
RI391	Retail-Small	16,681	112%	66%	2.95	91%	126%	94%	100%	5,577
RI773	Service	24,665	101%	61%	8.17	63%	102%	29%	100%	2,954
RI521	Service	4,082	100%	77%	0.96	96%	100%	95%	100%	3,640
RI667	Other	23,881	113%	56%	9.46	44%	126%	44%	100%	2,217
RI625	Education-Primary School	71,723	101%	67%	22.94	65%	103%	45%	100%	2,403
RI775	Retail-Small	34,459	105%	41%	6.52	28%	126%	62%	100%	3,897
RI648	Retail-Small	34,536	105%	60%	7.46	55%	119%	99%	100%	3,380
RI138	Other	38,971	112%	0%	4.93	97%	126%	96%	100%	6,188
RI238	Retail-Single-Story, Large	39,271	100%	27%	9.13	0%	100%	100%	100%	3,000
RI035	Health/Medical	2,593	100%	30%	0.60	0%	100%	100%	100%	3,000
RI213	Other	60,590	100%	40%	11.82	2%	129%	49%	100%	3,904
RI378	Manufacturing-Light Industrial	74,414	100%	43%	15.38	48%	101%	63%	100%	2,666
RI388	Retail-Small	16,405	100%	28%	4.01	0%	100%	100%	100%	2,080

Table 6-3: Sample Realization Rates and Primary Reasons for Discrepancies

DNVGL ID	Facility Type	Tracking Annual kWh	Evaluated Annual kWh RR (Including HVAC)	Connected kW RR	Primary Reasons for Discrepancies
RI376	Religious	19,219	37%	60%	Fixtures: The savings calculated using the detailed information provided to support the custom portion of this project was 5,330 kWh lower than reported in the tracking system. This documentation adjustment reduces the fixture savings by 30%. Five fewer fixtures were found on-site than was reported in the tracking system which results in a 1% reduction in savings. Evaluation hours of use are 29% lower than assumed in the tracking system. Controls: Occupancy sensors were not found in the dining room as reported in the site documentation which reduces savings by 45%. The hours of use reduction were found to be smaller onsite than assumed in the tracking system; reducing savings by an additional 34%.
RI189	Assembly	17,461	41%	100%	Evaluation hours are 59% lower than assumed in the tracking system.
RI396	Restaurant-Fast Food	4,023	47%	100%	Evaluation hours are 59% lower than assumed in the tracking system. Interactive effects increase savings by 5%.
RI118	Office-Small	19,238	52%	102%	Twenty-two fixtures reported by the tracking system to have been 37-watt fixtures were found to be 30-watt fixtures; increasing savings by 2%. Thirty fixtures were installed in unoccupied tenant areas which contributed to making the evaluation hours of use 45% lower than the tracking system assumption. The presence of electric heat causes an additional 5% reduction in savings due to interactive effects.
RI435	Office-Large	31,451	65%	100%	Evaluation hours are 40% lower than assumed in the tracking system. Interactive effects increase savings by 4%.
RI134	Assembly	1,463	65%	100%	Evaluation hours are 39% lower than assumed in the tracking system. Interactive effects increase savings by 4%.
RI325	Religious	46,267	65%	109%	Evaluation hours are 37% lower than assumed in the tracking system. Interactive effects increase savings by 2%.
RI728	Other	82,365	67%	98%	Thirty-six fixtures were found to have slightly higher wattages than reported in the tracking system, which results in a 1% decrease in savings. Five more 2L4' LED fixtures were found than reported in the tracking system; resulting in a 1% increase in savings. Evaluation hours are 36% lower than assumed in the tracking system. Interactive effects increase savings by 4%.
RI724	Other	103,424	78%	100%	Evaluation hours are 27% lower than assumed in the tracking system. Interactive effects increase savings by 5%.
RI169	Manufacturing-Light Industrial	7,915	79%	100%	Evaluation hours are 17% lower than assumed in the tracking system. The presence of electric heat causes an additional 4% reduction in savings due to interactive effects.

RI649	Industrial Warehouse-1-shift	62,776	82%	100%	Evaluation hours are 18% lower than assumed in the tracking system.
RI147	Retail-Mall Department Store	112,187	83%	100%	A tracking miscalculation resulted in a 3% reduction in savings. Evaluation hours of use are 15% lower than assumed in the tracking system.
RI620	Health/Medical	23,119	88%	87%	Evaluation hours are 18% lower than assumed in the tracking system. Interactive effects increase savings by 6%.
RI141	Other	49,745	90%	100%	Evaluation hours are 10% lower than assumed in the tracking system.
RI193	Retail-Small	5,014	75%	72%	Miscalculations in occupancy sensors savings caused a decrease in overall savings due to documentation adjustments. Sixty-four fixtures reported by the tracking system to be 10W LEDs were found to be 9.5W LEDs, which increases savings by 4%. Four fewer 2L4' LED fixtures and three fewer occupancy sensors were found onsite as compared to the tracking system, reducing savings by 11%. Evaluation hours are 12% lower than assumed in the tracking system. Interactive effects increase savings by 10%.
RI077	Service	9,293	95%	100%	Evaluation hours are 10% lower than assumed in the tracking system. Interactive effects increase savings by 6%.
RI391	Retail-Small	16,728	100%	100%	Evaluation hours are 11% lower than assumed in the tracking system. Interactive effects increase savings by 11%.
RI773	Service	24,033	103%	100%	Evaluation hours of use are 2% higher than assumed in the tracking system. Interactive effects increase savings by an additional 1%.
RI521	Service	3,494	117%	100%	Evaluation hours are 17% higher than assumed in the tracking system.
RI667	Other	19,144	125%	100%	Evaluation hours are 11% higher than assumed in the tracking system. Interactive effects increase savings by an additional 14%.
RI625	Education-Primary School	55,804	129%	100%	Evaluation hours are 27% higher than assumed in the tracking system. Interactive effects increase savings by an additional 2%.
RI775	Retail-Small	25,629	134%	100%	Evaluation hours are 29% higher than assumed in the tracking system. Interactive effects increase savings by an additional 6%.
RI648	Retail-Small	24,420	141%	98%	Documentation savings error results in a 1% decrease in savings. Evaluation hours of use are 37% higher than assumed in the tracking system. Interactive effects increase savings by an additional 7%. The occupancy sensor installed in the restroom was removed due to failure.
RI138	Other	27,227	143%	112%	Evaluation hours are 28% higher than assumed in the tracking system. Interactive effects increase savings by an additional 15%.
RI238	Retail-Single-Story, Large	27,378	143%	100%	Evaluation hours are 43% higher than assumed in the tracking system.
RI035	Health/Medical	1,800	144%	100%	Evaluation hours are 44% higher than assumed in the tracking system.
RI213	Other	38,506	157%	121%	Thirteen more exterior floods were found on-site versus what was reported by the tracking system; which increases savings by 23%. Evaluation hours are 10% higher than assumed in the tracking system.

RI378	Manufacturing-Light Industrial	43,136	173%	100%	Evaluation hours are 72% higher than assumed in the tracking system. Interactive effects increase savings by an additional 1%.
RI388	Retail-Small	8,345	197%	100%	Evaluation hours are 97% higher than assumed in the tracking system.