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RHODE ISLAND SMALL BUSINESS ENERGY EFFICIENCY PROGRAM PRESCRIPTIVE LIGHTING STUDY

Final Report

National Grid

Prepared by DNV GL

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1 EXECUTIVE SUMMARY

National Grid Rhode Island commissioned a study to evaluate the prescriptive lighting (without controls) installed through their 2013 Small Business Energy Efficiency (SBS) Program. The main objectives of this study were to provide summer and winter coincidence factors, connected demand (kW), energy (kWh), annual hours of use (HOU) realization rates, percent on-peak energy savings, and summer and winter demand and energy HVAC interactive effects factors. These results are based on on-site measurement and verification (M&V) performed at a statistically selected sample of 30 sites.

1.1 Program Description and Program Activity Summary

National Grid's Small Business Energy Efficiency Program in Rhode Island offers rebates for energy efficient technologies such as lighting, lighting controls/sensors, custom measures, commercial refrigeration equipment, and walk-in cooler efficiency measures. 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 program, the business must have an average peak monthly demand of 200 kW or less.

There were 1,176 billing accounts with savings credited to the SBS program in the 2013 program year. The total tracked gross annual energy savings among all program participants was 22,019,804 kWh while the diversified peak demand kW savings were estimated at 4,414 kW. Table 1 below provides a measure level summary of the 2013 Small Business Energy Efficiency Program population. This summary includes the number of accounts with each measure type and their total savings. Since participating accounts can have more than one measure type installed, the number of accounts in the total line exceeds the total unique accounts that participated in 2013. We created subgroups with and without lighting control measures under the prescriptive lighting category to show the relationship between our suggested sample frame (prescriptive lighting without controls) relative to lighting installed with controls as well as the overall population. It is clear from this table that savings related to lighting measures overall accounts for the vast majority of program savings, with 94% of accounts installing either a lighting measure or lighting control.

Table 1: 2013 Small Business Energy Efficiency Program Activity

	Participating Accounts		**kWh Savings**		**Peak Diversified kW Reduction**	
End Use	N (1,176)	%	kWh	%	kW	%
Prescriptive Lighting without Controls	842	56%	12,197,815	55%	2,585	59%
Prescriptive Lighting with Controls	180	12%	4,057,523	18%	886	20%
Custom Lighting	112	7%	2,855,136	13%	675	15%
Lighting Controls	181	12%	536,889	2%	107	2%
Non-Lighting	185	12%	2,372,442	11%	162	4%
Total	**1,500**	100%	**22,019,804**	100%	**4,414**	**100%**

1.2 Sampling Methodology

DNV GL used Model-Based Statistical Sampling (MBSS) methodologies to inform the design of the SBS evaluation sample. This methodology allows us to develop a sample design that targets ±10% relative precision at the 90% confidence interval around energy savings, which we understood to be the primary outcome of interest to this study. To develop a sample design of this nature, however, it was necessary to estimate the study error ratio. Error ratios are typically estimated based upon previous experience with similar evaluations. This is because the actual error ratio for the study is not known until the actual variation observed between the final sample points and the tracking data has been assessed.

Based on previous experience and input from National Grid, we decided to target 30 sites in this study as indicated in Table 2. This table also includes estimates of the precisions that were anticipated at the time of this design, assuming an error ratio of 0.31.

Table 2: Prescriptive Lighting Sample Design

Measure Type	Projects	Total Savings (kWh)	Assumed Error Ratio	Confidence Level	Planned Sample Size	Anticipated Relative Precision
Lighting Systems	842	12,197,815	0.31	90%	30	±9.0%

1.3 On-Site Visit Methodology and Data Analysis

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 ISO-NE Manual M-MVDR compliant lighting loggers were installed for a minimum of four weeks.

The data gathered from the on-sites were compiled into spreadsheets for analysis using the methods found in Appendix B. To summarize this approach; 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. All analyses were conducted in a manner that allowed for the provision of discrepancies between the tracked and gross savings according to each adjustment phase[1]. Final results were expanded to reflect population level impacts through case weighting, with precisions provided around all results. The results that follow cover all lighting types combined, but due to the large proportion of exterior fixtures rebated through the program, results are split by interior versus exterior fixtures in Appendix C.

[1] Documentation, technology, quantity, operation, and interactive adjustments.

1.4 Results

Table 3 summarizes the results of this analysis, which was based on 30 sampled sites. The realization rate for was found to be 102.4% with a precision of ±11.4% at the 90% confidence interval. Note that gross tracking savings do not include HVAC interactive effects. The error ratio was found to be 0.35, which is higher than the 0.31 assumed in the sample design.

Table 3: Summary of On-Site Savings Adjustments

Parameter	kWh	% Gross
Gross Savings (Tracking)	12,197,815	
Documentation Adjustment	51,511	0.4%
Technology Adjustment	4,447	0.04%
Quantity Adjustment	-159,458	-1.3%
Operational Adjustment	-58,367	-0.5%
HVAC Interactive Adjustment	456,740	3.8%
Adjusted Gross Savings	12,492,687	102.4%
Gross Realization Rate	102.4%	
Relative Precision	±11.4%	
Confidence Interval	90%	
Error Ratio	0.35	

Table 4 summarizes the savings factors resulting from our analysis. All relative precisions were calculated at the 80% confidence level[2]. The connected kW realization rate was 97.8%, with a relative precision of ±1.6%. The on-peak summer coincidence factor was 29.9%, with a relative precision of ±27.0%. The on-peak winter coincidence factor was 64.9%, with a relative precision of ±13.8%. The table also provides savings factors for on-peak summer and winter kW HVAC interactive effects, connected kWh realization rate, kWh HVAC interactive effect, hours of use realization rate and percent on-peak kWh. The heating HVAC interactive effect is lower than we typically see in small business evaluations due to the relatively large proportion of exterior lighting installations. Installations of this nature impact both the electric and non-electric interaction; as well as the summer coincidence factor.

[2] These results are reported at the 80% confidence interval to be consistent with ISO-NE requirements for peak demand results.

Table 4: Summary of Savings Factors

Savings Factors and Realization Rates at 80% Confidence	Value	Precision
kW Factors		
Connected kW Realization Rate	97.8%	±1.6%
Summer Coincidence Factor	29.9%	±27.0%
Winter Coincidence Factor	64.9%	±13.8%
Summer kW HVAC Interactive Effect	111.5%	±5.4%
Winter kW HVAC Interactive Effect	99.4%	±0.8%
kWh Factors		
Connected kWh Realization Rate	98.7%	±0.9%
kWh HVAC Interactive Effect	102.0%	±8.5%
Hours of Use Realization Rate	96.3%	±10.7%
% On-Peak KWh	44.0%	[3]
Non-Electric		
Heating HVAC Interactive Effect (MMBtu/kWh)	-0.000526	

1.5 Conclusions and Recommendations

Overall, the prescriptive lighting measures installed through National Grid Rhode Island's SBS program are performing well relative to tracking estimates and generating substantial savings. The primary driver for the higher evaluated gross savings estimates is the HVAC interactive adjustment. The increase in savings due to documentation and technology adjustments are almost equally balanced by the decrease in savings due to the operational adjustment. HVAC interaction, which is not included in the tracking savings estimates, exceeds the reduction in savings due to the quantity adjustment, resulting in an increase in savings of 2.4% over the tracking system estimate.

The energy realization rate of 102.4% is similar to those from previous lighting impact evaluations, which are typically at or above 100%. The error ratio of 0.35 was somewhat higher than the assumed error ratio (0.31). This is an indication of greater variability in the evaluated savings estimates as compared to those from the tracking system. Future impact evaluations of lighting systems should consider increasing the planning error ratio to 0.35 or even 0.4 to further hedge against the possibility of yet higher levels of variability.

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

Documentation Adjustment

Conclusion: The overall documentation adjustment resulted in an increase in savings of ~0.4%. Twenty-six of the thirty sites in the sample (86.7%) had the documentation to support the savings estimates provided in the tracking system. Two other sites had documentation which provided savings estimates that were only slightly different (~0.1%) from those in the tracking system. The documentation from the two remaining sites provided a savings estimate that was approximately 6%

[3] The precision around the % on-peak kWh result could not be calculated due to the lack of tracking values for this factor.

higher than their tracking system counterparts. Overall, National Grid does a great job with the tracking database used for the SBS Program 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. Although there were a couple isolated discrepancies between tracking system and supporting documentation for one site, we do not believe this incident warrants an explicit recommendation at this time.

Technology and Quantity Adjustments

Technology Adjustment Conclusion: There was one site in the sample that experienced a minor technology change; from 12-watt LEDs (tracking) to 11-watt LEDs (evaluation). National Grid does a great job tracking what was actually installed.

Quantity Adjustment Conclusion: Five of the sites in the sample had at least one fixture that was reported as installed by the tracking system and not found onsite or was removed prior to the site visit.

Recommendation: We believe the current system National Grid is using to track the type and quantity of fixtures installed is sufficient. No change to that system is recommended.

Operational Adjustment

Conclusion: 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 only a 0.5% reduction in savings.

Recommendation: Overall, the tracking system hours of use estimates appear to be very accurate. 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. Given the time sensitive nature of program installations and for lack of a more accurate cost-effective way to estimate hours, we recommend that National Grid continue to use the hours of use estimates provided by the vendors/customers.

HVAC Interactive Adjustment

Conclusion: HVAC interaction accounted for the largest adjustment to the tracking savings at approximately 3.8%. The HVAC interactive adjustment in this study is small when compared to other similar studies due to the relatively large proportion of exterior lighting installations.

Recommendation: We recommend that National Grid consider including HVAC interaction in their tracking system savings estimates. 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 toward interior fixtures.