New Hampshire Utilities

New Hampshire
Small Business Energy Solutions Program
Impact Evaluation

Final Report

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Prepared by

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New Hampshire Small Business Energy Solutions Program
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Executive Summary

This report summarizes an impact evaluation performed by RLW Analytics, Inc. (RLW) during 2004 to quantify the gross annual and lifetime energy impacts associated with lighting installed in the 2003 Small Business Energy Solutions (SBES) Retrofit Programs of the New Hampshire Sponsoring Utilities. These utilities include Public Service of New Hampshire (PSNH), Unitil, and New Hampshire Electric Cooperative (NHEC). National Grid USA performed a similar evaluation that included Granite State Electric Company. These results are shown in Section 6.

This evaluation of the SBES program covers the implementation period June 1, 2002 through December 31, 2003. The overall goal of the program is to help small businesses manage their operating expenses by increasing the efficiency of their electricity use through the installation of efficient lighting and other equipment to reduce energy consumption. Determining the level of annual and lifetime energy savings associated with lighting measures is the primary focus of this study. Commercial and Industrial customers under 100 kW are eligible for the program's turnkey services. The Small Business Energy Solutions Program served approximately 610 small commercial and industrial customers in the service territories of the three sponsoring utilities during 2003.

2003 Small Business Energy Solutions Program Summary

Table Ex-1 presents the amount of annual and lifetime savings of each utility by technology as gathered from the SBES tracking systems. The annual lighting savings in this table represents the population of savings from which the on-site sample design and selection was performed. Overall, PSNH, the largest utility involved in the evaluation, has generated 117,693 MWh of lifetime energy savings in its Small Business Solutions Program, the most of all sponsors. It should be noted that lifetime savings were based upon lifetime estimates that were 15 years for both Unitil and NHEC, and varied by lighting technology for PSNH. Among all sponsors, the majority of lifetime savings (78.1%) is in the lighting category, with 115,796 MWh. Custom measure savings is a distant second with an estimated 13.0% of all tracked lifetime energy savings.

Utility	Tracking System Estimates of Savings (kWh)								
	Air Comp.	HVAC	Refrigeration	Process	Custom	Lighting	Motors	VFD	Grand Total
Annual Savings									
PSNH	0	43,910	609,335	33,288	1,032,209	6,298,949	24,413	0	8,042,104
Unitil	26,166	122,427	0	0	0	1,340,463	0	29,998	1,519,054
NHEC	0	0	0	0	124,652	393,590	0	0	518,242
Total	26,166	166,337	609,335	33,288	1,156,861	8,033,002	24,413	29,998	10,079,400
Lifetime Savings									
PSNH	0	835,755	8,838,100	499,320	17,373,386	89,704,590	442,340	0	117,693,491
Unitil	392,490	1,836,405	0	0	0	20,106,945	0	449,970	22,785,810
NHEC	0	0	0	0	1,869,780	5,984,840	0	0	7,854,620
Total	392,490	2,672,160	8,838,100	499,320	19,243,166	115,796,375	442,340	449,970	148,333,921

Table Ex-1: SBES Program Annual and Lifetime Savings by Measure Type

Figure Ex- 1 provides an illustration of the savings at the measure type level according to the table above. As discussed above, lighting measures represent the overwhelming amount of program tracking savings.

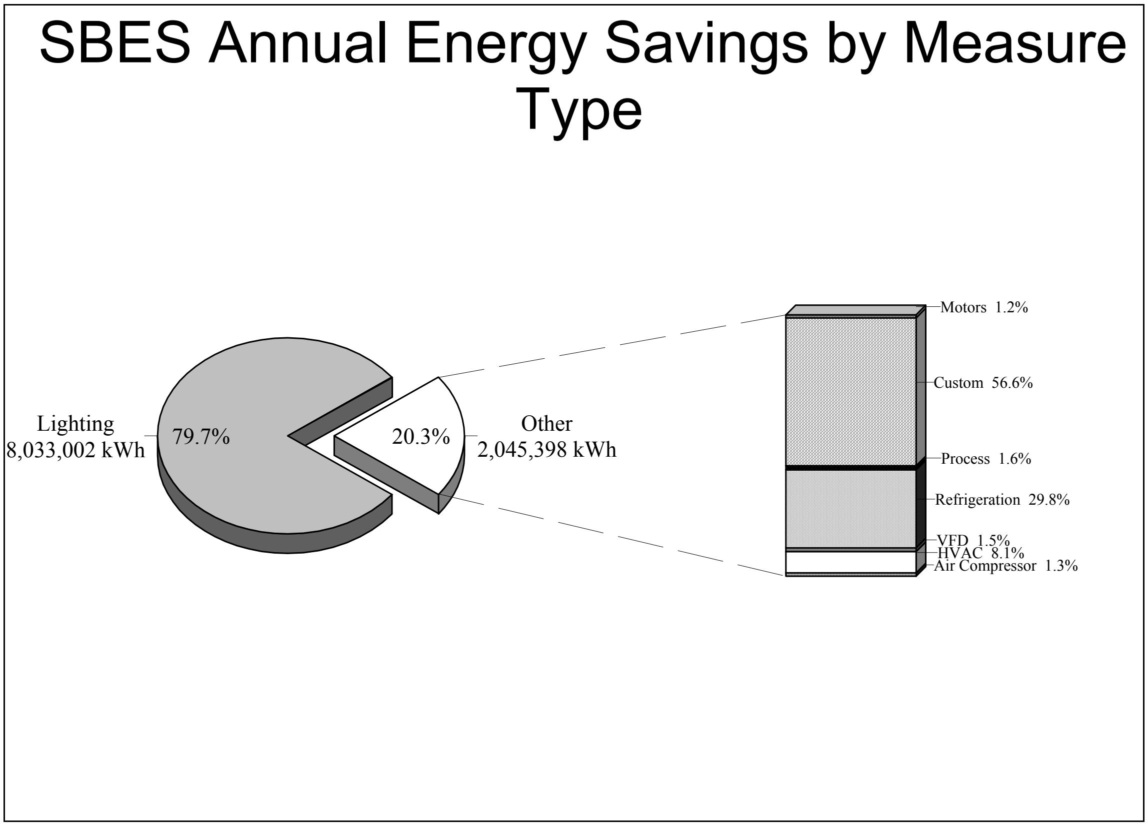

Figure Ex- 1: SBES Annual Savings by Measure Type

Evaluation Approach Summary

The primary goal of this study is to quantify the actual annual and lifetime energy savings due to the installation of energy efficient lighting projects in the SBES Program with a precision of ±10% at the 90% confidence level for each sponsor. The results of this impact evaluation are believed to accurately present determine annual and lifetime energy savings accomplishments, and defensibly demonstrate those savings to regulators and other interested parties. We believe a primary advantage of performing a consistent evaluation methodology across all sponsors of the program is that it will more readily enable direct comparisons between program implementation.

Key Evaluation Components

In order to attain the evaluation objectives, RLW conducted on-site engineering assessments on a statistically selected sample of program participants from the SBES Program. On-site activities included verification of measure quantity, technology, hours of operation, and subsequent engineering reanalysis. Specifically, this evaluation included the following steps:

1 An **efficient sample plan** for the selection of small business participants for on-site surveys was optimized to the extent possible to result in energy savings estimates with ±10% precision at the 90% confidence interval for service

territory precisions.

2 **Data gathering** was performed at 97 participating sites and an **analysis followed all data collection** to satisfy the evaluation objectives. The on-site analysis began with a file review of each sampled site that recreated the tracking energy savings, including the adjustment of wattage assumptions to those in use by the utilities in instances where savings calculations were based upon inconsistent wattages. The on-site data gathering included verification of measure quantities from the applications, verification of the installed technologies, and the determination of hours of operation through time-of-use (TOU) lighting loggers installed for a minimum of two weeks. A **participant feedback survey** was also implemented to gather information on program satisfaction, program marketing, and remaining opportunities.

3 **Analysis** included the calculation of annual and lifetime kWh savings, with the impact of quantity changes, technology changes, hours of operation changes, and interaction changes calculated and reported as discrete impacts. The analysis also included the appropriate expansion of the sample results to the population of each utility and in aggregate. This Report includes all pertinent reporting requirements, methodologies, and recommendations. Results have been provided for annual and lifetime energy savings at the utility level (with non-lighting measures) and for lighting measures alone at both the utility and state level.

Comparison of Lighting Impacts Across Sponsors

Table Ex-2 presents a comparison of annual lighting energy savings and their associated realization rates among the sponsors. The precisions associated with the energy savings estimates suggest strong realization rate estimates within a tight range of 93% to 112%. It is important to note that the PSNH tracking savings estimate in this table does not include 194,532 kWh of lighting savings associated with lighting purchases by Small C&I customers through the Lighting Catalog that are included in Table Ex-1.

	Annual Savings			
UTILITY	TRACKING KWH	ONSITE KWH	%REAL RATE	REL PREC
NHEC	393,590	388,327	98.7%	±4.8%
PSNH	6,104,417	5,672,191	92.9%	±8.1%
Unitil	1,340,463	1,502,884	112.1%	±7.0%

Table Ex-2: Comparison of Lighting Energy Savings and Realization Rates

Table Ex-3 presents a comparison of the energy adjustment factors among the New Hampshire sponsors. These factors are further described in Section 4.1 of this report. Quantity and operational adjustments are the primary drivers of the non-interactive energy savings among the sponsors, while the cooling adjustment consistently provides a net positive adjustment in interactive savings.

PARAMETER	NHEC	PSNH	Unitil
DOCUMENTATION ADJ.	-0.2%	-0.9%	-0.1%
TECHNOLOGY ADJ.	4.1%	-0.6%	-1.9%
QUANTITY ADJ.	-6.2%	-2.3%	-0.5%
OPERATION ADJ.	-1.4%	-5.2%	9.9%
HEATING ADJ.	0.0%	-1.1%	0.0%
COOLING ADJ.	2.4%	3.0%	4.7%
TOTAL ADJUSTMENT	-1.3%	-7.1%	12.1%
REALIZATION RATE	**98.7%**	**92.9%**	**112.1%**

Table Ex-3: Lighting Energy Adjustment Factor Comparison

Specific results for individual participating utilities are contained in the body of this report.

State Level Result Tables

Table Ex-4, Table Ex-5, and Table Ex-6 summarize the evaluation results for Small Business Energy Solutions lighting savings across all of the study sponsors in New Hampshire. It is important to note that in the total annual and lifetime energy estimates, we have included savings due to catalog purchases in the program that were not directly included in the sample but are estimated as part of the total program savings based upon the calculated realization rate of PSNH (these savings were associated with the PSNH Catalog Program).

In this way, total evaluated annual lighting energy savings is found to be 7,744 MWh, which includes savings from the lighting catalog, with a statewide realization rate of 96.4%. The relative precision for the evaluated annual energy savings is ±6.2%. The relative precision multiplied by the evaluated energy savings provides the error bound of the measured savings, which is calculated to be 480 MWh. In other words, the 90% confidence interval for the adjusted gross savings of all projects in the population is 7,744 ± 480 MWh.

Based upon the on-site activities, the largest adjustment in annual energy savings is due to an adjustment for cooling interaction, which yielded a 3.3% increase in energy savings. The second largest adjustment in energy savings is due to an adjustment for changes in operating hours observed on-site as compared to the documented lighting, which caused a 2.4% decrease in energy savings.

Parameter	Annual Energy kWh	% Adjustment
Sampled Gross Tracking Savings	**7,838,470**	**N/A**
Documentation Adjustment	-57,598	-0.7%
Technology Adjustment	-47,186	-0.6%
Quantity Adjustment	-170,510	-2.2%
Operation Adjustment	-190,881	-2.4%
Heating Adjustment	-65,682	-0.8%
Cooling Adjustment	256,788	3.3%
Evaluated Annual Energy Savings	**7,563,401**	**-3.5%**
Additional Catalog Tracking Savings	**194,532**	**N/A**
Realized Catalog Savings	**180,758**	**-7.1%**
Total Estimated Annual Energy Savings	**7,744,159**	**-3.6%**

Table Ex-4: Summary of New Hampshire Lighting Annual Energy Savings Results

Parameter	Lifetime Energy kWh	% Adjustment
Gross Tracking Savings	**114,629,183**	**N/A**
Adjustments	-5,728,327	-5.0%
HVAC Adjustment	3,296,616	2.9%
Evaluated Lifetime Energy Savings	**112,197,472**	**-2.1%**
Additional Catalog Tracking Savings	**1,167,192**	**N/A**
Realized Catalog Savings	**1,104,072**	**-5.4%**
Total Estimated Annual Energy Savings	**113,301,544**	**-2.2%**

Table Ex-5: Summary of New Hampshire Lighting Lifetime Energy Savings Results

Evaluation Result	Realization Rate	Relative Precision
Annual Energy	96.4%	±6.2%
Lifetime Energy	97.9%	±6.7%

Table Ex-6: Summary of New Hampshire Results

Table Ex-7 presents the impact of each lighting technology type on the overall lighting realization rate, including the total estimated savings to provide a sense of the importance of each technology in the overall impacts. Generally, T8 retrofits and LED exit savings estimates were very accurate, resulting in little impact on the overall savings in the program. Exterior lighting had the most pronounced impact, which experienced a 27% decrease in operation adjustment from the tracking system to the on-site. In exploring this further, this exterior lighting operational adjustment impact was primarily driven by 6 exterior fixtures at two sites that were assumed to be in operation 8,760 hours annually but were on photocell or timer control, and 14 fixtures at a third site that were assumed to operate 4,400 hours a year (just over half of the years hours), but were also on timer control and were found to operate only 3,600 hours a year.

Control measures also experienced a moderate decrease in savings due to operational adjustments. Primarily, three sites drove this decrease in control savings as a result of controls installed at two sites that were not being used as intended (sensors that were disabled and being overridden) and a site where the controls were not installed in one of the treated areas.

PARAMETER	T8 Retrofit	CFL	Controls	LED Exits	Exterior Ltg	Other
TECHNOLOGY ADJ.	-0.28%	-2.08%	0.00%	-0.07%	0.00%	-0.76%
QUANTITY ADJ.	-1.67%	-4.67%	-1.18%	-0.31%	0.00%	-2.46%
OPERATION ADJ.	-2.00%	-7.25%	-15.24%	-0.94%	-26.79%	6.83%
HEATING ADJ.	-0.46%	-3.25%	0.00%	-0.14%	0.00%	0.00%
COOLING ADJ.	4.03%	2.49%	0.00%	3.94%	0.00%	0.85%
TOTAL ADJUSTMENT	-0.38%	-14.76%	-16.42%	2.48%	-26.79%	4.46%
TOTAL EST. SAVINGS	4,954,492	1,076,707	62,678	471,454	86,347	911,723

Table Ex-7: Measure Level Summary of Savings Impacts

Super T8 Analysis

The 'Super T8' refers to a second generation fluorescent T8 lamp and electronic ballast lighting system that has begun to be introduced into the marketplace and is being rebated through the NH SBES Program. These systems offer advantages in energy efficiency, longer lamp life, and improved lumen depreciation. Currently, there is no standard industry definition of "super" T8, although it appears manufacturer specs for these second generation T8s fall close together. Super T8 systems are superior to standard T8s by virtue of a "program start ballast" that allows the lamp to be lit with a softer start up than the present instant start T8 ballast.

In this study, RLW gathered the rated wattages from the specification sheets of four well-known manufacturers on 'Super T8' lighting systems for comparison to the current New Hampshire assumed wattages. These detailed tables are provided in section 7 of this report. In our comparisons, it was apparent that the New Hampshire assumptions for 2 lamp F32 Super T8 fixtures align well with manufacturer wattages, but are slightly higher than the manufacturer wattages for 30-watt lamp Super T8 fixtures. In terms of 3 and 4 lamp 'Super T8' fixtures, the New Hampshire assumptions appear to align consistently with the Super T8 systems with 30-watt T8 lamps, but are somewhat lower than manufacturer wattages in the F32 column. This suggests that as long as vendors are installing the lower wattage T8 lamps in the 'Super T8' systems, the assumed wattages are reasonable.

As 'Super T8' systems continue to evolve and become more commonplace in the market, it is anticipated that information on these systems will become more available. The RPI Lighting Research Center reported in a February 2004 presentation for ACEEE that it would be generating a "Lighting Answers" publication soon to provide further independent information about this technology. When this publication is available, it will be located at http://www.lrc.rpi.edu/programs/NLPIP/publicationResults.asp?type=2.

Wattage Comparison Analysis

In the calculation of energy savings used to determine program realization rates, we utilized the assumed wattages used by each utility. However, as a core part of this study, we cross compared the wattage files provided to us from each utility against wattages RLW uses in its analysis of lighting measures. The wattages used by RLW are consistent with those being used and accepted by other utilities in New England, including many utilities in Connecticut, Rhode Island and Massachusetts. In a similar Small C&I study for these utilities in the summer of 2004, RLW used these wattages for determining program impacts. Therefore, they are believed to be appropriate for comparison to the current New Hampshire wattages.

This review found that PSNH and Unitil generally use the same codes and wattages as RLW, with only a handful of exceptions. NHEC forwarded tables of wattages published in September 1995 under the EPA Green Light Program "Lighting Upgrade Manual". There were several instances of differences in wattages between the NHEC wattages and those used by RLW and PSNH/Unitil. These differences are detailed in Section 8 of this report.

These differences can be accounted for mainly by considering that the wattage table used by NHEC was published in 1995, and a note on the tables cites the data source from "CEC/EPRI/DOE (1993) and manufacturer data". As would be expected, technology changes within established lighting types would naturally occur over a ten-year period. In addition, some manufacturers have dropped out or dropped product types over that 10-year horizon, which would alter the average wattages for some given lighting types shown.

Participant Feedback Survey Analysis

Participant Feedback Surveys were attempted at all 97 visited on-sites. A total of 85 were completed. Detailed results of these surveys are provided in Section 9 of this report. Highlighted results are provided as bulleted items below:

1. 60.5% of responding participants rated the program very favorable. Although not directly comparable, the levels of satisfaction noted in this study are very comparable to similar studies of small businesses. As a point of comparison, in a similar study performed for a utility in the Northeast in 2002 in which 56% of small business participants reported they were 'very satisfied'.
2. 91.6% of responding participants felt that the program met their expectations.
3. The two most common reasons for participation provided by respondents were to lower the electric bill and to save energy.
4. More than three quarters (83.4%) of respondents reported that the program marketing material was easy to understand, rating it a 4 or higher on a 1 (poor) to 5 (excellent) scale.
5. 78.5 % of respondents scored the marketing materials' completeness and accuracy a 4 or higher on a 1 (poor) to 5 (excellent) scale.
6. Overall scores provided by respondents for the initial energy assessment and installation service and results were 4.3 or higher on a 1 (poor) to 5 (excellent) scale.
7. 71.3% of responding participants were very satisfied with the energy efficiency measures that were installed and only a very small percentage (1.3%) of participants reported being not satisfied with the program measures.
8. A surprisingly large percentage of participants (35.1%) reported faulty

product quality, more specifically, the longevity of bulbs being highly undependable with numerous bulbs blowing in a very short amount of time.

9 29.4% of responding participants suggested that increasing program advertisement and information would be beneficial, and

10 36.7% of responding participants would like to see HVAC equipment in future program offers.

Recommendations

These recommendations rest upon our experience in performing the on-sites and working with the associated paperwork during the SBES impact evaluation. As this evaluation was concurrent with ongoing program QA/QC activities, some of these recommendations may be underway or completed before this study's publication. More detail on these recommendations are in Section 10 of this report.

1. An improvement goal for future operations might include using a consistent set of lifetimes among the utilities and varying those lifetimes according to lighting technology. Unitil and NHEC currently use 15 years as the lifetime for all SBES lighting measures. PSNH varies their lifetime based upon the specific lighting technology.

2. An improvement goal for future operations might include encouraging vendors to consistently and uniformly use utility assumed wattages in all lighting savings calculations in the SBES program.

3. Exterior lighting and controls had substantial negative impacts in their realized savings due to decreases in their operating hours observed on-site as compared to the assumed tracking system hours. An improvement goal might include encouraging customers at the time of control measure installation to not override them and encouraging vendors to account for timers and photocells on exterior fixture estimates of operation.

4. We suggest that the NH utilities ensure that vendors installing 'Super T8' systems through the program are using the correct assumptions depending upon the lamp installed. We suggest this since 'Super T8' systems can be installed with F32 or F30 lamps, each of which would each have different wattage assumptions associated with them. The current 'Super T8' wattage assumptions appear to be aligned well with the F30 lamps, but not other alternative lamps that may be installed.

5. We recommend that NHEC begin using more current wattages in the Small Business tracking calculations; one option available for use are the consistent wattages used by PSNH, Unitil and RLW.

6. An improvement goal for future operations might include examining the causes of reported pre mature lighting burnout by respondents, which might include tracking this issue over time to ensure improvement in lighting lifetime integrity.

New Hampshire Utilities
New Hampshire Small Business Energy Solutions Program
Impact Evaluation

1 Study Overview and Purpose

This report summarizes an impact evaluation performed by RLW Analytics, Inc. (RLW) during 2004 to quantify the gross annual and lifetime energy impacts associated with lighting installed in the 2003 Small Business Energy Solutions Retrofit Programs of the New Hampshire Sponsoring Utilities. These utilities include Public Service of New Hampshire (PSNH), Unitil, and New Hampshire Electric Cooperative (NHEC). National Grid USA performed a similar evaluation that included Granite State Electric Company. These results are shown in Section 6.

The SBES program was implemented from June 1, 2002 through December 31, 2003. The overall goal of the program is to help small businesses manage their operating expenses by increasing the efficiency of their electricity use through the installation of efficient lighting and other equipment to reduce energy consumption. Determining the level of annual and lifetime energy savings associated with lighting measures is the primary focus of this study. Commercial and Industrial customers under 100 kW are eligible for the program's turnkey services. The Small Business Energy Solutions Program has served approximately 610 small commercial and industrial customers in the service territories of the three sponsoring utilities during 2003.

Impact Evaluation Objective

Determine the annual and lifetime gross energy impacts associated with Small Business Energy Solutions lighting measure installations using on-site engineering assessments.

2 The Analysis Framework: Sample Design and Selection

This section of the report provides an overview of the program population as well as the statistical sampling methodology, including sample design and selection.

2.1 Population Characteristics

As stated earlier, the SBES program was implemented from June 1, 2002 through December 31, 2003. Table 1 presents the amount of annual and lifetime energy savings of each utility by technology as gathered from the SBES tracking system of each utility. The annual lighting savings in this table represents the population of savings from which the on-site sample design and selection was performed. Overall, PSNH has generated 117,693 MWh of lifetime energy savings in its Small Business Solutions Program, the most of all sponsors. It should be noted that lifetime savings were based upon lifetime estimates that were 15 years for both Unitil and NHEC, and varied by lighting technology for PSNH. Among all sponsors, the majority of lifetime savings (78.1%) is in the lighting category, with 115,796 MWh. Custom measure savings is a distant second with an estimated 13.0% of all tracked lifetime energy savings.

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Table 1: SBES Program Annual and Lifetime Savings by Measure Type

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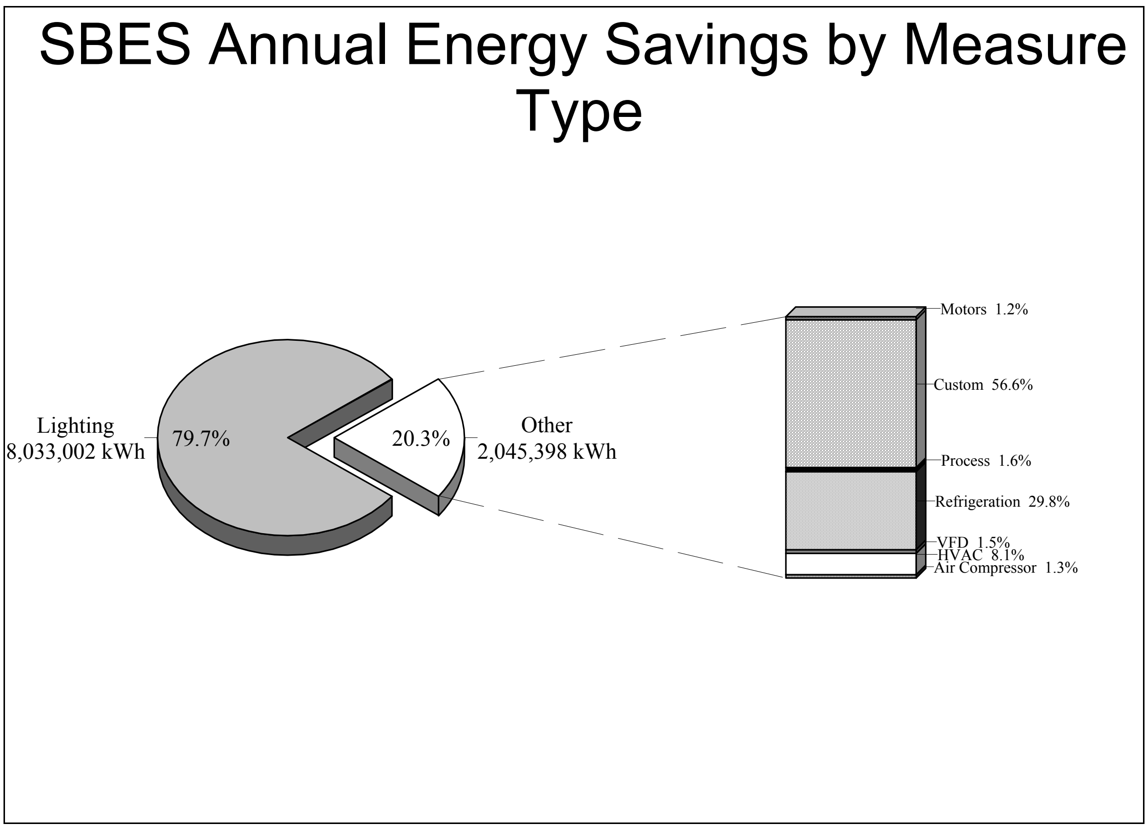


Figure 1: SBES Annual Savings by Measure Type

2.2 Statistical Sampling Methodology

A central impact evaluation challenge in a study such as this is to develop statistically reliable results. RLW used statistical sampling principles to select a sample of customers for analysis. The tracking information and sampling plan provided the basis for extrapolating the results found in the sample back to the target populations. We used the methods and principles of survey sampling and load research to target accurate estimates of the total impacts that would have been found by conducting the analysis for the entire population of program participants. The tracking system was used to develop a sampling frame and sampling plan for selecting the projects for analysis. Moreover, an error bound or confidence interval was associated with this estimate of total impact that reflects the sensitivity of the results to the sample that is actually analyzed.

RLW employed Model-Based Statistical Sampling (MBSS) methodologies for the design of the impact evaluation sample. MBSS offers proven methods for stratifying the populations of interest. Typically, the MBSS methodology begins by sorting the sample population by magnitude of estimated annual kWh savings. As the sample was designed to emphasize the portion of participants with larger impacts, MBSS provided an excellent framework for conducting the analysis and the subsequent stratified ratio estimation.

2.3 Sample Design

Since the on-site work includes only projects with lighting savings, the full population of program participants from each sponsor was reduced accordingly. Using information on savings type from tracking system descriptions of savings, evaluators developed an appropriate research sample of small business program participants.

Our MBSS methodology was used to target ±10% relative precision at the 90% confidence interval for annual energy savings at the sponsor level. In the development of the samples, an error ratio of 0.45 was assumed. As a point of comparison, the final error ratios for recent NGRID, NSTAR and NU Small C&I lighting logger studies were 0.45, 0.40, and 0.25, respectively. The chosen error ratio was a conservative prediction of the expected savings to be achieved through this study. The actual error ratios of this study can be found in the results section of this report.

Having established the error ratio, the next challenge was to determine the number of small business participants needed in each sample to target the relative precisions of interest among the sponsors. Given the development of the lighting savings population and the error ratio, RLW created optimized sample designs for each sponsor. The selection of the sample points to be visited and logged was important to assure that they adequately represented the participant population. Within each sponsor, RLW stratified the sample by the tracking system record of gross lighting savings.

Each of the following tables present the stratum, the maximum project lighting annual savings, the total number of projects in the population, the total annual lighting savings associated with the population of projects, the original and final sample size, and the final weight each sample point carried in the extrapolation of results for each sponsor. For example, in Table 2, stratum 1 for the NHEC SBES population is defined as all NHEC projects with an annual estimate of lighting savings less than or equal to 4,018 kWh. There were a total of 13 program participants in stratum 1 with total savings of 27,082 kWh. The originally designed and final sample size for stratum 1 was three (3) program participants. The final stratum 1 weight, i.e. the number of customers in the population represented by each sample point, is 13/3=4.33.

Sample sites were randomly selected by strata for inclusion in the sample based on the designs presented below. Despite a fairly aggressive recruitment process including letters and utility assistance, not all originally planned sample points were successfully recruited. In instances where sites were unable to be recruited, a randomly selected sample point in the original or next available strata was selected.

Strata	Maximum Lighting Savings (kWh)	Population Size (N)	Population Lighting Savings	Original Sample Size (n)	Final Sample Size (n)	Final Weight (N/n)
1	4,018	13	27,082	3	3	4.33
2	5,641	8	39,626	3	4	2.00
3	7,665	5	34,356	3	3	1.67
4	10,519	4	36,428	3	4	1.00
5	16,198	4	54,016	3	3	1.33
6	200,000	6	202,082	6	4	1.50
	Total	40	393,590	21	21	

Table 2: NHEC Sample Design Targeting ±9.1%, Achieved ±4.8%

Strata	Maximum Lighting Savings (kWh)	Population Size (N)	Population Lighting Savings	Original Sample Size (n)	Final Sample Size (n)	Final Weight (N/n)
1	8,072	49	196,920	6	7	7.00
2	16,171	21	241,526	6	8	2.63
3	34,560	13	293,231	6	6	2.17
4	42,964	8	316,576	6	6	1.33
5	200,000	4	292,210	4	4	1.00
	Total	95	1,340,463	28	31	

Table 3: Unitil Sample Design Targeting ±10.0%, Achieved ±7.0%

Strata	Maximum Lighting Savings (kWh)	Population Size (N)	Population Lighting Savings	Original Sample Size (n)	Final Sample Size (n)	Final Weight (N/n)
1	12,282	209	1,149,280	12	12	17.42
2	23,941	84	1,397,976	12	12	7.00
3	48,075	49	1,600,822	12	12	4.08
4	300,000	26	1,956,339	12	12	2.17
	Total	368	6,104,417	48	48	

Table 4: PSNH Sample Design Targeting ±9.8% Precision, Achieved ±8.1%

3 Participant Site Work

The fundamental data collection activities associated with this study was the on-site visits. The general flow of each on-site is presented in Figure 2 below. These activities were typically preceded with a review of the audit and/or rebate application documentation of each site. Each part of the on-site is described in sequence below. The on-site engineering assessment process culminated in the development of adjusted gross estimates of savings for the on-site sample. In Section 4, we discuss how the site-specific savings analyses were performed to express the gross impacts for the on-site sample.

Small Business Data Collection Flow Chart

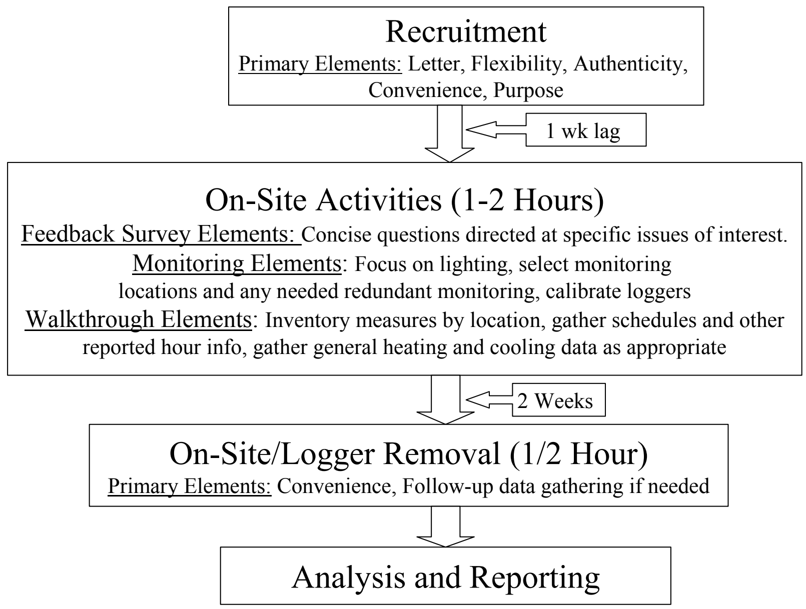


Figure 2: Overview of Onsite Data Collection

3.1 Recruitment

The flow of data collection activities begins with recruitment. *RLW* provided advance notice to the primary and secondary sample of potential recruits on utility letterhead. This letter informed the customer of the following:

- The utility is performing a study of program impacts,
- RLW is an approved contractor of the utility,
- RLW may be calling to set up an appointment to visit their business,
- Their participation in the study is important, and
- RLW would be installing lighting loggers for a minimum 2-week period.

RLW also used an experienced and dedicated full time recruiter to be sure the on-sites are scheduled and performed within the project timeline window. The opening to the recruiting call reminded the customer of the letter and sought to gain the customer's interest by letting them know that the goal is to collect information to optimize the utilities' services to its customers. RLW was flexible in conducting the visits and sought to accommodate the customer's schedule.

3.2 Documentation Review

The first step in the preparation for the on-site engineering assessments was to review the sampled applications available from each sponsor's small business program files. The purpose of the file review was two-fold. First, the file review provided a double check of the program tracking system values of the lighting by comparing the tracking system values to the estimates contained in the file. Second, the file reviews provided a means for evaluators to gather relevant information on the project in preparation for the on-site activities. Specifically, by doing a complete file review and understanding the locations and type of lighting installed, evaluators attained a more complete understanding of the facility and the lighting measures installed, which helped optimize the on-site time and minimize intrusiveness to the customer. The file review also facilitated the preparation of an informal plan to approach logging to be performed at each site.

Any discrepancies between the detailed information in the file and the tracking system information were explored with the utility and sometimes directly with the program vendor. Issues were explored until supporting documentation was identified or it was agreed that there was a documentation error in the tracking system (described later).

3.3 On-Site Interview

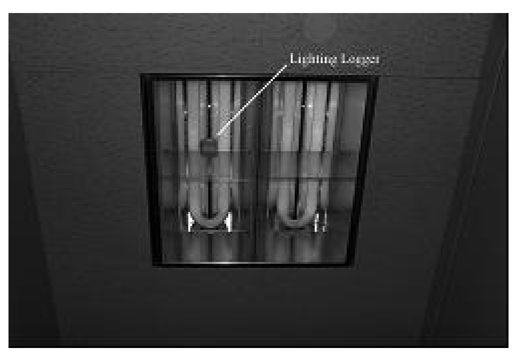
Once on-site, a participant feedback survey was implemented along with an informal discussion with the site representative to orient the contact and auditor to the facility and evaluation purpose. These interactions were with the facility representative(s) most familiar with participation in the program, the location of the lighting equipment installed, the schedule of the building (including holidays and other known schedule changes during the year), and HVAC information. After performing the feedback survey and the orientation to the facility via this interview, evaluators were typically escorted to physical locations where the lighting measures were installed. The participant feedback survey is included in Appendix A of this report.

3.4 Facility Walk-Through

The next task performed on-site was a facility walk-through that focused on verifying the post-retrofit condition. All relevant information pertaining to the annual energy savings of the installed equipment were gathered and recorded, including the quantity and technology of the installed lighting. The facility walk-through was a relatively thorough and aggressive investigation of all potential inputs and influences of the calculation of the energy savings of interest.

3.5 Short Term Monitoring

The final task in the on-site assessment was the installation of lighting loggers to aid in the development of independent savings estimates. Specifically, DENT lighting loggers were used to accurately measure the hours of use of the lighting installed. The lighting logger data was used to support the evaluation to develop annual hours of use for lighting measures and subsequent energy savings.



The figure to the right shows a typical lighting logger installation in a 2-lamp fluorescent U-tube fixture. These 1" x 2" x 4" devices use a photocell sensor to sense and record the dates and times that a light fixture turns on and off. The logger has a magnetic strip located on its side for mounting purposes. In situations where the magnetic strip cannot be used, a fiber optic wand can be bent to allow the logger to hang from a support and point directly at the light. A sensitivity adjustment on the logger can be adjusted to ensure that the logger is not tripped by ambient light. The data are downloaded from the logger to a PC where computer software provides for the reporting of various analysis needs.

The proper use of measurement equipment was vital to obtaining meaningful data for the calculation of accurate energy savings and peak savings estimates. There are three basic steps used in the installation of the lighting loggers in this study: 1) selection, 2) placement, and 3) calibration.

The application reviews performed in the early stages of this evaluation served as the primary source of information from which the engineers estimated the number of loggers needed in the on-site work. This first stage of *selection* refers to both choosing the general assessment techniques, i.e., the analytical means with which site personnel develop an independent estimate of savings, and decide upon the monitoring equipment that is employed to inform such estimates. The *placement* of the monitoring equipment is a critical part of energy monitoring. A blend of statistics, engineering judgment, and consideration of customer impact typically contributes to a site-monitoring plan. Since the fixtures chosen for monitoring are utilized to represent a larger portion of the lighting at a given site, it was important to select fixtures that are considered representative of other non-monitored lighting. The end result of judicious equipment placement was high coverage for the combined monitored and monitor-represented areas over the entire lighting installation. Finally, to secure the reliability of the data received, the lighting loggers required some degree of *calibration*. The calibration of the lighting loggers entailed adjustments of the sensitivity of the photocell sensor to ensure the logger registered the intended light source and not ambient lighting.

Once the loggers were retrieved from the facility following at least two weeks of monitoring, data were downloaded into a computer and analyzed using spreadsheet software. Depending on the logger and the analytical needs of the assessment, the data was used to develop total usage, discrete operating schedules, and other relevant expressions of the monitored data. To annualize the logger data, monitored data were aggregated to a typical operational matrix (seven days per week by twenty-four hours per day), and this matrix was expanded to a year of operation based on weekdays, weekends, and holidays as reported by the facility personnel.

Information on operating hour results at the site level are included in this report as Appendix C. This table includes a table presenting each site level information regarding the type of facility visited, the number of shifts, the verified lighting kWh savings, and the assumed versus verified operating hours. This information is expected to allow the utilities to analyze the discrepancies in terms of type of facility and number of shifts and make operating hour assumption adjustment moving forward.

4 Savings Analysis Methodology

Standard analysis spreadsheets were employed to calculate demand and annual energy savings, both with and without interactive effects. These calculations were performed with the best available characterization of pre-retrofit information (primarily project documentation informed by site interviews and/or observational inference) and the observed post-retrofit conditions.

The fundamental calculation of annual energy savings was as follows:

$$\text{kWh Savings} = \left(\frac{\text{Quantity}_{Pre} \times \text{Watts}_{Pre} \times \text{Hours}_{Pre}}{1{,}000}\right) - \left(\frac{\text{Quantity}_{Post} \times \text{Watts}_{Post} \times \text{Hours}_{Post}}{1{,}000}\right)$$

For each sampled site, RLW developed an estimate of annual and lifetime energy savings (kWh), the latter being the product of the annual savings and the assumed lifetime of the lighting measure in the project documentation. The annual and lifetime energy savings estimates were then calculated through a stratified ratio estimation (SRE) analysis framework. Statistical weights were developed and applied to each sample participant to develop the total estimates of savings by sponsor.

A practical example of all computations that details all formulae employed in the lighting analysis spreadsheet is provided as Appendix B of this report.

4.1 Adjustment Factors

The purpose of computing adjustment factors is to demonstrate which computational inputs were influential in the difference between the tracking system estimate and gross on-site estimate of energy savings. Put another way, these factors allocate the difference between the tracking and on-site savings into adjustment factor 'buckets'. The method of allocating these savings into these adjustment factors is somewhat arbitrary, as there are multiple sequences and logic that can be applied to the problem. RLW's adjustment factors were established in a project with NSTAR several years ago and were used in a similar recent study for the Massachusetts and Connecticut utilities. The sequence of computation used methodically in this study had Technology first, then Quantity, then Operation factors.

The adjustment factors are computed using series hypothesis logic. Since multiple parameters influence the on-site savings computation, we calculate the influence of individual adjustment factors by changing only one parameter at a time. All adjustments are derived in absolute savings terms and are computed in the format:

$$\text{ADJUSTMENT} = (\text{Onsite Savings Scenario}) - (\text{Basis for Comparison}) + (\text{Prior Adjustmen ts})$$

The Basis for Comparison for the fundamental adjustment factors that follow is the Tracking System Estimate of Savings. In the result tables, presentation of adjustment factors in percentage terms is done relative to the Basis for Comparison.

4.2 Interactive Effects

An important aspect of the energy savings assessment in this study is the consideration of interactive effects. In the context of this energy savings analysis, the term "interactive effect" refers to the interaction between the lighting measure installation and the local heating and cooling systems, as reductions in electrical use generally result in lower heat gain to space. In conditioned spaces, this reduced heat gain translates into lower cooling load and higher heating load, which would then be countered by the facility HVAC systems.

The identification of the cooling and heating technologies at a facility is central to quantifying the interactive effects for a measure. Evaluators quantified interactive effects that contributed to a facility's electrical use in this study.

Interactive savings estimates for this study were calculated according to standard industry practice, using the measure-specific demand reduction to determine the change in heat gain to space. Fundamentally, interactive effects for a lighting retrofit is a function of kW reduction, a heat gain to space fraction, coincident lighting and cooling hours, and cooling system (or heating system) efficiency.

For lighting systems, the heat gain to space resulting from a retrofit is a significant fraction of the kW reduction of the fixtures themselves, as the majority of the electrical input for lighting converts to heat output. The "heat gain to space" fraction varies by lighting type (incandescent is higher than fluorescent) and fixture location (recessed troffers in plenums transfer more heat than surface mount fixtures). For this study, evaluators employed a 'heat gain to space' fraction of 0.7 to encompass all lamp types and fixture configurations.

In our streamlined computation, the analysis spreadsheets utilized a number of default assumptions (see Appendix B), including kW/ton by system type for electrical cooling units, COP for heating systems by type, and seasonal heating and cooling fractions. While on-site, evaluators devoted a reasonable amount of time to collecting information about the heating and cooling systems. As accessible, engineers collected unit efficiency (EER, SEER or kW/ton) and rough schedules for cooling equipment. Intuitively, the interactive savings quantity is positive for electric cooling interaction and negative for electric heat interaction. In this way, interactive effects have two components as related to energy savings: cooling benefit, and heating penalty.

5 Energy Savings Results

This section of the report provides the annual and lifetime energy savings estimates by sponsor with their associated realization rate (RR) and relative precision (RP). Each annual savings table in this section presents results through six stages of tracking savings adjustment. Each of the adjustments used in the annual energy savings analysis is described in the table below.

Adjustment	Definition
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. Where wattages differed in the project file from those provided by the utility, RLW used the utility specified wattages, which is also captured as a documentation adjustment. 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 tracking system estimate of savings.
Quantity Adjustment	The Quantity Adjustment reflects the change in savings due to the identification of a different quantity of lighting fixtures at the site than presented in the tracking 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 lighting at the site than represented in the tracking system estimate of savings.
Heating and Cooling Adjustment	The Heating Adjustment and Cooling Adjustment reflect changes in savings due to interaction between the lighting and HVAC systems among the sampled sites. Generally, these impacts cause a heating penalty and a cooling credit. This adjustment reflects impacts from electric heating and/or cooling, not other fuels.

Table 5: Definition of Adjustment Factors

Each sponsor level table of results shows annual energy savings. The final estimate of annual energy savings is the sum of the gross tracking estimate plus the adjustment factors described above. In other words, the on-site estimate of savings equals Gross Energy Savings + Controls Adjustment + Documentation Adjustment + Technology Adjustment + Quantity Adjustment + Operation Adjustment + Heating Adjustment + Cooling Adjustment.

In the results tables to follow, the percent differences reflected in the adjustments are calculated from the gross tracking energy savings. This is due to the fact that the gross tracking savings was the primary expansion variable, and therefore is the most appropriate benchmark to reflect the on-site savings result as they are refined through the calculated adjustments.

5.1 Stratified Ratio Estimation Analysis

The on-site gross savings estimates were combined in a stratified ratio estimation (SRE) analysis framework. Statistical weights were developed and applied to each sample participant to develop the total gross estimates of savings. These same weights were utilized to compute the impacts of each savings adjustment, including the documentation adjustment, quantity adjustment, etc.

Figure 3, Figure 4, and Figure 5 present scatter plots of the tracking system estimates of savings versus the on-site engineering estimates of savings for the sampled participants for each sponsoring utility. A one-to-one reference line is plotted as a dashed line on the diagonal of each figure. In addition, the final realization rates for the lighting measures are plotted as solid lines reflecting the average savings-weighted realization rate of the sample points. More detail on the final realization rates and the impacts of the various adjustment factors on those realization rates are in the next section of this report.

The final error ratios in the study were 0.246 for NHEC, 0.385 for PSNH and 0.322 for Unitil. These error ratios can be used to guide the calculation of appropriate sample designs in future evaluations for the SBES Program.

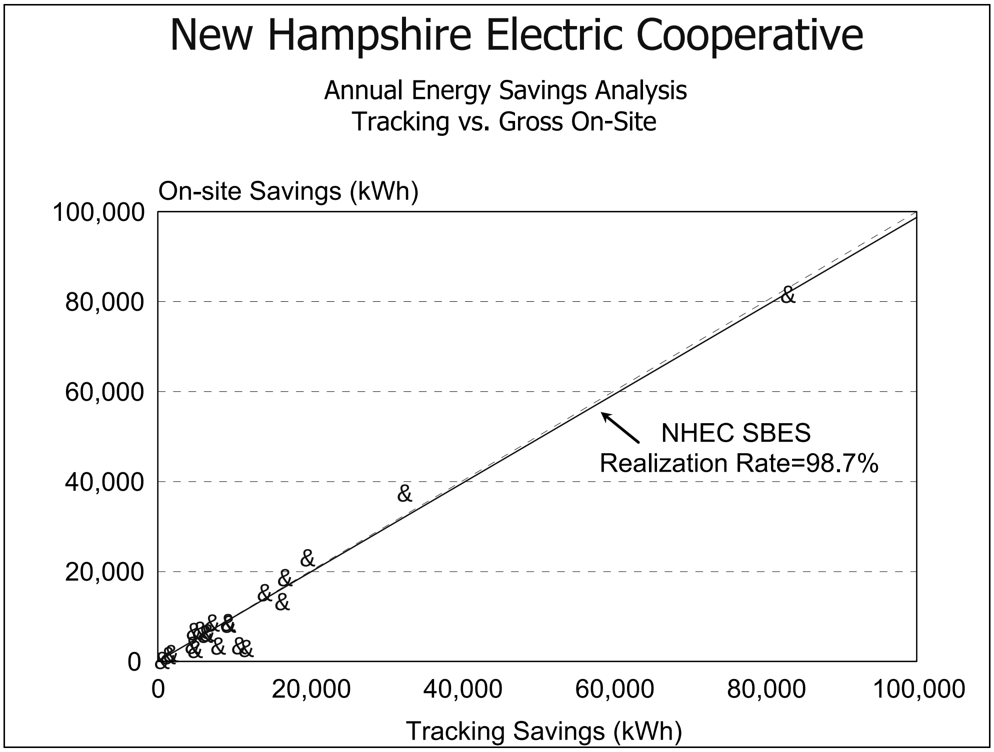


Figure 3: NHEC Tracking System vs. Gross On-Site Scatter plot

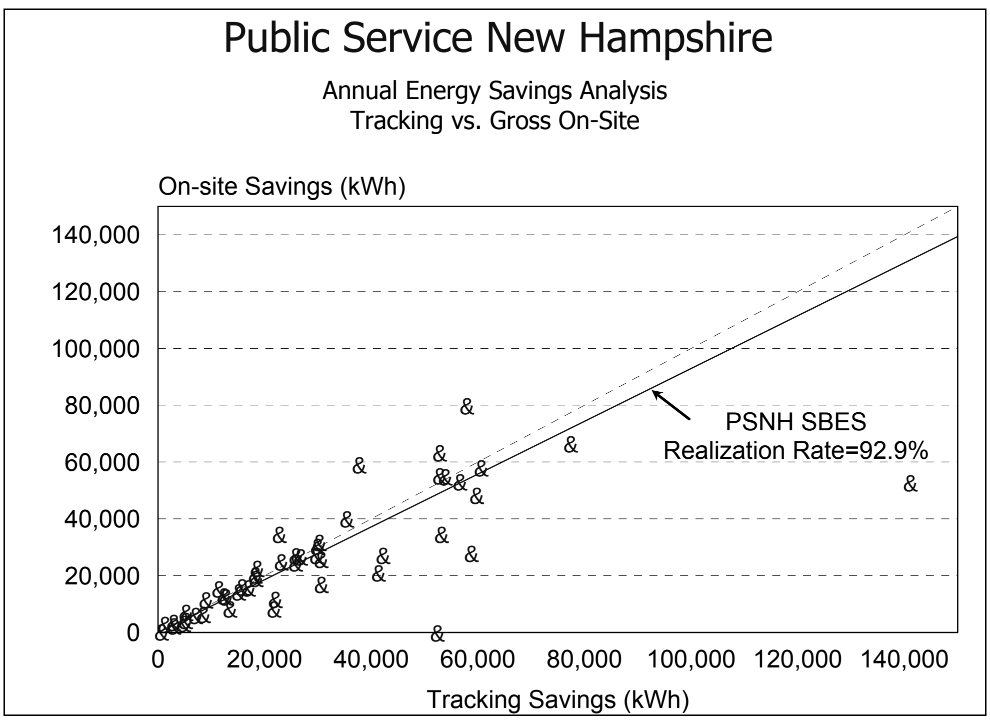


Figure 4: PSNH Tracking System vs. Gross On-Site Scatter plot

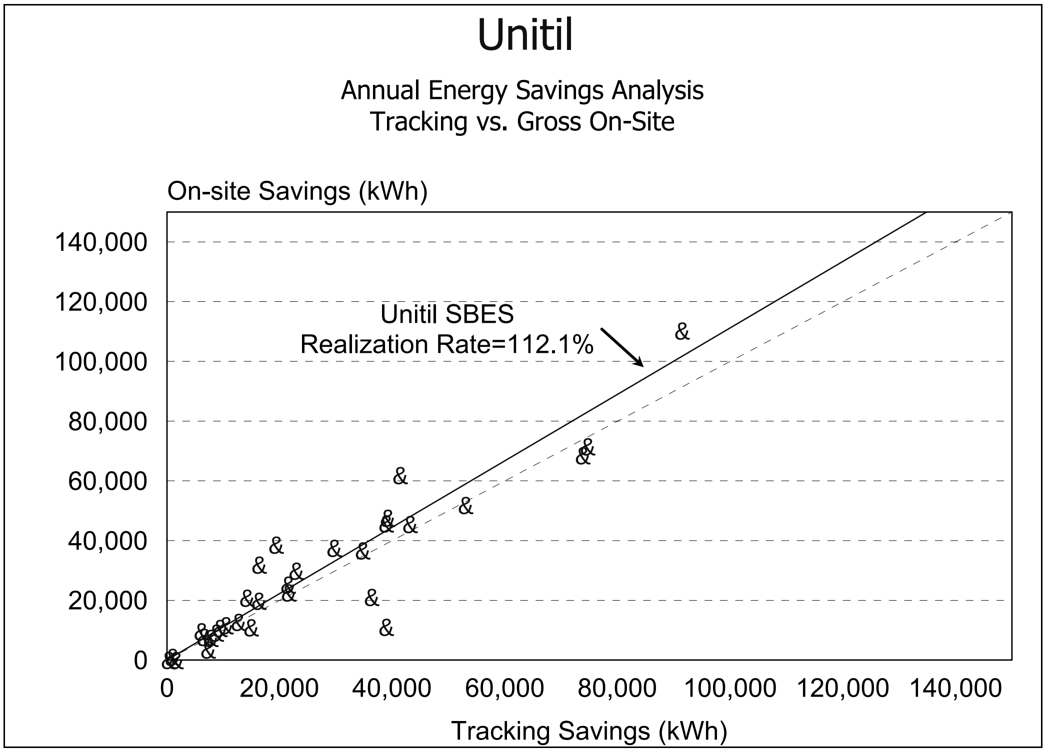


Figure 5: Unitil Tracking System vs. Gross On-Site Scatter plot

5.2 New Hampshire Electric Cooperative

Table 6, Table 7, and Table 8 summarize the evaluation results for lighting savings in the New Hampshire Electric Cooperative SBES program. Total evaluated annual lighting energy savings are 388,327 kWh, with an overall realization rate of 98.7%. The 90% confidence interval for the adjusted gross savings of all projects in the population is 388,327 ± 18,811 kWh, providing a relative precision of ±4.8%. The lifetime precision is also calculated to be ±4.8%. Based upon the on-site activities, the largest adjustment in energy savings is due to an adjustment for lighting quantity observed on-site, which caused a 6.2% decrease in energy savings. This was driven primarily by a school in the sample that had not retrofitted its gymnasium and a bed and breakfast facility that removed installed CFL lighting for performance and aesthetic reasons. The lifetime energy savings associated with NHEC SBES lighting activity is estimated to be 5,905 MWh.

Parameter	Annual Energy	
	kWh	% Adjustment
Gross Tracking Savings	**393,590**	**N/A**
Documentation Adjustment	-842	-0.2%
Technology Adjustment	16,245	4.1%
Quantity Adjustment	-24,462	-6.2%
Operation Adjustment	-5,628	-1.4%
Heating Adjustment	0	0.0%
Cooling Adjustment	9,425	2.4%
Evaluated Annual Energy Savings	**388,327**	**-1.3%**

Table 6: Summary of NHEC Lighting Annual Energy Results

Parameter	Lifetime Energy	
	kWh	% Adjustment
Gross Tracking Savings	**5,984,840**	**N/A**
Adjustments	-223,343	-3.7%
HVAC Adjustment	143,307	2.4%
Evaluated Lifetime Energy Savings	**5,904,804**	**-1.3%**

Table 7: Summary of NHEC Lighting Lifetime Energy Results

Evaluation Result	Realization Rate	Relative Precision
Annual Energy	98.7%	±4.8%
Lifetime Energy	98.7%	±4.8%

Table 8: Summary of NHEC Results

The following table presents the combined lighting and non-lighting savings from the NHEC tracking system. We have applied a 100% realization rate for non-lighting savings and the realization rate from the expansion analysis for the lighting savings. Calculated in this way, the total program annual energy savings is estimated to be 512,979 kWh.

End-Use/Technology	Tracking KWH	Realization Rate	Annual Energy Savings	Relative Precision
Custom	124,652	100.0%	124,652	N/A
Lighting	393,590	98.7%	388,327	±4.8%
Total Program Savings	**518,242**	**98.9%**	**512,979**	**N/A**

Table 9: NHEC Small C&I SBES Program Annual Savings

5.3 Public Service New Hampshire

Table 10, Table 11, and Table 12 summarize the evaluation results for lighting savings in the Public Service New Hampshire SBES program. It is important to note that PSNH had 194,532 kWh in SBES savings that were achieved through the Catalog Program. These savings were not included in the sample as detailed account level information was not available. However, these savings have been included in this table, adjusted by the evaluation results.

Overall, the total evaluated PSNH lighting annual energy savings are 5,853 MWh, with an overall realization rate of 92.9%. The error bound for the measured savings is 473 MWh, resulting in a relative precision of ±8.1%. The lifetime energy savings associated with PSNH SBES lighting activity is estimated to be 84,853 MWh. These savings are driven primarily by two outliers observed in Figure 4 earlier in this section. These two outliers are observed to have substantially lower on-site estimates of savings than the tracking estimate. The large savings point (with tracking savings of 140,963) experienced a decrease in hours of operation of the installed lighting from the tracking estimate of 5,600 annual hours of operation for all building areas to an on-site weighted average of 2,189 hours. The second outlier went from a tracking estimate of savings of 52,193 kWh to zero on-site savings due to a building that has not been occupied since installation.

	Annual Energy	
Parameter	**kWh**	**% Adjustment**
Sampled Gross Tracking Savings	**6,104,417**	**N/A**
Documentation Adjustment	-54,771	-0.9%
Technology Adjustment	-37,779	-0.6%
Quantity Adjustment	-139,560	-2.3%
Operation Adjustment	-318,288	-5.2%
Heating Adjustment	-65,682	-1.1%
Cooling Adjustment	183,854	3.0%
Evaluated Annual Energy Savings	**5,672,191**	**-7.1%**
Additional Catalog Tracking Savings	**194,532**	**N/A**
Realized Catalog Savings	**180,758**	**-7.1%**
Total Estimated Annual Energy Savings	**5,852,949**	**-7.1%**

Table 10: Summary of PSNH Lighting Annual Energy Results

	Lifetime Energy	
Parameter	**kWh**	**% Adjustment**
Gross Tracking Savings	**88,537,398**	**N/A**
Adjustments	-6,988,658	-7.9%
HVAC Adjustment	2,200,674	2.5%
Evaluated Lifetime Energy Savings	**83,749,414**	**-5.4%**
Additional Catalog Tracking Savings	**1,167,192**	**N/A**
Realized Catalog Savings	**1,104,071**	**N/A**
Total Estimated Annual Energy Savings	**84,853,486**	**-5.4%**

Table 11: Summary of PSNH Lighting Lifetime Energy Results

Evaluation Result	**Realization Rate**	**Relative Precision**
Annual Energy	92.9%	±8.1%
Lifetime Energy	94.6%	±8.8%

Table 12: Summary of PSNH Results

The following table presents the combined lighting and non-lighting savings from the PSNH tracking system. We have applied a 100% realization rate for non-lighting savings and the realization rate from the expansion analysis for the lighting savings. Calculated in this way, the total program annual energy savings is estimated to be 7,596 MWh.

End-Use/Technology	Tracking KWH	Realization Rate	Annual Energy Savings	Relative Precision
HVAC	43,910	100.0%	43,910	N/A
Refrigeration	609,335	100.0%	609,335	N/A
Process	33,288	100.0%	33,288	N/A
Custom	1,032,209	100.0%	1,032,209	N/A
Lighting	6,298,949	92.9%	5,852,949	±8.1%
Motors	24,413	100.0%	24,413	N/A
Total Program Savings	**8,042,104**	**94.4%**	**7,596,104**	**N/A**

Table 13: PSNH Small C&I SBES Program Annual Savings

5.4 Unitil

Table 14, Table 15, and Table 16 summarize the evaluation results for lighting savings in the Unitil SBES program. Total evaluated lighting annual energy savings are 1,503 MWh, with an overall realization rate of 112.1%. The error bound for the measured savings is 105 MWh, providing a relative precision of ±7.0%. Based upon the on-site activities, the largest adjustment in energy savings is due to an adjustment for changes in operating hours observed on-site as compared to the application information on the lighting, which caused a 10% increase in energy savings. The lifetime energy savings associated with Unitil SBES lighting activity is estimated to be 22,543 MWh.

	Annual Energy	
Parameter	**kWh**	**% Adjustment**
Gross Tracking Savings	**1,340,463**	**N/A**
Documentation Adjustment	-1,984	-0.1%
Technology Adjustment	-25,652	-1.9%
Quantity Adjustment	-6,487	-0.5%
Operation Adjustment	133,035	9.9%
Heating Adjustment	0	0.0%
Cooling Adjustment	63,509	4.7%
Evaluated Annual Energy Savings	**1,502,884**	**12.1%**

Table 14: Summary of Unitil Lighting Annual Energy Results

	Lifetime Energy	
Parameter	**kWh**	**% Adjustment**
Gross Tracking Savings	**20,106,945**	**N/A**
Adjustments	1,483,674	7.4%
HVAC Adjustment	952,635	4.7%
Evaluated Lifetime Energy Savings	**22,543,254**	**12.1%**

Table 15: Summary of Unitil Lighting Lifetime Energy Results

Evaluation Result	Realization Rate	Relative Precision
Annual Energy	112.1%	±7.0%
Lifetime Energy	112.1%	±7.0%

Table 16: Summary of Unitil Results

The following table presents the combined lighting and non-lighting savings from the Unitil tracking system. We have applied a 100% realization rate for non-lighting savings and the realization rate from the expansion analysis for the lighting savings. Calculated in this way, the total program annual energy savings is estimated to be 1,683,763 kWh.

End-Use/Technology	Tracking KWH	Realization Rate	Annual Energy Savings	Relative Precision
Air Compressor	26,166	100.0%	26,166	N/A
HVAC	122,427	100.0%	122,427	N/A
Lighting	1,340,463	112.3%	1,502,884	±7.0%
VFD	29,998	100.0%	29,998	N/A
Total Program Savings	**1,519,054**	**110.7%**	**1,681,475**	**N/A**

Table 17: Unitil Small C&I SBES Program Annual Savings

5.5 Comparison of Lighting Impacts Across Sponsors

One of the advantages of utilizing a consistent methodology, contractor and timeline for this study is that it helps facilitate a viable comparison of results among the sponsor programs. This section of the report compares the primary results among the sponsors.

Table 18 presents a comparison of energy savings realization rates among the sponsors. The precisions associated with the energy savings estimates suggest strong realization rate estimates within a tight range of 92.9% to 112.3%.

	Annual Savings			
UTILITY	TRACKING KWH	ONSITE KWH	%REAL RATE	REL PREC
NHEC	393,590	388,327	98.7%	±4.8%
PSNH	6,104,417	5,672,191	92.9%	±8.1%
Unitil	1,340,463	1,502,884	112.1%	±7.0%

Table 18: Comparison of Energy Savings and Realization Rates

Table 19 presents a comparison of the energy adjustment factors among the New Hampshire sponsors. These factors are further described in Section 4.1 of this report. Quantity and operational adjustments are the primary drivers of the non-interactive energy savings among the sponsors, while the cooling adjustment consistently provides a net positive adjustment in interactive savings.

PARAMETER	NHEC	PSNH	Unitil
DOCUMENTATION ADJ.	-0.2%	-0.9%	-0.1%
TECHNOLOGY ADJ.	4.1%	-0.6%	-1.9%
QUANTITY ADJ.	-6.2%	-2.3%	-0.5%
OPERATION ADJ.	-1.4%	-5.2%	9.9%
HEATING ADJ.	0.0%	-1.1%	0.0%
COOLING ADJ.	2.4%	3.0%	4.7%
TOTAL ADJUSTMENT	-1.3%	-7.1%	12.1%
REALIZATION RATE	**98.7%**	**92.9%**	**112.1%**

Table 19: Energy Adjustment Factor Comparison

6 State Level Result Tables

Table 20, Table 21, and Table 22 summarize the evaluation results for the Small Business Energy Solutions lighting savings across New Hampshire in the territories of the utilities involved in this study. It is important to note that in the annual and lifetime energy estimates, we have included savings due to catalog purchases in the program that were not directly included in the sample but are estimated as part of the total program savings based upon the calculated realization rate of PSNH as these savings were associated with the PSNH Catalog Program. Total evaluated annual lighting energy savings is found to be 7,744 MWh, with an overall realization rate of 96.4%. The relative precision for the evaluated annual energy savings is ±6.2%. The relative precision multiplied by the evaluated energy savings provides the error bound of the measured savings, which is calculated to be 480 MWh. In other words, the 90% confidence interval for the adjusted gross savings of all projects in the population is 7,744 ± 480 MWh.

Based upon the on-site activities, the largest adjustment in annual energy savings is due to an adjustment for changes in operating hours observed on-site as compared to the documented lighting, which caused a 3.3% decrease in energy savings. The second largest adjustment in energy savings is due to an adjustment for cooling interaction, which yielded a 3.3% increase in energy savings.

Parameter	Annual Energy kWh	% Adjustment
Sampled Gross Tracking Savings	**7,838,470**	**N/A**
Documentation Adjustment	-57,598	-0.7%
Technology Adjustment	-47,186	-0.6%
Quantity Adjustment	-170,510	-2.2%
Operation Adjustment	-190,881	-2.4%
Heating Adjustment	-65,682	-0.8%
Cooling Adjustment	256,788	3.3%
Evaluated Annual Energy Savings	**7,563,401**	**-3.5%**
Additional Catalog Tracking Savings	**194,532**	**N/A**
Realized Catalog Savings	**180,758**	**-7.1%**
Total Estimated Annual Energy Savings	**7,744,159**	**-3.6%**

Table 20: Summary of New Hampshire Lighting Annual Energy Savings Results

Parameter	Lifetime Energy kWh	% Adjustment
Gross Tracking Savings	**114,629,183**	**N/A**
Adjustments	-5,728,327	-5.0%
HVAC Adjustment	3,296,616	2.9%
Evaluated Lifetime Energy Savings	**112,197,472**	**-2.1%**
Additional Catalog Tracking Savings	**1,167,192**	**N/A**
Realized Catalog Savings	**1,104,072**	**-5.4%**
Total Estimated Annual Energy Savings	**113,301,544**	**-2.2%**

Table 21: Summary of New Hampshire Lighting Lifetime Energy Savings Results

Evaluation Result	Realization Rate	Relative Precision
Annual Energy	96.4%	±6.2%
Lifetime Energy	97.9%	±6.7%

Table 22: Summary of New Hampshire Results

Table 23 presents the impact of each lighting technology type on the overall lighting realization rate of the annual energy savings, including the total estimated savings to provide a sense of the importance of each technology in the overall impacts. Generally, T8 retrofits and LED exits had little impact on the overall savings in the program. Exterior lighting had the most pronounced impact, which experienced a 27% decrease in operation adjustment from the tracking system to the on-site. In exploring this further, this impact was primarily driven by 6 exterior fixtures at two sites that were assumed to be in operation 8,760 hours annually but were on photocell or timer control, and 14 fixtures at a third site that were assumed to operate 4,400 hours a year (just over half of the years hours), but were also on timer control and were found to operate only 3,600 hours a year. Primarily, three sites drove the decrease in control savings as a result of controls installed at two sites that were not being used as intended (sensors that were disabled and being overridden) and a site where the controls were not installed in one of the treated areas.

PARAMETER	T8 Retrofit	CFL	Controls	LED Exits	Exterior Ltg	Other
TECHNOLOGY ADJ.	-0.28%	-2.08%	0.00%	-0.07%	0.00%	-0.76%
QUANTITY ADJ.	-1.67%	-4.67%	-1.18%	-0.31%	0.00%	-2.46%
OPERATION ADJ.	-2.00%	-7.25%	-15.24%	-0.94%	-26.79%	6.83%
HEATING ADJ.	-0.46%	-3.25%	0.00%	-0.14%	0.00%	0.00%
COOLING ADJ.	4.03%	2.49%	0.00%	3.94%	0.00%	0.85%
TOTAL ADJUSTMENT	-0.38%	-14.76%	-16.42%	2.48%	-26.79%	4.46%
TOTAL EST. SAVINGS	4,954,492	1,076,707	62,678	471,454	86,347	911,723

Table 23: Measure Level Summary of Savings Impacts

6.1 Previous National Grid USA Results

In the late spring and early summer of 2004, RLW performed an evaluation for National Grid, among other Massachusetts and Connecticut utilities. The methodology for the previous study was nearly identical to that of this New Hampshire study, with the exception of lighting controls, which were not included in the earlier Massachusetts study, although they are included in this current New Hampshire study. It should be noted that the state level results presented earlier only include the results of this current study, including NHEC, PSNH and Unitil.

Table 24, Table 25, and Table 26 summarize the evaluation results for 2003 lighting savings in the National Grid USA Small Business Services program across the states in the National Grid New England territory: Massachusetts, Rhode Island, and New Hampshire. Total evaluated lighting energy savings are 13,903 MWh, with an overall realization rate of 99.4%. The error bound for the measured savings is 1,140 MWh, resulting in a relative precision of ±8.2%. Based upon the on-site activities, the largest adjustment in energy savings is due to an adjustment for cooling interaction, which caused a 5.3% increase in energy savings. Although not shown, the non-electric heating penalty amongst National Grid participants is estimated to be -17,456,999 MBTU.

	Annual Energy	
Parameter	**kWh**	**% Adjustment**
Gross Tracking Savings	**14,022,739**	**N/A**
Controls Adjustment	-34,847	-0.2%
Revised Tracking Savings	**13,987,892**	**N/A**
Documentation Adjustment	-53,391	-0.4%
Technology Adjustment	-73,620	-0.5%
Quantity Adjustment	15,198	0.1%
Operation Adjustment	-310,663	-2.2%
Heating Adjustment	-411,634	-2.9%
Cooling Adjustment	749,395	5.3%
Evaluated Annual Energy Savings	**13,903,177**	**-0.6%**

Table 24: Summary of National Grid Lighting Annual Energy Results

The connected demand reduction associated with lighting activity in 2003 is estimated to be 4,637 kW. Summer peak demand reduction is estimated to be 4,363 kW, and winter peak demand reduction is estimated to be 2,064 kW. The summer and winter diversity factors are calculated to be 94.1% and 44.5%, respectively.

Parameter	Connected Demand	
	kW	% Adjustment
Gross Tracking Savings	**4,723**	**N/A**
Controls Adjustment	0	N/A
Revised Tracking Savings	**4,723**	**N/A**
Documentation Adjustment	-56	-1.2%
Technology Adjustment	-45	-1.0%
Quantity Adjustment	15	0.3%
Connected Demand Reduction	**4,637**	**-1.8%**
Cooling Adjustment	670	14.2%
Summer Coincidence Adjustment	-944	-20.0%
Summer Peak Demand Reduction	**4,363**	**N/A**
Heating Adjustment	-428	-9.1%
Winter Coincidence Adjustment	-2,145	-45.4%
Winter Peak Demand Reduction	**2,064**	**N/A**

Table 25: Summary of National Grid Lighting Connected Demand Results

Evaluation Result	Evaluation Factors	Relative Precision
Annual Energy Realization Rate	99.4%	±8.2%
Energy On Peak Percentage	84.0%	±9.1%
Hours of Use Realization Rate	98.8%	±8.3%
Connected Demand Realization Rate	98.2%	±1.3%
Summer Diversity Factor	94.1%	±7.1%
Winter Diversity Factor	44.5%	±30.3%

Table 26: Summary of National Grid Results

6.2 Utility Realization Rate Summary

Figure 6 presents a summary of the realization rate point estimates for each utility (grey bar), along with the high and low ends of the error bounds based upon the calculated precisions. This illustration visually shows how tight the realization rates are among the various New Hampshire utilities studied.

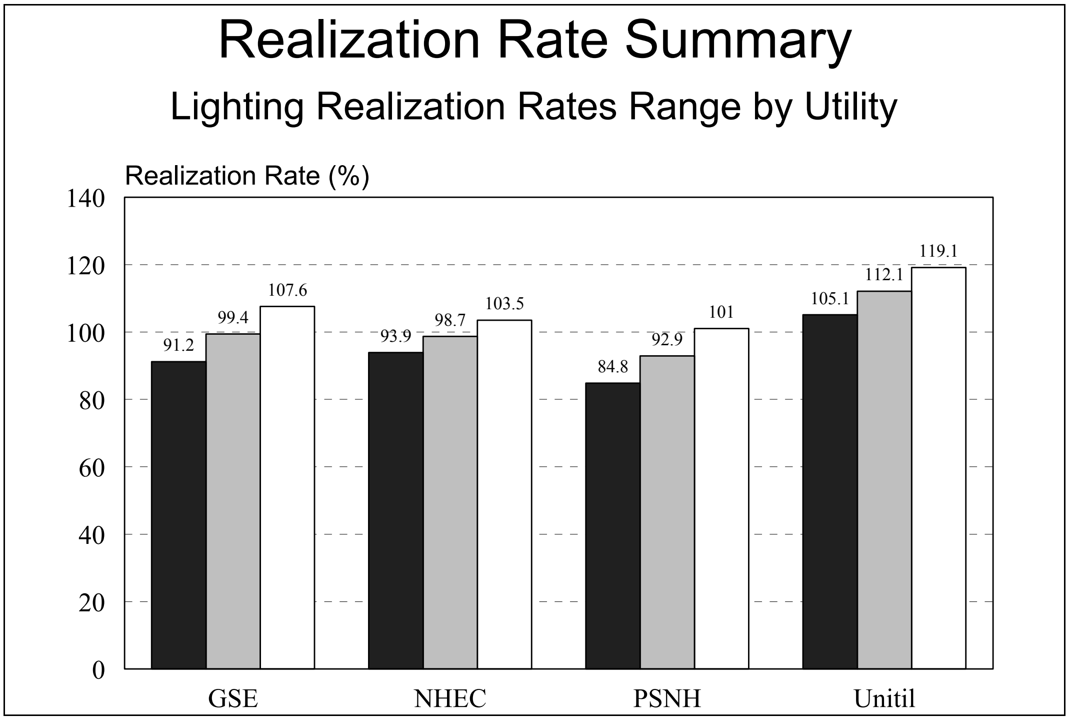


Figure 6: Summary of Realization Rates and Precisions

7 Super T8 Analysis

The 'Super T8' refers to a second generation fluorescent T8 lamp and electronic ballast lighting system that has begun to be introduced into the marketplace and are currently being rebated through the NH SBES Program. These systems offer advantages in energy efficiency, longer lamp life, and improved lumen depreciation. Although initially higher in cost than 'standard' T8s, it may be cost effective to retrofit even existing T8 electronically ballasted lighting with this new system for locations with significant annual operating hours. As part of the SBES study, RLW was asked to research Super T8's for purposes of gathering information on accepted industry wattages and comparing them to wattages used by the NH utilities.

Currently, there is no standard industry definition of 'super' T8, although it appears manufacturer specs for these second generation T8s fall close together. 'Super T8' systems are superior to standard T8s by virtue of a 'program start ballast' that allows the lamp to be lit with a softer start up than the present instant start T8 ballast. This results in improvements in the rated life of the lamp (generally regarded to increase from 20,000 to 30,000 hours). Further, this technology results in less light output loss over the life of the fixture, higher color rendering (80+ CRI), improved lumen depreciation (94%+), and has improved efficacy (90 or more average lumens per watt). The table below illustrates the improved light output of the Super T8 over other lamp and ballast types.

		Percentage improvement in efficacy	
Technology	**Light output (avg. lumens per watt)**	**Over T12**	**Over "standard" T8**
T12 40-watt lamp w/magnetic ballast	54	--	--
T12 34-watt lamp w/energy-saving ballast	54	--	--
"Standard" 32-watt T8 w/instant start ballast	75	39%	--
"Super" 32-watt T8 w/programmed start ballast	92	70%	23%
"Super" 32-watt T8 w/instant-start ballast	98	81%	31%

Source: Xcel Energy, courtesy of Benya Lighting Design and Rising Sun Enterprises

Table 27: Super T8 Light Output Compared to Previous Generations

The following three tables present the rated wattages from the specification sheets of four well-known manufacturers on 'Super T8' lighting systems. Also included are the branding terms these manufacturers are using to highlight this product and the assumed wattages being used by the New Hampshire utilities at this time. During the research on these systems, it was apparent that information on this technology is not easily interpreted as each manufacturer uses unique operating characteristics of 'Super T8' systems.

In this comparative analysis, we report the wattages of standard T8 lamps and 30-watt T8 lamps, although 28 watt T8's are also available for use. We did this as the New Hampshire assumptions appeared to be based upon standard T8 lamps, but in some instances the 30-watt lamps appeared to have manufacturer wattages that were more aligned with the utility assumptions. In the tables, we present the manufacturers' range of wattages when unique wattages are provided for different input voltages in addition to providing the wattages for both normal ballast and low power ballast systems. Table 28 presents the results for 2 lamp systems. The New Hampshire assumptions fall within the range of wattages provided by the four manufacturers examined in the F32 T8 column, but are slightly higher than the manufacturer wattages in the 30-watt lamp column.

		Manufacturer Wattages	
Manufacturer	**System Name**	**F32 T8**	**30 W T8**
2 L 4' Normal Ballast			
GE	Ultramax	53-54	52-53
Universal	TRIAD ULTim8	53-55	50-52
Advance	Optanium	55	52
Sylvania/Osram	PSX/XPS Xtreme	55	52
Utility Assumption	N/A	53	
2 L 4' Low Power Ballast			
GE	Ultramax	48	46
Universal	TRIAD ULTim8	47-48	44-46
Advance	Optanium	48	45
Sylvania/Osram	PSX/XPS Xtreme	46-47	43-44
Utility Assumption	N/A	47	

Table 28: 2 Lamp Super T8 System Comparisons

Table 29 and Table 30 present the results for 3 lamp and 4 lamp fixtures, respectively. The New Hampshire assumptions appear to align consistently with the Super T8 systems with 30-watt T8 lamps, but are somewhat lower than manufacturer wattages in the F32 column. This suggests that so long as vendors are installing the lower wattage T8 lamps in the 'Super T8' systems, the assumed wattages are reasonable.

Manufacturer	System Name	Manufacturer Wattages	
		F32 T8	**30 W T8**
3 L 4' Normal Ballast			
GE	Ultramax	80-82	77-78
Universal	TRIAD ULTim8	79-83	75-79
Advance	Optanium	82-83	76-77
Sylvania/Osram	PSX/XPS Xtreme	82-83	77-78
Utility Assumption	N/A	77	
3 L 4' Low Power Ballast			
GE	Ultramax	72-73	68-69
Universal	TRIAD ULTim8	70-74	65-70
Advance	Optanium	73	66-67
Sylvania/Osram	PSX/XPS Xtreme	71-73	67-69
Utility Assumption	N/A	67	

Table 29: 3 Lamp Super T8 System Comparisons

Manufacturer	System Name	Manufacturer Wattages	
		F32 T8	**30 W T8**
4 L 4' Normal Ballast			
GE	Ultramax	107-109	103-105
Universal	TRIAD ULTim8	105-109	99-103
Advance	Optanium	107-108	101-102
Sylvania/Osram	PSX/XPS Xtreme	107-108	101-102
Utility Assumption	N/A	101	
4 L 4' Low Power Ballast			
GE	Ultramax	96-97	91-92
Universal	TRIAD ULTim8	93-97	87-91
Advance	Optanium	95-96	89-88
Sylvania/Osram	PSX/XPS Xtreme	91-93	86-88
Utility Assumption	N/A	89	

Table 30: 4 Lamp Super T8 System Comparisons

As 'Super T8' systems continue to evolve and become more commonplace in the market, it is anticipated that information on these systems will become more available. The RPI Lighting Research Center reported in a February 2004 presentation for ACEEE that it would be generating a "Lighting Answers" publication soon to provide further independent information about this technology. When this publication is available, it will be located at http://www.lrc.rpi.edu/programs/NLPIP/publicationResults.asp?type=2.

8 Wattage Comparison Analysis

In the calculation of energy savings used to determine program realization rates, we utilized the assumed wattages used by each utility. However, as a core part of this study, we cross compared the wattage files provided to us from each utility against wattages RLW uses in its analysis of lighting measures. The wattages used by RLW are consistent with those being used and accepted by other utilities in New England, including many utilities in Connecticut, Rhode Island and Massachusetts. In a similar Small C&I study for these utilities in the summer of 2004, RLW used these wattages for determining program impacts. Therefore, they are believed to be appropriate for comparison to the current New Hampshire wattages.

In support of this element of the study, all three utilities forwarded electronic or hard copies of their wattage files to us. A review found that PSNH and Unitil generally use the same codes and wattages as RLW. NHEC forwarded tables of wattages published in September 1995 under the EPA Green Light Program "Lighting Upgrade Manual". We used the wattages listed in these tables for the comparison against the RLW wattages. The table below shows the most significant differences founds (of four watts or more).

Fixture Code	Fixture Type	Fixture Description	RLW Watts	Utility Watts	Difference
PSNH/Unitil					
1V0700S	Mercury Vapor	700W Mercury	760	775	+15
1M0175R	Metal Halide Lamp/Ballast	175W Linear	228	190	-38
1M0750P	Metal Halide Lamp/Ballast	750W MH CWA	850	815	-35
2F32EEL	4 Foot T8 Fluorescent System	2L4' T8EE/ELEE Low Pwr	52	47	-5
9F40BXE	2 Foot T8 Fluorescent System	9L2' F40BX/ELIG	306	288	-18
NHEC					
1H0070S	High Pressure Sodium	70W HPS	90	95	+5
1H0150S	High Pressure Sodium	150W HPS	190	195	+5
1H0250S	High Pressure Sodium	250W HPS	295	300	+5
1H0400S	High Pressure Sodium	400W HPS	460	465	+5
1H1000S	High Pressure Sodium	1000W HPS	1085	1100	+15
1M0100S	Metal Halide	100W Metal Halide	120	127	+7
1M0150S	Metal Halide	150W Metal Halide	190	195	+5
1M0175S	Metal Halide	175W Metal Halide	205	210	+5
1M1000S	Metal Halide	1000W Metal Halide	1075	1080	+5
1M1500S	Metal Halide	1500W Metal Halide	1615	1620	+5
2F96HSE	Eight Foot HO System	2L8' HO/STD/ELIG	195	209	+14
2F96SEM	4 Foot Fluorescent System	2L8' EE/EEMAG	123	128	+5
1H0360S	High Pressure Sodium	360W HPS	435	425	-10
1M0070S	Metal Halide	70W Metal Halide	95	90	-5
1M0360S	Metal Halide	360W Metal Halide	430	418	-12
1V0050S	Mercury Vapor	50W Mercury	75	67	-8
1V0250S	Mercury Vapor	250W Mercury	290	284	-6
1V1000S	Mercury Vapor	1000W Mercury	1075	1050	-25
2F96HEM	Eight Foot HO System	2L8' HO/EE/EEMAG	207	197	-10
3F32SSH	4 Foot T8 Fluorescent System	3L4' T8/ELIG HIGH LMN	112	96	-16

Table 31: Wattage Comparison Results

These differences can be accounted for mainly by considering that the wattage table used by NHEC was published in 1995, and a note on the tables cites the data source from "CEC/EPRI/DOE (1993) and manufacturer data". As would be expected, technology changes within established lighting types would naturally occur over a ten-year period. In addition, some manufacturers have dropped out or dropped product types over that 10-year horizon, which would alter the average wattages for some given lighting types shown.

9 Participant Feedback Survey

Participant feedback surveys were attempted at all on-sites. For the survey portion of the New Hampshire Small Business Energy Solutions Program evaluation our original total sample points were one hundred. However, of those, we were only able to complete a total of eighty-five participant feedback surveys. Those that were unable to be completed were due to the following:

1. Seven sites had a contact person that was hired after the installation of the lighting,
2. Two sites had contact people who refused to complete the survey,
3. One site did not have a contact person (the previous one had had left the position),
4. Two sites had contacts who could not recall the program well enough to respond to the survey, and
5. Two sites had contacts that we attempted to contact at the time of the visits and were unsuccessful in contacting over the phone following multiple attempts.

Also, it should be noted that the number of respondents for each of the questions varies slightly on account of the fact that some of the respondents chose not to answer certain questions due to a lack of knowledge on a specific topic.

Figure 7 and Figure 8 reveal program participants' overall impression of the Small Business Energy Solutions Program and whether or not the program met, exceeded, or fell below their expectations. Overall, the average program rating is 4.5 out of 5, on a one (unfavorable) to 5 (very favorable) scale. More than half of the respondents' overall impression of the program was very favorable (5 rating) with 60.5% reporting so. Only a very small percentage (1.2%) gave the lowest possible score. Program expectations were also quite high as nearly 97% of the respondents felt that the program either met or exceeded their expectations. Those who felt the program either fell below or exceeded their expectations were asked to specify what part of the program it was that made the difference. The results are shown below in Table 32.

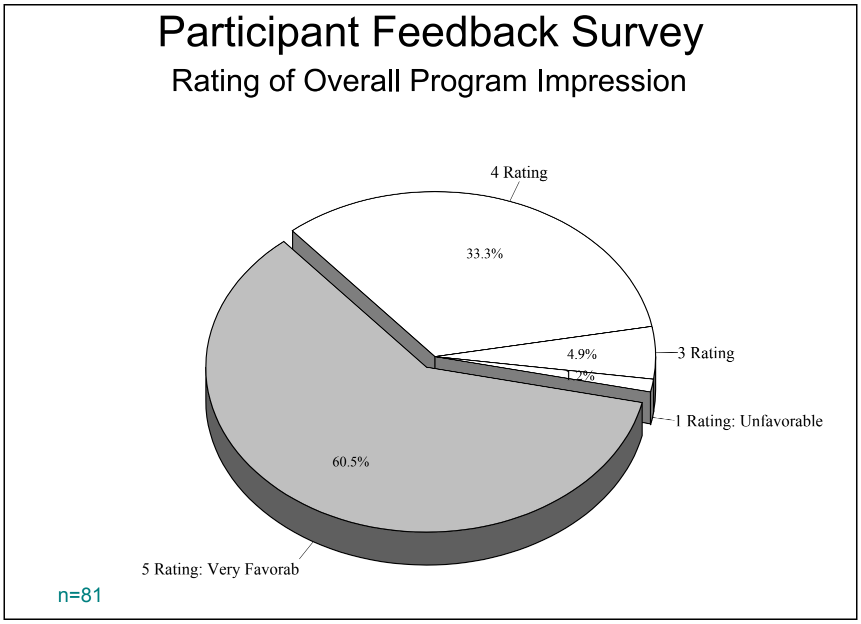


Figure 7: Overall Impression of the Program

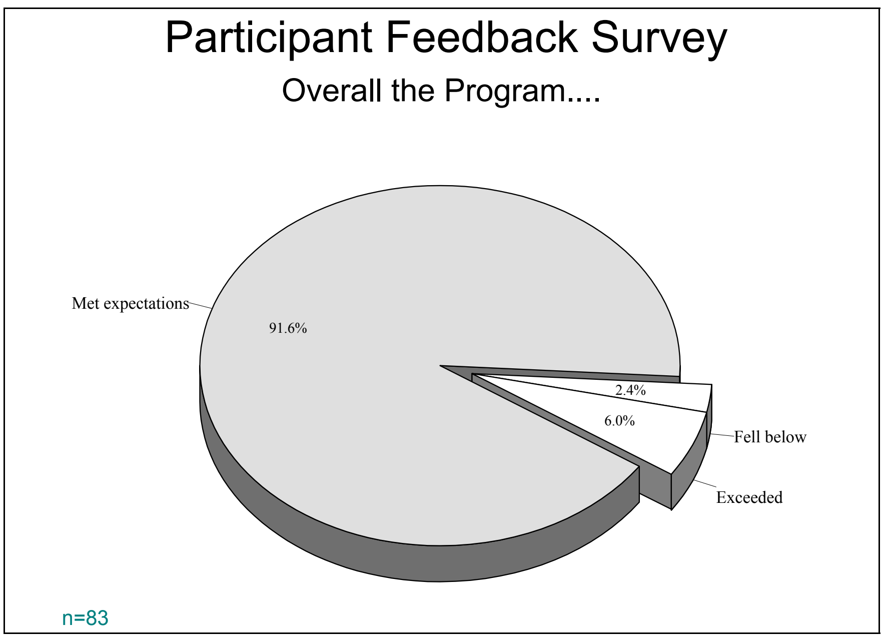


Figure 8: Meeting Program Expectations

What Part of the Program Caused it to…
Exceed my expectations (N=5)
Other - Value added to facility (3)
The amount of potential savings (2)
The size of the recommendations
The level of incentives
The installation work
Fall below my expectations (N=2)
The amount of potential savings
Other - Disappointed in CFL

Table 32: Part of the Program that Made the Difference in Expectation Levels

Survey respondents were provided a list of reasons from which to select why they decided to participate in the program. These responses are shown in Figure 9. The two most common reasons given for participation were to lower the electric bill (82.8%) and to save energy (82.8%). Survey respondents were also encouraged to give other reasons not listed above that may have influenced their decision to participate. Slightly more than 10% of the participants mentioned the need for improved quality of lighting as an influence on their decision to participate. Several others mentioned employee safety as a decision making factor.

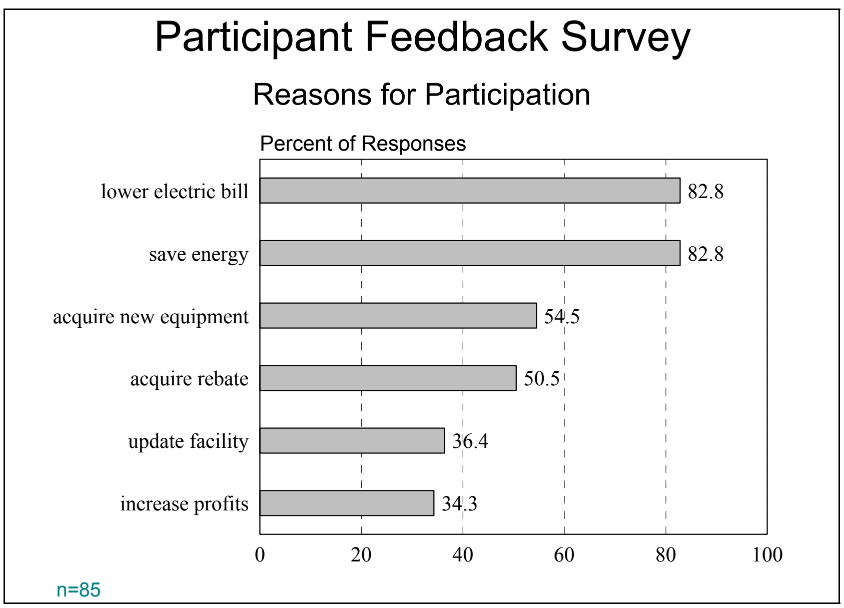


Figure 9: Reasons for Participating in the SBES Program

Participants were asked to describe the method through which they learned of the Small Business Energy Solutions Program. Table 33 reveals that more that one quarter (28.6%) of the respondents learned of the program through a mailing, such as a bill insert. Many respondents reported that they had heard of the program through 'other' means, with the majority of these respondents indicating they heard of the program through personal and/or business contact referrals such as company clients. Only 7% learned of the program through a telephone call received from their utility.

Method	# Of participants (N = 84)	% Of total
Other	43	51.2%
Received a mailing	24	28.6%
Utility account executive referral	10	11.9%
Received a call	6	7.1%
Not sure	1	1.2%
Grand Total	**84**	**100.0%**

Table 33: How Participants Learned about the Program

Table 34 below shows that while 38.6% applied to the Small Business Energy Solutions Program as soon as they learned of it, more than half (58.4%) of the respondents applied to the program after taking some time to think about it.

Application to Participate	# Of participants (N=83)	% Of total
Applied as soon as I learned about it	32	38.6%
Applied after some time thinking about it	45	54.2%
Applied after I received a second call or mailing	2	2.4%
Other	4	4.8%
Grand Total	**83**	**100.0%**

Table 34: How did you Decide to Participate

Participants were asked to rate the program marketing information that they received on two specific criteria using a scale of one to five where five means "excellent". The first was the level of ease in understanding the program and the second was the completeness and accuracy of the program marketing material. The results are shown in Figure 10. Participants reported that the program was easy to understand with more that three quarters (83.4%) rating the program a four or higher on a 1 (poor) to 5 (excellent) scale. Only 2.4% of the respondents reported that the program marketing material was somewhat difficult to understand (rating it a two). Results were similar for the completeness and accuracy of the program marketing material with slightly more that three quarters of the respondents (78.5%) scoring the marketing material a four or higher and only a small percentage (3.6%) giving it score of two or lower.

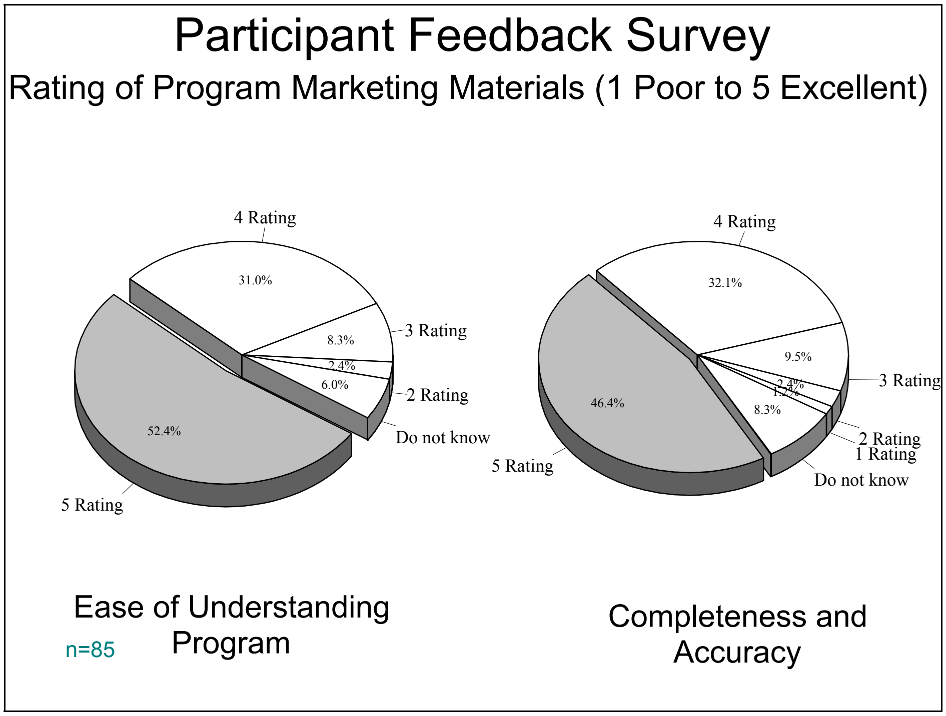


Figure 10: Rating the Program Marketing Information

Participants were asked to rate the various performance elements of the contractor that visited their facility from the program. Table 35 presents this information by utility on a scale of one to five where five means "excellent". Ratings were found to be quite high across all three New Hampshire utilities as all received a score of 4.4 or higher for each of the criteria with NHEC receiving a 4.9 in all but one category. When averaged together, the three utilities scored highest in courtesy and professionalism. Figure 11 below shows the overall service score by utility of the contractor who performed the energy assessment audit.

Initial Visit Element	Average Score out of 5			
	Total (n=82)	NHEC (n=14)	PSNH (n=39)	Unitil (n=29)
Scheduling of assessment at a convenient time	4.7	4.9	4.5	4.7
Timeliness of arrival for assessment	4.7	4.9	4.7	4.5
Ability to explain assessment in a clear and simple manner	4.7	4.9	4.8	4.5
Ability to answer questions adequately	4.7	4.9	4.8	4.4
Knowledge and competency	4.7	4.9	4.9	4.4
Courtesy and professionalism	4.8	4.9	4.9	4.5
Content and clarity of assessment report	4.5	4.8	4.6	4.3
Overall service received	4.7	4.9	4.8	4.4

Table 35: Initial Visit & Energy Assessment - Average Scores by Utility

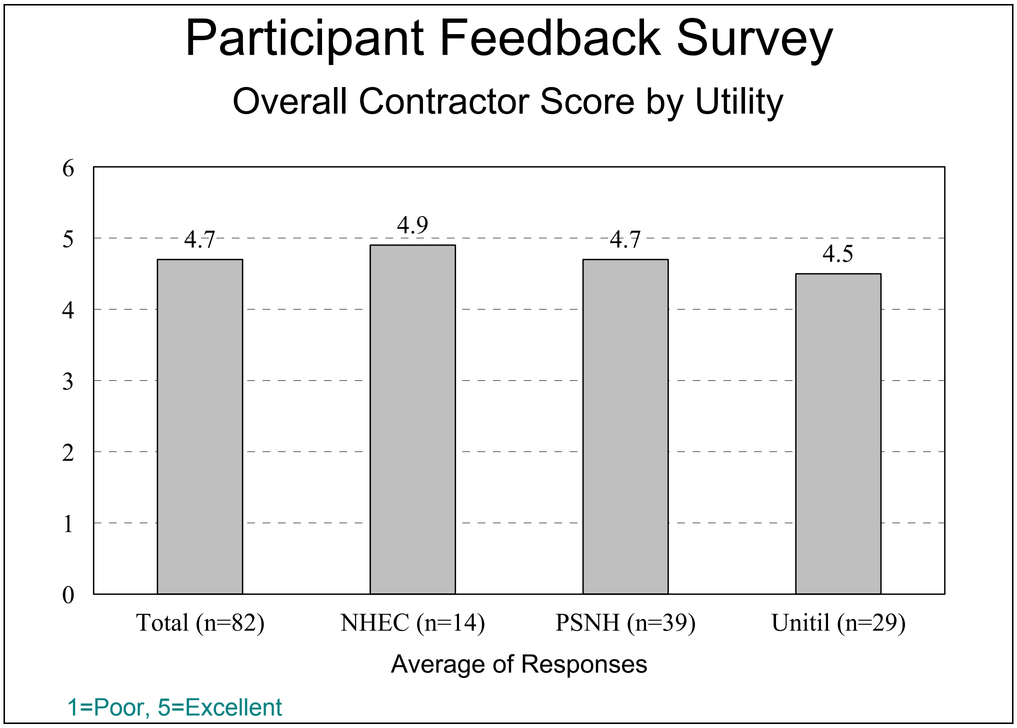


Figure 11: Overall Contractor Score by Utility

Table 36 shows participant responses when asked whether or not the contractor had informed them of any other measures that would benefit their facility but that were not covered under the program. Fourteen out of 83 (16.9%) respondents reported that their contractor did inform them of other measures; the two most common measures mentioned were occupancy sensors and motors.

Informed of Other Measure	# of participants (N=78)	% of total
Yes	14	16.9%
No	64	77.1%
Don't know	5	6.0%
Grand Total	**83**	**100.0%**

Table 36: Other Contractor Informed Measures

Survey participants were asked to comment on the audit service they received. Table 37 shows more than half of respondents (58.1%) reported being quite satisfied with the energy assessment audit process as they stated it was either "good" or "excellent". Several respondents did suggest that an improved clarity of information, more specifically, potential savings and level of incentives, would have been favorable.

Response	# Of Respondents (N=31)	% Of Total
Good Program	14	45.2%
Excellent Program	4	12.9%
Improved clarity of information	4	12.9%
Need better coordination	4	12.9%
Audit Incomplete	3	9.7%
Building weatherization measures should be indoors	1	3.2%
Cleaning fixture should be included	1	3.2%
Grand Total	**31**	**100.0%**

Table 37: Comments on Audit Service

Program participants were asked to rate the electrician who installed the measures on a scale of one to five where five means "excellent". Table 38 above shows the average score by utility. NHEC did quite well, receiving an average rating of 4.9 across all criteria. Figure 12 below illustrates the overall ratings received by utility for the electrician who installed the measures.

Installing Electrician Element	Average Score out of 5			
	Total (83)	NHEC (14)	PSNH (40)	Unitil (29)
Scheduling of installation at a convenient time	4.3	4.9	4.4	4.0
Timeliness of arrival for installation	4.4	4.9	4.5	4.0
Adequacy and completion of installation	4.3	4.9	4.6	3.8
Explanation of how to operate new equipment	4.0	4.9	4.1	3.4
Cleanliness of work areas	4.4	4.9	4.5	4.0
Knowledge and competency	4.4	4.9	4.7	4.0
Courtesy and professionalism	4.4	4.9	4.7	3.8
Overall service received	4.3	4.9	4.5	3.7

Table 38: Electrician Installation Service & Results - Average Scores by Utility

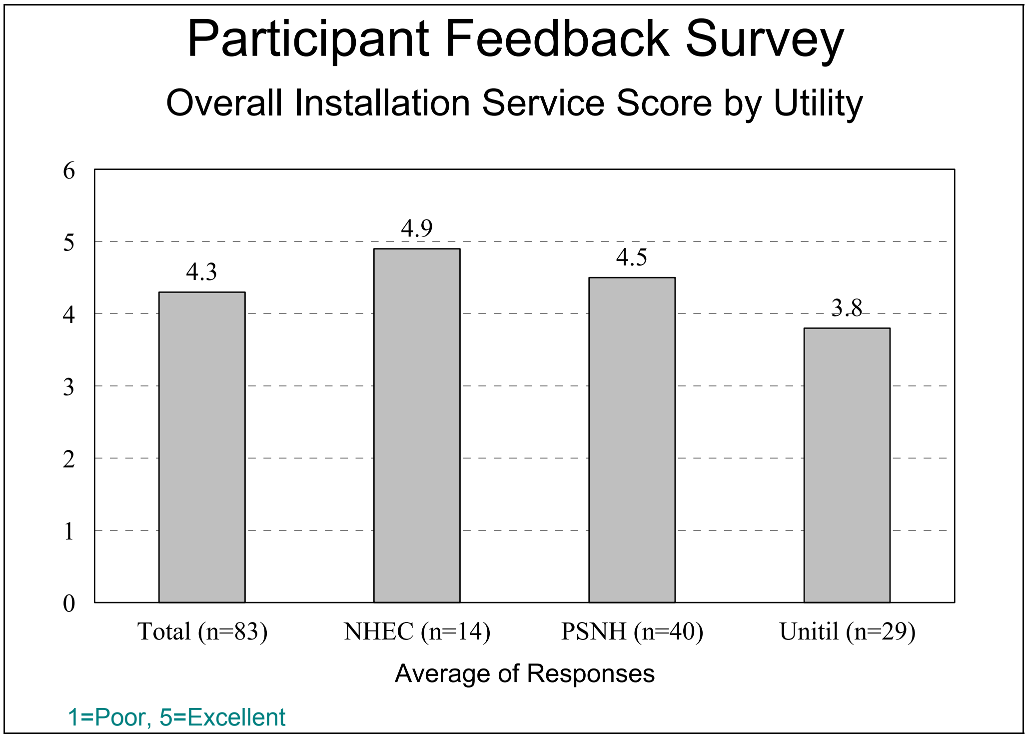


Figure 12: Overall Installation Service Score by Utility

Table 39 presents program participant comments on the installation service and results they received from the electrician who installed the measures. In general, respondents were quite satisfied with the service they received with slightly more than 40% stating that they felt the electrician did either a "good" or "excellent" job. However, a significant percentage (20%) reported that they had difficulty with the electrician cleaning up after the installation or the electrician did not remove the old materials. Other problems reported to a lesser degree include some instances in which the project was never completed by the electrician, inconsiderateness of day-to-day business operations by at least one electrician, and a lack of communication between auditors, electricians, and the customer.

Comment	**# Of Partipants (N=49)**	**% Of Total**
Good job	14	28.6%
Did not clean up after themselves/did not dispose of waste	10	20.4%
Excellent job	6	12.2%
Project never completed by electrician	6	12.2%
Confusion due to lack of communication	4	8.2%
More convenient installation times	4	8.2%
Prefer to use local contractor not utility contractor	2	4.1%
Inconsiderate	1	2.0%
Match contractor to need of site. Project overwhelmed installers	1	2.0%
Part of new construction - no "lighting only" installation	1	2.0%
Grand Total	**49**	**100.0%**

Table 39: Comments on Installation Service and Results

When asked, a total of 46 respondents reported they recalled receiving a follow up inspection from a utility representative. Those that did receive a follow up inspection were asked to rate the individual who inspected the installation of the energy efficient measures on a scale of one to five where five means "excellent" on the items listed below in Table 40. Results are shown by utility. The three New Hampshire utilities received considerably high ratings with all scoring at least a 4.1 or higher in each of the categories.

Inspection of Measure Element	Average Score out of 5			
	Total (46)	NHEC (7)	PSNH (28)	Unitil (11)
Scheduling of appointment at a convenient time	4.7	4.8	4.8	4.4
Timeliness of arrival for appointment	4.7	4.8	4.8	4.4
Ability to explain information in a clear and simple manner	4.6	4.8	4.7	4.1
Ability to answer questions adequately	4.6	4.8	4.7	4.3
Accessibility if you had questions	4.7	4.8	4.7	4.4
Knowledge and competency	4.8	4.8	4.9	4.4
Courtesy and professionalism	4.8	4.8	4.9	4.4
Overall service received	4.7	4.8	4.9	4.3

Table 40: Inspection of Measures - Average Scores by Utility

Program participants seem to be particularly satisfied with utility engineer who inspected the installation of the energy efficiency measures with the overall score across all three utilities being a 4.7 out of 5 as illustrated in Figure 13. Respondents were asked to comment on the inspection service. Most reported that the utility engineer's inspection was quite good and the process was relatively quick. One participant in particular mentioned that at one point he had a problem with the paperwork but the utility engineer "went out of his way" to resolve the problem.

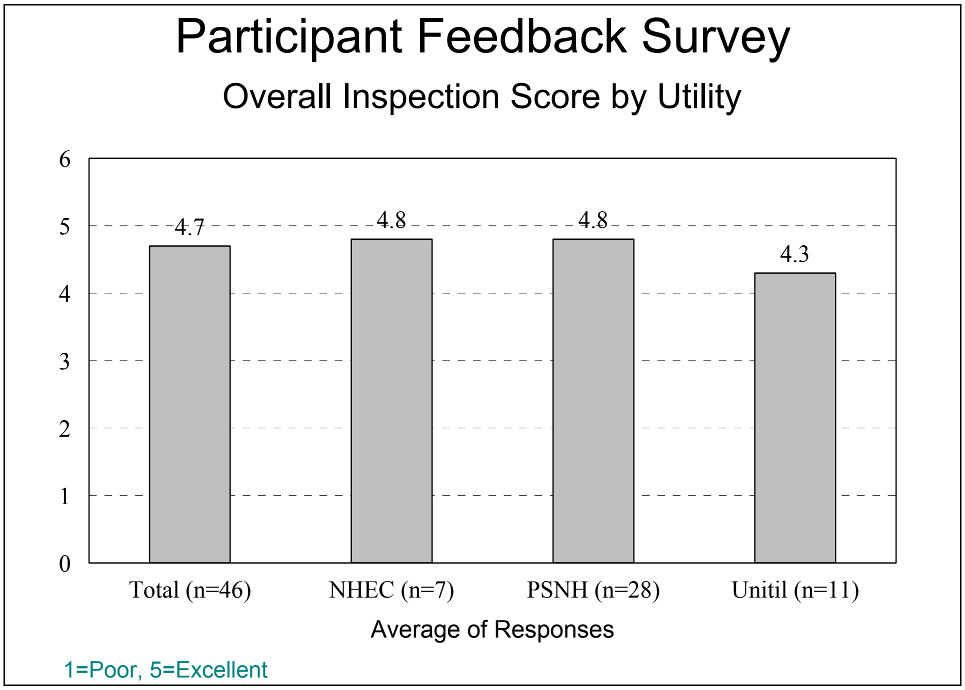


Figure 13: Overall Scores of Utility Inspection Representative

Participants in the Small Business Energy Solutions Program were asked to rate their satisfaction levels with the energy efficiency measures that were installed. Figure 14 illustrates that satisfaction levels are fairly high. Only a very small percentage (1.3%) of participants reported being not satisfied with the program measures. This dissatisfaction was on account of an increase in electric bills after the energy efficient measures were installed but there was no change in operation levels. Other comments provided on measure satisfaction are illustrated in Table 41 below. A surprisingly large percentage of participants (35.1%) reported faulty product quality, more specifically, the longevity of bulbs being highly undependable with numerous bulbs blowing in a very short amount of time. This issue was further examined to determine whether these faulty products were associated with a particular utility or vendor, and found no such trends. These faulty products appear to be random instances of faulty products installed through the program.

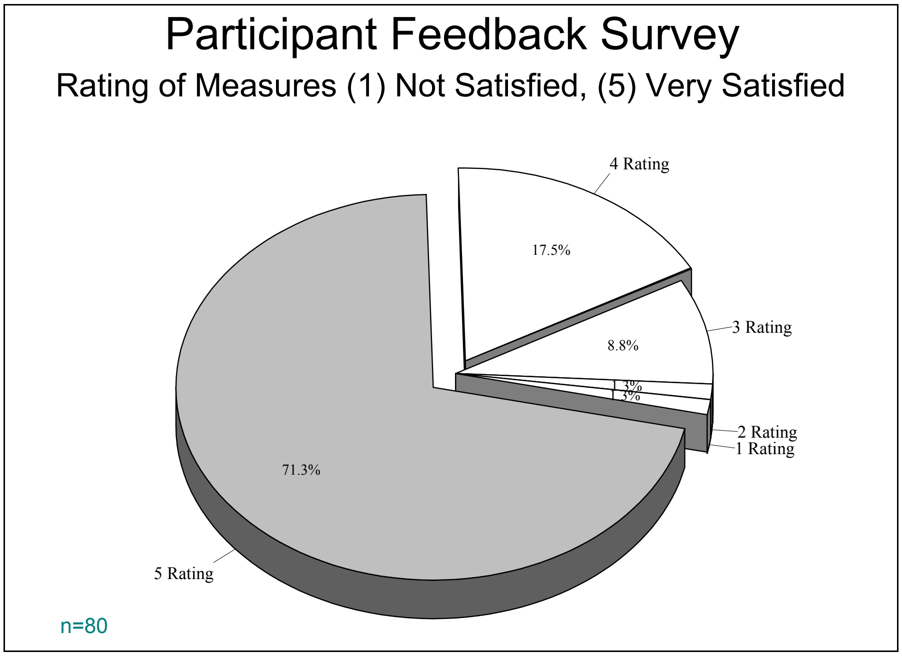


Figure 14: Post Installation Satisfaction

Comment	# Of Participants (N=37)	% Of Total
Faulty products	13	35.1%
Very Satisfied	6	16.2%
Improved quality of lighting	6	16.2%
Energy savings verified	5	13.5%
Incorrect measures installed or missing	4	10.8%
Difficult to verify energy savings	2	5.4%
Difficulty finding exterior fixtures	1	2.7%

Table 41: Comments on Post Installation Satisfaction

Participants were asked an open-ended question on any improvements that should be made to the program. Nearly one third of the respondents (29.4%) suggested increasing program advertisement in addition to more detailed information in advertisements. A significant portion, 13.7%, would prefer to use a local contractor instead of a utility authorized contractor to perform the work and an equal amount of respondents reported they could not think of any improvements to the program.

Suggested Improvement	# Of Participants (N=51)	% Of Total
Increase program advertisement/information	15	29.4%
No improvements needed	7	13.7%
Improved quality of contractors/use local contractors	7	13.7%
Better post installation follow up to confirm savings/operation	5	9.8%
Make it easier to obtain replacements	4	7.8%
Decrease length of time of entire process	3	5.9%
More opportunities for energy efficiency	3	5.9%
Quicker pick up of old materials/recyclables	2	3.9%
Faster payment of incentives	2	3.9%
Greater incentives for non-profits	2	3.9%
Increased product quality	1	2.0%
Grand Total	**51**	**100.0%**

Table 42: Participant Suggested Improvements to the Program

When asked, most respondents reported a relatively low number of problems with the program. The majority of respondents reported experiencing no problems at all. Of those that did experience problems, the most common were faulty products. Specifically, most of these respondents reported either CFLs that had failed or dimmed over time or ballast failures. The second most reported problem were situations in which measure installations were noted as incomplete or missing. Less mentioned problems included difficulty in getting old materials picked up for recycling, difficulty in finding replacements for products under warrantee, and contractors who did not clean up after themselves.

Problem	# Of times reported
Faulty products	11
Incorrect measures installed, missing, or not completed	8
Difficulty in getting old materials picked up/recycled	5
Lack of communication/coordination	4
Contractor did not clean up after himself	4
Difficult to find replacement products	1
Grand Total	**36**

Table 43: Problems Experienced with the Program

Participants in the Small Business Energy Solutions Program were asked to tell of any other energy efficient opportunities they believe their building could use. Less than half (37.5%) reported a perceived need for additional energy efficient measures. Of those that did see an opportunity for additional measures, more than one third (36.7%) reported their building is in need of energy efficient HVAC equipment. Several participants also mentioned their building could use energy efficient lighting in locations other than those already treated. Several other participants felt their buildings were in need of higher efficiency motors.

Energy Efficient Opportunities	Count (n=30)	% Of Total
HVAC	11	36.7%
More lighting	4	13.3%
High efficiency motors	3	10.0%
Digital Thermostats	1	3.3%
Energy efficient washers	1	3.3%
Energy Management Systems	1	3.3%
Ground source heat pumps	1	3.3%
Install new coating machines	1	3.3%
Insulation	1	3.3%
New doors	1	3.3%
Photo volt	1	3.3%
Refrigeration units	1	3.3%
Solar water preheat	1	3.3%
Variable speed drives	1	3.3%
Window replacements	1	3.3%
Grand Total	**30**	**100.0%**

Table 44: Other Perceived Efficiency Opportunities of Participants

For those participants who saw a need for other energy efficient opportunities for their facility, nearly half (43.3%) would prefer to use their own contractor to perform the installation work and only one quarter (26.7%) would rather have an authorized utility contractor. These results are shown in Table 45. In addition to their preferred method of installation of additional energy efficient measures, participants were also asked to specify their approximate level of interest in pursuing these potential upgrades at the current time. Table 46 below reveals participant responses. The percentage of participants who currently have a high level of interest (46.2%) and the percentage that will wait at least one year to pursue potential energy efficient upgrades (42.3%) are similar.

Installation	Count (N=30)	% Of Total
Myself/in-house	3	10.0%
Own contractor	13	43.3%
Authorized Utility Contractor	8	26.7%
Most cost effective	3	10.0%
Don't know	3	10.0%
Grand Total	**30**	**100.0%**

Table 45: Preferred Installation Method

Level of Interest	Count (N=26)	% Of Total
High level of interest	12	46.2%
Moderate interest	3	11.5%
Will wait at least one year	11	42.3%
Grand total	**26**	**100.0%**

Table 46: Current level of interest in pursuing potential upgrades

At the end of the survey participants were asked for any final comments or opinions about the program. Table 47 details those responses. For the most part the responses are varied, however, nearly one third (27.6%) of the respondents replied that the Small Business Energy Solutions Program is a "good program".

Comment	Count (N=29)	% of Total
Great program	8	27.6%
Better post installation follow up to verify savings and product performance	3	10.3%
Expand program offerings	2	6.9%
Improve quality of products available through the program	2	6.9%
Increase the number of schools involved	2	6.9%
Better coordination and contractor selection	1	3.4%
Electric utility need gas improvement for heating.	1	3.4%
Increase aid to non-profit agencies	1	3.4%
Increase program advertisement	1	3.4%
Lack of coordination for replacement of products under warrantee	1	3.4%
Make sure give enough credit to Rich Chagnon	1	3.4%
Need to increase heat pump incentives	1	3.4%
Next year maybe expansion. A/C surges power. Lighting operates w/ breakers w/o direct switch.	1	3.4%
Nice to get rebate	1	3.4%
Nice to have T8's	1	3.4%
No utility cooperation	1	3.4%
Difficulty in getting old materials picked up/recycled	1	3.4%
Grand Total	**29**	**100.0%**

Table 47: Final Comments or Opinions about the Program

10 Recommendations

These recommendations rest upon our experience in performing the on-sites and working with the associated paperwork during the SBES impact evaluation. As this evaluation was concurrent with ongoing program QA/QC activities, some of these recommendations may be underway or completed before this study's publication.

1. In performing file reviews and subsequent on-site analysis, it was noted that lifetimes are not consistent for similar measures among (and sometimes within) projects. Examples include LED lights noted to have a lifetime of 12 years in one project and 15 for another within the same utility and an instance of CFLs having a lifetime of both 13 years and 6 years with the same operating hours in the same project. It should also be noted NHEC and Unitil currently use an assumed lifetime of 15 years for all lighting measures, regardless of type. An improvement goal for future operations might include using a consistent set of lifetimes among all utilities and varying those lifetimes according to lighting technology (currently done by PSNH).

2. During the file reviews, it was noted that some projects did not use the wattages assumed by the utilities. For example, one project with 32 watt CFLs used 32 watts as the spreadsheet wattage when the utility assumed wattage for that lighting type should have been 34 watts. An improvement goal for future operations might include encouraging vendors to consistently and uniformly use

utility assumed wattages in all lighting savings calculations in the SBES program.

3. Exterior lighting and controls had substantial negative impacts in their realized savings due to decreases in their operating hours observed on-site as compared to the assumed tracking system hours. While difficult to account for, an improvement goal might include encouraging customers at the time of control measure installation to not override them and encouraging vendors to account for timers and photocells on exterior fixture estimates of operation.

3. We suggest that the NH utilities ensure that vendors installing 'Super T8' systems through the program are using the correct assumptions depending upon the lamp installed. We suggest this since 'Super T8' systems can be installed with F32 or F30 lamps, each of which would each have different wattage assumptions associated with them. The current 'Super T8' wattage assumptions appear to be aligned well with the F30 lamps, but not other alternative lamps that may be installed.

4. We recommend that NHEC begin using more current wattages in the Small Business tracking calculations; one option available for use are the consistent wattages used by PSNH, Unitil and RLW.

5. An improvement goal for future operations might include examining the causes of reported pre mature lighting burnout by respondents, which might include tracking this issue over time to ensure improvement in lighting lifetime integrity.

Appendix A: Participant Feedback Survey

Visit Date/Time: _______________________ Auditor: ___________________________________
Business Name: ____
Account /Project#: _____________________ Sq. Ft.: ____________________________________
Contact Name: ________________________ Phone: ____________________________________

DIRECTIONS: **Follow the survey as directed.**

	Unfavorable				Favorable	Don't Know
1. On a scale of 1 to 5, where 5 means "very favorable", what is your overall impression of the Small Business Energy Solutions Program?	1	2	3	4	5	99

2. How did you learn about the program?

__a. Received a call b. __ received a mailing __c. utility account executive referral __d. Other _

3. Which statement best represents how you decided to participate?

__a. Applied as soon as I learned about it b. __ applied after some time thinking about it __c. applied after I received a second call or mailing __d. OTHER (describe) ______________________________

Program marketing information > On a scale of 1 to 5, where 5 means "excellent", please rate the following items pertaining to the program marketing:

	Poor				Excellent	Don't Know
4. Ease of understanding the program.	1	2	3	4	5	99
5. Completeness and accuracy of the program marketing material.	1	2	3	4	5	99

6. To you, would there have been a better way to learn about the program? Y N
IF YES > What would that be? (use back of page if desired):

7. Which of the following best describes why you decided to participate (check all that apply):
__a. Save energy __b. Lower electric bill __c. Get a rebate __ d. increase profits
__g. Get new equipment __h. Update building __i. OTHER ______________________________

Initial visit > On a scale of 1 to 5, where 5 means "excellent", please rate the contractor who PERFORMED THE ENERGY ASSESSMENT of your facility on the following items:

	Poor				Excellent	Don't Know
8. Scheduling of assessment at a convenient time	1	2	3	4	5	99
9. Timeliness of arrival for assessment	1	2	3	4	5	99
10. Ability to explain assessment in a clear and simple manner	1	2	3	4	5	99
11. Ability to answer questions adequately	1	2	3	4	5	99
12. Knowledge and competency	1	2	3	4	5	99
13. Courtesy and professionalism	1	2	3	4	5	99
14. Content and clarity of assessment report	1	2	3	4	5	99
15. Overall service	1	2	3	4	5	99

16. Did the contractor inform you of other measures that would benefit your facility that were not covered under this program? Y N > 16a. IF YES > Please list:

17. Comments on audit service (use back of page if needed):

Installation service and results > On a scale of 1 to 5, where 5 means "excellent", please rate the electrician who INSTALLED THE MEASURES on the following items

	Poor				Excellent	Don't Know
18. Scheduling of installation at a convenient time	1	2	3	4	5	99
19. Timeliness of arrival for installation	1	2	3	4	5	99
20. Adequacy and completion of installation	1	2	3	4	5	99
21. Explanation of how to operate new equipment	1	2	3	4	5	99
22. Cleanliness of work areas	1	2	3	4	5	99
23. Knowledge and competency	1	2	3	4	5	99

24. Courtesy and professionalism	1	2	3	4	5	99
24. Overall service received	1	2	3	4	5	99

25. Comments on installation service (use back of page if needed):

26. Did you receive a follow up inspection from a utility representative?

__a.YES __b.NO > **SKIP TO Q36** __c.DK > **SKIP TO Q36**

Inspection of Measures > On a scale of 1 to 5, where 5 means "excellent", please rate the utility engineer who INSPECTED THE INSTALLATION of the energy efficiency measures on the following items:

	Poor				Excellent	Don't Know
27. Scheduling of appointment at a convenient time	1	2	3	4	5	99
28. Timeliness of arrival for appointment	1	2	3	4	5	99
29. Ability to explain information in a clear and simple manner	1	2	3	4	5	99
30. Ability to answer questions adequately	1	2	3	4	5	99
31. Accessibility if you had questions	1	2	3	4	5	99
32. Knowledge and competency	1	2	3	4	5	99
33. Courtesy and professionalism	1	2	3	4	5	99
34. Overall service received	1	2	3	4	5	99

35. Comments on inspection service (use back of page if needed):

Post Installation Satisfaction > On a scale of 1 to 5, where 5 means "very satisfied":

36. How satisfied are you with the energy efficiency measures that were installed?	1	2	3	4	5	99
37. Comments on post-installation results (use back of page if needed):						

38. What could be done, if anything, to improve this program?

39. What kind of problems, if any, did you experience with this program?

40. What other energy efficient opportunities do you believe that your building could use? (CLARIFY TO THE CUSTOMER THAT THE QUESTION REFERS TO BUILDING EFFICIENCY MEASURES, NOT GENERIC BUILDING IMPROVEMENTS SUCH AS NEW ROOFS, WALLS, FOUNDATIONS, ETC.)

41. ____
42. ____
43. ____
44. ____

41. If the utility offered a program to support any of these opportunities, how would you prefer to have the installations done – by yourself, by your own contractor, or by an authorized utility contractor?

42. __ a. myself/in-house __b. own contractor __c. authorized utility contractor
43. __ a. myself/in-house __b. own contractor __c. authorized utility contractor
44. __ a. myself/in-house __b. own contractor __c. authorized utility contractor
45. __ a. myself/in-house __b. own contractor __c. authorized utility contractor

42. Please specify the approximate level of interest you have in pursuing these potential upgrades at this time.

43. __ a. High level of interest __b. Moderate Interest __c. Will wait at least a year
44. __ a. High level of interest __b. Moderate Interest __c. Will wait at least a year
45. __ a. High level of interest __b. Moderate Interest __c. Will wait at least a year
46. __ a. High level of interest __b. Moderate Interest __c. Will wait at least a year

43. Please choose what you think best fills in the blank.

"Overall, I felt the program -

A. ___ fell below what I expected." B. ___ met what I expected." C.___ exceeded what I expected."

44. **IF ANSWER ABOVE IS "A" or "C"** > What were the parts that made a difference?

45. ___ The size of the recommendations
46. ___ The amount of potential savings
47. ___ The level of incentives
48. ___ The installation work

49. ___ Other (list) ____

45. Finally, any other comments or opinions about the program? (use back of page if needed):

Appendix B: Savings Calculation Methods

This section serves as a detailed example that illustrates the calculation of all savings and adjustment factors. RLW shows a single line item from a sample customer to serve as an example of the calculation methods.

Table 48 presents the pre-retrofit condition for this space as it might be outlined in the application documentation. The pre-retrofit condition included 24 2F96SES fixtures rated at 138 watts each. The application also assumes 3,536 annual operating hours.

TRACKING: PRE-RETROFIT CONDITION					
Quantity	Fixture Code	Description	Fixture Type	W/Fixt	Hours of Operation
24	2F96SES	2L8' EE/STD	EIGHT FOOT FLUORESCENT SYSTEMS	138	3,536

Table 48: Tracking Pre-Retrofit Condition

Table 49 represents the post-retrofit condition according to the tracking system. In this case, the pre-retrofit fixtures were to be replaced with 24 2F59SSL fixtures rated at 100 watts per fixture. The hours of operation in the post-retrofit condition were 3,536 hours.

TRACKING: POST-RETROFIT CONDITION					
Quantity	Fixture Code	Description	Fixture Type	W/Fixt	Hours of Operation
24	2F59SSL	2L8' T8/ELIG LOW	EIGHT FOOT T8 SYSTEMS	100	3,536

Table 49: Tracking Post-Retrofit Condition

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

$$\begin{aligned} \text{DOC KWH ADJ} &= \text{RLW RECREATED TRACKING SAVINGS} - \text{TRACKING KWH SAVINGS} \\ &= 3{,}225 - 3{,}225 = 0\ \text{kWh} \end{aligned}$$

Hours of Use

The first on-site task was establishing the customer's holiday and vacation/shutdown schedule. Table 50 shows the input for the site holiday analysis, which was also used to block out planned days of vacations shutdowns in a facilities' schedule. In this particular case, the site contact informed the evaluating engineer that the facility was closed during 5 major holidays. For this site, the total number of holidays was 5 and there were 255 weekdays that the facility was open.

SITE HOLIDAYS	year =	2004
Holiday	**Date**	**Include?**
New Years Day	01/01/04	Y
MLK Day	01/19/04	N
Washington's Bday	02/16/04	N
Good Friday	04/09/04	N
Memorial Day	05/31/04	N
Independence Day	07/05/04	Y
Labor Day	09/06/04	Y
Columbus Day	10/11/04	N
Veterans Day	11/11/04	N
Thanksgiving Day	11/25/04	Y
Thanksgiving Friday	11/26/04	N
Christmas	12/24/04	Y
Christmas Eve	12/23/04	N

Table 50: Input for Site Specific Holidays

To determine the annual operating hours from monitoring lighting logger data, engineers examine the hourly percent run time across the entire monitoring period. Hourly data was analyzed in blocks of full seven-day weeks so as not to weight a given day more than another.

Table 51 presents a one-day sample of logger data as it was examined in the analysis spreadsheet. The first four columns are from the lighting logger, and the last three columns extract the hour of day, day of week, and set a TRUE/FALSE flag if the date is listed in Table 48 as a holiday.

Date	Hr Starting	Hr Ending	Percent on	Hour	Weekday	Holiday
6/7/2004	12:00:00 AM	12:59:59 AM	0.00%	1	2	FALSE
6/7/2004	1:00:00 AM	1:59:59 AM	0.00%	2	2	FALSE
6/7/2004	2:00:00 AM	2:59:59 AM	0.00%	3	2	FALSE
6/7/2004	3:00:00 AM	3:59:59 AM	0.00%	4	2	FALSE
6/7/2004	4:00:00 AM	4:59:59 AM	0.00%	5	2	FALSE
6/7/2004	5:00:00 AM	5:59:59 AM	0.00%	6	2	FALSE
6/7/2004	6:00:00 AM	6:59:59 AM	0.00%	7	2	FALSE
6/7/2004	7:00:00 AM	7:59:59 AM	91.10%	8	2	FALSE
6/7/2004	8:00:00 AM	8:59:59 AM	100.00%	9	2	FALSE
6/7/2004	9:00:00 AM	9:59:59 AM	100.00%	10	2	FALSE
6/7/2004	10:00:00 AM	10:59:59 AM	100.00%	11	2	FALSE
6/7/2004	11:00:00 AM	11:59:59 AM	100.00%	12	2	FALSE
6/7/2004	12:00:00 PM	12:59:59 PM	100.00%	13	2	FALSE
6/7/2004	1:00:00 PM	1:59:59 PM	100.00%	14	2	FALSE
6/7/2004	2:00:00 PM	2:59:59 PM	100.00%	15	2	FALSE
6/7/2004	3:00:00 PM	3:59:59 PM	100.00%	16	2	FALSE
6/7/2004	4:00:00 PM	4:59:59 PM	100.00%	17	2	FALSE
6/7/2004	5:00:00 PM	5:59:59 PM	100.00%	18	2	FALSE
6/7/2004	6:00:00 PM	6:59:59 PM	100.00%	19	2	FALSE
6/7/2004	7:00:00 PM	7:59:59 PM	100.00%	20	2	FALSE
6/7/2004	8:00:00 PM	8:59:59 PM	1.90%	21	2	FALSE
6/7/2004	9:00:00 PM	9:59:59 PM	0.00%	22	2	FALSE
6/7/2004	10:00:00 PM	10:59:59 PM	0.00%	23	2	FALSE
6/7/2004	11:00:00 PM	11:59:59 PM	0.00%	24	2	FALSE

Table 51: Hourly Logger Data

Next, an 8x24 profile (Sunday through Saturday plus Holiday by hour-of-day) is generated to represent the average percentage of time that the fixture operated during the monitoring study. In instances where photocells were controlling exterior fixtures, hours of light per day were used to estimate the percent on-times akin to how the logger data was used. Table 52 presents the profile of the logger used for this example. In this analysis, the 8x24 matrix on the right was reduced to a 4x24 profile (Weekday, Saturday, Sunday, and Holiday by hour-of-day), from which the spreadsheet computes the annual hours per year.

LOGGER 1

Logger S/N 940927-254
Description
Space Type Parts Loft

Hr	WD	Sat	Sun	Hol	Hrs/Yr
1	0.10	0.00	0.00	0.00	26
2	0.10	0.00	0.00	0.00	26
3	0.10	0.00	0.00	0.00	26
4	0.10	0.00	0.00	0.00	26
5	0.10	0.00	0.00	0.00	26
6	0.10	0.00	0.00	0.00	26
7	0.16	0.00	0.00	0.00	40
8	0.67	0.08	0.00	0.00	177
9	0.98	0.66	0.00	0.00	284
10	1.00	0.93	0.00	0.00	304
11	1.00	1.00	0.00	0.00	307
12	1.00	1.00	0.00	0.00	308
13	1.00	1.00	0.00	0.00	308
14	1.00	0.94	0.00	0.00	304
15	1.00	0.75	0.00	0.00	295
16	1.00	0.28	0.00	0.00	270
17	1.00	0.00	0.00	0.00	256
18	0.69	0.00	0.00	0.00	176
19	0.22	0.00	0.00	0.00	56
20	0.05	0.00	0.00	0.00	13
21	0.05	0.00	0.00	0.00	13
22	0.05	0.00	0.00	0.00	13
23	0.05	0.00	0.00	0.00	13
24	0.05	0.00	0.00	0.00	14
Total	11.6	6.6	0.0	0.0	3,304

	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Hol
Tot	52	50	52	53	50	51	52	5
Hour	**Sun**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Hol**
1	0.0	0.0	0.0	25.0	0.0	25.0	0.0	0.0
2	0.0	0.0	0.0	25.0	0.0	25.0	0.0	0.0
3	0.0	0.0	0.0	25.0	0.0	25.0	0.0	0.0
4	0.0	0.0	0.0	25.0	0.0	25.0	0.0	0.0
5	0.0	0.0	0.0	25.0	0.0	25.0	0.0	0.0
6	0.0	0.0	0.0	25.0	0.0	25.0	0.0	0.0
7	0.0	5.0	4.9	28.9	10.9	29.0	0.0	0.0
8	0.0	64.7	58.7	61.4	84.0	68.1	8.0	0.0
9	0.0	100.0	99.1	89.3	100.0	100.0	66.0	0.0
10	0.0	100.0	100.0	100.0	100.0	100.0	93.2	0.0
11	0.0	100.0	98.9	100.0	100.0	100.0	100.0	0.0
12	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0
13	0.0	100.0	100.0	100.0	100.0	100.0	100.0	0.0
14	0.0	97.8	100.0	100.0	100.0	100.0	94.0	0.0
15	0.0	100.0	99.9	100.0	100.0	100.0	74.8	0.0
16	0.0	98.1	100.0	100.0	100.0	100.0	28.0	0.0
17	0.0	100.0	100.0	100.0	100.0	100.0	0.0	0.0
18	0.0	76.9	78.3	58.1	57.0	73.4	0.0	0.0
19	0.0	28.9	19.7	18.0	34.9	7.0	0.0	0.0
20	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0
24	0.0	0.0	2.5	0.0	25.0	0.0	0.0	0.0

Table 52: Logger Profile Summary

This analysis concluded that this fixture operates 3,304 hours per year. For significantly sized spaces or broad space definitions (such as 'private offices'), we over-sampled lighting fixtures by deploying multiple lighting loggers and averaged the hourly usage of such loggers to incorporate fixture diversity.

There were some occupancy sensors installed among the sampled sites in the study. The loggers for these controls were analyzed on a case-by-case basis, with determinations made by the auditor on the pre and post hour reduction through an assessment of site contact reported operating hours and the logger data itself. For example, if a site contact reported that an offices hours were 9am to 5pm and the data on a fixture controlled by a sensor showed the light going on around 9am with multiple on/off transitions throughout the day that decreased the actual hours of operation to 5 hours a day, the 8 hours per day would be used as the pre-sensor hours and 5 hours a day would be used as the post sensor hours.

Non-Interactive On-Site Savings

Table 53 represents the on-site post-retrofit condition as found by the evaluating engineer. For this example, the engineer identified 20 2F59SSL fixtures installed, which was four less than the amount of fixtures listed in the project documentation. A logger identification number ("1" in this example) maps the hours of operation into this spreadsheet.

ONSITE: POST-RETROFIT CONDITION							
Quantity	Fixture Code	Description	Fixture Type	W/Fixt	Logger Number	Hours of Operation	Measure Life
20	2F59SSL	2L8' T8/ELIG LOW	EIGHT FOOT T8 SYSTEMS	100	1	3,304	15

Table 53: On-Site Post-Retrofit Condition

The on-site pre-retrofit condition was established through review of project documents, discussion with facility personnel, and observational inference. This lighting fixture savings analysis presumes that operating hours did not change between the pre- and post-retrofit condition, as shown in Table 54.

ONSITE: PRE-RETROFIT CONDITION					
Quantity	Fixture Code	Description	Fixture Type	W/Fixt	Hours of Operation
20	2F96SES	2L8' EE/STD	EIGHT FOOT FLUORESCENT SY	138	3,304

Table 54: On-Site Pre-Retrofit Condition

Table 55 presents the adjusted gross on-site savings for this example.

ONSITE SAVINGS	
kW Savings	kWh Fixture Savings
0.760	2,511

Table 55: Adjusted Gross On-Site Savings

The on-site savings quantities were calculated according to the following formulae:

$$\text{ONSITE KWH SAVINGS} =$$

$$\left(\frac{\text{Onsite Quantity}_{Pre} \text{ x Onsite Watts}_{Pre} \times \text{Onsite Hours}_{Pre}}{1{,}000}\right)$$

$$-\left(\frac{\text{Onsite Quantity}_{Post} \text{ x Onsite Watts}_{Post} \times \text{Onsite Hours}_{Post}}{1{,}000}\right)$$

$$= \left(\frac{20 \times 138 \times 3{,}304}{1{,}000}\right) - \left(\frac{20 \times 100 \times 3{,}304}{1{,}000}\right) = 9{,}119 - 6{,}608 = 2{,}511 \text{ kWh}$$

The lifetime savings were calculated by multiplying the onsite kWh savings by the measure lifetime as defined by the project paperwork.

kWh Adjustment Factors

Adjustment factors demonstrate which computational inputs were influential in the difference between the gross tracking system estimate and adjusted gross on-site estimate. The adjustment factors are computed using series hypothesis logic. Since multiple parameters influence the on-site savings computation, we calculate the influence of individual adjustment factors by changing only one parameter at a time. The sequence of computation matters, and RLW computes Technology first, then Quantity, then Operation factors.

Table 56 presents the energy (kWh) adjustment factors.

KWH ADJUSTMENTS		
Technology kWh Adjustment	Quantity kWh Adjustment	Hours kWh Adjustment
0	-537	-177

Table 56: kWh Adjustment Factors

The Technology Adjustment employs an on-site savings scenario in which only the watts/fixture reflects the observed on-site condition:

$$\begin{aligned}\text{TECH KWH ADJ} &= \left(\frac{\text{Tracking Quantity}_{\text{Pre}} \text{ x Onsite Watts}_{\text{Pre}} \text{ x Tracking Hours}_{\text{Pre}}}{1{,}000}\right)\\ &-\left(\frac{\text{Tracking Quantity}_{\text{Post}} \text{ x Onsite Watts}_{\text{Post}} \text{ x Tracking Hours}_{\text{Post}}}{1{,}000}\right)\\ &-(\text{Revised Tracking kWh Savings})\\ &=\left(\frac{24 \text{ x } 138 \text{ x } 3{,}536}{1{,}000}\right)-\left(\frac{24 \text{ x } 100 \text{ x } 3{,}536}{1{,}000}\right)-3{,}225\\ &=11{,}711-8{,}486-3{,}225=0\text{ kWh}\end{aligned}$$

The Quantity Adjustment proceeds to modify both the on-site wattage and quantity:

$$\begin{aligned}\text{QTY KWH ADJ} &= \left(\frac{\text{Onsite Quantity}_{\text{Pre}} \text{ x Onsite Watts}_{\text{Pre}} \text{ x Tracking Hours}_{\text{Pre}}}{1{,}000}\right)\\ &-\left(\frac{\text{Onsite Quantity}_{\text{Post}} \text{ x Onsite Watts}_{\text{Post}} \text{ x Tracking Hours}_{\text{Post}}}{1{,}000}\right)\\ &-(\text{Revised Tracking kWh Savings})-(\text{TECH ADJ})\\ &=\left(\frac{20 \text{ x } 138 \text{ x } 3{,}536}{1{,}000}\right)-\left(\frac{20 \text{ x } 100 \text{ x } 3{,}536}{1{,}000}\right)-3{,}225-0\\ &=9{,}760-7{,}072-3{,}225-0=-537\text{ kWh}\end{aligned}$$

The Operational Adjustment is inclusive of all on-site observations, modifying the on-site wattage, quantity, and operating hours:

$$\begin{aligned}\text{OPER KWH ADJ} &= \left(\frac{\text{Onsite Quantity}_{\text{Pre}} \text{ x Onsite Watts}_{\text{Pre}} \text{ x Onsite Hours}_{\text{Pre}}}{1{,}000}\right)\\ &-\left(\frac{\text{Onsite Quantity}_{\text{Post}} \text{ x Onsite Watts}_{\text{Post}} \text{ x Onsite Hours}_{\text{Post}}}{1{,}000}\right)\\ &-(\text{Revised Tracking kWh Savings})-(\text{TECH ADJ})-(\text{QTY ADJ})\\ &=\left(\frac{20 \text{ x } 138 \text{ x } 3{,}304}{1{,}000}\right)-\left(\frac{20 \text{ x } 100 \text{ x } 3{,}304}{1{,}000}\right)-3{,}225-0-(-537)\\ &=9{,}119-6{,}608-3{,}225-0+537=-177\text{ kWh}\end{aligned}$$

Any adjustments due to the use of controls like occupancy sensors were calculated as operational adjustments as a separate line item in the savings calculation spreadsheet. This was done to isolate the occupancy sensor savings from any retrofit savings associated with a change of fixture.

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. For each line item of the lighting retrofit, evaluators choose the type of "Space Heating and Cooling" from a pull down menu: "Heat Only", "Cool Only" or "Heat and Cool."

Interactive Heating "Penalty"

Table 57 shows the heating interaction for this example.

HEATING INTERACTION				HEATING PENALTY
Space Heating and Cooling	Percent Of Space Heated	Fuel Type	Heating System Type	Heating MBTU's Penalty
Heat and Cool	100%	Natural Gas	Warm Air	(3,749)

Table 57: Heating Interaction

Next, the user inputs the percent of the space that is heated. The "Fuel Type" is selected as a pull down including the following choices:

1 Electric
2 Fuel Oil #2
3 Fuel Oil #6
4 Natural Gas
5 Propane

The "Heating System Type" is then selected as a pull down including the following choices:

1 Air to Air Heat Pump
2 Electric Resistance
3 Hot Water Boiler
4 Infrared
5 Steam Boiler
6 Warm Air
7 Water to Air Heat Pump

The "Heating MBTU Penalty" is calculated according to the following equation:

$$\text{Heating MBTU Penalty} =$$
$$\text{ONSITE KWSAVINGS} \times 0.7 \times (\text{\% of Space Heated}) \text{ x ONSITE HOURS} \times \left(\frac{7.5}{12}\right) \times 3.413$$

where

0.7 is the percent heat gain to space

3.413 is the BTU/kWh conversion factor

$\frac{7.5}{12}$ is the fraction of heating months per year

$$\text{Heating MBTU Penalty} = 0.760 \times 0.7 \times 100\% \text{ x } 3{,}304 \times \left(\frac{7.5}{12}\right) \times 3.413 = -3{,}749 \text{ MBTU}$$

As this space was heated via natural gas, the electric heating interaction for this example is zero. If the "Fuel Type" had been "Electric", the electric heating interaction would have been computed as follows:

$$\text{Electric Heat kWh} = \frac{\text{Heating MBTU Penalty}}{3.413}$$

The energy consumption of the heating system is a function of system efficiency. The Electric Heating System efficiency was taken from the lookup table based on the type of cooling system employed on-site. Table 58 presents the default system efficiencies used in the interactive calculations.

HEATING	
Air to Air HP	1.50
Elec Resistance	1.00
Water to Air HP	2.80

Table 58: Heating System Efficiency Lookup Table

Interactive Cooling "Credit"

Table 59 shows the cooling interaction for this example. The first column is where the user inputs the percent of the space that is cooled. The "Cooling System Type" is selected as a pull down including the following choices:

1 Packaged DX
2 Window DX
3 Chiller < 200 Ton
4 Chiller > 200 Ton
5 Air to Air Heat Pump
6 Water to Air Heat Pump
7 Refrigerated Area

COOLING INTERACTION		COOLING BENEFIT		
Percent Of Space Cooled	Cooling System Type	Cooling MBTU's Savings	Electric Cooling kW	Electric Cooling Savings
100%	1 Packaged DX	2,249	0.17	216

Table 59: Cooling Interaction

If either the selected space was "Heat and Cool" or "Cool Only", the cooling MBTU savings are calculated as follows:

$$\text{Cooling MBTU Savings} =$$
$$\text{ONSITE KWSAVINGS} \times 0.7 \times (\text{\% of Space Cooled}) \text{ x ONSITE HOURS} \times \left(\frac{4.5}{12}\right) \times 3.413$$

where

0.7 is the percent heat gain to space

3.413 is the BTU/kWh conversion factor

$\frac{4.5}{12}$ is the fraction of cooling months per year

$$\text{Cooling MBTU Savings} = 0.760 \times 0.7 \times 100\% \text{ x } 3{,}304 \times \left(\frac{4.5}{12}\right) \times 3.413 = 2{,}249 \text{ MBTU}$$

For electrically cooled spaces, the interactive cooling "credit" was computed as follows:

$$\text{Electric Cooling kWh} = \frac{\text{Cooling MBTU Savings}}{12} \times \text{Cooling System Efficiency kW/Ton}$$
$$= \frac{2{,}249}{12} \times 1.15 = 216 \text{ kWh}$$

The energy consumption of the cooling system is a function of system efficiency. The Cooling System Efficiency was taken from the lookup table based on the type of cooling system employed on-site. Table 60 presents the default system efficiencies (kW/ton) used in the interactive calculations. When available and notably different from the calculation defaults, evaluators would override the lookup table and input the site-specific cooling efficiencies.

COOLING	
1 Packaged DX	1.15
2 Window DX	1.30
3 Chiller <200 Ton	0.75
4 Chiller >200 Ton	0.67
5 A to A HP	0.90
6 W to A HP	0.80
7 Refrig Area	2.45

Table 60: Cooling System Efficiency kW/Ton Lookup Table

Appendix C: Site Level Lighting Information by Utility from Sample

NHEC

Site ID	Facility Type	# of Shifts	Verified kWh Savings	Assumed Full Load Equivalent Hours	On-site Full Load Equivalent Hours
NHEC1	Auto Repair	1	2,837	3,640	2,360
NHEC2	Retail	1	6,620	3,376	5,284
NHEC3	Dairy Farm	3	3,047	1,937	1,511
NHEC4	Office	1	18,239	2,025	2,388
NHEC5	Hotel	3	8,793	3,017	3,365
NHEC6	School	1	81,694	2,792	2,588
NHEC7	Office	3	394	2,210	2,559
NHEC8	Restaurant	2	3,480	3,489	2,751
NHEC9	Hotel	3	3,604	8,760	6,565
NHEC10	Hotel	3	3,530	1,577	4,007
NHEC11	Retail	1	21,381	4,475	4,732
NHEC12	Dentist Office	1	5,729	2,470	2,339
NHEC13	Car Dealership	1	13,483	4,368	3,636
NHEC14	Movie Rental Store	2	6,541	4,904	5,086
NHEC15	Hair Salon	1	1,342	2,652	3,947
NHEC16	Movie Rental Store	2	6,017	4,436	4,273
NHEC17	Hotel	3	17,353	3,415	3,849
NHEC18	Town Offices	1	7,796	2,469	1,832
NHEC19	Florist	1	8,004	2,470	2,961
NHEC20	School	1	37,605	2,437	2,573

PSNH

Site ID	Facility Type	# of Shifts	Verified kWh Savings	Assumed Full Load Equivalent Hours	On-site Full Load Equivalent Hours
PSNH1	Manufacturing	1	79,918	2,122	2,962
PSNH2	School	1	54,941	2,365	2,463
PSNH3	Residence	3	31,612	5,683	6,132
PSNH4	School	1	24,509	3,779	3,606
PSNH5	Retail	1	6,407	6,649	5,109
PSNH6	Bank	1	12,944	3,737	3,973
PSNH7	Office	0	-	3,715	-
PSNH8	Veterinary Hospital	1	25,226	5,930	3,560
PSNH9	School	1	22,626	2,008	2,335
PSNH10	Recreation Center	1	21,130	4,160	3,102
PSNH11	Town Office	1	352	2,080	1,631
PSNH12	Recreation Center	1	19,262	2,199	2,319
PSNH13	Town Offices	1	15,059	2,748	2,441
PSNH14	Retail	2	61,470	4,194	4,568
PSNH15	Retail	1	24,880	2,011	2,138
PSNH16	Town Garage	2	16,730	1,045	926
PSNH17	Office	1	10,747	1,293	1,592
PSNH18	Manufacturing	1	13,784	2,857	2,650
PSNH19	Manufacturing	1	26,428	2,311	2,360
PSNH20	School	1	48,162	3,352	2,712
PSNH21	Office	1	31,756	2,641	3,412
PSNH22	Manufacturing	1	19,204	3,173	3,345
PSNH23	Retail	1	3,356	2,600	3,196
PSNH24	Auto Sales	1	61,211	3,691	4,285
PSNH25	School	1	34,362	2,594	4,044
PSNH26	Office	1	3,034	2,601	1,710
PSNH27	School	1	25,871	2,214	1,993
PSNH28	School	2	5,568	3,120	2,520
PSNH29	Office	1	2,233	2,000	1,658
PSNH30	Recreation Center	2	11,111	4,732	2,529
PSNH31	Recreation Center	2	37,543	2,817	3,000
PSNH32	Liquor Store	2	28,048	5,442	5,352
PSNH33	Residence	3	58,007	5,037	4,834
PSNH34	School	1	31,995	2,669	2,432
PSNH35	Manufacturing	1	56,914	2,615	3,573
PSNH36	School	1	66,278	3,249	2,790
PSNH37	Retail	1	26,679	4,445	4,465
PSNH38	Retail	1	26,874	3,211	2,939
PSNH39	Residence	1	12,593	7,764	7,783
PSNH40	School	1	52,531	5,600	2,189
PSNH41	Town Offices	1	52,055	2,719	2,650
PSNH42	Retail	1	15,076	2,963	2,664
PSNH43	Post Office	1	4,029	4,160	3,369
PSNH44	Residence	1	13,294	2,000	1,231
PSNH45	Residence	1	28,181	2,479	2,038

Unitil

Site ID	Facility Type	# of Shifts	Verified kWh Savings	Assumed Full Load Equivalent Hours	On-site Full Load Equivalent Hours
Unitil1	Office	1	23,302	1,999	2,184
Unitil2	Residence	3	68,479	7,243	6,747
Unitil3	Retail	2	57,189	3,640	5,177
Unitil4	Auto Supply	2	70,134	3,606	3,408
Unitil5	Auto Sales	1	10,802	3,600	4,220
Unitil6	Office	1	43,889	2,754	3,078
Unitil7	Office	1	25	2,340	148
Unitil8	Office	1	101,687	2,721	3,009
Unitil9	Office	1	48,262	3,259	2,969
Unitil10	Retail	1	7,461	2,096	3,020
Unitil11	Office	2	10,188	3,936	2,867
Unitil12	Auto Sales	1	36,258	3,512	3,706
Unitil13	Auto Sales	1	31,496	3,387	3,834
Unitil14	Auto Sales	1	58,936	3,389	6,223
Unitil15	Manufacturing	2	29,388	2,532	3,230
Unitil16	Library	2	34,683	2,642	3,230
Unitil17	Office	1	1,110	2,132	2,644
Unitil18	Greenhouse - Retail	2	9,188	2,185	2,738
Unitil19	Office	1	20,882	3,326	3,265
Unitil20	School	1	9,690	2,450	3,882
Unitil21	Laundromat	2	7,805	4,965	6,027
Unitil22	Hotel	3	20,260	8,619	4,838
Unitil23	Town Offices	1	42,421	2,224	2,497
Unitil24	Fire Dept	3	10,774	2,430	2,550
Unitil25	Fire Dept	3	10,800	5,382	5,082
Unitil26	Town Garage	1	3,566	7,732	3,876
Unitil27	Auto Sales	2	44,788	3,482	3,609
Unitil28	School	1	29,481	3,055	3,181