

New Hampshire Utilities

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

Final Report

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Prepared by



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Impact Evaluation**

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

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)								Grand Total
	Air Comp.	HVAC	Refrigeration	Process	Custom	Lighting	Motors	VFD	
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.

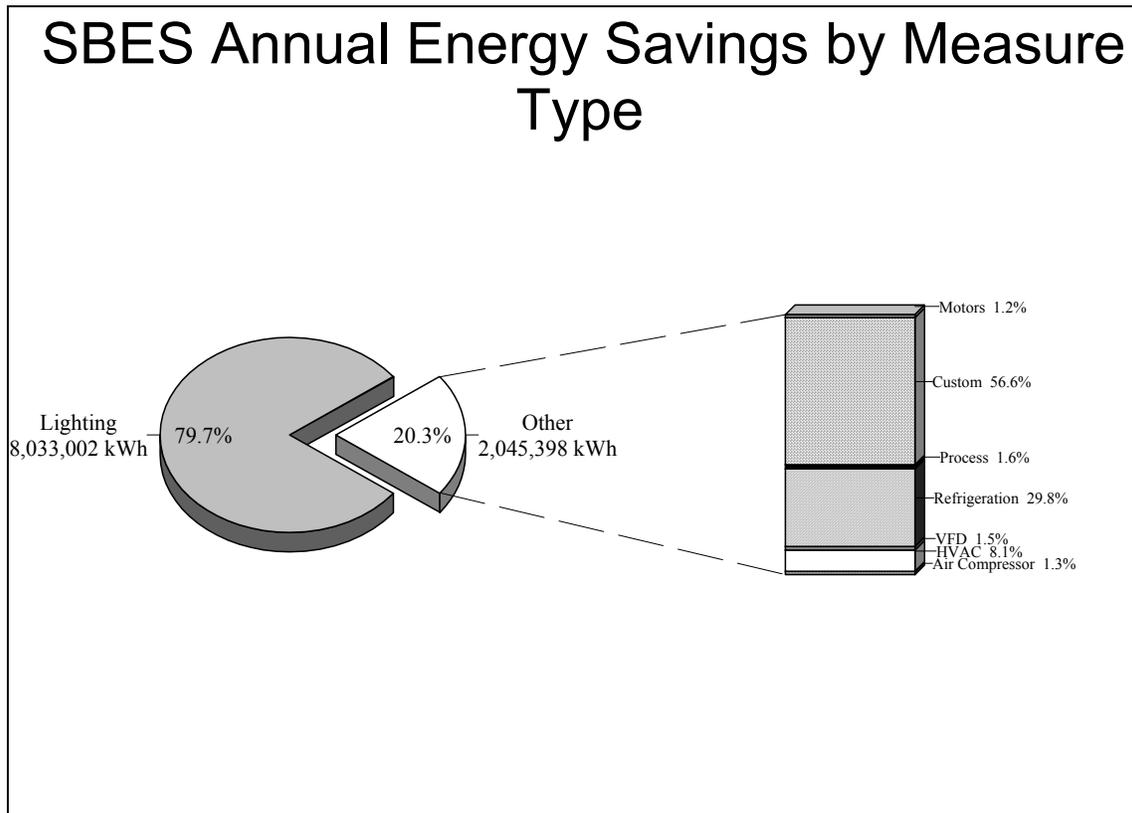


Figure Ex- 1: SBES Annual Savings by Measure Type

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 $\pm 10\%$ 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 $\pm 10\%$ 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.

UTILITY	Annual Savings			
	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/NLP/IP/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.